

On The Route Towards Renewal? The Polish Academy Of Sciences In Post-Socialist Context

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Abstract

Investigating the question of *scientific via organizational renewal*, this article adds an original perspective to the study of public research systems in Central and Eastern European countries (CEECs). Though previous studies have focused predominantly on policy, this article explores organizational structures that affect the performance of public research organizations (PROs) in a post-socialist setting. After assessing the performance of the Polish Academy of Sciences in terms of both research output and portfolio using bibliometric data, the article explores organizational factors linked to the generation of new scientific knowledge. Through this in-depth analysis, links between the specific historical context of post-socialist Poland and the Academy's ability to conduct novel scientific research are uncovered.

Key words: Public research organization (PRO); scientific renewal; organizational renewal; institutional change; Polish Academy of Sciences; post-socialism.

1. Introduction

The collapse of state socialism in 1989/90 has led to tremendous changes throughout the countries of Central Eastern Europe (CEECs). In addition to transformative changes in the political and economic spheres, processes of change have occurred in all areas of the post-socialist societies. As recent studies have shown, these processes are often more gradual than radical since they occur within the existing institutions inherited from socialism (Crouch and Keune 2005; Saxonberg 2014; Heinecke 2017). However, studies on post-socialist transformations predominantly focus on the shifts in public policy and the actors or forces driving these policy shifts. In contrast, studies on how institutional and organizational structures have changed in post-socialist societies are rare.

Past studies on post-socialist systems of science and research have investigated policy changes and the development of differing public funding systems after 1989 (Mayntz et al. 1995; Radosevic and Auriol 1998; Meske 2004; Jablecka and Lepori 2009; Radosevic and Lepori 2009; Kwiek 2014). Compared to the radical changes in the immediate transition period (1989–1991), change was rather gradual in the 1990s and 2000s (Lepori et al. 2009; Heinecke 2016). While these studies focus on the policy level, the current article focuses on changes in the institutional and organizational context.

Studies on organizations and the sociology of science have shown that the institutional and organizational context can have a considerable impact on scientific research and the production of scientific knowledge (Whitley 2003; Bonaccorsi 2007; Wilson 2008; Hollingsworth 2008; Whitley and Gläser 2014; Jappe and Heinze

2016). These observations strengthen the argument that the performance of national research systems cannot be explained solely by science policy (the macro level), but have to take into account the institutional and organizational structures underlying these systems (the meso level). An in-depth analysis of such structures has been largely missing from discussions on the research systems in CEECs.

This article builds on prior work, particularly work on the entire Polish Public Science System (PPSS) and on changes in the legal-regulatory context in which the Polish Academy of Sciences (PAS) has operated since 1989 (Heinecke 2016, 2017). As these studies have shown, the PAS has undergone various processes of gradual change in order to implement new legislation, adapt to the new political and economic environment, and find its place in the international scientific community. Consequently, the PAS has lost many of its former functions and competences: it is no longer involved in the planning and coordination of basic research on a national level, is no longer responsible for the funding of the PAS institutes, and its ability to establish new research units has been cut. In addition, changes on the legal-regulatory level have affected more than 70 PAS institutes, including the decentralization of power and resources from the central administration to the PAS institutes; growth in the scientific and organizational autonomy of the PAS institutes; diversification in funding sources, including various third parties, such as the European Commission, international organizations, and private foundations; the introduction of performance-based funding; and growing competition from research institutes located at Higher Education Institutions (HEIs).

This article also investigates the research performance of the PAS and its capability to conduct novel scientific research. The PAS still

exists as the umbrella organization for more than 70 institutes, many of which are considered to be the nations' best performing and most prestigious institutes within their fields. The question posed in this article is how legal–regulatory changes have affected the capability of the PAS institutes to generate new scientific knowledge. For this purpose, this article studies the processes of *scientific via organizational renewal* that have occurred inside the PAS over the past 25 years.

As argued below, *scientific via organizational renewal* is operationalized on two dimensions: firstly, the classic concept of scientific renewal as growth in scientific output. By examining publications from PAS institutes and their share in Poland's overall number of publications, as well as the research profiles of PAS institutes, the scope of growth in scientific output can be assessed. Secondly, the concept is extended by analysing two indicators of organizational renewal at the level of the PAS: the growth in new research units and the growth in scientific staff positions, particularly professorial positions. These indicators for scientific and organizational renewal are complemented by expert interviews and archival material.

The exploratory empirical findings presented in this article show the restrictions on the PAS in terms of *scientific via organizational renewal*; although the scientific output has increased, its growth has been slower than in other sectors of the PPSS. Similar conclusions can be drawn from the data on organizational renewal, which exhibit severe cuts in professorial positions and few, if any, newly established research units. These findings are in line with the situation on the legal–regulatory level, as PAS appears to be no longer the leading organization conducting research within the PPSS.

The article is structured as follows. Firstly, the *theoretical framework* of the study is presented to define and contextualize the concept of *scientific via organizational renewal*. Secondly, the operationalization of this concept for the empirical analysis is addressed in the *data and methods* section. Thirdly, the *empirical findings* from the bibliometric analysis are presented, followed by the findings from the organizational analysis. A discussion of these findings then *concludes* the article.

