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Article

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Evolution and Structure of Public and Private Funding of Clusters in Europe: Results of Three Original Independent Questionnaire Surveys

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Abstract

Data collected from three self-administered questionnaire surveys conducted in 2011, 2016, and 2022 are used in this scientific paper. The paper aims to analyse the revenue structure of European clusters and focus on identifying possible differences in their funding in 2011, 2016, and 2022. Over eleven years, the revenue structure of clusters has changed to some extent, and the evolution and extent of these changes are the subjects of this paper. At the same time, it is necessary to determine whether the relatively high level of dependence of European clusters on public resources continues to persist, decreases, or increases over time. The results show that the differences in the funding of the clusters studied in the selected years are statistically significant. The share of public and private funds has varied particularly over the last five years, and the share of public resources in cluster budgets has been steadily increasing. When comparing the shares of different public and private funding types, significant differences were observed for most clusters during the period under review. One of the few resources that have had a constant representation in cluster budgets over the whole period is the EU Structural Funds and Community Programmes, whose share in the budgets of European clusters has fluctuated only slightly, according to our statistical survey. Similarly, there has been no change in the share of credit instruments, such as bank loans, in cluster budgets. This share is consistently meagre in all three questionnaire surveys, which means that European clusters hardly use this funding source.

Keywords

Clusters, Cluster Policies, Financing Clusters, Public/Private Resources, Financial Structure

JEL Classification

O31, O38, R58

Introduction

The topic of the advantages of spatial agglomerations has been analysed since the late 19th century in the works of Alfred Marshall (Cumbers and MacKinnon, 2004; Andini et al., 2013; Ehrl, 2013; Bezkhlibna et al., 2018). However, Bahlmann a Huysman (2008) state that in order to properly understand the concept of clusters, it is helpful to consider several key insights that have shaped cluster theory into its current form. The pioneering work of Marshall (1890, 1920) was followed by Jacobs (1970) and several Italian authors, especially Becattini (the late 1970s), forming the so-called "Italian School of Industrial Districts", followed by the work of Piore and Sabel (1984), the work of the so-called GREMI (Groupe de Recherche Européen sur les Milieux Innovateurs), of which Aydalot (1984) was the founder and leader. Nevertheless, the topic of clusters, cluster initiatives, and cluster policies has become a subject of great interest to the professional public, mainly as a result of the publication of Michael Porter's book *The Competitive Advantage of the Nations* (Porter, 1990).

In his subsequent papers, Porter developed the concept of clusters in more detail (1998, 2003). Since then, research studies dealing with clusters, their funding, and various other aspects have been growing in numbers. Clusters have gradually received even more attention from practitioners and policymakers. As noted by Martin, Mayer, and Mayneris (2011), industrial clusters are prevalent among policymakers; and during the last three decades, national and local governments have attempted to foster their development. Supporting the development of clusters through their funding has been the focus of many studies, particularly since 2003, which, among other factors, have looked at the structure of public and private financing of clusters. These studies included (Sölvell et al., 2003; OECD, 2007; and Lindqvist et al., 2013) or concentrated on surveying finance, predominantly in European

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countries (Oxford Research AS, 2008; Barsoumian et al., 2011; Lämmer-Gamp et al., 2011; Müller et al., 2012; Meier zu Köcker and Müller, 2015). Other studies analysed clusters and their support in groups of countries which are somewhat specific and demonstrate some common features which frequently distinguish them from others (Ketels and Sölvell, 2006, dealing with clusters in the EU-10 new member countries, or Ketels et al., 2006, exploring clusters in developing and transition economies; Kergel et al. (2018), particularly clusters in the Danube Region). Similarly, some of the research studies were mainly concerned with financing clusters in some selected European countries (Hantsch et al., 2013), regarding clusters in Germany, France, and Norway. Okamuro and Nishimura (2015) compared Germany, France, and Japan; Hantsch et al. (2015) studied ICT clusters from Mexico, Germany, Poland, and Spain), Sölvell and Williams (2013) clusters in Sweden, and Buhl et al. (2019) clusters in Germany. In contrast, Sedlmayr et al. (2021) examined cluster financing in four broad regions (the Middle East/North Africa, EU 27, Latin America, and Middle East Asia).

These and numerous other studies have dealt with the issues of the best suitable methods of cluster funding, the shares of public and private funds in cluster budgets, the amounts of financial support from public funds, and the levels from which clusters should be supported (whether a local, regional, national or international level), the methods of creating an optimum cluster programme, and the appropriate length of government cluster support. Simultaneously, many authors have since criticised cluster theory (Martin and Sunley, 2003) or at least pointed out the potential risks in inefficient spending of support in the implementation of cluster policies, such as Maier and Trippel (2012) or Stejskal and Hájek (2012).

