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UNIVERSITIES 2014-2018**

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This paper studies the relationship between university institutional autonomy (both formal and informal) and their performance and efficiency using multi-stage empirical methodology. First, we measure an “autonomy-in-use” index, and then we employ Data Envelopment Analysis in order to evaluate institutional efficiency. Lastly, we use a panel fixed effect regression and an instrumental variable approach to provide robust evidence for the relationship between institutional autonomy, performance and efficiency. We find that formal status of autonomy does not predict higher publication activity or efficiency. However, the findings also reveal that informal autonomy is positively associated with efficiency scores, and advanced practices in staff management can contribute to increases in publication activity and overall institutional efficiency.

JEL Classification: I22, I23, I28

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1. Introduction

The Russian higher education (HE) system is composed of numerous heterogeneous institutions, despite the high level of governmental regulation of the sector (Platonova & Semyonov, 2018). The central government sets the rules for public financing, determines lower price boundaries for private universities, and develops standard costs for HE. However, higher education institutions (HEI) feel the necessity to have space for organizing their activities in a more decentralized way. For example, some universities are supported by special programs defined by the government (such as the Excellence Initiative, see Turko et al., 2016); and all universities operate in different regional contexts and have to cope with exogenous, e.g. demographic, constraints. Russian universities, just like other non-profit organizations in the country, can have (or not) different degrees of autonomy. According to the classification adopted in the federal legislation, universities can be labelled as (i) autonomous, (ii) budgetary autonomous or (iii) completely state-owned (the latter defined as “kazennoe”). Autonomous universities develop their own charters, can create internal governance bodies, develop their own rules for enrollment, salaries, and financial plans. The other two groups enjoy limited freedoms in those management areas.

In the academic literature, scholars have always paid particular attention to the relationship between universities and the government-as-regulator, with the specific aim of identifying and classifying forms of HEI autonomy and evaluating its effects. Berdahl (1990) defines university “institutional” autonomy and separates it from academic freedom. He argues that institutional autonomy includes a sustainable and a procedural aspect. The first reflects an institution’s right to determine its own goals and programs (the “what” dimension), the second reflects the power to determine the means and mechanisms by which these goals will be achieved (the “how” dimension). From an institutional perspective, which is relevant for the case study presented in this work, the three key aspects of autonomy described by Berdahl are coherent with those set by the Russian government: namely the freedoms of (i) selecting staff, (ii) determining the curriculum and (iii) reallocating funds.

When considering the hypotheses about the economic and managerial mechanisms that can be activated by a higher degree of institutional autonomy, the main assumption is that relatively more autonomous universities tend to be more efficient and productive (see Verhoest, 2005). Aghion et al. (2010) explicitly test the hypothesis that universities are more productive when they are more autonomous and face more competition. They argue that European universities could benefit from a combination of greater autonomy and greater accountability, to become more productive following the example of their US counterparts. This topic deserves more empirical validation in the context of the Russian HE sector. The only recent study in this area, conducted by Zinchenko and Egorov (2019), finds that autonomy is a statistically insignificant predictor of university efficiency. A potential explanation for this lack of statistical significance is that formal autonomous status does not necessarily expand a university’s freedom and flexibility in practice (i.e. the autonomy is limited to unimportant practices). Alternatively, it can be the case that university management does not use the whole spectrum of available powers. For instance, according to public financial reports, only a limited number (9 out of 48) of Russian state universities, which are formally labelled as autonomous, actually used their autonomy to invest resources gained from private sources. If this is the case, the gap between “formal” and “actual” autonomy can be measured and can explain why formal autonomy does not affect performance.

In this paper we deal with the relationship between autonomy and performance in the HE industry. Specifically, this paper answers the following two research questions: (i) *to what extent do Russian universities differ in their autonomy, formally and practically?* (ii) *is there a robust statistical association between university autonomy (both formal and actual), and their efficiency and performance?*

To answer these questions, we use a multi-step methodology. We first propose a definition of university autonomy, which is based on existing theoretical models and operationalize it into three components, based on the freedom to (i) allocate funds, (ii) deploy specific staff policy and (iii) determine curriculum content. Then, we construct a composite synthetic indicator of autonomy, based on the Benefit-of-the-Doubt methodology (Cherchye et al., 2007). Once the indicator of autonomy is derived, we measure the relationship between formal autonomy (i.e. the autonomy that is regulated by the legislation and is fixed in the legal status of a university) and the actually used autonomy. Then, we statistically explore the relationship between the autonomy of universities and their efficiency and performance. In so doing, we argue that our composite indicator is a more robust evaluation of university autonomy than the corresponding formal definition, as it measures autonomy through its contributing dimensions and indicates whether university management is able to take advantage of the managerial tools to produce better results, especially in terms of efficiency.