2. Theoretical framework

In the study of national research systems, various theoretical approaches and levels of investigation have been explored, spanning from the goals and design of national science policies and funding systems (Guston 2000; Laredo and Mustar 2001; Braun 2003) to the behaviour of individual researchers (Sanz-Menéndez and Cruz-Castro 2003; Laudel 2006). Some have proclaimed the global convergence of policy rationales and evaluation mechanisms (Lemola 2002), whereas others have focused on national differences in science policy and its instruments (Senker 2000; Poti and Reale 2000; Lepori et al. 2009). In this regard, Lepori defined research funding systems as 'sets of interconnected spaces of interaction between different layers of funders and performers ... shaped by different institutional settings' (Lepori 2011: 356). In order to determine the effect of these different institutional settings on the 'interaction between different layers of funders and performers', and ultimately, on the production of scientific knowledge; more detailed case studies on the meso level are needed. At the same time, we need to develop the theoretical approach used to study these effects further. This article aims to do both by analysing the effects of meso level changes within the PAS on its research performance, using the concept of *scientific via organizational renewal*.

A variety of recent studies have tackled in the complex relationship between science policy, institutional and organizational structures, and research performance (Braam and van den Besselaar 2014; Sandström et al. 2014). Studies on the *macro level* aim to link policy (research funding) directly to performance (research output). However, a recent study concluded that 'the relation between these two variables is less obvious than suggested' (Sandström et al. 2014: 532). In contrast, studies on the *micro level* concentrate on the performance of individual research groups in relation to policy, institutional structure, and other environmental factors. A recent study found that 'major and smaller shifts in the research focus relate to the international development of the field, to pioneering individuals, and to local science policy circumstances' (Braam and van den Besselaar 2014: 969). However, findings from micro-level studies remain limited because they focus on individual cases and actors. A third type of study is located on the *meso level* of institutions and organizations, focusing on the relationship between organizational variables (in the broadest sense) and scientific performance. Organizational variables include environmental conditions, characteristics of the research personnel (Carayol and Matt 2004), management and academic leadership (Vebree et al. 2015), degree of organizational autonomy (Sanz-Menéndez and Cruz-Castro 2003), and institutional arrangements.

Although macro and micro level studies have received more attention in the past, the need for studies on the meso level has become evident (Whitley and Gläser 2014; Baur et al. 2016; Heinze and Münch 2016). Of particular interest for these studies are public research organizations (PROs)¹ because they are deeply embedded in their environment, thereby linking the macro and the meso level. Studying PROs has the potential for illuminating the complex relationship between institutional and organizational structures and the level of knowledge production. This article aims to expand the corpus of literature on PROs by studying them in a specific historical context: the post-socialist Polish context.²

In this case study, we try to link the macro (Polish science policy since 1990), meso (PAS as an umbrella organization for research institutes) and micro level (e.g. behaviour of directors of PAS institutes) in order to determine their effect on the PAS' research performance. A combination of the three distinct levels of analysis is needed and has been attempted by other studies (Baur et al. 2016). Furthermore, the relevance of meso level structures is considered in our novel way of operationalizing research performance: as *scientific via organizational renewal*.

In previous studies on PROs, performance was defined and operationalized mostly with bibliometric output indicators, using the number of publications as an indicator of the amount of knowledge produced (Sandström et al. 2014); the number of citations per publication as a proxy for quality and the number of publications per group member as an indicator of productivity (Vebree et al. 2015). Performance has been measured in innovation indicators, such as patents (Carayol and Matt 2004). Organizational dimensions were not incorporated as measures of performance in these studies. In contrast, organizational variables are usually conceptualized as determinants of scientific performance rather than an indicator of performance. This article strives to change this by adding organizational indicators to bibliometric indicators to account for scientific renewal in a more holistic fashion.

Referring to concepts in organizational studies, this article adds organizational growth as an indicator of the performance of PROs. A broad range of organizational studies suggest that novel solutions are typically put forward by new organizations or organizational

units, rather than incumbents (DiMaggio and Stenberg 1985; Tushman and Anderson 1990; Jordan et al. 2008). This has also been shown for novel scientific knowledge, which is typically linked to growth on the organizational level (Powell et al. 1996; Hollingsworth 2008; Hallonsten and Heinze 2015).

Expanding on this issue, the complex relationship between scientific innovations and organizational renewal was recently put on the science policy agenda (Heinze and Krücken 2012; Whitley and Gläser 2014; Heinze and Münch 2016). In this regard, renewal in science is understood as (a) ‘the capability of research organizations to generate original and transformative intellectual contributions, such as new theories, methods, instrumentation, and empirical discoveries’, and (b) ‘the capability of research organizations to absorb new intellectual developments and to institutionalize new fields of research’ (Heinze and Münch 2016: 2). Here, renewal is conceptualized as a process of dual nature—including scientific (a) as well as organizational (b) dimensions. Scientific contributions are always generated within organizational structures, and it is necessary to include the latter in assessments of research performance. Scientific renewal can manifest itself *organizationally* as new types of research consortia and networks (Baneke 2016; Hackett and Parker 2016; Mody 2016), or as gradual shifts in organizational structures (Hallonsten and Heinze 2016; Launius 2016).

This article focuses on the organizational dimensions of renewal within the PAS. Herein, four distinctive processes of organizational renewal within research organizations can be distinguished: the *layering* of new structures or entities on top of existing ones, *displacement* of existing structures or entities by new ones, *conversion* of existing structures or entities for new purposes, and the *dismantling* of existing structures or entities without building up of new ones (Streeck and Thelen 2005; Mahoney and Thelen 2010). On the organizational level, these structures or entities could be research institutes, centres, departments, or professorial positions (Kwiek 2014; Heinecke 2016). These processes are highly dependent on human and material resources and deeply embedded in the institutional and organizational structures of the post-socialist PPSS.

3. Data and methods

The concept of *scientific via organizational renewal* has been operationalized in two groups of variables. The first group addresses the aspect of scientific renewal, which is broadly operationalized here as scientific output and measured with bibliometric indicators. The second group addresses the aspect of organizational renewal as organizational growth, which is measured through organizational variables.

