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The evolution of cluster initiatives in Russia: the impacts of policy, life-time, proximity and innovative environment

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Abstract

Purpose – *This paper aims at assessing the impacts of the national cluster policy, cluster age, cluster development benchmarks of neighbouring regions and the cumulative level of regional innovative capacity on the quantity and quality of cluster initiatives in Russia.*

Design/methodology/approach – *Hypotheses' testing was carried out by a series of calculations comparing the qualitative and quantitative characteristics of cluster initiatives; the number of new cluster initiatives to the number of neighbouring regions, where cluster initiatives had begun to develop earlier; and ranks of regions within the Russian regional innovation scoreboard to the quantity and quality characteristics of cluster initiatives therein.*

Findings – *The results of the study empirically confirm that the national cluster policy significantly influenced the emergence and advancement of cluster initiatives in Russia. The proximity to the regions, having previously launched cluster support programmes, also had an impact on the emergence of new cluster initiatives. The cluster initiatives' age had an ambiguous effect on their performance. Finally, the level of regional innovative capacity was correlated only with the number of cluster initiatives localised therein.*

Practical implications – *The findings show that along with the direct effects of the national cluster policy for the government-supported clusters, there are positive externalities, e.g. the emergence of new cluster initiatives throughout the country.*

Originality/value – *The research database of 277 cluster initiatives has been drawn up as a part of the first national cluster mapping and covers almost a decade of clustering activity in Russia. The study analyses not only the cluster initiatives supported by the federal government but also those developed independently.*

Keywords *Russia, Regions, Cluster policy, Cluster initiative, Cluster Map of Russia, Russian regional innovation scoreboard*

Paper type *Research paper*

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Introduction

The emergence of clusters in the economy had begun long before the respective term appeared and the theoretical concept was developed. Almost a century ago, A. Marshall described the so-called localised industry in relation to the pre-industrial era in detail, which "gradually prepared the way for many of the modern developments of division of labour" (Marshall, 1920, pp. 268-269). Most of the existing clusters did not occur in a vacuum: their genesis could be traced to the industries of modern age. Take, for example, the production of ceramic tiles in the Italian town of Sassuolo, which arose in the sixteenth century on the basis of high-quality local clay mining. Even though the clay deposits have long been exhausted, Sassuolo remains the centre of ceramics thanks to the engineering experience of its local masters. The vast beech groves of High Wycombe in southern England fostered the emergence of furniture manufacturing firms since the seventeenth century. The sources of iron ore in the UK, Germany, Italy, France and Poland stimulated the development of the

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steel industry, which, in turn, created the basis for future high-tech specialisations in medical engineering, the production of weapons, machine tools, metal manufacturing, etc. (Marsh, 2012). The term cluster was first used only in the 1970s to describe the geographical concentration of value chains and institutions (Czamanski and de Albas, 1979; Gorkin and Smirnyagin, 1979). Today, "close to 50 per cent of European employment are in economic sectors that 'cluster' and in these sectors, productivity and patenting are significantly higher than in the average of the economy" (Ketels, 2014, p. 3). US statistics also shows that clusters in traded industries provide 36 per cent of employment, 50 per cent of income and 96.5 per cent of patents in the national economy (Harvard Business School, 2014).

Since the mid-1990s, cluster initiatives have begun to appear, which are defined as "organised efforts to increase the growth and competitiveness of a cluster within a region involving cluster firms, government and/or research community" (Sölvell *et al.*, 2003, p. 31). A survey conducted in 2003 revealed 509 cluster initiatives worldwide. In 2013, the second round of the study resulted in identification of 2,580 cluster initiatives around the globe (Lindqvist *et al.*, 2013).

In the past two decades, governmental bodies have come into action in terms of cluster identification and development. Gradually, cluster policy has become one of the most important elements of innovation and industrial policies in a number of countries, while remaining a subject of debate. There is still no consensus as to whether cluster policy is *per se* a management tool of the public authorities (i.e. without bottom-up cluster initiatives) or whether it should focus on the support of cluster initiatives by co-financing cluster organisations and the joint projects of cluster members (Andersson *et al.*, 2004).

The first approach is fraught with the risks of inefficiency, as it reproduces the logic of the traditional industrial policy. There is a layer of research proving the low productivity and even the harm of top-down clustering induced by the government (Desrochers, 2011; Duranton, 2011). Typical errors of such governmental intervention are the mismatch of regulatory measures and existing problems, excessive emphasis on the spatial location instead of improving the macroeconomic environment or encouraging more intensive interactions, erroneous prioritisation or selection of support recipients, interception of governmental benefits by groups with special interests, etc. (Kutsenko, 2012). However, such an approach might be appropriate in the cases of industrialising countries where the regulatory role of the government is high (e.g. China, Vietnam and earlier – South Korea) (Mathews and Cho, 2007).

In the second approach, the cluster policy aims at overcoming so-called systemic failures. They occur when there is "a mismatch or inconsistency between these interrelated institutions, organisations, market conditions, or playing rules" (Andersson *et al.*, 2004, p. 51). This approach is typical, above all, for the European Union (EU), Russia and Latin America, and is gradually spreading among the developing countries, supplied with detailed guides of international organisations (World Bank, 2009). In recent years, cluster policy in EU countries has been under the process of change towards the support of emerging industries (European Cluster Observatory, 2012, 2015; Ketels and Protsiv, 2014; Christensen *et al.*, 2012). The role of cluster initiatives is therefore to accelerate industrial transformation, overcoming the locked-in effects. They can be "effective innovation intermediaries", capable of ensuring the continuity of social communication, leading to the growth of trust between cluster members, the innovative activity and sharing of knowledge (Wise, 2014). Cluster initiatives are able to organise the professional community, which, in turn, starts to provide additional expertise of new ideas and solutions. One of the potential functions of cluster initiatives is to provide feedback from business to policymakers. As noted by the World Bank (2009, p. 5), "dense network of domestic firms can compensate for potential negative side effects of policy reforms". Cluster initiatives enable the establishment of strategic public–private partnerships, which are "critical to ensure that

such a strategy is consistent with the views of companies and thus able to mobilise their actions" (Ketels, 2013, p. 278).

In recent years, the number and quality of cluster initiatives have grown visibly in Russia. Since 2008, 277 cluster initiatives in total have been identified, some of them have already vanished, and others emerged only over the past three years. Twenty-seven cluster initiatives were selected in 2012-2016 for the provision of federal government subsidies within the pilot innovative cluster support programme in Russia (hereinafter – PIC).

Several studies (Menzel and Fornahl, 2007; Sölvell, 2009) highlight the existence of cluster life cycles, which have evolved over decades, while cluster initiatives are addressed as public policy instruments to accelerate or adjust the natural dynamics (World Bank, 2009, p. 67). However, there is empirical evidence which claims that cluster initiatives are network structures with their own economic logic and life cycle, often outside the cluster policy context.

So the key question of the study is what affected the emergence of cluster initiatives and their development in Russia? Was it the national cluster policy that encouraged further clustering and the evolution of cluster initiatives? Or, were there other factors: the age of cluster initiatives (which had emerged before the federal government began to pursue a targeted cluster policy), or the successful cluster policy benchmarks in neighbouring regions, or the accumulated innovative capacity in regions (which ensured a favourable environment for the emergence and development of cluster initiatives therein)? These questions are of practical interest. If the increased number of cluster initiatives in recent years is an effect of the federal government programme to support PICs, this fact becomes a very important rationale for the national cluster policy. The more cluster initiatives emerge (especially if they are not supported directly by the government, or have a large share of private funding), the more effectively systemic failures are solved. That is, the intensive interaction of various members (from multinational corporations to small and medium-sized enterprises [SMEs], universities and R&D institutions, public authorities) ensures better technology transfer, infrastructure use, more joint investments and innovative projects. The efficiency of the future cluster support programmes in turn depends on the quantity and quality of participating cluster initiatives. Competition is an important factor for the selection of the best cluster initiatives – the ones that are able to contribute to the industrial transformation, the emergence of future markets and industries. There are benchmarks of leading countries where the allocation of public support is based on cluster initiatives' contests (BMBF, 2006).

The article is made up of six sections. The first section provides an overview of the relevant literature, the second section describes Russian cluster landscape and provides a more in-depth empirical research context, the third section reveals the research databases and methodology and the fourth section presents the results of hypotheses' testing. Implications for policy and practice are in the fifth section. We summarise the main ideas and challenges for future studies in the sixth section.

Literature review

The intense emergence of cluster initiatives around the world has not been followed up by a proportionate increase in their evaluation. The "Redbook" express survey of 50 clusters and cluster organisations from 17 countries revealed that only 10 per cent of the respondents conducted efficiency measures of cluster development programmes (Sölvell, 2009, p. 88). The problem of cluster evaluation is associated with the complexity of a cluster as the object of study (i.e. the set of companies, cluster management organisation, joint projects of cluster members), various activities performed within a cluster (manufacturing, R&D, innovation, marketing, HR development, networking, internationalisation, government relations, fundraising, etc.) as well as external factors (business environment, industrial

cycles, the impact of public policies and support activities). World Bank (2009, p. 4) experts describe cluster initiatives as implying "a comprehensive assessment of a cluster's markets, products, linkages, externalities, and synergies to help identify regulatory and business constraints, tap new and wider market opportunities, and develop sound business strategies to tackle its main competitors".

The existing cluster assessment systems are primarily focused on evaluating clusters as industries, rather than networks – i.e. the actual cluster initiatives. Such methodologies include the identification and analysis of areas with the highest potential for clustering in the regional context. Among them, in particular, it is worth noting US cluster mapping, supervised by Porter (2003) (Delgado *et al.*, 2016; Harvard Business School, 2014) and the cluster mapping project of the European Cluster Observatory (2016). The first steps to identify priority areas for cluster development based on the European Cluster Observatory methodology (first edition) were taken by Russia in 2010 (Kiselev *et al.*, 2011). However, the statistical approach to cluster evaluation has several limitations. Not all of the cluster features can be identified in such a way. Moreover, the revealed statistical categories of the region are just the areas with the highest potential for cluster development, but not the clusters as such.

In addition to statistical projects, there are several databases of cluster initiatives (European Cluster Observatory, 2016; European Platform for Cluster Collaboration, 2016a; TCI Network, 2016) and relevant monitoring projects (Lindqvist *et al.*, 2013; Müller *et al.*, 2012), which allow for issues concerning the impact of various factors on the emergence of cluster initiatives and improvement to be raised. The results of these research projects indicate a high share of public funding and activity in the establishment of cluster initiatives: 32 per cent and 41 per cent of the latter were established under the influence of cluster policy in 2003 and 2013, respectively (Sölvell *et al.*, 2003, p. 39; Lindqvist *et al.*, 2013, p. 19). It is also noted that the cluster initiative at an early stage of its development is largely dependent on public funding. At the same time, the hypothesis that the share of public funding should have declined over time (Sölvell *et al.*, 2003, p. 54) was not confirmed. On the contrary, in 2013, a pool of public-funded cluster support programmes was launched and their importance has not decreased so far (Lindqvist *et al.*, 2013, p. 52). At the same time in these studies, we found sparse evidence for cluster policy affecting cluster initiatives, which had not received any public funding. One of the few relevant sources is the German study of 421 cluster initiatives which were unable to win the InnoRegio programme contest (out of 444 applications). Nevertheless, 40 per cent of the cluster initiatives with rejected applications still exist and are implementing their projects. Among them, 61 per cent received public funding as part of other programmes; another 39 per cent had no demand for it (Eickelpasch and Fritsch, 2005). Moreover, employment within the cluster initiatives' members that participated in the InnoRegio programme increased by 11 per cent from 2000 to 2004. Slightly less than half of them (44 per cent) were able to apply for patents, and 40 per cent were able to make new products (BMBF, 2006).

In addition to financial support measures, cluster initiatives can improve their quality over time, involving new members, establishing management organisations and so on. According to the cluster management assessment approach, developed by the European secretariat for cluster analysis, the minimum requirement for a cluster organisation is existence for at least two years (Hagenauer *et al.*, 2011, p. 2). The "Greenbook" study also showed that the age of a cluster initiative is important. There is a positive correlation between the cluster initiative's maturity and its sustainability (i.e. the increase in international competitiveness, employment growth, the creation of new firms, technology development) (Sölvell *et al.*, 2003, p. 53-55). However, there is a hypothesis that the cluster initiative's age is associated with the life cycle of the cluster: the initiative emerges at the growth and maturation stages. As there are many clusters that have existed for decades and even centuries, gradually transforming their specialisation, their actual effectiveness

depends on the life cycle stage (INNO Germany AG, 2010, pp. 31-32). In some cases, a cluster can become a "museum" due to excess concentration, superabundant policy intervention aimed at rescuing and funding companies or radical technological and market shifts caused by the activity in other clusters (Sölvell, 2009, p. 17) that do not stimulate economic activity, but, on the contrary, constrain it. Studies have shown that the economic benefits generated by a cluster are not permanent, and often the decline is caused by the same factors, which fostered cluster progress in the past (Menzel and Fornahl, 2007, p. 2).