The contribution of our work is particularly innovative, as no literature on Russian HEI goes deeply into the question of the effects of different HEI statuses on their operations and performance. The specific focus on the relationship between the autonomy and performance of universities can be interesting for the international reader, given the broad debate in the academic and institutional arenas (Enders, De Boer and Weyer, 2003).

The paper is organized as follows. Section 2 presents a review of the literature on the autonomy of universities and its potential effect on efficiency. Section 3 describes the Russian HE system's context. In section 4, a conceptual framework is derived to develop the hypotheses about the effects of autonomy on performance. Section 5 presents our data and the methodological strategy for the empirical analysis. Section 6 reports the results, while the policy and managerial implications are discussed in section 7.

2. Literature review

This section is divided in four parts. We first introduce the notion of autonomy in public sector organizations. Secondly, we present a review of the literature which considers the autonomy of universities, and we make a particular focus on the multidimensional nature of autonomy in HE and the distinction between formal and non-formal, or *de facto* autonomy. The third part covers the relationship between autonomy and performance in the public management literature. Lastly, we present research dedicated to the impact of autonomy on the performance and efficiency of HEI.

2.1 Autonomy of public sector organizations

The key for providing a definition for organizational autonomy is the neoliberal logic of new public management (NPM) in the public sector. NPM reforms occurred in two main stages: the first starts from aligning state interests in increasing efficiency, legitimacy and participation (Christensen

& Lægveid, 2008) with the main principles in organizational operations in the early 1980s. The move towards new objectives together with a reorientation to market mechanisms required substantial structural reorganization. The increasing complexity of authority structures and organizational hierarchies demanded institutionalization in managing the restructuring and intensifying cross-sectoral and inter-institutional collaboration in the public sector (Christensen, 2011). The second stage resulted in granting public organizations and their managers the possibility of making decentralized and depoliticized decisions.

Verhoest et al. (2004) define organizational autonomy as one's level of freedom in making decisions without restrictions by upper-level managers, authorities and organizations. The downward movement of top management autonomy to lower levels can be expected to result in the improved performance of public organizations (Andrews et al., 2007; Wynen et al., 2014). From the neo-institutional perspective, granting autonomy might be beneficial as the reconfiguration of centralized monolithic organizations into specialized ones involves an adjustment in their performance and efficiency. However, this reasoning is true only in agencies only if sufficient incentives are provided on the regulator's side (Verhoest et al., 2004). This issue of creating incentives stimulated a wave of post-NPM reforms which stressed renegotiating control and coordination in the public sector (Christensen, Lie and Lægveid, 2007) in order to recognize autonomy as a trade-off between deregulation and accountability.

One of the trends in NPM reforms is the decentralization of managing authorities and reallocating decision-making power, which was taken from the central government or any other superior specialized governing authority and transmitted directly to public service providers (Cheng et al., 2016; Enders et al., 2013; Anand et al., 2012). In this vein, decentralization, the distinction between legislative and real autonomy, performance-based accountability and the provision of incentives are universal traits of autonomy.

2.2 The concept of autonomy in higher education

As autonomy of organizations providing HE is the primary focus of this research, we provide a more thorough analysis of the literature on this concept. The key highlight is that many authors inevitably use the accountability-deregulation trade-off in their definition of autonomy, while others provide a gradual sophistication of the concept, underlying its multidimensionality and the formal-informal dichotomy.

University autonomy can be opposed to governmental regulation in the sense that autonomy is an organization's capacity to govern itself without external control (McLendon, 2003; Osipian, 2008), or public accountability. Berdahl and Millett (1991) argue that, in theory, accountability and autonomy should not be considered as opposites, because the first one implies responsible actions and the second one responsible power of internal self-control. However, in reality the notions represent two poles, as autonomy cannot be present under complete external intervention. Albornoz (1991), however, argues that the contemporary, post-industrial notion of autonomy does not contradict public or governmental control.