Here, scientific output is measured as publication output² because scientific explanations, and scientific knowledge in general, are typically ‘contained in written documents constituting scientific literature’ (Riviera 2013: 1446). Although the representation of scientific productivity as sheer numbers of publications can be criticized (Larsen and von Ins 2010) and inherent problems exist in the choice of journals covered by the Web of Science (WoS) (Zitt et al. 2003),³ publications are used as an indicator of scientific performance throughout the literature (Braam and van den Besselaar 2014; Sandström et al. 2014; Kozak et al. 2015; Vebree et al. 2015). The data was obtained from the WoS (Thomson Reuters, January 2016). The bibliometric indicators chosen for the analysis of scientific renewal in the PAS institutes are the publication output of PAS institutes before and after 1990, publication output of PAS institutes

as the share of total Polish output since 1990, number of publications in *Nature* and *Science* (by PAS institutes and total), number of research areas covered in publications by PAS institutes since 1990, and publication profile of PAS institutes since 1990. These longitudinal data covering a research-performing sector in the post-socialist context are presented here for the first time.

For the analysis of organizational renewal, two sets of organizational variables were selected: organizational growth in terms of new units and organizational growth in terms of new staff positions.⁴ Both are derived from the concept of organizational renewal presented above, which assumes that *layering* occurs when positions or units that represent new research fields are added to the existing research capacity, whereas *dismantling* means that the research capacity in existing fields is abandoned. In order to track layering and dismantling, the following variables are analysed: the founding of new PAS institutes before and after 1990, the availability of professorial positions before and after 1990, and ranking of PAS institutes by their funding agency (KBN) since 1990. All data were collected from the annual reports of the PAS (*Sprawozdanie PAN*) and the Statistical Yearbook of the Central Statistical Office (*Rocznik Statystyczny, GUS*), which are available at the National Library in Warsaw and the GUS. The quantitative indicators were partly complemented with expert interviews conducted by the author in the fall of 2014, with representatives from the PAS’ central administration and three research institutes. Previous work showed that performance can only be evaluated in the appropriate disciplinary context (Vebree et al. 2015). Therefore, we selected interview partners from the PAS Division III (mathematics, physics, chemistry, and earth sciences). Division III was chosen because it is the biggest in terms of budget and staff and has the highest rate of scientific output (see below).⁵ These interviews provided valuable information that complemented inconclusive or incomplete data from other sources.

4. Empirical findings

4.1 Bibliometric analysis: Indicators of scientific renewal

For the period between 1945 and 2015, the WoS lists 493,177 publications with Polish authors or co-authors, 84,366 of which were published by members of PAS institutes. The number of publications by PAS research institutes is shown in Fig. 1. During Socialism, the number of publications increased from 817 in 1975 to 1,282 in 1989, a factor of 1.5 in 15 years. In the following 15 years, from 1990 to 2005, the number of publications increased by a factor of 2.3 (from 1,281 to 2,965). Compared to the scientific output of all Organization for Economic Co-operation and Development countries and major economies, Poland currently ranks 17th with 1.3 per cent of the world scientific publication output (OECD 2016). Its share in worldwide publications has remained stable since the beginning of the 2000s, indicating an average growth rate.

Though a global comparison may be inapt due to the bias of WoS towards American journals and the English language, bibliometric studies on CEECs have shown that Poland and the Czech Republic are the only two former Socialist countries with a significant increase in the number of WoS papers published (Kozak et al. 2015).⁶ A notable share of this increase stems from an increase in international collaboration among Eastern European countries, as well as with Western countries (Teodorescu and Andrei 2011).⁷

Table 1 shows the share of PAS publications within the total number of Polish publications. Though the total number of PAS publications has steadily increased, the share of publications from

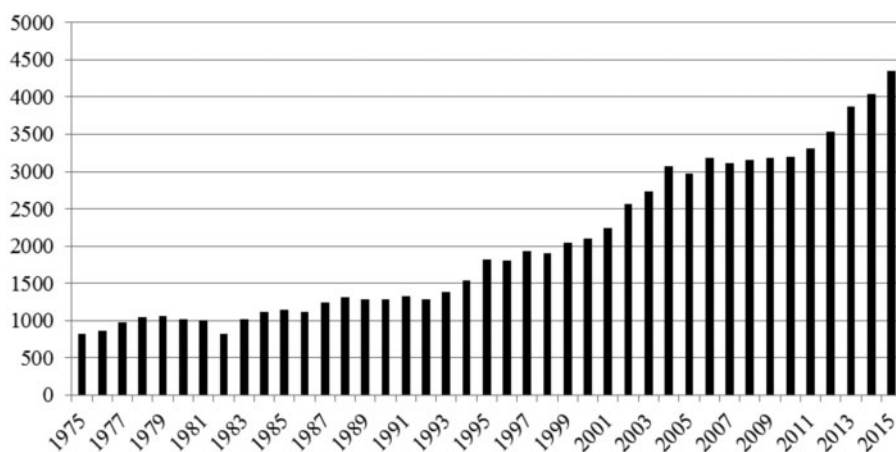


Figure 1. Publications by PAS institutes each year since 1975 based on data from the WoS (Thomson Reuters).

Table 1. All Polish and PAS publications listed in WoS since 1990

Origin	1990	1995	2000	2005	2010	2015
Poland	6,119	8,230	10,946	16,575	23,266	31,072
PAS	1,281	1,821	2,099	2,965	3,185	4,356
PAS as % of Poland	21	22	19	18	14	14

PAS research institutes has declined from 21 per cent in 1990 to 14 per cent in 2015. Relative to the research institutes in other PPPS sectors, the research output of PAS institutes has grown below average. The highest growth rate in research output was observed in research institutes located at HEIs (Kwiek 2014). In the period 2003–12, 77.5 per cent of all scientific publications from Poland (listed in WoS) were produced in HEIs; 19 per cent in other publicly funded research organizations (mostly PAN, see Table 1) (OECD 2016: 53). This is not surprising, since (a) the higher education sector has grown much more significantly in terms of units, staff and budget (see sub-Section 4.2), and (b) it matches global trends in publication. Publications from HEI have increased 2.2 times (from 2003 to 2012), while publications from other publicly funded research organizations have increased only 1.8 times (OECD 2016: 55).