Another factor that affects the emergence and development of cluster initiatives could be the inter-regional transfer of competencies and public policy instruments. The hypothesis in this case is that neighbouring regions compete with each other for human capital, firms and the ability to receive benefits from the national government, which makes regional authorities copy successful or simply fashionable policies from each other. For example, in Silva and Yamaguchi (2010, p. 219), we find that "competing regional governments may not only provide public goods that generate transboundary spill-overs efficiently, but also implement inter-regional transfers to each-other so that a socially efficient population distribution is obtained". If this hypothesis is correct, then "spikes" in the clustering activity are more likely to be caused by the inter-regional transfer of cluster support measures and benchmarking against neighbouring regions with fruitful clustering, rather than by the national cluster policy. The academic literature describes various effects produced by neighbouring regions on each other. Territorial proximity may not always coincide with institutional or organisational relatedness, or take into account administrative boundaries (Gordon and McCann, 2005; Hamilton *et al.*, 1994; Boschma, 2005). Ramajo *et al.* (2008) showed that the level of gross regional product (GRP) per capita, employment rate and even the shares of agricultural employment in neighbouring regions influence the process of convergence of a given region (in terms of EU Cohesion policy). Anselin *et al.* (1997) and Acs *et al.* (2002) provide evidence of knowledge spill-overs in university research between neighbouring metropolitan statistical areas in the USA based on a spatial econometric analysis. Our hypothesis is also rooted in the idea of an "innovative cross" in Europe. It says that the regions – leading innovators and strong innovators – border each other, shaping a cross (European Commission, 2015). Based on a comparative analysis of citing patents in closer or more distant regions, Maurseth and Verspagen (2002) prove the existence of regional groups in Europe with a high and low level of technological development .

Finally, the third independent condition positively affecting the emergence and advancement of cluster initiatives could be the cumulative innovative capacity of their home regions. We presume that a gradual (over decades) increase of regional innovative development can result in ensuring a more favourable environment for the evolution of cluster initiatives. There are empirical studies that show links between regional innovation level (often measured by the relative number of patents) and the number of statistical clusters or their performance (Porter, 2003; Lindqvist, 2009; Sölvell, 2009; Ketels and Protsiv, 2014). Lindquist tested a hypothesis about the influence of regional clustering on three variables reflecting innovation activity: patent applications per one million employees, the share of private R&D expenditures in the GRP and the share of public R&D expenditures in the GRP. And he found a positive effect for the first two variables (Lindqvist, 2009 p. 236). Sölvell's (2009, p. 35) study also discovered a correlation between the number of clusters and the level of patent activity in European regions. Ketels and Protsiv (2014, p. 17) showed the relationship emerging through the concentration of industries in regions with the most favourable conditions for innovation, the number of patents per capita and per employee in S&T sectors and the number of SMEs that have implemented innovations. Chatterji *et al.* (2014, p. 143) indicate a strong asymmetry in the spatial distribution of innovative activity: "entrepreneurship and innovation are even more spatially concentrated than general industry". There is empirical research proving that heterogeneity of regions in EU countries by scientific sector efficiency is much higher than by level of production efficiency (Foddi and Usai, 2013).

Typically, the connection between regional innovative level and level of cluster development is interpreted as the influence of the latter on the former. However, this connection can turn vice versa. Firstly, as already noted, innovation activity is unevenly distributed in space: there are areas with clear "cluster-like" concentration (OECD, 2011, p. 19; Cheshire and Malecki, 2004; Crescenzi *et al.*, 2007). Secondly, the level of innovation development is the apex of numerous conditions (infrastructure, business environment, human capital, even the tolerance culture, etc.; Florida, 2002) that are being formed over a long period. As cluster initiatives (not clusters) began to emerge relatively recently, they could not have become the origin of the accumulated innovation development level in regions. For example, in a number of studies, it was shown that the Russian PICs were located mainly in the regions with a high level of innovation development (Bortnik *et al.*, 2015). Aside from the aforementioned fragmentary evidence, the link between the level of regional innovation development and the qualitative/quantitative characteristics of cluster initiatives has not yet been thoroughly tested.

The present article is devoted to developing a complex insight into the emergence of cluster initiatives and their evolution based on the case of Russia. It tests the following four hypotheses:

H1. The quantity and quality of Russian cluster initiatives are influenced by the federal policies (the PIC support programme).

H2. The quantity and quality of cluster initiatives in Russia are influenced by the neighbouring regions, where cluster support programmes have previously been launched.

H3. The quality of cluster initiatives in Russia depends on the duration of their existence.

H4. The quantity and quality of cluster initiatives in Russia are influenced by the cumulative innovative capacity of their home regions.

The deficiency of the existing relevant studies is primarily related to the lack of information about cluster initiatives. In particular, these limitations concern:

- *The timeline of the cluster initiatives analysis*: Müller *et al.* (2012) presented the data on clusters from 2010 to 2012. Lindqvist *et al.* (2013) examined cluster initiatives over a decade; however, at each time interval (2003 – 2005 – 2012), different samples were surveyed.
- *The lack of data distinguishing the cluster initiatives supported by public funding and effects of such an influence*: Only in one study, we found that in the cluster initiatives funded mainly by the government, there were more members, and those cluster initiatives were more likely to have a development strategy (Müller *et al.*, 2012, pp. 24-25).
- *The validity of data sources*: Some of them were based on the surveys, reflecting the views of cluster managers, interested in high-efficiency assessment ranks of clusters under their supervision (Sölvell *et al.*, 2003; Lindqvist *et al.*, 2013).

The main feature of our study is the database on cluster initiatives that were identified in 2008, 2012 and 2015. The key data source is the Russian cluster mapping project, which presents extensive information about nearly 100 cluster initiatives (HSE, 2016a). The study has some other features. Firstly, it covers almost a decade of clustering activity in Russia during which cluster initiatives emerged, disappeared or transformed. Secondly, the study analyses not only government-supported cluster initiatives (PICs) but also those developed independently. So, we have an additional opportunity for comparison to study the impact of cluster policy intervention. Thirdly, the study is based on the data sources that are different from those used in "Greenbook" and "Greenbook 2.0". We do not collect or analyse data based on cluster managers' estimations of the cluster initiatives' effectiveness, or on their members' satisfaction with the level of cluster management. Our

assumption is that in a heterogeneous environment, such responses may significantly distort the reality, especially in cross-country comparisons. We analyse actual data (year of establishment, employment, the number of participants in cluster initiatives), which have no estimation features and are relatively easy to verify.

Empirical research context

Cluster initiatives in Russia are developing in line with the European approach, which implies the identification and support of localised concentrations of enterprises, intermediate organisations, R&D and educational institutions. Cluster initiatives are supervised by cluster management organisations, and their development perspectives are defined in specific strategic documents.

The basic principles of cluster policy in the Russian Federation were introduced in 2008 in the Long-Term Socio-Economic Development Strategy until 2020 (Government of the Russian Federation, 2008). It indicated the establishment of cluster initiatives in priority high-tech industries, raw materials processing and energy production sectors as one of the key factors ensuring the successful modernisation of the national economy and in competitiveness increase of the Russian regions. The support of cluster initiatives was among the key tools of the Strategy for Innovation Development until 2020 (Government of the Russian Federation, 2011).

Since 2010, the Ministry for Economic Development of Russia has been providing subsidies to regions for the establishment and support of cluster development centres (hereinafter – CDC). CDC is a legal entity referring to SME support infrastructure, which is established by regional authorities. The goals of these centres are to identify cluster initiatives and assist cooperation between cluster members (Government of the Russian Federation, 2014). CDCs provide consulting and various services to SMEs within cluster initiatives, such as marketing, PR and exhibition activities, business-planning, education and training. From 2010 to 2016, 1,062bn roubles (€20m)[1] were allocated, resulting in the establishment of 34 CDCs in 33 Russian regions. Some of them function as cluster management organisations, supervising around 80 cluster initiatives.

In 2012, the Ministry for Economic Development of Russia launched the PIC support programme, which has been the most large-scale national programme of that kind so far. It was a competition between cluster initiatives for co-funding from the federal budget. Twenty-five cluster initiatives were selected out of 94 initial applications; they were assigned the status of PICs (HSE, 2013). In subsequent years, the list of PICs was expanded to 27 cluster initiatives, including machine-building cluster of the Udmurt Republic and photonics cluster for fibre-optic technologies of the Perm region. In 2013-2015, the PIC home regions were granted subsidies from the federal budget totalling more than 5bn roubles (€87m). The subsidy expenditure was restricted to innovative infrastructure development, which accounted for about 70 per cent of funds allocated, as well as to co-financing training programmes and activities to facilitate foreign market entry by PIC members. The PIC support programme resulted in the increased investment activity of PIC home locations: every rouble of public funding spent on PICs (within the framework of various programmes) turned into 3.5 roubles of private investments with an overall volume of 360bn roubles in 2013-2015 (around €6bn).

As of 2014, all PICs[2] concentrated 1,900 firms and organisations with 580,000 employees. Total revenues of PIC members comprised 1,647.6bn roubles (€26.8bn), including 390.7bn roubles (€6.4bn) of export revenues. The volume of joint R&D projects (both domestic and international) totalled 26.3bn roubles (€43m). Meanwhile, PICs vary a lot in terms of the above-mentioned indicators. For example, in 2014, an average PIC concentrated 72 entities, while in the largest PIC, there were 297 members. Average revenues and export revenues of PIC members were 63.4bn roubles (€1.03bn) and 15bn

roubles (€0.24bn) accordingly compared to the largest PIC with 412.4bn roubles (€6.72bn) of revenues and 310.5bn roubles (€5.05bn) of export revenues.

Cluster initiatives in Russia have different proportions of R&D and industrial activities. Each PIC includes a university or other higher education institutions. There are three typical models of cluster initiatives regarding their composition, spatial affiliation, industrial and technological specialisation:

- the locations of the post-Soviet high-tech industry (e.g. aerospace, automotive and shipbuilding, petro chemistry and coal processing cluster initiatives in the city of Zheleznogorsk, the Bashkir and Tatar republics, Arkhangelsk, Kemerovo, Khabarovsk, Nizhny Novgorod, Perm, Samara, Ulyanovsk regions);
- the leading R&D and university centres (e.g. nuclear and radiation technologies, pharmaceutical and biotechnology, IT and microelectronics cluster initiatives in the cities of Dimitrovgrad, Dubna, Obninsk, Pushchino, Sarov, Troitsk and Zelenograd, the Novosibirsk and Tomsk regions); and
- the concentrations of innovative SMEs (e.g. IT, pharmaceutical and biotechnology cluster initiatives in Saint-Petersburg and the Altai region) (The Ministry for Economic Development of Russia, 2015).

The above-mentioned differences of PICs are due to the diversity of their key members. They can be:

- large industrial firms (e.g. JSC Academician M.F. Reshetnev "INFORMATION SATELLITE SYSTEMS" in nuclear and space pilot innovative cluster of the Krasnoyarsk region);
- SMEs (e.g. RUSSOFT Association in IT and space pilot innovative cluster of Saint-Petersburg);
- leading national research centres (e.g. institutes of the Russian Science Academy in Pushchino biotech pilot innovative cluster of the Moscow region);
- higher educational institutions (e.g. Moscow Institute of Physics and Technology in pharmaceutical, IT and new materials pilot innovative cluster of the Moscow region); and
- regional authorities (e.g. the regional ministry for economic development, investment and trade in aerospace pilot innovative cluster of the Samara region).

The increased number of cluster initiatives has led to the launch of new federal cluster support programmes. Currently, several Russian ministries are stepping up efforts to identify and support cluster initiatives. In 2016, the Russian Ministry for Industry and Trade launched the programme, which implied granting subsidies from the federal budget for the co-funding joint projects of cluster initiatives, operating in various industrial sectors. Seventeen cluster initiatives were included in the ministerial short list; five joint projects with an overall volume of 697m roubles (€15.15m) were approved for subsidising.

The emergence of cluster initiatives is linked to the population density, historically shaped up in Russia. Most of them are concentrated in major settlement and economic development zones. Since 2000, the Russian Federation has been split by eight federal districts – scaled-up areas, involving from 6 to 18 regions. Five federal districts are located in the European part of Russia (area covering one-fourth of the country's territory and inhabited by 80 per cent of the population). These federal districts concentrate 20 out of 27 PICs, and 78 per cent of all cluster initiatives analysed in our research. Conversely, Russian regions, which are fully or partially in the Extreme North and in equated localities (covering two-thirds of the country's territory and inhabited by 10 per cent of the population), concentrate only 6 out of 27 PICs, and 22 per cent of all cluster initiatives considered.

All PIC initiatives are managed by specialised organisations established by regional or municipal authorities of the PIC home locations (according to the requirements of the supervising Ministry for Economic Development of Russia). Meanwhile, in other cluster support programmes (e.g. the programme of the Russian Ministry for Industry and Trade), or when cluster initiatives are established regardless of governmental requirements, their management organisations are founded by cluster members. Cluster management organisations in Russian are comparable with their foreign peers in terms of people employed for the core cluster development activities, with an average of 6 employees in PICs and 4.5 in other Russian clusters (HSE, 2016c), and 4 employees in cluster management organisations in Europe (Lindqvist *et al.*, 2013). Cluster initiatives in Russia are governed by cluster boards or general assembly of members.