Empirical Research on Cluster Financing

In the last ten years, several interesting studies have been produced on the structure of cluster budgets and organisations. Among the most interesting and significant are the following:

Lindqvist et al. (2013), using the data from The Global Cluster Initiative Survey, examined 356 clusters and cluster initiatives from 50 countries. A majority are found in the OECD countries. Two hundred fifty-four are found in Europe. The survey was a follow-up to a similar survey by the same authors conducted in 2003. It can be said that despite the slightly different categorisation of financial resources, which was narrower and more specific in 2013 than in 2003, the proportion of public and private funds in cluster funding over those ten years did not change. The role of the public sector and financial support from public resources continued to be particularly important for the functioning of clusters and cluster initiatives in the OECD countries in 2013.

Table 1. Share of public and private funding in the total budget of clusters.

	Lindqvist et al. (2013)			Hantsch et al. (2013)			Hantsch et al. (2015)			
	Respondents from 50 countries			Germany	France	Norway	Mexico	Germany	Poland	Spain
Number of clusters	356			60	71	10	13	17	8	17
Public resources	54%			41%	59%	69%	38%	37%	40%	35%
	National	Regional / Local	International							
	18%	23%	13%							
Membership fees	26%			28%	18%	23%	27%	36%	27%	40%
Chargeable services	8%			22%	8%	1%	16%	20%	5%	12%
Other private resources	12%			9%	15%	7%	19%	7%	28%	13%
Private resources	46%			59%	41%	31%	62%	63%	60%	65%

Source: Own elaboration based on Lindqvist et al. (2013), Hantsch et al. (2013), and Hantsch et al. (2015).

Similar scientific research conducted by Hantsch et al. (2013) analysed various aspects of cluster operations in Germany, France, and Norway, including their sources of revenue. The analysis was based on the results of benchmarking activities of the European Secretariat for Cluster Analysis. As cluster initiatives are usually established through public co-funding, there is an intense ongoing debate on how much public funding should be recommended and for what length of time. European countries follow quite different approaches. In 2013, German clusters had significantly less public funding within their budgets than French clusters, proportionally 41% to 59%. On the contrary, revenues from membership fees and chargeable services were more represented in their budgets.

Hantsch et al. (2015) conducted a similar but smaller survey comparing the funding of ICT clusters from Mexico,

Germany, Poland, and Spain. The number of clusters participating in the survey (those operating in the ICT sector) was lower than in the previous two surveys. Compared to the previous surveys, the share of public resources in cluster budgets has again decreased slightly. The authors state that although many cluster organisations indeed were established with significant public support, they are aware that due to the public support being mostly limited in time, it is crucial for cluster management to tap other sources of financing. The substitution of public funding by private means over time can indicate good cluster management practices as products and services are sold to cluster participants or other parties.

Kergel et al. (2018) created a study entitled "Cluster Management Excellence in the Danube Region – Pan-European Snapshot of the Current Status of Cluster Development", in which, among other things, they compared the funding structure of cluster organisations in the European Union countries and Norway with countries in the Danube Region. The Danube Region in this study covered ten countries: Austria, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Romania, Bulgaria, Serbia, Montenegro, and the two German regions of Baden-Württemberg and Bavaria. The entire region is home to a total of 82 cluster initiatives, benchmarked between March 2016 and March 2018. The second comparison group comprised 234 benchmarked clusters from the EU's 28 Members States and Norway. They were benchmarked during the same period as the cluster initiatives from the Danube Region. Comparing both portfolios reveals the different conditions in which cluster initiatives operate. EU28 cluster initiatives, on average, receive 44% of public funding, compared to 29% in the Danube Region. The share of membership fees and chargeable services is similar, whereas cluster managements in the Danube Region succeeded in attracting more private funding sources than their EU28 peers. These findings point out that cluster initiatives in the EU28 are significantly more dependent on public funding than those in the Danube Region. It also suggests that some countries in the Danube Region may not have optimal access to public funding. However, comparing these findings with 2013 (notably with similar extensive research by Lindqvist et al., 2013) shows a significant decline in the overall share of public funding over the last five years.

Buhl et al. (2019) investigated cluster financing in Germany using a sample of 105 clusters. Data collection took place in 2017 and 2018. The share of public and private resources in the budgets of German clusters remained almost unchanged compared to the 2013 research (Hantsch et al., 2013). This also shows that the support of clusters in Germany is steady and stable, which is incredibly positive for the clusters.

Sedlmayr et al. (2021) examined cluster financing in four broad regions. The financial sources and their composition varied significantly from region to region. The European Secretariat for Cluster Analyses (ESCA) continuously benchmarks and measures indicators relevant to cluster development. The figures indicate typical financing patterns for clusters around the world. Cluster development in the Middle East/North Africa region started in 2010 and was strongly subsidised by third-party donors. Even ten years later, there were still high public funding streams involved. Private financing through membership and/or service fees plays a minor role. These figures align well with the first findings from the Cluster Observatory Africa. Cluster development in the EU 27 has been high on the policy agenda for many years. Thus, the public financing share is comparably high. Private funding streams play a vital role as well. Clusters in Latin America are considerably less publicly supported than clusters in the EU27.