When looking only at publications in two of the most prestigious international journals, *Nature* and *Science*, the picture is very similar (Table 2). During socialism, the PAS contributed a significant number of Polish publications (34 per cent). In the years right before and immediately after the collapse of the socialist system, the total number of Polish publications was relatively low. In these years of instability and re-orientation, the performance by PAS institutes was relatively stable and its share especially high (53 per cent). In the second half of the 1990s and the first half of the 2000s, the performance of the PAS decreased significantly but the output of research institutes located in HEIs increased (see section 4.2). This general trend is represented by a severe decline in the share of publications by PAS (25 per cent) and the increase in the overall number of Polish publications since the mid-2000s (see Table 2). However, the number of PAS publication in *Nature* and *Science* (as well as in all journals listed in WoS) has grown since the mid-2000s, but not as much as in the research institutes of HEIs. Publications in *Nature* and *Science* are used here as a proxy for the quality of the knowledge produced in Poland. Therefore, the publications in *Nature* (impact factor: 42.4) and *Science* (impact factor: 31.5) were chosen, since

Table 2. Polish and PAS publications in *Nature* and *Science* as listed in WoS

Origin	1976–85	1986–95	1996–2005	2006–15
Poland	56	53	68	182
PAS	19	28	17	52
PAS as % of Poland	34	53	25	29

Table 3. The change in the number of research areas in publications by PAS institutes since 1990, as listed in WoS

	1990	1995	2000	2005	2010	2015
Number of research areas	74	84	83	95	112	118
Research areas added		21	11	10	21	13
Research areas dropped		11	12	7	4	7

these two are currently the most cited journals; they cover a number of fields and cover topics beyond disciplinary interest (Petschick 2016: 493). Another proxy for quality is of an institution’s scientific output that is included into the set of the 10 per cent of the most cited papers in their respective scientific fields. This data is only available on the national level: Poland’s share of highly cited documents has grown insignificantly from 5.7 per cent (2004–08) to 6.4 per cent (2008–12). It remains far below the world average of 10 per cent (OECD 2016: 25).

It is also crucial to look at the research areas covered by PAS institutes. Thus, the number of research areas and the shifts in the top 10 research areas were investigated. In concurrence with the data presented above, a significant increase in research topics covered in publications by PAS institutes started in the mid-2000s (from 74 in 1990 to 118 in 2015, see Table 3). In contrast to several existing fields disappearing as new research areas were added in the 1990s, since the mid-2000s new research areas have been added while keeping most of the already covered areas.

Table 4 provides the top 10 research areas covered in the publications of PAS institutes over the past 25 years, including the total number of records in each field (A) and the publications in a specific field as the percentage of the total number of records (B). Research fields that were strongest during socialist era still remain strong: physics, chemistry, and materials science. However, the share of these disciplines has decreased somewhat over the years, which could hint at the

Table 4. Top 10 subject codes in PAS institute publications

1990			1995			2000			
<i>Discipline</i>	A	B	<i>Discipline</i>	A	B	<i>Discipline</i>	A	B	
1. Physics	397	31	Physics	642	35	Physics	649	31	1.
2. Chemistry	266	21	Chemistry	433	24	Chemistry	480	23	2.
3. Materials science	132	10	Materials science	260	14	Materials science	224	11	3.
4. Engineering	107	8	Biochemistry	108	6	Biochemistry	173	8	4.
5. Biochemistry	93	7	Neurosciences	103	6	Neurosciences	88	4	5.
6. Mathematics	72	6	Engineering	95	5	Engineering	83	4	6.
7. Pharmacy	52	4	Mathematics	72	4	Mathematics	74	4	7.
8. Crystallography	52	4	Polymer science	70	4	Pharmacy	73	3	8.
9. Neurosciences	49	4	Spectroscopy	50	3	Polymer science	61	3	9.
10. Polymer science	35	3	Astrophysics	48	3	Computer science	56	3	10.
2005			2010			2015			
<i>Discipline</i>	A	B	<i>Discipline</i>	A	B	<i>Discipline</i>	A	B	
1. Physics	776	26	Physics	679	21	Physics	855	20	1.
2. Chemistry	606	20	Chemistry	517	16	Chemistry	763	18	2.
3. Materials science	303	10	Materials science	229	7	Materials science	384	10	3.
4. Biochemistry	243	8	Biochemistry	215	7	Biochemistry	295	7	4.
5. Neurosciences	143	5	Ecology	167	5	Science technology	233	5	5.
6. Engineering	131	4	Engineering	166	5	Engineering	214	5	6.
7. Computer science	123	4	Pharmacy	153	5	Neurosciences	187	4	7.
8. Metallurgy	117	4	Mathematics	151	5	Pharmacology	181	4	8.
9. Plant sciences	114	4	Neurosciences	133	4	Environmental sciences	181	4	9.
10. Pharmacy	100	3	Agriculture	104	3	Mathematics	180	4	10.