Goals and projects of Russian cluster initiatives are documented in strategies with a planning horizon up to six to eight years. These documents are subjects to scrutiny, coordination and approval by regional authorities, whenever a cluster initiative applies for federal support.

The funding structure of Russian cluster management organisations is rather heterogeneous: 20-22 per cent of organisations are funded solely from public or private sources (e.g. membership fees, donations, sponsoring and commercial services). However, in most cases (58 per cent), funding is mixed (HSE, 2016c).

In recent years, the number and quality of cluster initiatives in Russia have grown visibly. Before 2008, the phenomenon of a cluster was rather exotic: a few regions could boast of any cluster policy (the Tatar Republic, Perm, Kaluga, Samara, Tomsk regions, the city of Saint-Petersburg were the pioneers). However, over the past 10 years, the situation has changed. Between 2008 and 2015, there emerged 277 cluster initiatives. Some of them disappeared (170), others continue to exist since 2008 (37) and 2012 (24) and many emerged from 2012 to 2015 (46).

Research data and methodology

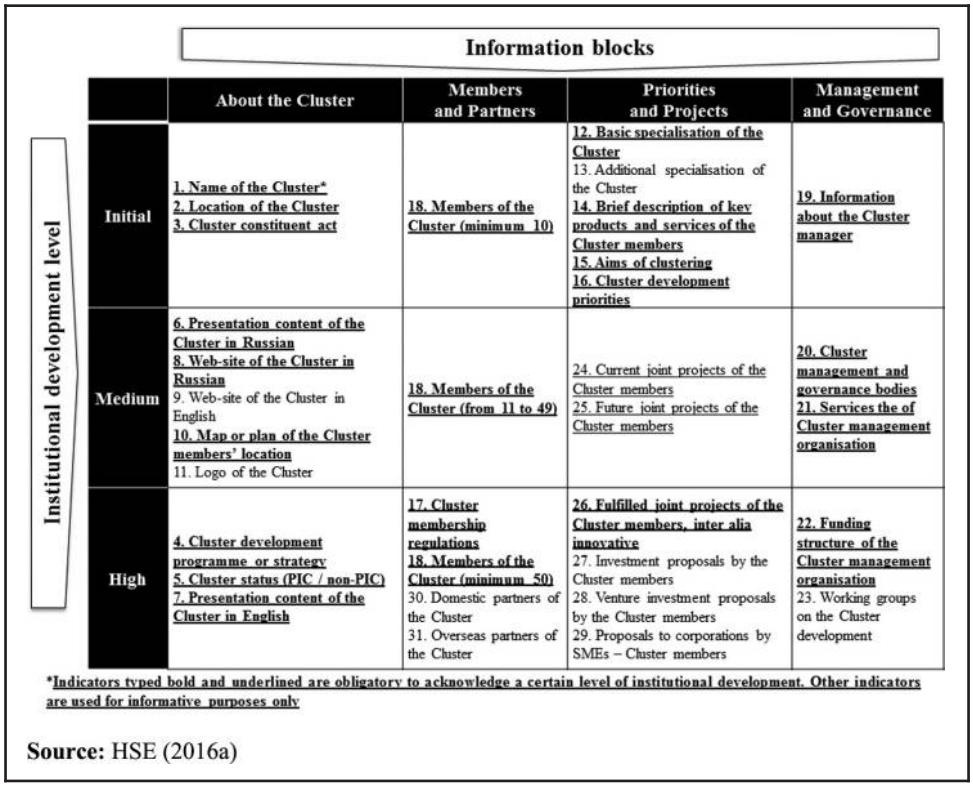
To test our hypotheses, we used three databases containing information about cluster initiatives identified in 2008, 2012 and 2015:

- a database of 169 cluster initiatives (name, region of location, specialisation), compiled according to the information provided by regional government offices in 2008 at the request of the Ministry for Economic Development of Russia;
- a database of 92 cluster initiatives (name, region of location, specialisation), compiled according to the applications for the PIC support programme in 2012 (HSE, 2013); and
- a database of 107 cluster initiatives (information reflecting 31 indicators – see Figure 1), compiled according to the Cluster Map of Russia supervised by the Russian Cluster Observatory (on 31 December, 2015) (HSE, 2016a).

These databases are intersected, which means that on the Cluster Map of Russia, there are cluster initiatives which emerged in different years. But not all of the cluster initiatives identified in the two previous databases (2008 and 2012) are displayed on the map (2015), simply because some of them ceased to exist. A cluster initiative was defined as "active" at the time of the survey, if there was a corresponding account on the Cluster Map of Russia. We referred to the cluster initiatives identified by cluster mapping as "new cluster initiatives", as no information on them was available in previous databases. The time of their emergence was thus supposed to be between 2013 and 2015.

So, the subject to our analysis were 107 active cluster initiatives registered on the Cluster Map of Russia. The earlier databases (2008 and 2012) were used to trace their progress. For those databases, misleading or false information was ignored. For example, industrial parks or business incubators, submitted by regional government offices in response to the

Figure 1 The Cluster Map of Russia scorecard



Source: HSE (2016a)

ministerial request in 2008 or in the PIC contest applications in 2012 as cluster initiatives, were excluded. Nor did we take into account data on cluster initiatives with equivocal sectorial orientation.

Table I summarises the numerical data on cluster initiatives broken down by three periods, so that we can see the dynamics of their emergence and disappearance.

The current landscape of Russian cluster initiatives is also pictured in Appendix 1.

To assess the influence of four factors, namely, PIC support programme, proximity to regions with previously established cluster initiatives, the duration of cluster initiatives' existence and accumulated innovative capacity of the cluster initiatives' home regions, on the emergence and performance of cluster initiatives, we used three variables.

To determine the factors which affected the emergence of cluster initiatives, we analysed how their number changed in different periods: 2008, 2012 and 2015 – according to our databases.

Table I The number of cluster initiatives in Russia in dynamics

The year a cluster initiative was identified	*Total no. of cluster initiatives in the database*	*The no. of active cluster initiatives*
2008	169	37 (14 PICs *inter alia*)
2012	62	24 (13 PICs *inter alia*)
2015	46	46
Total	*277*	*107*

Note: PICs – pilot innovative cluster initiatives
Source: Own survey data (2008-2015)

To determine the factors which affected the performance of cluster initiatives, we used two indicators from the Cluster Map of Russia scorecard:

- Employment in cluster initiatives' member organisations was used as a quantitative indicator. It is commonly used for both the identification of statistical clusters (Porter, 2003) and evaluation of cluster initiatives (European Cluster Observatory, 2016).
- Institutional development level of cluster initiatives was used as a qualitative indicator. It is an integral indicator of the Cluster Map of Russia (Figure 1).

There are 31 information fields, reflecting cluster initiatives' characteristics. Depending on the number of fields filled, each cluster initiative gets initial, medium or high level of institutional development within the Cluster Map of Russia. In this research, we distinguished cluster initiatives with initial level of institutional development from those with medium or high level. Cluster initiatives that were registered on the Cluster Map of Russia but failed to fill in their account profiles (at least to reach the initial level) were referred as "proto-clusters". So, among 107 active cluster initiatives that we analysed, there were 16 "proto-clusters" invisible on the map.

The calculations to assess the cluster initiatives' emergence were made using the data on all 107 cluster initiatives, including "proto-clusters"; the calculations to evaluate the cluster initiatives' performance were made using the data on 91 cluster initiatives (i.e. without "proto-clusters"). To test our hypotheses, we also made separate calculations on 27[3] PICs. The comparison of their quantitative and qualitative characteristics with those of other cluster initiatives or exclusion of PICs from certain calculations allowed us to estimate the influence of federal cluster policy on the emergence and evolution of cluster initiatives. In addition, to test *H1*, we used data from the Ministry for Economic Development of Russia on the establishment of CDCs and subsidy allocation to support them (from 2010 to 2015). Testing of *H4* was based on the Russian regional innovation scoreboard (HSE, 2016b). The scoreboard is composed according to the values of Russian regional innovation index (hereinafter – RRII), which is calculated as the mathematical average of normalised values of 37 indicators grouped into four thematic blocks: "Socio-economic conditions for innovation activities", "S&T potential", "Innovation activities" and "Quality of innovation policy" (Appendix 2). Russian regions were ranked decreasingly according to their RRII values. Further on, the regions were clustered into four groups based on the RRII values (Table II).

The hypotheses were tested using the formulae indicated in Appendix 3. For initial data, see Appendix 4:

Ha1. The impact of federal cluster policy on the emergence and performance of cluster initiatives was assessed by comparing qualitative and quantitative characteristics of cluster initiatives, which had received subsidies from the federal budget (PICs), to those of cluster initiatives, which had been developing without governmental support (non-PICs).

Ha2. The impact of proximity to regions with previously established cluster initiatives on the emergence of new cluster initiatives was assessed by comparing the number of new cluster initiatives to the number of neighbouring regions, where clusters had begun to develop earlier.

Table II Regional grouping by average RRII values in 2014

Regional group	*Average RRII value*	*No. of regions in a group*
Group I	0.5523	3
Group II	0.4148	29
Group III	0.3128	40
Group IV	0.2037	11

Source: HSE (2016b)

Ha3. The impact of cluster initiatives' age on their performance was assessed by comparing qualitative and quantitative characteristics of younger cluster initiatives to those of more mature cluster initiatives.

Ha4. The impact of accumulated regional innovative capacity on the emergence and performance of cluster initiatives was assessed by comparing the values of RRII to qualitative and quantitative characteristics of cluster initiatives in the respective regions.

Key findings

Federal cluster policy has had a significant impact on the emergence of cluster initiatives and their performance.

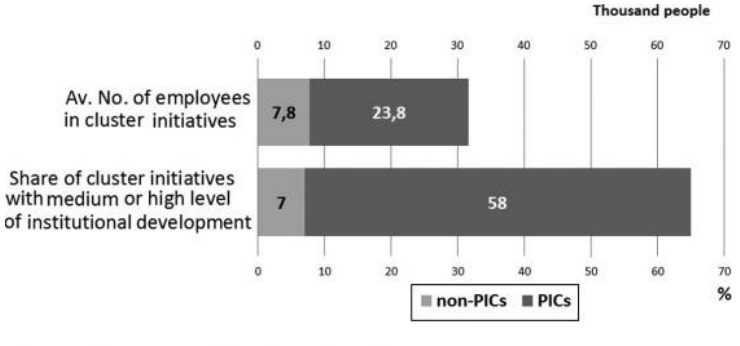
Comparing the average number of new cluster initiatives located in the home regions of government-supported cluster initiatives (PIC) to the average number of new cluster initiatives located in other regions, we found that in PIC home regions, new cluster initiatives emerged on average twice as intensively as in other regions. The analysis of regions with at least one new cluster initiative showed that PIC home regions again turned out to be 34 per cent more fruitful in terms of new cluster initiatives' emergence (Appendix 3, calculations *1.1-1.2*).

Average employment in the cluster initiatives supported by the federal subsidy was 3 times higher than in the cluster initiatives, which received no funding (Appendix 3, calculation *1.5*). The share of cluster initiatives with high and medium level of institutional development in the total number of cluster initiatives supported by the federal subsidy was 8.29 times higher than that of non-PICs (Appendix 3, calculation *1.6*) (Figure 2).

Federal cluster policy also influenced the survival capability of cluster initiatives (i.e. the ability to remain active after the PIC support programme of 2012). All 27 PICs remained active until now. The share of cluster initiatives which remained active in the total number of cluster initiatives which applied for the federal subsidy in 2012, but failed to receive it, was 27.69 per cent. This share is lower compared to 40 per cent in Germany (Eickelpasch and Fritsch, 2005). However, the share of cluster initiatives which did not apply for the federal subsidy and remained active in the total number of cluster initiatives, identified in 2008, was only 9.46 per cent. We consider the higher survival capability of cluster initiatives which participated in the PIC support programme compared to cluster initiatives which ignored it as a positive effect of the federal cluster policy (Appendix 3, calculations *1.3-1.4*).