On the contrary, the structure of their private funding (membership fees, chargeable services, and other private sources) is relatively balanced, positively impacting the financial stability of clusters in the region. Public support for cluster development in Middle East Asia is higher than in Latin America. While private financing by membership fees and chargeable services is relatively low, other private resources account for a sizeable proportion of the financing portfolio.

Table 2. Share of public and private funding in the total budget of clusters.

	Kergel et al. (2018)		Buhl et al. (2019)	Sedlmayr et al. (2021)			
	Danube Region	EU 28 and Norway	Germany	Middle East/ North Africa	EU 27	Latin America	Middle East Asia
Number of clusters	82	234	105	420 clusters (a total in all surveys)			
Public resources	29%	44%	40%	58%	52%	31%	39%
Membership fees	25%	26%	30%	3%	21%	25%	13%
Chargeable services	15%	14%	18%	1%	14%	23%	7%
Other private resources	31%	16%	12%	38%	13%	21%	41%
Private resources	71%	56%	60%	42%	48%	69%	61%

Source: Own elaboration based on Kergel et al. (2018), Buhl et al. (2019), and Sedlmayr et al. (2021).

Methodology and Determination of Hypotheses

The data included in this paper were collected in three independent questionnaire surveys conducted in 2011, 2016 and 2022. European clusters were asked the same questions about their funding in all three questionnaire surveys.

The first self-initiated empirical investigation was based on extensive primary research. A survey was conducted during the year 2011. In total, 834 clusters from 32 European countries were addressed, and a total of 125 cluster representatives correctly responded to the questionnaires. The overall response rate was 14.99%. Primarily, it was the facilitators of the clusters that were interviewed. The majority of responses were received from the cluster representatives in the Czech Republic (17), Germany and Slovakia (14), Hungary (12), Sweden (8), Denmark (7) and Spain (6). Four responses came from each cluster in Austria, Italy, Norway, Poland, Romania, Switzerland, and the UK. Three responses per cluster were obtained from the Netherlands and Lithuania, and the other European countries delivered only a maximum of two responses.

The second in-house empirical investigation was based on extensive primary research too. Data were obtained from an independent questionnaire survey conducted in the first half of 2016. The goal of the survey was to determine the budget structure of the clusters in question and the proportion of public and private funds in their financing. Out of 29 European countries, a total of 1,017 clusters were invited to participate in the survey. 119 completed questionnaires were obtained, and the response rate was 11.70%. The most significant numbers of correctly filled questionnaires were recorded in the Czech Republic (13); Poland (11); Germany, Slovakia, Spain, and Sweden (10 each); Hungary (7); Norway and Italy (6 each); Austria, Switzerland, and the UK (5 each); and Bulgaria, Denmark, Romania, and Slovenia (4 each). Clusters from other European countries delivered only two, one or no responses.

A third independent survey took place in the first half of 2022. 1,403 clusters from 33 European countries were contacted, and 182 responses were completed correctly, resulting in a return rate of 12.97%. The highest number of correctly completed questionnaires came from Germany (20), Slovakia (19), Spain (14), Czech Republic (13), Belgium and Italy (9 each), Norway and Poland (8 each), Hungary, Lithuania, Romania and Sweden (7 each), Bulgaria, France (6 each), Denmark, Austria and the Netherlands (5 each), Latvia, Greece, and Slovenia (4 each), and Serbia, Portugal, Ireland (3 each). A maximum of two correctly completed questionnaires were received from the other countries addressed.

Based on the literature by Sölvell et al. (2003), Ketels and Sölvell (2006), Barsoumian et al. (2011), Lindqvist et al. (2013), Hantsch et al. (2013), Meier zu Köcker and Müller (2015), Urbančíková and Burger (2016), Burger et al. (2017), Kergel et al. (2018), Strelcová and Janasová (2018), Buhl et al. (2019), and Sedlmayr et al. (2021), eight possible funding sources have been included in the questionnaire. Different funding options were classified as public or private resources (see Table 3). In the questionnaire surveys, clusters indicated which sources make up the revenues in their annual budgets. They also indicated what percentage each funding source made up of the cluster's total annual budget, while the total amount of all funding sources for the cluster was set at 100%. Clusters were also offered the possibility of selecting "other sources" without closely specifying which source of financing it was. Despite having that possibility, none of the clusters decided on such an option.

Table 3. Funding sources included in the questionnaire.

Public resources	EU Structural Funds and Community Programmes (EU funds to finance cluster activities)
	National subsidies and grants (national/governmental funds)
	Regional subsidies and grants (regional funds, including state level in case of federal states)
	Local subsidies and grants (municipal funds)
Private resources	Membership fees of cluster members
	Cluster revenues from own activities
	Credit funds – bank loans
	Venture capital, business angels, and donor contributions

Source: Own elaboration.

The theoretical framework and previous empirical studies led to the evaluation of the following hypotheses. The hypotheses align with the paper's aim to identify possible European cluster funding differences.