A = total number of records; B = per cent of total records that year.

growth of other, newer research fields. In addition, many of the traditional disciplines, such as chemistry, mathematics and physics, are among the slowly growing disciplines, and new disciplines, such as engineering sciences, life sciences and computer science, have high-growth rates (Larsen and von Ins 2010). Therefore, the relatively lower growth rates in Table 4, as well as Table 2, do not necessarily indicate a lower performance of PAS scientists. They could also be interpreted as indicators for the specialization of PAS institutes. Since PAS institutes are rather specialized in traditional disciplines with lower growth rates; their publication output might be lower and grow more slowly than the publication output of HE institutes specialized in newer fields. In global comparison, Poland is relatively active in the following fields (world average = 1): veterinary science (2.5), physics (1.7), agricultural and biological sciences (1.6), mathematics (1.6) and chemistry (1.5) (OECD 2016: 41). These findings concur with studies throughout the region: they have shown that CEECs have the highest publication rates in the fields of chemistry and mathematics and lower publication rates in medical disciplines. This finding is explained by the nature of clinical research, which requires costly infrastructure. The resources needed to invest in more infrastructure-intensive fields are often lacking in CEECs (Vinkler 2008). It is necessary to keep in mind that performance indicators are used as a proxy for scientific renewal and are tools to describe the quantity, quality, and content of the knowledge generated by PAS institutes. For a more detailed evaluation of the level of scientific renewal in the PAS, one would need to trace certain fields in more detail. A qualitative analysis of specific research topics and new forms of knowledge pursued within the PAS could be conducted on the level of institutes, departments, or even research teams.

In summary, PAS institutes published much more in the post-socialist era than in the socialist era, a development that is in line with the general growth in scientific publications worldwide. However, the growth in publications by PAS institutes has been below the PPSS's average. At the same time, the research profile has not changed dramatically. Although new research areas have been covered by PAS institutes, research fields with a long tradition still account for most of the publications by PAS institutes. In fact, the lower publication rates in these more 'traditional' fields might partly explain the relative decline of PAS publication in comparison to HEI publications. Nevertheless, shifts in the number and focus of publications have been observed since the mid-2000s. Whether these findings from the bibliometric analysis are matched by processes on the organizational level will be addressed in the following section.

4.2 Organizational analysis: Indicators of organizational renewal

Next, we assessed the organizational capability of the PAS institutes to conduct novel scientific research. A variety of indicators of organizational renewal could potentially be studied, including the founding of new units, the establishment of new positions, shifts within the organizational structure, and the formation of informal networks. This article focuses on the indicators of organizational growth in terms of new organizational units and new staff positions. As shown previously for other PROs (Sanz-Menedez and Cruz-Castro 2003), the organizational capabilities of the PAS institutes in terms of organizational growth are strongly connected to their institutional environment. Therefore, a brief description of the changing

historical context of the PAS needs is included in this chapter (for a more detailed analysis see Heinecke (2017)).

The PAS was established as a socialist institution in 1952 to fulfil three roles: a learned society for leading Polish scientists, the national coordinator of basic research, and an umbrella organization for the best research institutes in Poland. The PAS was designed as the sole planner and performer of basic research in the People’s Republic of Poland (PRL). The political power of the PAS was personified in the Secretary General, who was responsible for planning, coordinating, and funding all basic research activities. His position replicated ‘the organizational hierarchy of the socialist party within the academy’ (Mayntz 1998: 786) and ensured the centralization of power and resources within the PAS. The Secretaries of the divisions were in charge of the coordination of the PAS institutes, including the founding of new institutes, the allocation of funds, their staff, and the setting of research agendas in accordance with the central research plan (Kuźnicki 1978). The early research institutes founded in the PAS had partly existed before 1952 and were re-established within the organization of the Academy. They were built around two or more professors who were considered the leading experts in their field and needed to be staffed with scientists from Polish universities. By the end of the 1960s, the PAS had gained a ‘monopoly in several fields in basic research, placing serious limits on research opportunities for teachers at universities and colleges’ (Matejko 1969: 641). The establishment and organization of PAS institutes was decided by the managerial bodies of the PAS itself, whereas the HEIs did not have this kind of power.

With the collapse of the PRL at the end of the 1980s, the PAS was stripped of its political powers; the planning, coordination, and funding of basic research was resumed first by the Committee for Scientific Research (KBN) and later by the Ministry of Science and Higher Education (MNiSW). The new funding arrangement meant the loss of the Academy’s capacity to distribute funds as an umbrella organization and the gain of autonomy for the PAS institutes. Until 1990, ‘the central bodies of the academies provided their respective institutes with an organizational and financial framework to support pre-chosen avenues of research’ (Simeonova 1998: 127). After 1990, statutory funding was provided through the KBN on the basis of an ex-post evaluation, linking the PAS institutes’ level of funding directly to their performance. The evaluation, which was conducted by the KBN committees, put the PAS in direct competition with institutes from the HEI sector and the Governmental Research and Development Institutes (GRDIs).

In the 1997 law on PAS, the institutes were given the status of an independent legal entity, including their own rights, obligations, and administrative competences. Regardless, the president of the PAS and the divisions were still responsible for appointing the institutes’ directors, approving their charters, and initiating their liquidation (law of 1997, Articles 38–59). Although the funding of PAS institutes had become the task of the KBN, the PAS still acted as an intermediary umbrella organization representing the interests of the PAS institutes vis-à-vis the state authorities (Heinecke 2017). With the diversification of funding sources in the late 1990s and throughout the 2000s (EU accession in 2004), the PAS institutes grew more and more independent of the central organization of the Academy. This process was cemented in a new law in 2010 that aimed at the ‘clear separation between the tasks to be performed by the Academy as a corporation of outstanding scholars and the tasks to be performed by scientific institutes of the Academy’ (Ministry of Science and Higher Education 2012: 1).⁹ Since then, the relationship between the PAS and its institutes can be described as mostly symbolic (Heinecke 2017).