To test *Ha1*, we also examined the influence of the PIC support programme on the dynamics of CDCs' establishment and funding. The graph below shows that in 2013-2015,

Figure 2 Comparison of PICs and other cluster initiatives (non-PICs)



Source: Own survey data (Appendix 4)

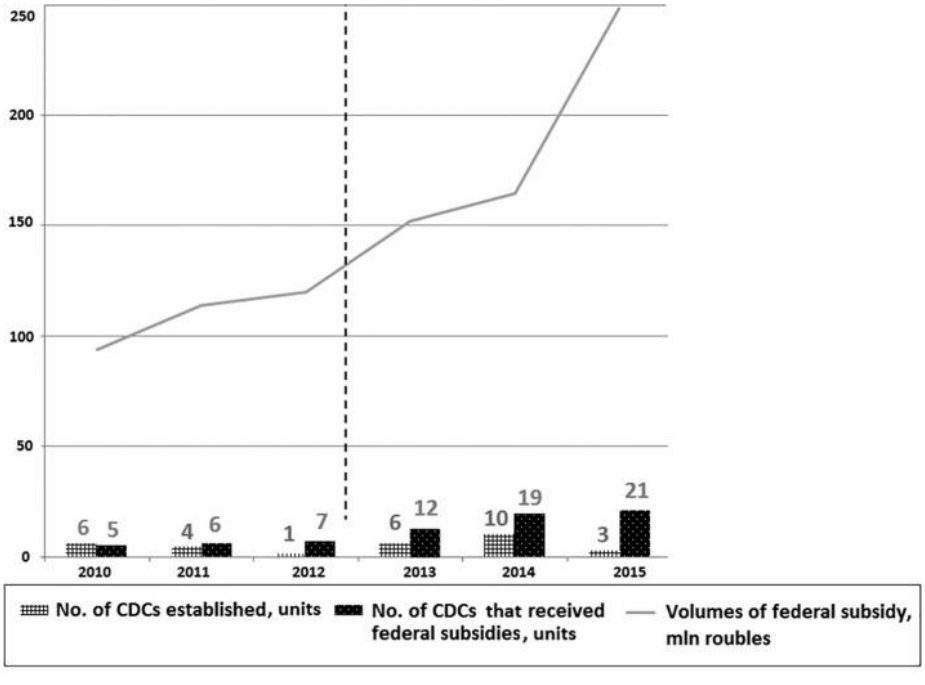
the number of newly created CDCs increased and so did the subsidy volumes compared to 2010-2011 – the time before the federal PIC support programme (Figure 3).

Proximity to regions with previously established cluster initiatives influenced the emergence of new cluster initiatives. However, no extra impact of the neighbouring PICs on inducing new cluster initiatives establishment was detected.

In regions bordering the home locations of more mature cluster initiatives (identified in 2008 or 2012), there emerged 3.55-4.19 cluster initiatives in subsequent periods. On the contrary, seven Russian regions, where cluster initiatives were not detected in any of our databases, had far less influence on the emergence of cluster initiatives in the neighbouring regions: the average number of newly emerged cluster initiatives was 0.71 (Appendix 3, calculations *2.1-2.3*).

In regions bordering the home locations of government-supported cluster initiatives (PICs), there appeared 4.23 new cluster initiatives on average (Appendix 3, calculation *2.4*). However, when we considered the emergence of new cluster initiatives only in the areas without PICs therein, the influence of proximity to PIC home regions decreased: on average, there emerged 2.46 new cluster initiatives (Appendix 3, calculation *2.5*). The influence of regions without PICs on the emergence of new cluster initiatives in the neighbouring areas also without PICs was higher: there appeared on average 3.3 new cluster initiatives (Appendix 3, calculation *2.6*). Such outcomes may occur due to the fact that, for example, the cities of Moscow and Saint-Petersburg – the home regions of five PICs – are relatively isolated from other Russian regions in terms of sharing the same border. The neighbouring regions of the city of Moscow are the Kaluga and the Moscow regions, and the city of Saint-Petersburg borders only the Leningrad region. All these areas: the Moscow, Kaluga and Leningrad regions are the locations of PICs. Thus, in calculation *2.5*, the influence of two capital cities on the emergence of new clusters in regions without

Figure 3 The dynamics of subsidy volumes, the number of CDCs established and the number of CDCs that received federal subsidy



Source: Own survey data (2010-2015)

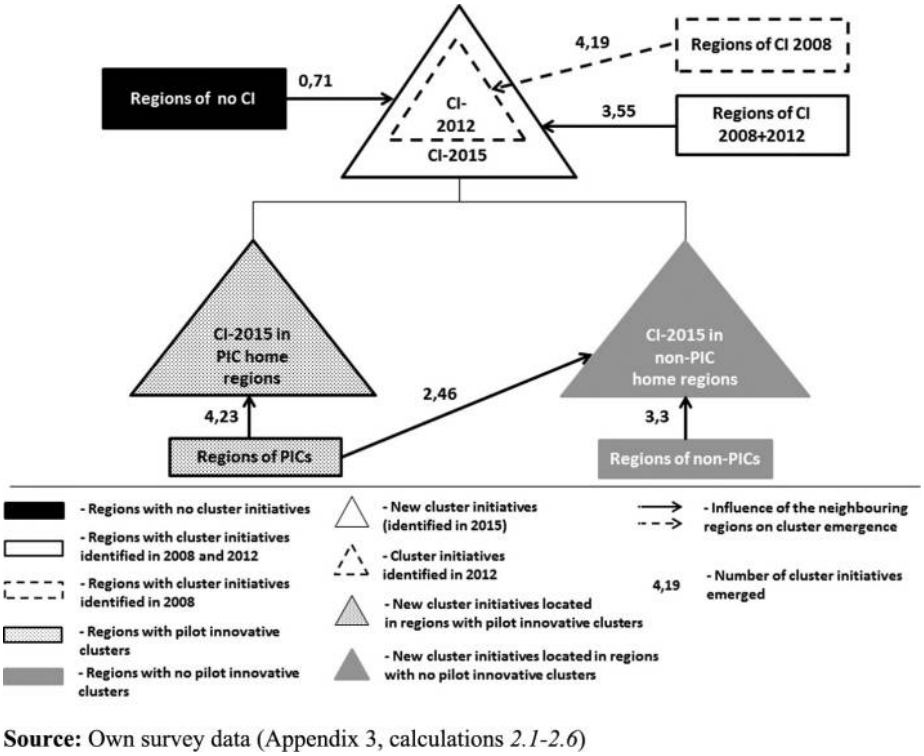
PICs could not be taken into account. Influence of the proximity to various types of regions on the emergence of cluster initiatives in the bordering regions is pictured in Figure 4.

Despite the fact that the assessment of neighbourhood impact (by analysing regions sharing the same border) was limited due to geographical features and configuration of inter-regional boundaries in Russia, neighbourhood factor did matter. When we compared federal districts by the share of regions with at least one cluster initiative located therein, they were ranked as follows: the Central federal district (83 per cent of the regions had at least one cluster initiative); the Urals federal district (83 per cent); the Siberian federal district (75 per cent); the Volga federal district (71 per cent); the North-West federal district (55 per cent); the Far East federal district (44 per cent); the Southern federal district (38 per cent); and the North Caucasus federal district (0 per cent). Seventy-five per cent of all cluster home regions were located in four federal districts – leaders by the share of regions with at least one cluster initiative.

PIC initiatives tended to be even more concentrated and consequently unevenly distributed throughout the country. When we compared federal districts by the share of PIC home regions located therein, they were ranked as follows: the Volga federal district (57 per cent); the Siberian federal district (42 per cent); the North-West federal district (27 per cent); the Central federal district (17 per cent); the Urals federal district (17 per cent); the Far East federal district (11 per cent); and the Southern federal district and the North Caucasus federal district (0 per cent). Ninety per cent of PIC home regions were located in four federal districts – leaders by the share of regions with at least one PIC initiative.

Neighbourhood factor was also evident because PIC home regions often shared the same border. For example, all PIC home regions located in the Volga (eight), Siberian (five) and Central (three) federal districts had at least one common border with another PIC home region

Figure 4 Influence of proximity to various types of regions on the emergence of cluster initiatives



Source: Own survey data (Appendix 3, calculations *2.1-2.6*)

located in the same federal district. Two of three PIC home regions located in the North-Western federal district also bordered each other. The only PIC home region in the Urals federal district (the Sverdlovsk region) bordered PIC home regions of the Volga federal district (the Perm region and the Bashkir Republic). Only 2 of 27 PIC home regions – Arkhangelsk and Khabarovsk – did not share borders with other PIC home regions. So, we conclude that the influence of PIC home regions on non-PIC home regions was limited due to the concentration of PIC home regions and the lack of common borders with other regions.

The cluster initiatives' age had an ambiguous influence on their performance. The assumption that cluster initiatives' age was positively correlated with the average number of employees therein was confirmed only for the cluster initiatives which had received federal subsidy (PICs).

Generally, average employment in cluster initiatives was practically constant regardless of their identification period: 2012 or 2008 (Appendix 3, calculation *3.1.1.1*). The temporal factor had an effect on employment only when new cluster initiatives (2015) were compared to those identified in 2008 and in 2012 (Appendix 3, calculations *3.1.1.2-3.1.1.3*). The cluster initiatives' age also turned out to be important when we compared PICs identified in 2008 to PICs identified in 2012 (Appendix 3, calculation *3.2.1*). A significant excess of average employment in PICs identified in 2008 over PICs identified in 2012 can be explained by the fact that 11 of the 14 PICs (2008) emerged in traditional industries (shipbuilding, automotive, aerospace, oil, gas, coal, etc.) with concentrations of large companies accumulating considerable employment. On the contrary, 9 of 13 PICs (2012) operated in modern sectors (biotech, ICT, new materials, etc.) and consisted mainly of innovative SMEs.

However, the exclusion of PICs from our analysis revealed reverse results: earlier identified non-PICs (2008) demonstrated the lowest employment characteristics compared to non-PICs identified later (2012) and even to new cluster initiatives (2015) (Appendix 3, calculations *3.3.1, 3.4.1, 3.5.1*). Comparison of employment in cluster initiatives split by identification period and federal support is pictured in Figure 5.

So, when testing *Ha3*, we could not find valid confirmation of the importance of the time factor for cluster initiatives not supported by the federal government.

Meanwhile, the level of institutional development in earlier-generated cluster initiatives was, in all cases, higher than in cluster initiatives that emerged later (Appendix 3, calculations *3.1.2.1-3.1.2.3, 3.2.2, 3.3.2*) (Figure 6).

The innovative capacity of regions was closely linked to the number of cluster initiatives located therein. Even in relatively weak regions, there were strong cluster initiatives.

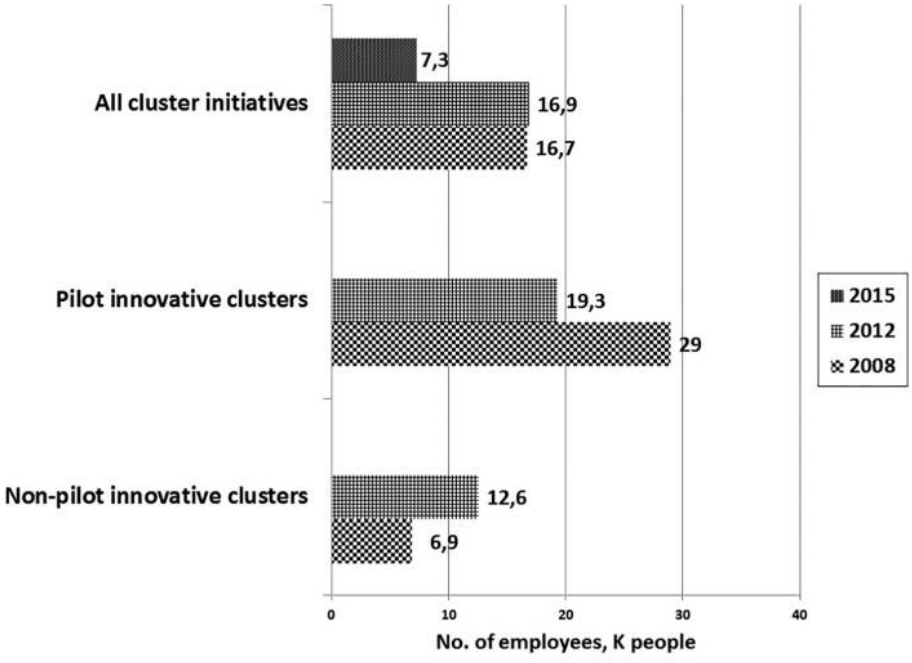
Maximum cluster initiatives (all, PICs and non-PICs) were concentrated in the leading innovative regions of Russia according to their RRII values (Figure 7).

However, a similar relationship could hardly be traced by comparing the performance characteristics of cluster initiatives: if not considering the most lagging regions (Group IV), the employment and institutional development level of cluster initiatives (both PICs and non-PICs) were quite even, regardless of their home regions' RRII values (Figures 8 and 9).