- *Hypothesis 1: There is no statistically significant difference in the use of public and private resources in financing clusters between the results of the questionnaire surveys in 2011, 2016 and 2022.*
- *Hypothesis 2: There are no statistically significant differences in the structure of public and private resources in financing clusters when comparing the questionnaire surveys conducted in 2011, 2016 and 2022.*

Hypothesis testing and detecting the presence of statistically significant differences in the financial structure of cluster budgets is conducted through the Kruskal-Wallis test, followed by pairwise comparisons using the Mann-

Whitney test with Bonferroni correction.

The Kruskal-Wallis test is considered a non-parametric alternative to the single-factor analysis of variance. It compares medians of more than two independent populations providing that the conditions for the use of classical parametric analysis of variance are not met. The Kruskal-Wallis test requires neither the fulfilment of the condition for statistical homogeneity of variance nor the normality of distribution. If the null hypothesis is rejected, there is a difference between at least one of the pairs of medians (Sheskin, 2007; Hudec et al., 2007; Urbančíková and Burger, 2016). After rejecting the null hypothesis in the Kruskal-Wallis test, a post hoc test is performed, i.e. the Mann-Whitney test with Bonferroni inequality correction. The Mann-Whitney U-test belongs to more powerful non-parametric tests, converting the scores on the continuous variable to ranks across the two groups (Civelek et al. 2020). The significance level is corrected with Bonferroni correction (Field, 2005; Monroe, 2006) to minimise type II errors.

Evaluation of the Results

From the basic descriptive statistics, it is possible to see a trend in the funding of European clusters since 2011 while seriously considering the limitations of a questionnaire survey of this kind. The share of public and private resources in the annual budgets of clusters has varied from a fairly even ratio of 48.24% to 51.76% in 2011 through a reasonably strong predominance of private resources of 57.18% to 42.82% in 2016 to the current predominance of public resources in the annual budgets of clusters of 54.78% to 45.22% in 2022. The share of some funding sources in the annual budgets of clusters has changed only minimally over the last 11 years. For instance, the share of EU Structural Funds and Community Programmes in the clusters studied was 25.44% in 2011, 24.29% in 2016, and 25.99% in 2022. On the contrary, the share of the cluster's income generated from chargeable activities (i.e. obtained by selling products and providing services) was only 10.96% in 2011, whereas it rose to 25.13% in 2016 and has remained at the level of 16.07% of the total income available to the cluster throughout 2022.

Table 4. Descriptive statistics (% ratios).

	Research in 2011 (125 respondents)				Research in 2016 (119 respondents)				Research in 2022 (182 respondents)			
	Mean	Std. dev	Min	Max	Mean	Std. dev	Min	Max	Mean	Std. dev	Min	Max
Public resources	48.24	32.653	0	100	42.82	31.087	0	100	54.78	27.421	0	100
Private resources	51.76	32.653	0	100	57.18	31.087	0	100	45.22	27.421	0	100
EU Structural Funds and Community Programmes	25.44	27.635	0	100	24.29	27.412	0	100	25.99	27.804	0	100
National subsidies and grants	6.88	12.009	0	50	6.51	9.991	0	40	14.26	20.468	0	100
Regional subsidies and grants	9.32	17.290	0	70	7.23	10.571	0	65	12.34	19.230	0	100
Local subsidies and grants	6.60	15.471	0	100	4.79	6.324	0	40	2.20	6.316	0	25
Membership fees of cluster members	39.84	32.897	0	100	23.99	15.779	0	70	27.20	24.727	0	100
Cluster revenues from own activities	10.96	14.448	0	70	25.13	19.533	0	80	16.07	18.843	0	100
Credit funds – bank loans	0.88	4.402	0	40	1.13	5.691	0	50	0.55	3.402	0	35
Venture capital, business angels, and donor contributions	0.08	0.894	0	10	6.93	16.157	0	80	1.40	6.402	0	60

Source: Own elaboration based on three self-administered questionnaire surveys.

Whether the differences in cluster funding are statistically significant, either in terms of the breakdown into public and private funds in cluster budgets (Hypothesis 1) or the individual types of public and private resources in cluster budgets (Hypothesis 2), was investigated employing the Kruskal-Wallis test. After the rejection of H_0 in this test, post hoc Mann-Whitney tests with Bonferroni correction were used.

Kruskal-Wallis test

$H_0: \mu_1 = \mu_2 = \mu_3$

$H_1: \text{non } H_0$

The Kruskal-Wallis test has clearly demonstrated statistically significant differences at the 0.05 significance level between the clusters that participated in the 2011, 2016, and 2022 questionnaire surveys for most of the public or private funds examined. There are also statistically significant differences between the share of public and private resources (as per the wording of Hypothesis 1). Among the diverse types of financial sources, there are no

statistically significant differences at the 0.05 level of significance in public resources regarding the EU Structural Funds and Community Programmes and subsidies and grants from the regional level. In private resources, there are no statistically significant differences between clusters, only in credit instruments such as bank loans, the use of which was deficient among clusters in all three surveys (2011, 2016 and 2022). There are statistically significant differences in other types of public or private funding. Pairwise comparisons using Mann-Whitney tests with Bonferroni correction were used to assess where precisely the statistically significant differences for each type of funding occurred (in which years of the survey).