Next to these general contextual developments, one legalregulatory aspect is of central importance when studying organizational growth within the PAS: the founding of new research institutes. During the socialist era, new research entities were founded on the initiative of the Academy’s governing bodies and the Secretary General. In the 1997 law, it was stated that the consent of the Council of Ministers is needed, as well as the agreement of the KBN, to establish a new institute. The Presidium could still found departments and centres, which were left under its control. The new law of 2010 requires the consent of MNiSW for the founding of a new research institute. It also requires the PAS to equip the new institute with the necessary resources and to transfer all assets to the newly founded institute. This shall prevent future conflicts and ensure the truly independent status of the institute from the beginning. In addition, the 2010 law abolished the status of an independent department, which means that the PAS can no longer establish a new research group or topic outside existing research institutes. New topics or fields have to be formally organized under the roof of an existing PAS institute, placing all of the power in the hands of the institutes’ director and council.

Now that we have clarified the institutional context, we can turn to the empirical data concerning the founding of new research units. Twenty-one full institutes and 49 support units or departments were set up between 1952 and 1956. By 1968, there were still 23 institutes, but 59 other entities, mostly departments, had been established (Hoffman 2002: 45). This high number reflects the willingness to invest in new research fields and to explore new scientific avenues. When new departments were established, they were administered and monitored by the Academy’s central administration, thereby serving as a tool for *organizational renewal through layering* outside the already established research organizations. In addition, some departments were opened by the division to support or supplement the existing research institutes. Once departments grew in size and topics, they could send in a proposal to get the status of a centre or institute upgraded.

In the 1970s and 1980s, a phase of consolidation followed with some departments being turned into institutes and some being closed down or merged with existing institutes.

Table 5 includes the founding of all research institutes that exist today. No significant growth in the number of institutes occurred after 1990; most of them were kept in place after 1990, with some departments being upgraded to the status of an independent institute. Therefore, *organizational renewal through layering* of new departments or institutes did not occur on a sizeable scale in the case of the post-socialist PAS. This can be explained by institutional structures, such as limited financial resources throughout the PPSS or the investment of available resources in the growth of the HEI sector (Heinecke 2016), as well as organizational structures, such as

Table 5. Founding of new research institutes within the PAS (only possible until 2010) in the socialist and post-socialist era. List only includes currently existing research institutes

		1952–1989	1990–2010
Established as institute		30	2
Department turned into institute	Department founded before 1990	24	8
	Department founded after 1990	–	0

the reduction of the power and autonomy of the PAS over the founding of new institutes (Heinecke 2017).

In this specific post-socialist context, the PAS could not grow institute-wise. In addition, the quality of research performed in the PAS institutes and departments declined considerably during the first post-socialist decade, as shown by the ex-post evaluations conducted by KBN between 1992 and 2000 (Table 6) and the bibliometric data presented in sub-Section 4.1.

Faced with shrinking budgets, declining performance, and no possibility to grow institute-wise, the PAS leadership started an initiative to restructure PAS institutes in the mid-2000s. A total of 14 units that received low ratings from the KBN throughout the 1990s were partly or fully restructured (Supplementary Table S1), with six units merged into three new institutes, two units turned into international laboratories, four units closed down,⁸ and two units transferred into existing institutes. By the end of this internal restructuring, the ratings went up (Table 6), with 12 PAS institutes receiving an A+ ranking in 2013,⁹ indicating the success of the internal restructuring process.

However, with the 2010 law abolishing the status of the independent department, the main mode of establishing a new research group or topic within the PAS is no longer available. New topics or fields now have to be formally organized under the roof of an existing PAS institute. This gives the scientific establishment in existing PAS institutes considerable veto power regarding the support of new and emerging research fields. Not only did the 2010 law weaken the administrative function of the PAS as an umbrella organization, it also closed one of the former routes to *scientific via organizational renewal* within PAS: the founding of new departments or institutes.

Table 6. Categories assigned in institutional ranking by KBN (1992–2004) and the MNiSW (2007–13), as published in *Dzienniki Urzędowe Ministra Nauki i Komitetu Badań Naukowych*

Categories	1992	2000	2007	2013
1 or A	61	42	68	60*
2 or B	15	26	5	2
3 or C	3	7	4	–
4 or D	3	2	–	–
5	–	2	–	–
Total	82	79	77	62**

The A to D categorization was used in 1992, 2007, and 2013, and the 1 to 5 system in 2000.

*Twelve of these 60 institutes with an ‘A’ ranking were chosen as ‘A+’ institutes (see Notes, Endnote 9).

**Not all institutes are accounted for because research institutes are evaluated every 4 years.

The second major route to renewal is the establishment of new scientific staff positions and recruiting staff who represent new research fields. As shown elsewhere, the growth of scientific staff positions with the license to conduct independent research—typically professorial positions—is a prerequisite for renewal in science (Jappe and Heinze 2016: 151). The loss of qualified scientific staff is one of the most pressing issues for the PAS institutes in the post-socialist era. With dramatically low salaries and job insecurity in the early 1990s, many scientists chose to leave the PAS institutes for research facilities abroad or for the private sector.¹⁰ In a climate of a multitude of opportunities in newly established banks, insurance companies, and other lucrative endeavours of the free market, a respectable number of scientific staff left science altogether (interview).