Implications for policy and practice

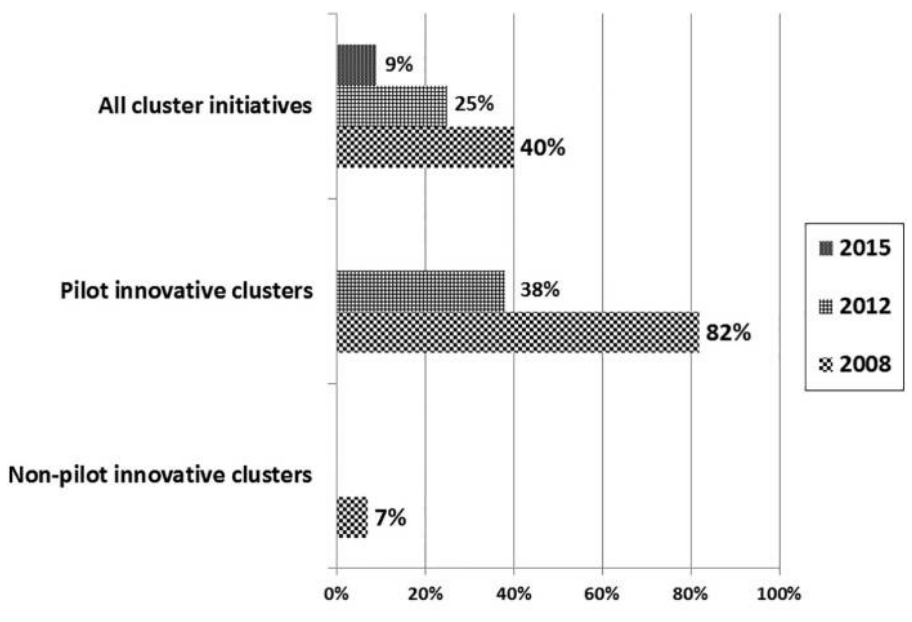
Federal policy produces a significant, and probably key, impact on the emergence and evolution of cluster initiatives. This is a trivial statement for cluster initiatives, having been granted subsidies, but it also appears relevant for the cluster initiatives not supported directly. Scattered examples could be found in the literature, such as the case of the German InnoRegio programme (Eickelpasch and Fritsch, 2005) or ESCP-4i programme (European Platform for Cluster Collaboration, 2016b). In our study, we made an attempt to find sound evidence for this influence based on the case of one country with all its cluster initiatives analysed during a decade.

Figure 5 Employment in cluster initiatives split by identification period and federal support



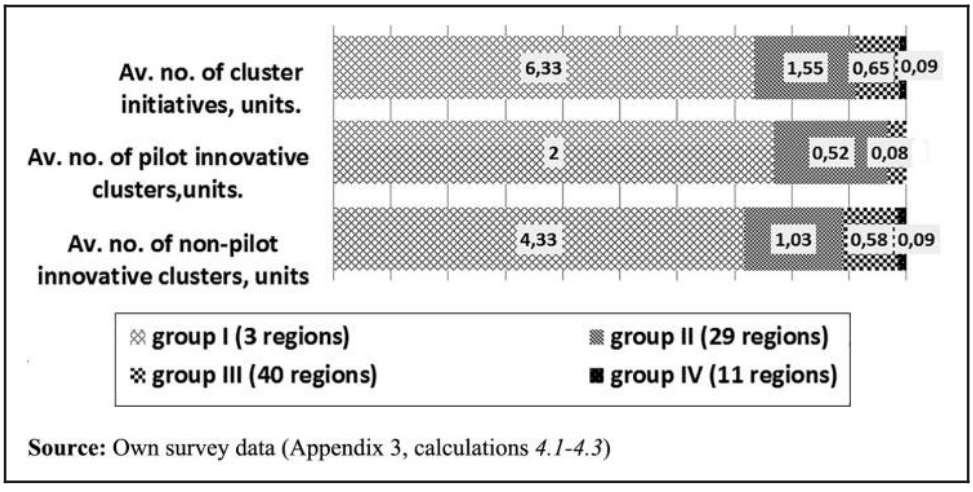
Source: Own survey data (Appendix 4)

Figure 6 The shares of cluster initiatives with medium or high level of institutional development split by identification period and federal support



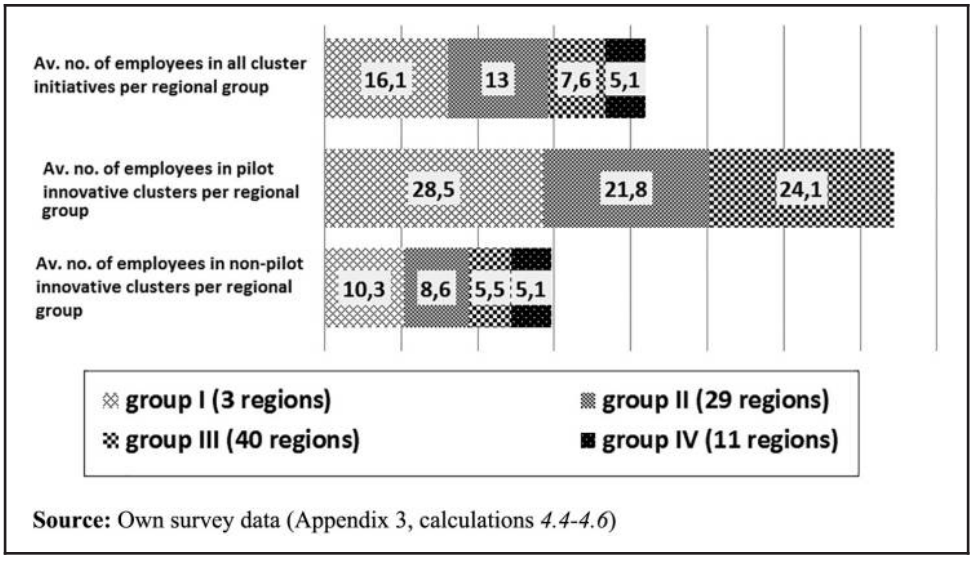
Source: Own survey data (Appendix 4)

Figure 7 Average number of cluster initiatives split by regional groups regarding innovation development



Source: Own survey data (Appendix 3, calculations *4.1-4.3*)

Figure 8 Employment in cluster initiatives split by regional groups regarding innovation development

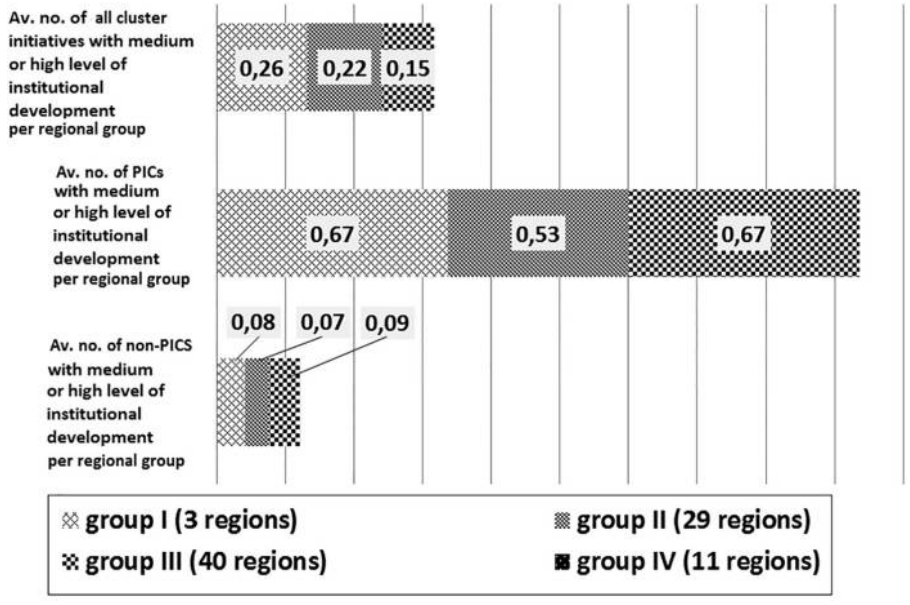


Source: Own survey data (Appendix 3, calculations *4.4-4.6*)

Considering our findings, we presume there are institutionally oriented industrial policies that are focused not so much on the support of existing entities (i.e. subsidies, direct investments, loans, etc.) as on the framing of new forms of interaction (e.g. clusters, living labs, consortia, technological platforms, network programmes such as national network for manufacturing innovation (NNMI) in the USA). With these policies, the government introduces such new forms and tests them. If successful, the new forms of interaction are accepted by regional stakeholders (firms, universities, financial institutions, research organisations). Should this happen, institutionally oriented industrial policies produce extra effects.

Another possible goal of these policies is the cultivation of demand among economic agents for new transaction goods, typical for the countries with highly developed economies. In such a case, the government demonstrates patience and will, supporting

Figure 9 Average number of cluster initiatives with medium or high level of institutional development split by regional groups regarding innovation development



Source: Own survey data (Appendix 3, calculations *4.7-4.9*)

new forms of interaction beyond the "testing policy" framework, and tries to habituate economic agents to such interactions.

The fact that cluster initiatives are really effective is still to be proven. However, their attractiveness for analysis and implementation is explicit, so member companies are willing to invest in their establishment and development, even if prospects to be supported by the government are unclear. At the same time, members of cluster initiatives are quite sensitive to the national policy agenda, thus we conclude that these novel forms of interaction require certain legitimacy.

Such legitimacy is needed not only for companies (universities, research and intermediate organisations, etc.) which chose to experiment with a cluster initiative, but also – and to a greater extent, we believe – for regional authorities. On the one hand, in Russia, as in most other countries, regional authorities play a decisive role in cluster policy design and implementation. But on the other hand, regional authorities seek both a financial and a conceptual base of support from the national level of governance. In Russia, there are cases of cluster policy pursued by regional authorities independently from the federal funding, however, entwined intellectually with the central cluster agenda (e.g. the Penza and Voronezh regions). Our findings confirm the results of earlier studies drawing a link between the importance of cluster policy at the national and regional levels (Furre, 2008).

By extension, we would suggest defining different roles of the federal (national) government, which supports cluster initiatives not only by allocating funds but also by providing methodical guidance and training. In Russia, such an approach is introduced within the PIC support programme, governed by the Ministry for Economic Development. Operational management of the programme is entrusted to a specialised office, established on an *ad hoc* basis. Its key activities include benchmarking and promotion of the best cluster management practices, encouraging joint cluster projects, consulting and

provision of various support services to cluster initiatives. The office runs six thematic working groups (export and international R&D cooperation; investment attraction; innovative infrastructure development; commercialisation of technologies; HR training; cluster management enhancement), bringing together cluster initiatives, relevant federal officials and experts, to foster horizontal cooperation and provide feedback to the Ministry in charge of the programme. We believe that such forms of collaboration and coordination are especially important for large countries (or cross-country unions) with strong authority of the central government and a variety of diverse regions that maintain weak inter-regional relations and adhere to a national agenda.

Another important function of national governments is to introduce standard solutions for regional authorities. Three national cluster support programmes in Russia exploit different instruments determined by their goals, which allows regional authorities to test different types of cluster initiatives in terms of sectorial orientation, membership structures and management. Meanwhile, it is up to regional authorities to select whether a cluster approach is required, and to what extent (sometimes it is limited to the strategy design with no cluster initiatives establishment afterwards). In Russia, there are different approaches to integrating cluster policy into regional systems of public administration (e.g. in the Tatar Republic, cluster initiatives are assigned high importance by regional authorities with defined funds, responsibilities and programming; in the Sverdlovsk region, cluster initiatives are mixed with other innovative infrastructure tools and organisations; in the City of Moscow, cluster initiatives are almost missing in the outlook of regional authorities).

The prosperous advancement of cluster initiatives requires the long-term participation of public authorities (in cooperation with private sector). Initially, the hypothesis was that a cluster initiative should rely on public funding for the first three to six years to ensure sustainability (CLOE, 2004). After that, they would either shift to self-financing, or vanish, giving way to more enduring initiatives. Later the hypothesis was corrected. Today there is little evidence of decrease in public funding within cluster initiatives; its share remains stable (Lindqvist *et al.*, 2013). A shift to total self-financing is possible, although it takes about 10 years (Pamminger, 2014). Even in such cases, the government's influence does not end (INNO Germany AG, 2010).

Our research proves more formally the need for long-term or permanent governmental participation in cluster initiatives: PICs evolved over time much better than cluster initiatives not supported by the federal funding. Thus, the idea is that cluster initiatives reproduce the logic of public–private partnerships in the innovation sector, with business and government involved. One of the best illustrations for this thesis is Clusterland, a regional CDC of Upper Austria, where an effective business model was built, providing sufficient private income via annual membership fees to be almost self-financing, and, consequently, virtually independent from the regional authorities (Pamminger, 2014). Despite this fact, Pamminger is persuaded that it is inappropriate to increase the share of private funding to 100 per cent. Participation of public authorities in cluster development is necessary along with business, academia and civil institutions. It is often the government that promotes a radical innovation agenda, following global science, technology and innovation (STI) trends and increasing technological standards. As this requires long-term risky projects with multi-stakeholder participation, the government exploits cluster initiatives to eliminate the risks by co-investments, organisational and ideological support. Without governmental participation, cluster initiatives are likely to transform into regional associations with less ambitious projects limited to lobbying and "low hanging fruits" (e.g. logistics, training, end exhibitions).

However, governmental support of cluster initiatives might be tricky. Over time, some may degenerate into special interest groups, which counteract disruptive innovation (like

economic and political elite, defending their status quo by limiting vertical social mobility and competition) (Lindqvist *et al.*, 2013, pp. 45-46). During the analysis of qualitative characteristics of the cluster initiatives that emerged in different periods, we supposed that some of them became prone over time to blocking disruptive innovations and grant-seeking behaviour as alternative sources of competitiveness. If this hypothesis is true, then the government's contribution to overcoming systemic failures by supporting cluster initiatives will be insufficient for intensive economic growth.