Table 5. Comparison of the share of diverse types of public and private funds in the annual clusters' budgets in 2011, 2016 and 2022 questionnaire surveys.

Comparison of the share of the selected resource in the annual budgets of clusters	Classification of clusters according to the year of the questionnaire survey	Number of clusters	Mean rank	Minimum significance level for the rejection of the null hypothesis	
Public resources	Clusters in the 2011 questionnaire survey	125	209.78	p-value	0.006
	Clusters in the 2016 questionnaire survey	119	187.24		
	Clusters in the 2022 questionnaire survey	182	233.22		
	Total	426			
0.006 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					
Private resources	Clusters in the 2011 questionnaire survey	125	217.22	p-value	0.006
	Clusters in the 2016 questionnaire survey	119	239.76		
	Clusters in the 2022 questionnaire survey	182	193.78		
	Total	426			
0.006 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					
EU Structural Funds and Community Programmes	Clusters in the 2011 questionnaire survey	125	209.92	p-value	0.645
	Clusters in the 2016 questionnaire survey	119	207.68		
	Clusters in the 2022 questionnaire survey	182	219.76		
	Total	426			
0.645 > 0.05 H0 is not rejected					
National subsidies and grants	Clusters in the 2011 questionnaire survey	125	190.01	p-value	0.001
	Clusters in the 2016 questionnaire survey	119	203.27		
	Clusters in the 2022 questionnaire survey	182	236.32		
	Total	426			
0.001 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					
Regional subsidies and grants	Clusters in the 2011 questionnaire survey	125	195.17	p-value	0.084
	Clusters in the 2016 questionnaire survey	119	218.15		
	Clusters in the 2022 questionnaire survey	182	223.05		
	Total	426			
0.084 > 0.05 H0 is not rejected					
Local subsidies and grants	Clusters in the 2011 questionnaire survey	125	216.35	p-value	0.000
	Clusters in the 2016 questionnaire survey	119	245.83		
	Clusters in the 2022 questionnaire survey	182	190.40		
	Total	426			
0.000 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					
Membership fees of cluster members	Clusters in the 2011 questionnaire survey	125	245.34	p-value	0.003
	Clusters in the 2016 questionnaire survey	119	200.54		
	Clusters in the 2022 questionnaire survey	182	200.10		
	Total	426			
0.003 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					
Cluster revenues from own activities	Clusters in the 2011 questionnaire survey	125	169.30	p-value	0.000
	Clusters in the 2016 questionnaire survey	119	272.58		
	Clusters in the 2022 questionnaire survey	182	205.22		
	Total	426			
0.000 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					
Credit funds – bank loans	Clusters in the 2011 questionnaire survey	125	214.92	p-value	0.657
	Clusters in the 2016 questionnaire survey	119	215.61		
	Clusters in the 2022 questionnaire survey	182	211.15		
	Total	426			
0.657 > 0.05 H0 is not rejected					
Venture capital, business angels, and donor contributions	Clusters in the 2011 questionnaire survey	125	187.66	p-value	0.000
	Clusters in the 2016 questionnaire survey	119	254,58		
	Clusters in the 2022 questionnaire survey	182	204,39		
	Total	426			
0.000 < 0.05 H0 is rejected – it is necessary to conduct a post hoc test					

Source: Own elaboration.

Mann-Whitney tests with Bonferroni correction

$$\begin{array}{lll}
 H_0: \mu_1 = \mu_2 & H_0: \mu_1 = \mu_3 & H_0: \mu_2 = \mu_3 \\
 H_1: \mu_1 \neq \mu_2 & H_1: \mu_1 \neq \mu_3 & H_1: \mu_2 \neq \mu_3
 \end{array}$$

Table 6. Pairwise comparison of the share of public and private funds in the annual clusters' budgets in 2011, 2016 and 2022 questionnaire surveys.

Comparison of the share of the selected resource in the annual budgets of clusters	Year of survey	Number of clusters	Mean rank	Minimum significance level for the rejection of the null hypothesis		
Public resources	Clusters in the 2011 questionnaire survey	125	128.38	p-value	0.180	
	Clusters in the 2016 questionnaire survey	119	116.32			
	Total	244				
	0.180 > 0.016667 H0 is not rejected					
	Clusters in the 2011 questionnaire survey	125	144.40	p-value	0.115	
	Clusters in the 2022 questionnaire survey	182	160.59			
	Total	307				
	0.115 > 0.016667 H0 is not rejected					
	Clusters in the 2016 questionnaire survey	119	130.92	p-value	0.001	
	Clusters in the 2022 questionnaire survey	182	164.13			
	Total	301				
	0.001 < 0.016667 H0 is rejected – significant difference					
Private resources	Clusters in the 2011 questionnaire survey	125	116.62	p-value	0.180	
	Clusters in the 2016 questionnaire survey	119	128.68			
	Total	244				
	0.180 > 0.016667 H0 is not rejected					
	Clusters in the 2011 questionnaire survey	125	163.60	p-value	0.115	
	Clusters in the 2022 questionnaire survey	182	147.41			
	Total	307				
	0.115 > 0.016667 H0 is not rejected					
	Clusters in the 2016 questionnaire survey	119	171.08	p-value	0.001	
	Clusters in the 2022 questionnaire survey	182	137.87			
	Total	301				
	0.001 < 0.016667 H0 is rejected – significant difference					

Source: Own elaboration.