Based on the data assembled for this article, the overall number of scientific staff decreased by 18 per cent between 1990 and 2010 (Table 7). Most importantly, the number of professorial staff decreased by 17 per cent between 1990 and 2010, with assistant professors experiencing the strongest decline in the number of available positions; one-third of all assistant professor positions disappeared between 1990 and 2010. Thus the position for future leaders in Polish science is the staff category in the PAS which experienced the most pronounced cutback. Although some of these assistant professors might have climbed up the academic ladder (the number of professors increased by 8 per cent), a significant number of assistant professor positions has been cut.¹¹

Shifts in the staff structure are crucial when it comes to renewal, as the kind of scientist needed for renewal is not only excellent at science, but also as a manager and to some extent an entrepreneur. In order to establish a new research area, a new theory, method, or instrument; the ability to get grant money and to organize are necessary. Many younger scientists with these kinds of skills left the PAS institutes in the early 1990s in order to pursue a career elsewhere. One of the interviewees, who was a director of a research institute immediately after the collapse of the PRL, put it like this: ‘[T]hese numbers are not very impressive. If you count, you know, how many emigrated. But the problem is that who emigrated . . . not even the best, but the ones with high initiative. Which were, you know, like a driving force.’

PAS scientists did not only take positions in industry or abroad, but have increasingly migrated to research institutes of HEIs since the beginning of the 2000s (Legocki 2005). This corresponds to the finding that universities and colleges have been the most dynamic and growing PPSS sector, particularly since the early 2000s (Lepori et al. 2009; Kwiec 2012; Heinecke 2016). While the scientific staff in PAS institutes has decreased by 20 per cent, the staff at HEI research institutes has increased by 50 per cent from 1994 to 2012 (Heinecke 2016). A study on generational differences in attitudes,

Table 7. Staff in the PAS research institutes according to *Sprawozdanie PAN 1990, 2000, 2010*. *‘Professors’ include all professorial positions equivalent to the ‘full professor’ and ‘associate professor’ used in the English language: *profesor zwyczajny*, *profesor nadzwyczajny*, *profesor wizytujący*, and the formerly used *docent* (see Notes, Endnote 9)

	1980	1990	2000	2010	Change in %	
					1990/2000	1990/2010
Professors*	997	1,327	1,404	1,434	+5.8	+8
Assistant professors (<i>adiunkt</i>)	2,061	2,118	1,713	1,421	–19.1	–32.9
Professorial staff	3,058	3,445	3,117	2,855	–9.5	–17.1
Research assistants (<i>asystent</i>)	1,492	1,163	956	913	–17.8	–22.5
Scientific staff	4,550	4,608	4,073	3,768	–11.6	–18.3
Non-scientific staff	6,892	7,059	4,239	5,293	–40.0	–25.1
Staff total	11,442	11,667	8,312	9,061	–28.76	–22.3

behaviour and research productivity among Polish HEI staff has zoomed in on these young academics ('academics under 40'), which have partly migrated from the PAS. They represent 'a clear preferred image for a new generation of Polish academics: highly motivated, embedded in international research networks, publishing mostly internationally, and heavily involved in the competition for academic recognition and research funding' (Kwiek 2015: 1354).

5. Conclusion

This article has shown how the institutional and organizational structures specific to the Polish post-socialist context have impaired the capability of PAS institutes to renew themselves. As the generation of novel scientific knowledge, referred to here as scientific renewal, is dependent on the capability for organizational renewal, this study has focused on both types of renewal with particular emphasis on the latter.

The article's findings highlight the importance of adding a meso-level perspective to studies of science and science policy. In order to understand the effects of policy reforms on research performance, we need to trace the implementation of specific aspects of reform into the organizational and institutional structures in which research is conducted. In the case of the PAS, post-socialist reforms have led to decentralization within the PAS and the growth of scientific and organizational autonomy for the PAS institutes. Furthermore, the restructuring of the PPSS has led to a diversification of the sources of funding, the introduction of performance-based funding, and growing competitiveness between research-performing sectors (Kwiek 2014; Heinecke 2016, 2017). This article links these specifics of the post-socialist Polish context and the PAS's capability to generate novel scientific knowledge.

Thus, the scientific performance of the PAS was assessed in terms of quantity, quality, and content. Although the scientific output of the PAS has increased, its growth has been slower than in other sectors of the PPSS. Therefore, similar conclusions were drawn from the data on organizational renewal, which exhibit severe cuts in professorial positions and few, if any, newly established research units.

Various aspects of the institutional and organizational structures embedded in the PAS have hindered organizational growth. Firstly, on the legal-regulatory level, the laws of 1991, 1997, and 2010 successively reduced the competence and power of the PAS as an umbrella organization. New organizational units can no longer be established at the level of the PAS. This limits the possibilities for establishing new research areas more generally, because it provides the scientific establishment at PAS institutes with strong veto power.

Secondly, on the funding level, the budgets of PAS institutes were severely cut in 1990 and stagnated throughout the 1990s and 2000s. With the diversification of funding sources in the mid-2000s, the budgets of PAS institutes have started to grow again, with up to 40 per cent of their budgets now covered by grant monies. However, these additional resources are no longer available to the PAS as an umbrella organization. Instead, they are disposed of at the level of the institutes or research groups and individual researchers.

Thirdly, as shown elsewhere, growth in Polish science after 1989 occurred predominantly in the HEI sector. With the increased demand for higher education and the political decision to transform the HEIs into the prime performer of scientific research, the HEI sector has grown significantly in terms of units, staff, and budget (Jablecka and Lepori 2009; Kwiek 2014; Heinecke 2016, 2017). In this resource context, the PAS has had limited capabilities or

organizational renewal through layering. This also shows how highly dependent processes of *scientific via organizational renewal* are upon institutional and organizational resources, and how deeply embedded they are in the institutional and organizational structures of the post-socialist PPSS.