In addition to the national cluster policy, other factors are relevant for the emergence and progress of cluster initiatives in regions. In our study, we found evidence for the importance of accumulated innovative capacity of the cluster home regions and the proximity to regions with previously established cluster initiatives and successful cluster policy benchmarks. Systemic failures require systemic solutions, so the use of discrete support measures is insufficient. We conclude that a sole cluster policy is not enough for the evolution of cluster initiatives. It is necessary to synchronise different support measures, which is, indeed, a challenge. However, in our research, we claim that cluster initiatives (previously considered one of the cluster development tools) are self-sufficient and require diverse support, not limited to public funding.

Russia started to implement cluster support programmes in 2012, but has not yet seen tangible results. The key limitation concerns conflicts that occur among governmental offices competing for mandates to introduce various support tools and distribute funds, as well as for the acknowledgement to be "the leading ministry in the pursuit of cluster policy". For example, in Russia, all three cluster support programmes are not synchronised at the federal level. However, such synchronisation is possible (and best seen) at the regional level, especially if federal programmes are based on regional expenditure co-funding (e.g. the CDC and PIC support programmes by the Ministry for Economic Development of Russia). A more difficult case is when funding is allocated directly to companies (the Ministry for Industry and Trade of Russia) or universities and research organisations (the Ministry for Education and Science of Russia). A possible solution could be to prioritise support to the regions which have a holistic vision of the future and are able to synchronise various support measures within the framework of common roadmaps or programmes (such as Innotomsk in the Tomsk region or Innokam in the Tatar Republic).

Our research showed that the overall level of regional innovative capacity is more closely correlated with the number of cluster initiatives than with their quality. That is, even in relatively weak regions, there can emerge strong cluster initiatives (though fewer in number).

In this regard, we believe it makes sense to introduce differentiated approaches for regions that are leading and lagging behind within the national cluster policy. Otherwise, support programmes designed on a competitive basis are more likely to be in favour of the leading regions, simply because more cluster initiatives are located therein. Policymakers should then decide whether they pick winners or create opportunities for lagging regions. One good example is the German "Entrepreneurial Regions" – a programme aimed at building and expansion of special technological, scientific and economic competences in East German regions. Its goal is the sustainable transfer of these competences to innovations, economic growth and employment. The "Entrepreneurial Regions" development programmes therefore establish the basis for the creation of regional economic clusters (BMBF, 2006). In Russia, there are no programmes for clusters and, more broadly, SME innovation support focused on regions that are lagging behind or regions with some location features (northern/southern).

Nevertheless, we have witnessed a certain "awakening" of these regions, which are slowly joining federal cluster support programmes. For example, a number of home regions of

industrial cluster initiatives in Russia (Ministry for Industry and Trade programme, 2016) are medium-developed and even lagging. Some of these cluster initiatives previously participated in the PIC support programme, but were not selected to become PICs. The programme of the Ministry for Industry and Trade proved to be more accessible to those regions because it has less focus on innovation, strong universities and research institutes, export activities and so on. Its goal is import substitution and the development of local value chains.

The idea for regional policymaking is thus to pursue specified support programmes. For leading regions, we would suggest promoting several cluster initiatives simultaneously or cross-clustering to foster structural change of the regional economy based on the mix of emerging industries and traditional specialisation.

For lagging regions, there could be other approaches. On the one hand, it might be suitable to focus on the advancement of existing cluster initiatives, which can be rather strong. On the other hand, less developed cluster initiatives should also be considered: even though their world-class competitiveness is doubtful, they can increase their members' performance due to cooperation with cluster initiatives in other regions or integration in the national value-added chains.

Conclusion

The paper was aimed at assessing the impact of the national policy, cluster age, cluster development benchmarks in the neighbouring regions and the cumulative level of regional innovative capacity on the emergence of cluster initiatives in Russia and their characteristics. A key feature of the study was the database of 277 cluster initiatives, spanning nearly a decade, which had been drawn up with information from the Ministry for Economic Development of Russia and cluster management organisations as a part of the first national cluster mapping.

The testing of the hypotheses showed that the number of new clusters in the home regions of public-funded cluster initiatives (PICs), average employment in PICs and the share of PICs with high and medium level of institutional development were 2.02, 3.05 and 8.29 times higher, respectively, than the equivalent characteristics of the cluster initiatives not supported by the government. The mere participation in the PIC support programme enabled one-third of all cluster initiatives to remain active afterwards, in spite of the lack of subsidy. In this study, we proved the significant influence of the PIC support programme on the quantitative and qualitative characteristics of cluster initiatives, which is empirical evidence of the national cluster policy's effectiveness in terms of overcoming systemic failures.

The article also empirically proved the impact of proximity to the home regions of previously established clusters on the emergence of new cluster initiatives. In the regions bordering the locations where the cluster initiatives had appeared earlier, there emerged an average of four cluster initiatives afterwards. Cluster initiatives, and particularly PICs, tended towards spatial concentration, which proved our idea of clustering activity spikes in certain parts of the country as a result of inter-regional benchmarking and transfer of successful cluster policy.

In this article, we took the first step in assessing the impact of the cluster initiatives' age on their characteristics. The results of testing this hypothesis were mixed. The assumption that the length of cluster initiatives' existence was positively correlated with their performance appeared to be true only for cluster initiatives with federal funding (PICs). The PICs identified in 2008 were 34 per cent stronger in terms of average employment and 54 per cent more institutionally developed than the PICs identified in 2012. Conversely, the performance of new cluster initiatives surpassed the performance of cluster initiatives identified in 2008, which were not supported by the federal subsidy, by 6 and 29 per cent,

respectively. Finally, the clusters that were identified in 2012 and received budget funding exceed the non-PICs identified in 2008 by 179 per cent in terms of average employment and by 443 per cent in terms of institutional development.

The hypothesis concerning the importance of regional innovative level was confirmed in relation to the number of cluster initiatives. On average, the number of cluster initiatives located in the most innovative regions exceeded the number of cluster initiatives in other regions by 7 times, the number of PICs in corresponding regions was 9 times higher and the number of non-PICs was 3 times higher. We also conclude that strong cluster initiatives could emerge in regions with high and moderate STI capacity.

With this paper we suggest the advisability of consistent, long-standing and tailor-made cluster support programmes both at the national and regional levels with strong public–private partnerships and inter-departmental cooperation. The government's role is not only in the allocations of funds but also in the legitimation of relevant cluster policies, setting broad cluster agenda, supervision, mentoring and encouragement of inter-regional cooperation and cross-clustering.

Notes

1. For all currency equivalents (roubles – euro), the exchange rate of the Central Bank of the Russian Federation was used on 31 December of the respective year. For multiannual periods, arithmetic average of the exchange rates of the Central Bank of the Russian Federation was used on 31 December of each year.
2. In 2014, there were 26 PICs.
3. The list of 27 PICs used in this study does not fully match the official list of 27 PICs. This is due to the fact that on the Cluster Map of Russia, there is no information on the Sarov PIC (the Nizhniy Novgorod region). The PICs of Saint-Petersburg originally were four in number and they are displayed on the Cluster Map of Russia as four cluster initiatives, but for the official list of the PICs, they merged into two cluster initiatives. The photonics cluster for fibre-optic technologies (the Perm region), included in the official list of PICs at the end of 2015, was not considered in this study as the PIC, as it was formed after the competitive selection of 2012 and up to January 2016 had not received subsidies from the federal budget.

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Figure A1 Russian cluster initiatives and the regions of their location (December, 31 2015)

Appendix 2

Table AI Indicator system applied in the Russian regional innovation scoreboard

№.	*Indicator*	*Data source*
1. Socio-Economic Conditions for Innovation Activities		
1.1 Basic macroeconomic indicators		
1.1.1	GRP per worker employed in the regional economy, *thousand roubles*[a,b]	Rosstat, CSDB, USIEC
1.1.2	Fixed assets renewal coefficient, *%*	Rosstat, USIEC
1.1.3	Share of workers employed in advanced high- and medium-technology manufacturing industries in the total number of workers employed in the region, *%**	Rosstat, USIEC
1.1.4	Share of workers employed in research-intensive service industries in the total number of workers employed in the region, *%**	Rosstat, USIEC
1.2 Education potential of the population		
1.2.1	Share of workers with higher education aged between 25-64 in this age group, *%**	Rosstat, population employment survey
1.2.2	Number of students attending higher education programmes (bachelors, specialists, masters) per 10,000 population	RF Ministry of Education and Science, form № VPO-1; Rosstat, demographic statistics
1.3 Development of information society		
1.3.1	Share of organisations with broadband internet access (bandwidth of at least 256 Kbit/s) in the total number of organisations, *%*	Rosstat, form № 3-inform
1.3.2	Share of households with internet access in the total number of households, *%*	Rosstat, household budgets survey
2. S&T Potential		
2.1 R&D funding		
2.1.1	Internal R&D expenditures as a share of GRP, *%*[a,b]	Rosstat, form № 2-science, USIEC
2.1.2	Internal R&D expenditures per researcher, *thousand roubles*	Rosstat, form № 2-science
2.1.3	R&D expenditures of the business enterprise sector as a share of total internal R&D expenditures, *%*	Rosstat, form № 2-science
2.1.4	Average monthly salary of R&D personnel as a share of average accrued nominal monthly wages in the region, *%*	Rosstat, form № 2-science, USIEC
2.2 R&D personnel		
2.2.1	Share of R&D personnel in average annual number of workers employed in the region, *%*[a]	Rosstat, form № 2-science, USIEC
2.2.2	Share of people aged up to 39 in the total number of researchers, *%*	Rosstat, form № 2-science
2.2.3	Share of doctorate holders in the total number of researchers, *%*	Rosstat, form № 2-science
2.3 R&D productivity		
2.3.1	Number of papers published in peer-reviewed journals indexed by the Russian Science Citation Index (RSCI) per 10 researchers, *units*	Scientific Electronic Library RSCI; Rosstat
2.3.2	Number of patent applications for inventions filed at the Rospatent by national applicants per one million economically active population of the region	Rospatent, Rosstat, CSDB
2.3.3	Number of advanced production technologies developed in the region per one million economically active population	Rosstat, form № 1-technology, CSDB
2.3.4	Revenues from technology exports as a share of GRP (per 1 thousand roubles of GRP)[a,b]	Rosstat, form № 1-license, CSDB
3. Innovation Activities		
3.1 Innovation activities of organisations		
3.1.1	Share of organisations which have created technological innovations in the total number of organisations (for manufacturing organisations), *%**	Rosstat, form № -4-innovation
3.1.2	Share of organisations which have created non-technological (marketing and/or organisational) innovations in the total number of organisations (for manufacturing organisations), *%**	Rosstat, form № -4-innovation
3.1.3	Share of organisations which have applied existing in-house developed technological innovations in the total number of organisations (for manufacturing organisations), *%**	Rosstat, form № -4-innovation
3.1.4	Share of organisations which have participated in joint R&D projects in the total number of organisations (for manufacturing organisations), *%**	Rosstat, form № -4-innovation
3.2 Small innovative companies		
3.2.1	Share of small companies which have created technological innovations in the total number of small companies (for manufacturing companies), *%*[a]	Rosstat, form № 2-MP-innovation

(*continued*)

Table AI

№.	*Indicator*	*Data source*
3.3 Expenditures on technological innovations		
3.3.1	Intensity of expenditures on technological innovations (for manufacturing organisations), %	Rosstat, form № -4-innovation
3.4 Productivity of innovation activities		
3.4.1	Share of innovative products/services in the total volume of shipped products/provided services (for manufacturing organisations), %	Rosstat, form № -4-innovation
3.4.2	Share of new (or subjected to significant technological changes) innovative products/services new to the market in the total volume of shipped products/provided services (for manufacturing organisations), %*	Rosstat, form № -4-innovation
3.4.3	Share of organisations which have named reduced materials and energy consumption as the main result of their innovation activities in the total number of organisations which have created technological innovations (for manufacturing organisations), %	Rosstat, form № -4-innovation
4. Quality of Innovation Policy		
4.1 Legal basis of innovation policy		Open sources: Web portals and websites of relevant regional authorities, specialised regional legislation databases
4.1.1	Availability of regional innovation development strategy (concept) and/or section on promotion of innovation in regional development strategy	
4.1.2	Priority innovation development areas specified in regional territorial development schemes and supporting documents	
4.1.3	Availability of specific legislation establishing basic principles, areas and measures for providing government support of regional innovation	
4.1.4	Availability of specialised programmes or integrated government support packages to promote innovation, innovation activities or innovators	
4.2 Organisational support of innovation policy		Open sources: Web portals and websites of relevant regional authorities, specialised regional legislation databases
4.2.1	Availability of specialised coordination (consulting) bodies to assist top regional authorities in shaping innovation policy (promoting innovation)	
4.2.2	Availability of specialised regional development institutes (foundations, agencies, development corporations, etc.) responsible for supporting innovation and/or implementing innovation projects in the region	
4.3 Public R&D and innovation expenditures		
4.3.1	Appropriations from consolidated regional budget to support civil R&D activities as a share of total expenditures of the consolidated regional budget, %	Annual report of the Federal Treasury on regional and local budget performance in Russian regions
4.3.2	Share of the regional budget and local budgets' appropriations in the total expenditures on technological innovations (for manufacturing organisations), %	Rosstat, form № -4-innovation
4.3.3	Amount of federal budget subsidies to develop innovation infrastructure received by small and medium enterprises, as a share of GRP (per 1 million roubles of GRP)[a,b]	Rosstat, USIEC; open sources: website of the RF Ministry of Economic Development