Statistically significant differences between clusters participating in the questionnaire surveys were observed for public and private funds only between the last two surveys in 2016 and 2022. Since the clusters in the 2016 questionnaire survey had predominantly private resources in their budgets (57.18% to 42.82%), and the clusters in the 2022 survey had predominantly public resources in their budgets (54.78% to 45.22%), statistically significant differences in funding between the clusters participating in the two questionnaire surveys had been expected.

Mann-Whitney tests with Bonferroni correction

$$\begin{array}{lll}
 H_0: \mu_1 = \mu_2 & H_0: \mu_1 = \mu_3 & H_0: \mu_2 = \mu_3 \\
 H_1: \mu_1 \neq \mu_2 & H_1: \mu_1 \neq \mu_3 & H_1: \mu_2 \neq \mu_3
 \end{array}$$

One primary reason for the growth in the share of public funds in clusters' budgets is the statistically significant increase in the share of subsidies and grants from the national level. While in 2011 and 2016, the share of national subsidies and grants in cluster budgets was less than 7%, it was 14.26% in 2022. This difference between the national support for clusters at the moment (2022) and that observed in the previous surveys (2011 and 2016) is statistically significant.

Conversely, subsidies and grants from the local level have been declining over time. Their share in cluster budgets in 2022 is statistically significantly lower than in 2011 and 2016, accounting for only a third of the original amount in 2011.

Further considerable and statistically significant differences in cluster budgets were observed for three out of the four types of private funds. Membership fees of individual cluster members have traditionally been one of the critical sources of revenue for almost every cluster. In 2011, the share of cluster membership fees was almost 40%. In subsequent questionnaire surveys, this share dropped to 23.99% in 2016 and 27.20% in 2022. There are statistically significant differences between cluster membership fees in the questionnaire survey in 2011 compared with 2016 and 2022. However, no statistically significant differences were found when comparing the share of membership fees in cluster budgets between 2016 and 2022.

The share of clusters' own revenues has varied over time as well. It reached a record high in the 2016 questionnaire survey (25.13%). It was considerably lower in both 2011 and 2022 (and even lower in 2011 than 2022), and therefore statistically significant differences were also identified for all three mutual comparisons.

Table 7. Pairwise comparison of the share of diverse types of public and private funds in the annual clusters' budgets in 2011, 2016 and 2022 questionnaire surveys.

Comparison of the share of the selected source of funding in the annual clusters' budgets	Year of survey	Number of clusters	Mean rank	Minimum significance level for the rejection of the null hypothesis		
National subsidies and grants	Clusters in the 2011 questionnaire survey	125	118.46			
	Clusters in the 2016 questionnaire survey	119	126.74	p-value	0.292	
	Total	244				
	0.292 > 0.016667 H0 is not rejected					
	Clusters in the 2011 questionnaire survey	125	134.55			
	Clusters in the 2022 questionnaire survey	182	167.36	p-value	0.000	
	Total	307				
	0.000 < 0.016667 H0 is rejected: significant difference					
	Clusters in the 2016 questionnaire survey	119	136.53			
	Clusters in the 2022 questionnaire survey	182	160.46	p-value	0.012	
Total	301					
0.012 < 0.016667 H0 is rejected: significant difference						
Local subsidies and grants	Clusters in the 2011 questionnaire survey	125	115.41			
	Clusters in the 2016 questionnaire survey	119	129.95	p-value	0.061	
	Total	244				
	0.061 > 0.016667 H0 is not rejected					
	Clusters in the 2011 questionnaire survey	125	173.94			
	Clusters in the 2022 questionnaire survey	182	137.17	p-value	0.006	
	Total	307				
	0.006 < 0.016667 H0 is rejected: significant difference					
	Clusters in the 2016 questionnaire survey	119	175.88			
	Clusters in the 2022 questionnaire survey	182	134.73	p-value	0.000	
Total	301					
0.000 < 0.016667 H0 is rejected: significant difference						
Membership fees of cluster members	Clusters in the 2011 questionnaire survey	125	135.70			
	Clusters in the 2016 questionnaire survey	119	108.63	p-value	0.003	
	Total	244				
	0.003 < 0.016667 H0 is rejected – significant difference					
	Clusters in the 2011 questionnaire survey	125	172.64			
	Clusters in the 2022 questionnaire survey	182	141.20	p-value	0.002	
	Total	307				
	0.002 < 0.016667 H0 is rejected – significant difference					
	Clusters in the 2016 questionnaire survey	119	151.91			
	Clusters in the 2022 questionnaire survey	182	150.40	p-value	0.883	
Total	301					
0.883 > 0.016667 H0 is not rejected						
Cluster revenues from own activities	Clusters in the 2011 questionnaire survey	125	94.26			
	Clusters in the 2016 questionnaire survey	119	152.16	p-value	0.000	
	Total	244				
	0.000 < 0.016667 H0 is rejected – significant difference					
	Clusters in the 2011 questionnaire survey	125	138.04			
	Clusters in the 2022 questionnaire survey	182	164.96	p-value	0.007	
	Total	307				
	0.007 < 0.016667 H0 is rejected – significant difference					
	Clusters in the 2016 questionnaire survey	119	180.42			
	Clusters in the 2022 questionnaire survey	182	131.76	p-value	0.000	
Total	301					
0.000 < 0.016667 H0 is rejected – significant difference						
Venture capital, business angels, and donor contributions	Clusters in the 2011 questionnaire survey	125	103.93			
	Clusters in the 2016 questionnaire survey	119	142.00	p-value	0.000	
	Total	244				
	0.000 < 0.016667 H0 is rejected – significant difference					
	Clusters in the 2011 questionnaire survey	125	146.73			
	Clusters in the 2022 questionnaire survey	182	158.99	p-value	0.003	
	Total	307				
	0.003 < 0.016667 H0 is rejected – significant difference					
	Clusters in the 2016 questionnaire survey	119	172.57			
	Clusters in the 2022 questionnaire survey	182	136.90	p-value	0.000	
Total	301					
0.000 < 0.016667 H0 is rejected: significant difference						