This embeddedness is reflected in the approach chosen in this article, which investigates the relation between science policy, institutional and organizational structures, and research performance. Referring to the specifics inherent in post-socialist Poland, this study helps us better understand these complex relations. Furthermore, the article applies new indicators for organizational renewal. In order to characterize the amount, quality, and direction of scientific renewal within the PAS, bibliometric and organizational data were collected and analysed. Organizational variables are often operationalized as mere determinants of scientific performance rather than an indicator of performance. By complementing indicators of scientific output with indicators of organizational growth, this article not only described the changes in knowledge production within the PAS since 1990, but also outlined the routes to and limitations on scientific renewal. Since 2010, *scientific via organizational renewal* has occurred on the level of the PAS institutes, where the legal and financial possibilities to do so are located. With the two main routes towards renewal (e.g. organizational growth in terms of new units or staff positions) being closed or severely limited after 1989, new forms of organizational renewal may shape the future of the PAS.

A preliminary sampling of cases illustrates these new institute-driven routes towards renewal. Firstly, the establishment of a new scientific field (spintronics) within the Institute of Physics seemed possible due to the high international reputation of its founding father and his ability to attract international, third party funding. A second example is the Institute of High Pressure Physics, which managed to turn fundamental discoveries into successful spin-off companies; it has grown significantly since 1990. Third, the new *Centre for Polar Studies* was formed by two PAS institutes and one university, a new type of collaboration facilitated by the 2010 law.

These three cases exemplify that *scientific via organizational renewal* within the PAS is possible. Due to changes in the institutional and organizational structures, the capability for renewal now depends on the PAS institutes and their links to their environment, such as international research funding, closer links to industry, or collaboration with HEIs. Further case studies on the meso-level of PAS institutes are needed to better understand scientific via organizational renewal at the institute level. Future studies should also include micro level investigations of successful individual researchers or research teams that have managed to work around the structural restrictions. The empirical findings of this study indicate that researchers within PAS institutes have indeed managed to enter new research fields (Table 3); however, these efforts have not been formalized within the organization. However, before we can draw our attention to processes of *scientific via organizational renewal* within PAS institutes or individual research teams, it is necessary to understand the PAS as a whole within its post-socialist context. This article has added to our understanding of post-socialist scientific structures. Furthermore, it has managed to showcase the embeddedness of the production of scientific knowledge within organizational and institutional structures, which have gradually changed since the collapse of state socialism.

Supplementary data

Supplementary data is available at *Science and Public Policy Journal* online.

Notes

1. PROs were created after WWII in many Western countries in order to perform scientific research at the highest level. In the 1960s and 1970s, the policy focus shifted towards establishing incentives for universities and private companies to create research units. Since then all three forms of research institutes have coexisted, with country-specific emphasis on different sectors (Sanz-Menéndez and Cruz-Castro 2003). The three sectors also existed in Socialist countries but had much clearer and more limited tasks: HEIs were responsible for teaching, GRDIs for applied research, and the Academies of Sciences (AoS) for basic research.
2. Scientific renewal has also been understood as breakthroughs or major discoveries and, in that case, measured in Nobel prizes or similar awards (see Hollingsworth 2002; Heinze et al. 2009).
3. Special attention needs to be paid to this aspect in the case of the post-socialist CEECs: 'Because of the isolation of the EE countries from Western countries back in the communist times, researchers from these countries routinely published in journals that were not indexed in the Web of Science, and accordingly the number of papers published in international journals was rather small.' (Kozak et al. 2015: 1102)
4. Other studies have also focused on organizational variables, such as the characteristics of the research personnel (composition and features of staff (Carayol and Matt 2004), group size, and academic leadership (Vebree et al. 2015).
5. Since the main focus of the empirical analysis is on the division III of the PAS, the current chair of the council of provost, the deputy chair, and the dean of division III were interviewed.
6. Despite Poland having the second to lowest GDP per capita (half the European level) and the Czech Republic increasing its GERD significantly, in Poland it has only increased by 9% (1998–2006). However, there is much higher potential in Poland, as its share of publications per million inhabitants is much lower than in other CEECs (400 in 2008), as is its GERD to GDP ratio (Lepori et al. 2007).
7. However, the percentage of international collaboration (as a share of all Polish publications listed in WoS) has only been 29% between 2003 and 2012; while 61% where publications with no collaboration, and 10% domestic collaborations (OECD 2016: 21). Of these internationally co-authored publications, a little less than 50% had a domestic leading author (OECD 2016: 23).
8. When it comes to the closure of institutes, reliable data is missing, but regarding the founding of institutes and departments, closure was easier before 1990 than after 1990. Generally, the closure of institutes is 'the decision of the Presidium of the Academy. It's not easy of course, because a lot of belongings of the institutes belong to the institutes not to the Academy. So we own the building. So it's quite a difficult legal thing to close the institute. But it's quite easy when somebody has this C mark a few times, because they do not get support from the government at all.' (interview).

9. In the latest cycle of evaluation in 2013, scientific units from all sectors were categorized as follows: A+(leading units), A (very good units), B (sufficient units), C (insufficient units). The units ascribed an 'A+' were selected from the list of 'A' ranked units. Altogether, forty-five units received an 'A+' rating, out of 963 evaluated units. For more details on the performance-based comprehensive evaluation of scientific units in Poland, see Kulczycki (2017).
10. 'Poland—along with India, the UK, and Taiwan—is considered one of the four most important countries contributing to a great increase in the number of scientists and engineers in the USA in the 1980s.' (Kozak et al. 2015: 1115).
11. In this article, I refer to 'professors' as all professorial positions equivalent to the 'full professor' and 'associate professor' used in the English language. In Poland, these are: *profesor zwyczajny*, *profesor nadzwyczajny*, *profesor wizytujący*, and the increasingly rare *docent*. The Polish status of *adiunkt* is translated into 'assistant professor'. This translation is commonly used 'according to an equivalent degree of prestige as in those countries; i.e. one generally becomes an 'assistant professor' quickly after being hired after finishing one's PhD, much like an *adiunkt* following the completion of the 'dr hab' (Sax 2015: 15).

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