Notes: *Indicators compatible with the 2014 European Ranking: European Commission (2014) regional Innovation Scoreboard 2014; http://bookshop.europa.eu/en/regional-innovation-scoreboard-2014-pbNBBC14001/ (accessed 10 May 2016); [a]the 2014 Ranking was calculated using 2013 data; [b]the 2013 Ranking was calculated using 2012 data

Source: HSE (2016b)

Appendix 3

Table AII Indicators, formulae, calculation results and methodical comments

№.	Indicator	Formula	Result
Ha1. Indicators, formulae and calculation results of assessing the federal policy impact on the emergence and performance of cluster initiatives			
1.1	Ratio of the average number of new cluster initiatives located in PIC home regions to the average number of new cluster initiatives located in other regions	$\bar{C}^{2015}_{R_{PIC}} \Big/ \bar{C}^{2015}_{R_{nonPIC}}$, where $\bar{C}^{2015}_{R_{PIC}} = \sum C^{2015}_{R_{PIC}} \Big/ \sum R_{PIC}$; $\bar{C}^{2015}_{R_{nonPIC}} = \sum C^{2015}_{R_{nonPIC}} \Big/ \sum R - \sum R_{PIC}$	2.02
1.2	Ratio of the average number of new cluster initiatives located in PIC home regions with at least one new cluster to the average number of new cluster initiatives located in other regions with at least one new cluster	$\bar{C}^{PIC}_{R^{2015}_{\min 1\,C}} \Big/ \bar{C}^{nonPIC}_{R^{2015}_{\min 1\,C}}$, where $\bar{C}^{2015}_{R^{PIC}_{\min 1\,C}} = \sum C^{2015}_{R_{PIC}} \Big/ \sum R^{PIC}_{\min 1\,C^{2015}}$; $\bar{C}^{2015}_{R^{nonPIC}_{\min 1\,C}} = \sum C^{2015}_{R_{nonPIC}} \Big/ \sum R^{nonPIC}_{\min 1\,C^{2015}}$	1.34
1.3	The share of active cluster initiatives identified in 2008, which did not apply to the PIC contest, in the total number of cluster initiatives identified in 2008	$\left(\sum C^{2008;NO\ applic.}_{2015} \Big/ \sum C^{2008}\right) \times 100$	9.46%
1.4	The share of active cluster initiatives identified in 2008 and 2012 which applied to the PIC contest but lost in the total number of cluster initiatives which applied to the PIC contest but lost	$\left(\sum C^{2008;2012}_{2015\ Applic.,\ non-PIC} \Big/ \sum C^{2008;2012}_{Applic.} - \sum C^{2008;2012}_{PIC}\right) \times 100$	
1.5	Ratio of the average employment in PICs to the average employment in other cluster initiatives (without new cluster initiatives)	$G(E) = \bar{E}^{PIC} / \bar{E}^{nonPIC}$	3.05
1.6	Ratio of the share of PICs with medium or high level of institutional development to the share of other cluster initiatives with medium or high level of institutional development (without new cluster initiatives)	$G(L) = L^{PIC} / L^{nonPIC}$	8.29
Ha2. Indicators, formulae and calculation results of assessing the neighbouring regions' impact on the emergence and performance of cluster initiatives			
2.1	Ratio of the number of cluster initiatives identified in 2012 that are located in regions bordering the regions with clusters identified in 2008 to the number of regions with clusters identified in 2008	$\sum C^{2012}_{R.\ board.R.^{2008}} \Big/ \sum R^{2008}_{board.R^{2012}}$	4.19
2.2	Ratio of the number of new cluster initiatives, that are located in regions bordering the regions with clusters identified in 2008 and 2012 to the number of regions with clusters identified in 2008 and 2012	$\sum C^{2015}_{R.board.R.^{2008;2012}} \Big/ \sum R^{2008;2012}_{board.R^{2015}}$	3.55
2.3	Ratio of the number of new cluster initiatives that are located in regions bordering the regions where no clusters were identified to the number of regions where no clusters were identified	$\sum C^{2015}_{R.board.\ R^{nonC}} \Big/ \sum R^{non\ C}_{board.R^{2015}}$	0.71
2.4	Ratio of the number of new cluster initiatives that are located in regions bordering the PIC home regions to the number of PIC home regions	$\sum C^{2015}_{R.\ board.\ R^{PIC}} \Big/ \sum R^{PIC}_{board.R^{2015}}$	4.23
2.5	Ratio of the number of new cluster initiatives that are located in non-PIC home regions bordering the PIC home regions to the number of PIC home regions	$\sum C^{2015}_{R^{nonPIC}board.\ R^{PIC}} \Big/ \sum R^{PIC}_{board.R_{nonPIC}^{2015}}$	2.46
2.6	Ratio of the number of new cluster initiatives that are located in non-PIC home regions bordering the non-PIC home regions to the number of non-PIC home regions	$\sum C^{2015}_{R^{nonPIC}board.\ R^{nonPIC}} \Big/ \sum R^{nonPIC}_{board.R_{nonPIC}^{2015}}$	3.30

(*continued*)

Table AII

№.	Indicator	Formula	Result
Ha3. Indicators, formulae and calculation results of assessing the impact of clusters' age on their performance			
3.1.1.1	Ratio of the average employment in cluster initiatives identified in 2012 to the average employment in cluster initiatives identified in 2008	$T(\bar{E}) = \bar{E}^{2012} / \bar{E}^{2008}$	*1.01*
3.1.1.2	Ratio of the average employment in new cluster initiatives to the average employment in cluster initiatives identified in 2012	$T(\bar{E}) = \bar{E}^{2015} / \bar{E}^{2012}$	*0.43*
3.1.1.3	Ratio of the average employment in new cluster initiatives to the average employment in cluster initiatives identified in 2008	$T(\bar{E}) = \bar{E}^{2015} / \bar{E}^{2008}$	*0.44*
3.1.2.1	Ratio of the share of cluster initiatives identified in 2012 with medium or high level of institutional development to the share of cluster initiatives identified in 2008 with medium or high level of institutional development	$T(L) = L^{2012} / L^{2008}$	*0.63*
3.1.2.2	Ratio of the share of new cluster initiatives with medium or high level of institutional development to the share of cluster initiatives identified in 2012 with medium or high level of institutional development	$T(L) = L^{2015} / L^{2012}$	*0.36*
3.1.2.3	Ratio of the share of new cluster initiatives with medium or high level of institutional development to the share of cluster initiatives identified in 2008 with medium or high level of institutional development	$T(L) = L^{2015} / L^{2008}$	*0.23*
3.2.1	Ratio of the average employment in PICs identified in 2012 to the average employment in PICs identified in 2008	$T(E) = \bar{E}_{PIC}^{2012} \Big/ \bar{E}_{PIC}^{2008}$	*0.67*
3.2.2	Ratio of the share of PICs identified in 2012 with medium or high level of institutional development to the share of PICs identified in 2008 with medium or high level of institutional development	$T(L) = L_{PIC}^{2012} \Big/ L_{PIC}^{2008}$	*0.46*
3.3.1	Ratio of the average employment in non-PICs identified in 2012 to the average employment in non-PICs identified in 2008	$T(E) = \bar{E}_{nonPIC}^{2012} \Big/ \bar{E}_{nonPIC}^{2008}$	*1.83*
3.3.2	Ratio of the share of non-PICs identified in 2012 with medium or high level of institutional development to the share of non-PICs identified in 2008 with medium or high level of institutional development	$T(L) = L_{nonPIC}^{2012} \Big/ L_{nonPIC}^{2008}$	*0.00*
3.4.1	Ratio of the average employment in new cluster initiatives to the average employment in non-PICs identified in 2008	$T(E) = \bar{E}^{2015} \Big/ \bar{E}_{nonPIC}^{2008}$	*1.06*
3.4.2	Ratio of the share of new cluster initiatives with medium or high level of institutional development to the share of non-PICs identified in 2008 with medium or high level of institutional development	$T(L) = L^{2015} \Big/ L_{nonPIC}^{2008}$	*1.29*
3.5.1	Ratio of the average employment in PICs identified in 2012 to the average employment in non-PICs identified in 2008	$T(E) = \bar{E}_{PIC}^{2012} \Big/ \bar{E}_{nonPIC}^{2008}$	*2.80*
3.5.2	Ratio of the share of PICs identified in 2012 with medium or high level of institutional development to the share of non-PICs identified in 2008 with medium or high level of institutional development	$T(L) = L_{PIC}^{2012} \Big/ L_{nonPIC}^{2008}$	*5.43*
Ha4. Indicators, formulae and calculation results of assessing the regional innovative capacity's impact on the emergence and performance of cluster initiatives			
4.1	The average number of cluster initiatives by regional groups (I-IV), *units*	$\overline{C}_{gr\,i} = \sum C_{gr\,i} \Big/ \sum R_{gr\,i}$	Group I: *6.33* Group II: *1.55* Group III: *0.65* Group IV: *0.09*
4.2	The average number of PICs by regional groups (I-IV), *units*	$\overline{C}_{gr\,i}^{PIC} = \sum C_{gr\,i}^{PIC} \Big/ \sum R_{gr\,i}$	Group I: *2.00* Group II: *0.52* Group III: *0.08* Group IV: *0.00*
4.3	The average number of non-PICs by regional groups (I-IV), *units*	$\overline{C}_{gr\,i}^{nonPIC} = \sum C_{gr\,i}^{nonPIC} \Big/ \sum R_{gr\,i}$	Group I: *4.33* Group II: *1.03* Group III: *0.58* Group IV: *0.09*

(*continued*)

Table AII

№	Indicator	Formula	Result
4.4	The average employment in clusters by regional groups (I-IV), *thousand people*	$\bar{E}_{C_{gr\,i}} = \sum E_{C_{gr\,i}} \Big/ \sum C_{gr\,i}$	Group I: *16.1* Group II: *13.0* Group III: *7.6* Group IV: *5.1*
4.5	The average employment in PICs by regional groups (I-IV*), thousand people*	$\bar{E}^{PIC}_{gr\,i} = \sum E^{PIC}_{gr\,i} \Big/ \sum C^{PIC}_{gr\,i}$	Group I: *28.5* Group II: *21.8* Group III: *24.1* Group IV: *0.00*
4.6	The average employment in non-PICs by regional groups (I-IV), *thousand people*	$\bar{E}^{nonPIC}_{gr\,i} = \sum E^{nonPIC}_{gr\,i} \Big/ \sum C^{nonPIC}_{gr\,i}$	Group I: *10.3* Group II: *8.6* Group III: *5.5* Group IV: *5.1*
4.7	The average number of cluster initiatives with medium or high level of institutional development by regional groups (I-IV), *units*	$\bar{L}_{gr\,i} = \sum L_{gr\,i} \Big/ \sum C_{gr\,i}$	Group I: *0.26* Group II: *0.22* Group III: *0.15* Group IV: *0.00*
4.8	The average number of PICs with medium or high level of institutional development by regional groups (I-IV), *units*	$\bar{L}^{PIC}_{gr\,i} = \sum L^{PIC}_{gr\,i} \Big/ \sum C^{PIC}_{gr\,i}$	Group I: *0.67* Group II: *0.53* Group III: *0.67* Group IV: *0.00*
4.9	The average number of non-PICs with medium or high level of institutional development by regional groups (I-IV), *units*	$\bar{L}^{nonPIC}_{gr\,i} = \sum L^{nonPIC}_{gr\,i} \Big/ \sum C^{nonPIC}_{gr\,i}$	Group I: *0.08* Group II: *0.07* Group III: *0.09* Group IV: *0.00*