Source: Own elaboration.

The last of the funding sources examined was the share of venture capital and funds provided by business angels and donors in the budgets of European clusters. Whereas in 2011, this type of revenue was almost non-existent in the clusters' budgets, the situation has changed to date (with the most dramatic changes in 2016). Nowadays, the share of venture capital and funds from business angels and donors in the budgets of European clusters is higher, as is the case of the share of clusters' income generated by their own activities. Statistically, significant differences were detected in all three mutual comparisons of the questionnaire surveys conducted in 2011, 2016, and 2022.

Evaluation of Hypotheses

According to the available studies and the author's questionnaire surveys, the method of cluster financing and the share of the various sources of cluster finance have varied significantly between 2011 and 2022. If only the surveys which dealt primarily with clusters in Europe (and with a more substantial number of European countries) are considered, the share of public and private resources in the budgets of clusters in the period under study has widely fluctuated. At the same time, the ratio of public and private funds has not exceeded 60% to 40% in favour of public or private resources throughout the period.

Hypothesis No. 1 in the wording "there is no statistically significant difference between the results of the questionnaire surveys in 2011, 2016 and 2022 in the use of public and private funding sources in clusters" was rejected. The Kruskal-Wallis test indicated that the differences in the shares of public and private resources in the budgets of clusters in the questionnaire surveys in 2011, 2016 and 2022 were statistically significant. Subsequently, the post hoc test identified statistically significant differences in the share of public and private funding when comparing the results of the questionnaire surveys in 2016 and 2022. The ratio of public and private resources was obtained at 42.82% to 57.18% against the public funds in 2016 and moved from 54.78% to 45.22% in favour of the public funds in 2022.

Hypothesis No. 2 in the wording "there are no statistically significant differences in the structure of public and private funding sources in clusters when comparing the questionnaire surveys conducted in 2011, 2016 and 2022" was also rejected. When examining the eight sources of cluster funding (four public and four private ones) in 2011, 2016, and 2022 questionnaire surveys, statistically significant differences were identified for five sources of cluster funding - only the shares of the EU Structural Funds and Community Programmes, public regional subsidies and grants, and private credit instruments such as bank loans remained the same at the 0.05 significance level for all three questionnaire surveys. Statistically significant differences were identified when comparing the shares of the other five surveyed funding sources (public or private) in the cluster budgets.