Notes: Calculation *1.1* shows the intensity of new cluster initiatives' emergence in PIC home regions and in other regions of Russia. Formula *1.2* specifies this comparison, taking into account only regions where there is at least one new cluster initiative; formulae *1.3* and *1.4* determine the shares of cluster initiatives which received no federal funding and remained active in the total number of cluster initiatives identified in 2008 and 2012, respectively; thus, we can see the survival rate of cluster initiatives not supported by the government; formulae *1.5* and *1.6* compare the qualitative characteristics of the PICs and other cluster initiatives that were not granted subsidies; in calculation *1.5*, cluster initiatives are compared by their employment; in calculation *1.6*, the comparison is made according to the institutional development level of PICs and non-PICs; to eliminate the influence of the temporal factor (cluster age), new cluster initiatives were excluded from these calculations; formulae *2.1* and *2.2* are used to calculate the average number of cluster initiatives identified in 2012 and 2015 in the regions neighbouring regions with previously established cluster initiatives; calculation *2.3* shows the intensity of new cluster initiatives' emergence in the regions bordering the regions where no cluster initiatives were identified from 2008 to 2015 with the databases used in our research; calculation *2.4* determines the average number of new cluster initiatives that appeared in the regions bordering the home regions of government-supported clusters; as discovered above, the intensity of new cluster emergence in PIC regions is higher than in others (calculations *1.1* and *1.2*); so, we made further calculations to see to what extent the proximity to PIC and non-PIC home regions influenced the emergence on new clusters (Formulae *2.5* and *2.6*); formulae *3.1.1.1-3.1.2.3* compare average employment and institutional development level of cluster initiatives identified in different periods: in 2008, 2012 and 2015; we also used those characteristics to compare the following pairs of cluster initiatives: PICs identified in 2008 and 2012 (calculations *3.2.1* and *3.2.2*); non-PICs identified in 2008 and 2012 (calculations *3.3.1* and *3.3.2*); non-PICs identified in 2008 and new cluster initiatives (calculations *3.4.1* and *3.4.2*); non-PICs identified in 2008 and PICs identified in 2012 (calculations *3.5.1* and *3.5.2*); calculations *4.1-4.3* show the average number of all cluster initiatives, PICs and non-PICs, distributed by their home locations' grouping according to the values of the RRII; in calculations *4.4-4.9*, employment and institutional development level in PICs and non-PICs located in different regional groups are compared

Appendix 4

Table AIII Initial data of the research

Indicator	*Description*	*Value*
$\sum R$	Total number of Russian regions, *units*	85
$\sum R_{PIC}$	Total number of home regions of pilot innovative clusters (PICs), *units*	21
$\sum R^{PIC}_{\min 1\ C^{2015}}$	Total number of PIC home regions with at least one new cluster initiative, *units*	7
$\sum R^{nonPIC}_{\min 1\ C^{2015}}$	Total number of non-PIC home regions with at least one new cluster initiative, *units*	14
$\sum C^{2015}_{R_{PIC}}$	Total number of new cluster initiatives located in PIC home regions, *units*	18
$\bar{C}^{2015}_{R_{PIC}}$	Average number of new cluster initiatives located in PIC home regions, *units*	0.85
$\sum C^{2015}_{R_{nonPIC}}$	Total number of new cluster initiatives located in non-PIC home regions, *units*	27
$\bar{C}^{2015}_{R_{nonPIC}}$	Average number of new cluster initiatives located in non-PIC home regions, *units*	0.42
$\bar{C}^{2015}_{R^{PIC}_{\min 1\ C^{2015}}}$	Average number of new cluster initiatives located in PIC home regions with at least one new cluster, *units*	2.57
$\bar{C}^{2015}_{R^{nonPIC}_{\min 1\ C^{2015}}}$	Average number of new cluster initiatives located in non-PIC home regions with at least one new cluster, *units*	1.92
$\sum C^{2008}$	Total number of cluster initiatives identified in 2008, *units*	169
$\sum C^{2008}_{2015}$	Total number of active cluster initiatives identified in 2008, *units*	37
$\sum C^{2008}_{PIC}$	Total number of PICs identified in 2008, *units*	14
$\sum C^{2008;NO\ applic.}_{2015}$	Total number of active cluster initiatives identified in 2008 which did not apply to the PIC support programme, *units*	16
$\sum C^{2012}$	Total number of cluster initiatives identified in 2012, *units*	62
$\sum C^{2012}_{2015}$	Total number of active cluster initiatives identified in 2012, *units*	24
$\sum C^{2012}_{PIC}$	Total number of PICs identified in 2012, *units*	13
$\sum C^{2008;2012}_{Applic.}$	Total number of cluster initiatives identified in 2008 and 2012 which applied to the PIC support programme, *units*	92
$\sum C^{2008;2012}_{PIC}$	Total number of PICs identified in 2008 and in 2012, *units*	27
$\sum C^{2008;2012}_{2015\ Applic.,\ nonPIC}$	Total number of active cluster initiatives identified in 2008 and 2012 which applied to the PIC support programme but lost, *units*	18
G (E)	Government support influence on the average employment in cluster initiatives, *units*	if $G > 1$, then there is influence, if $G < 1$, then there is no influence
G (L)	Government support influence on the level of institutional development in cluster initiatives, *units*	
$\bar{E}^{PIC}$	Average employment in PICs, *thousand people*	23.8
$\bar{E}^{nonPIC}$	Average employment in non-PICs (new cluster initiatives excluded), *thousand people*	7.8
L^{PIC}	The share of PICs with medium or high level of institutional development, *%*	58
L^{nonPIC}	The share of non-PICs with medium or high level of institutional development (new cluster initiatives excluded), *%*	7
$\sum R^{PIC}_{board.R^{2015}}$	Total number of PIC home regions bordering the regions of new cluster initiatives, *units*	17
$\sum R^{PIC}_{board.R^{2015}_{nonPIC}}$	Total number of PIC home regions bordering non-PIC home regions with new cluster initiatives, *units*	13
$\sum R^{nonPIC}_{board.R^{2015}_{nonPIC}}$	Total number of non-PIC home regions bordering other non-PIC home regions with new cluster initiatives, *units*	43

(*continued*)

Table AIII

Indicator	*Description*	*Value*
$\sum R^{2008}_{board.R^{2012}}$	Total number of regions with cluster initiatives identified in 2008 bordering the regions with cluster initiatives identified in 2012, *units*	47
$\sum R^{2008;\ 2012}_{board.R^{2015}}$	Total number of regions with cluster initiatives identified in 2008 and 2012 bordering the regions with new cluster initiatives, *units*	69
$\sum R^{non\ C}_{board.R^{2015}}$	Total number of regions with no cluster initiatives ever identified bordering the regions with new cluster initiatives, *units*	7
$\sum C^{2012}_{R.\ board.R.^{2008}}$	Total number of cluster initiatives identified in 2012 located in the regions bordering the regions where cluster initiatives were identified in 2008, *units*	197
$\sum C^{2015}_{R.board.R.^{2008;2012}}$	Total number of new cluster initiatives located in the regions bordering the regions where cluster initiatives were identified in 2008 and 2012, *units*	245
$\sum C^{2015}_{R.\ board.\ R^{PIC}}$	Total number of new cluster initiatives located in the regions bordering the PIC home regions, *units*	72
$\sum C^{2015}_{RnonPICboard.\ R^{PIC}}$	Total number of new cluster initiatives located in the non-PIC home regions bordering the PIC home regions, *units*	32
$\sum C^{2015}_{R^{nonPIC}board.\ R^{nonPIC}}$	Total number of new cluster initiatives located in the non-PIC home regions bordering the non-PIC home regions, *units*	142
$\sum C^{2015}_{R.board.\ R^{nonC}}$	Total number of new cluster initiatives located in the regions bordering the regions with no cluster initiatives ever identified, *units*	5
T(E) T(L)	Cluster age influence on the average employment in cluster initiatives Cluster age influence on the level of institutional development in cluster initiatives	if $T < 1$, then there is influence, if $T > 1$, then there is no influence
$\bar{E}^{2008}$	Average employment in cluster initiatives identified in 2008, *thousand people*	16.7
$\bar{E}^{2012}$	Average employment in cluster initiatives identified in 2012, *thousand people*	16.9
$\bar{E}^{2015}$	Average employment in new cluster initiatives, *thousand people*	7.3
$\bar{E}^{2008}_{PIC}$	Average employment in PICs identified in 2008, *thousand people*	29,0
$\bar{E}^{2012}_{PIC}$	Average employment in PICs identified in 2012, *thousand people*	19.3
$\bar{E}^{2008}_{nonPIC}$	Average employment in non-PICs identified in 2008, *thousand people*	6.9
$\bar{E}^{2012}_{nonPIC}$	Average employment in non-PICs identified in 2012, *thousand people*	12.6
L^{2008}	The share of cluster initiatives identified in 2008 with medium or high level of institutional development, %	40
L^{2012}	The share of cluster initiatives identified in 2012 with medium or high level of institutional development, %	25
L^{2015}	The share of new cluster initiatives with medium or high level of institutional development, %	9
L^{2008}_{PIC}	The share of PICs identified in 2008 with medium or high level of institutional development, %	82
L^{2012}_{PIC}	The share of PICs identified in 2012 with medium or high level of institutional development, %	38
L^{2008}_{nonPIC}	The share of non-PICs identified in 2008 with medium or high level of institutional development, %	7
L^{2012}_{nonPIC}	The share of non-PICs identified in 2012 with medium or high level of institutional development, %	0
$\sum R_{gr\ I}$	Total number of Group I regions (by RRII value), *units*	3
$\sum R_{gr\ II}$	Total number of Group II regions (by RRII value), *units*	29
$\sum R_{gr\ III}$	Total number of Group III regions (by RRII value), *units*	40
$\sum R_{gr\ IV}$	Total number of Group IV regions (by RRII value), *units*	11

(*continued*)

Table AIII

Indicator	*Description*	*Value*
$\sum C_{gr\ I}$	Total number of cluster initiatives in Group I regions, *units*	19
$\sum C_{gr\ II}$	Total number of cluster initiatives in Group II regions, *units*	45
$\sum C_{gr\ III}$	Total number of cluster initiatives in Group III regions, *units*	26
$\sum C_{gr\ IV}$	Total number of cluster initiatives in Group IV regions, *units*	1
$\sum C^{PIC}_{gr\ I}$	Total number of PICs in Group I regions, *units*	6
$\sum C^{PIC}_{gr\ II}$	Total number of PICs in Group II regions, *units*	15
$\sum C^{PIC}_{gr\ III}$	Total number of PICs in Group III regions, *units*	3
$\sum C^{PIC}_{gr\ IV}$	Total number of PICs in Group IV regions, *units*	0
$\sum C^{nonPIC}_{gr\ I}$	Total number of non-PICs in Group I regions, *units*	13
$\sum C^{nonPIC}_{gr\ II}$	Total number of non-PICs in Group II regions, *units*	30
$\sum C^{nonPIC}_{gr\ III}$	Total number of non-PICs in Group III regions, *units*	23
$\sum C^{nonPIC}_{gr\ IV}$	Total number of non-PICs in Group IV regions, *units*	1
$\sum E_{C_{gr\ I}}$	Total employment in cluster initiatives in Group I regions, *thousand people*	305.49
$\sum E_{C_{gr\ II}}$	Total employment in cluster initiatives in Group II regions, *thousand people*	585.16
$\sum E_{C_{gr\ III}}$	Total employment in cluster initiatives in Group III regions, *thousand people*	198.67
$\sum E_{C_{gr\ IV}}$	Total employment in cluster initiatives in Group IV regions, *thousand people*	5.12
$\sum E^{PIC}_{gr\ I}$	Total employment in PICs in Group I regions, *thousand people*	171.04
$\sum E^{PIC}_{gr\ II}$	Total employment in PICs in Group II regions, *thousand people*	327.38
$\sum E^{PIC}_{gr\ III}$	Total employment in PICs in Group III regions, *thousand people*	72.27
$\sum E^{PIC}_{gr\ IV}$	Total employment in PICs in Group IV regions, *thousand people*	0.0
$\sum E^{nonPIC}_{gr\ I}$	Total employment in non-PICs in Group I regions, *thousand people*	134.45
$\sum E^{nonPIC}_{gr\ II}$	Total employment in non-PICs in Group II regions, *thousand people*	257.78
$\sum E^{nonPIC}_{gr\ III}$	Total employment in non-PICs in Group III regions, *thousand people*	126.39
$\sum E^{nonPIC}_{gr\ IV}$	Total employment in non-PICs in Group IV regions, *thousand people*	5.12
$\sum L_{gr\ I}$	Total number of cluster initiatives with medium or high level of institutional development in Group I regions, *units*	5
$\sum L_{gr\ II}$	Total number of cluster initiatives with medium or high level of institutional development in Group II regions, *units*	10
$\sum L_{gr\ III}$	Total number of cluster initiatives with medium or high level of institutional development in Group III regions, *units*	4
$\sum L_{gr\ IV}$	Total number of cluster initiatives with medium or high level of institutional development in Group IV regions, *units*	0
$\sum L^{PIC}_{gr\ I}$	Total number of PICs with medium or high level of institutional development in Group I regions, *units*	4
$\sum L^{PIC}_{gr\ II}$	Total number of PICs with medium or high level of institutional development in Group II regions, *units*	8
$\sum L^{PIC}_{gr\ III}$	Total number of PICs with medium or high level of institutional development in Group III regions, *units*	2
$\sum L^{PIC}_{gr\ IV}$	Total number of PICs with medium or high level of institutional development in Group IV regions, *units*	0
$\sum L^{nonPIC}_{gr\ I}$	Total number of non-PICs with medium or high level of institutional development in Group I regions, *units*	1
$\sum L^{nonPIC}_{gr\ II}$	Total number of non-PICs with medium or high level of institutional development in Group II regions, *units*	2
$\sum L^{nonPIC}_{gr\ III}$	Total number of non-PICs with medium or high level of institutional development in Group III regions, *units*	2
$\sum L^{nonPIC}_{gr\ IV}$	Total number of non-PICs with medium or high level of institutional development in Group IV regions, *units*	0