Discussion and Concluding Remarks

In order to ensure the long-term and sustainable functioning of the cluster, it is crucial to have a variety of financial resources available to quickly replace those that are in short supply at any given time. As Kergel et al. (2018) have it, a broad mix of various sources of income for clusters has proven to be the best for the long-term sustainable existence and development of clusters. Such a mix is usually the most resilient to a shortfall of one of the financial sources. However, although the emergence of many clusters was initially strongly supported by public funds (international, national, regional, or local grant schemes) and they have become scarce over time, the assumption (Madleňák, 2020; Kordoš, 2018) that cluster organisations currently have to work harder to attract new sources of funding is probably not valid. The reality is that the level of global resources available to clusters remains fairly constant and that the possibilities for European clusters to obtain funding from national budgets have increased since 2016. These resources present a more significant part of the income of cluster budgets nowadays. In addition to the regular resources obtained from membership fees, the possibility of raising more funds from clusters' own activities seems to be the optimal solution. Madleňák (2020) mentions a greater popularisation of clusters' paid services as a potential source of such income, such as providing facilitation or consultancy services, conducting market research, or activities related to the internationalisation of business entities. For regular customers, there are also opportunities for cooperation in the implementation of innovation processes, technology transfer, and others. At the same time, clusters can demonstrate their ability to respond to challenges and solve problems. Moreover, cooperation with foreign partners helps clusters to maintain a high technological level or to improve access to new markets. Despite these clear facts, it should be noted that the income of clusters from their own activities has statistically significantly decreased between 2016 and 2022. This is probably because most clusters find it easier and more convenient to raise funds from national budgets than to dramatically increase customer interest in providing their own commercial services, as has been reported by several clusters in another part of the author's research. Such a mindset of some clusters is understandable, but in most cases, it neither contributes to increasing their competitiveness nor the competitiveness of the region where they operate.

Based on a unique data set collected from three independent questionnaire surveys, several insights into the funding structure of clusters in Europe have been obtained. The main results can be listed as follows:

- (1) Cluster funding has changed quite dramatically between 2011 and 2022. The share of public and private resources in the budgets of the clusters in the questionnaire survey in 2016 (PubR - 42.82%; PriR - 57.18%) and 2022 (PubR - 54.78%; PriR - 45.22%) was notably different, while the differences found were also statistically significant.
- (2) The structure of the diverse types of revenue sources in the cluster budgets has also varied statistically significantly. Five statistically significant differences were identified when examining the eight sources of cluster funding (four public and four private resources).
- (3) The level of one of the essential sources of cluster funding – the EU Structural Funds and Community

Programmes – has remained interestingly constant in cluster budgets. According to the questionnaire survey, their share was 25.44% in 2011, 24.29% in 2016, and 25.99% in 2022. Given the significant changes in most other types of funding that clusters receive in their budgets, this stability is quite interesting. At the same time, the situation where European clusters can secure a quarter of their long-term funding from the EU funds is regarded as highly desirable.

(4) The share of credit instruments, such as bank loans in cluster budgets, has remained unchanged since 2011 and is still extremely low. The vast majority of clusters in Europe do not use this potential revenue source.

(5) At the same time, the research of the author of the article has confirmed what Sopoligová and Pavelková (2017) state, that public support for clusters in Europe is mainly provided at the national level and through the EU Structural Funds and Community Programmes. Support from public funds through subsidies and grants from the regional and especially the local levels is used to a lesser extent than that from the national and international levels.

(6) Interestingly, Germany, one of Europe's best-described and researched countries, has a long-term share of public resources in cluster budgets of around 40%, which is remarkably lower than the European average. Even when examining the 20 clusters that participated in the author's 2022 questionnaire survey, the ratio of public to private resources is 42.75% – 57.25%. Despite the small sample size, it reflects that clusters in Germany, given the well-developed cluster support from the national, regional, and local levels, use public funds to a lesser extent than most European clusters. This is because most clusters in Germany believe that a greater part of the revenue in their budget should come from private funding sources. They also believe private funds will ensure better financial sustainability in the medium and long term.

(7) Many clusters that were already sufficiently publicly funded at their formation still rely on continued public funding. Curiously, clusters in the Danube region, which often lack significant public support, show less financial insecurity in the face of lower public revenues since they have learnt how to cope over time. However, this often results in smaller clusters with a less positive impact on regional development (Kergel et al., 2018).

Continuous public funding for clusters, increasing in time, as indicated by the author's other research, poses a challenge to policymakers to prove that the financial resources spent in this manner are spent efficiently. Ketels and Protsiv (2021) provide three key findings relevant to policymakers and serving to support clusters. First, clusters are an essential dimension in understanding the underlying competitiveness of a location. Second, clusters have to be seen within a broader context of locational competitiveness that also includes business environment quality. This integrated perspective was already introduced by Porter (1990) but has been lost in an often-misleading debate between cluster-specific and general business environment-focused policies. Third, cluster strength is a factor that is complementary to business environment quality in its relationship to economic performance. While other factors, in particular density and industry mix, are endogenous to business environment quality, cluster strength represents a distinguishing factor with its impact on wages and prosperity. This makes cluster-based efforts a tool that can be applied at all stages of economic development, not only in already highly advanced locations (Ketels, 2019).

Nevertheless, the results obtained have some limitations. The results would have been more informative and indicative if more respondents had participated in all three surveys. Despite that, some of the results are quite convincing and complement the investigations of mainly German and Swedish authors who have been working on the issue for a long time. At the same time, it should be pointed out that this paper does not aim to study the impact of different funding structures on clusters' effectiveness. It would be interesting to extend the current research and examine in more detail the relationship between cluster financing and cluster effectiveness measured by the number of new jobs created, company formations, products launched, and increase in sales or research activity. Such findings will be part of other papers currently in preparation for publication.

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