Starting from Ashby & Anderson (1966), the notion of autonomy has been decomposed into a range of elements. In the distinction between academic freedom, substantive and procedural autonomy, the first means a university's freedom in its search for the new knowledge and the way

the scholars transfer this knowledge to students and society. The second, according to Ashby (1996), is a way of creating a university's vision, determining its strategic goals and development. The third is choosing the ways and mechanisms in which the organization operates. De Groof et al. (1998) also highlight three components of autonomy: substantive, procedural and organic. The first two parts are defined in accord with Ashby, and organic autonomy denotes an organization's right to establish its academic structure, i.e. faculties, departments, institutes. Institutional autonomy may include a university's independence in determining internal organization, e.g. its structure and governance, the redistribution of financial flows generated by non-public money, its own rules in staff recruitment, and its policy in educational and research activities.

Durham (1989), cited by Albornoz (1991), defines autonomy as having four elements: autonomy in research, teaching, financial expenditure and administration. Estermann and Nokkala (2009) distinguish between organizational, financial, staffing and academic autonomies. Verhoest et. al. (2004) underline structural autonomy, financial autonomy (in the sense of independence from government funding), legal autonomy (status-related granting of certain rights) and interventional autonomy (freedom from external sanctions due to incompliance with regulations).

Finally, one should differentiate between formal and informal autonomy, or autonomy-in-use (de Boer and Enders, 2017). This distinction is particularly important, as we claim in this paper that formal and informal autonomy can operate very differently in the case studied. Formal autonomy is legally determined, but the formal regulation of required and prohibited actions might not be implemented in reality and do not necessarily predict university management in reality. As universities operate in a complex context and have to operate in the presence of resource dependence and normative rules, they have to adjust their behavior in order to comply with stakeholders' views or use formally unrestricted practices in order to facilitate functioning and meet self-determined goals. Thus, autonomy-in-use depends on whether the formal autonomy is inherent.

2.3 Autonomy and performance of public organizations

Being conditional on external (legislation) and internal (management) factors, and time-variant (Tapper and Salter, 1995), autonomy requires a more profound analysis in terms of how it is related to performance and efficiency through the way autonomous public organizations are managed.

Research on whether autonomy has an impact on the performance of public organizations has not reached a definitive conclusion. We consider the cases of health care and secondary education. Ali et al. (2019) studied UK hospitals and find that the organizations with a higher level of managerial autonomy are characterized by lower values of productivity. This conclusion might be explained by these hospitals accumulating income surpluses in order to increase salaries or make capital investments, which can lead to a lower productivity index due to increase in inputs. Ferreira and Marques (2015) studied the Portuguese partial corporatization of public hospitals using non-parametric measures of efficiency and productivity. They conclude that higher autonomy is associated with lower productivity. Nevertheless, more autonomous hospitals outperformed traditionally managed ones in terms of efficiency. Zhang et al. (2018) study Japanese healthcare and found local reform resulted in a temporary increase in efficiency and productivity, positively related to the degree of decentralization.

Studies on autonomy in secondary education provide more promising and unambiguous evidence of a positive relationship between operational management features and performance. Verschelde et al. (2012) found a strong positive effect of school staff autonomy on educational performance. Falch and Fisher (2012) found evidence of a positive relationship between financial decentralization in the secondary sector and student performance. Hashim et al. (2019), using mixed methods, observed a positive relationship between principals' actual autonomy and the realization of school plans, teacher collaboration and positive learning outcomes.

2.4 Management and performance of autonomous universities

An increase in HEI performance and efficiency due to autonomy might be expected because of such mechanisms as resource allocation, a better ability to compete for scarce resources and flexible human resource management. As long as the functioning of universities lies at the boundaries of public financing and the subsequent control, universities might be motivated to exercise more autonomy in order to comply with the parameters that determine increased funding (Tapper and Salter, 1995). Aghion et al. (2010) show that a higher degree of autonomy is an essential driver of university performance; more autonomous universities have more capacity to respond to market competition and to convert revenues into performance outcomes. McCormack et al. (2014) prove that managerialism matters in universities in the sense that a more flexible management style generates a better research and teaching performance. They underline the importance of operational management in key activities and the general institutional setting.

Quiroga-Martinez et al. (2018) studied the factors that explain the variability of efficiency scores of Argentinian universities. They find that distinctive management characteristics such as a higher proportion of highly qualified faculty members and a higher number of hours taught by full-time position holders is positively related to efficiency. They argue that a particular trait of certain universities – their institutional autonomy and budget independence – allow universities to focus on core activities and to embody managerial practices such as restructuring the organization or to pursue special staff policies. Knott and Payne (2004) identified that universities under a weaker governmental control perform better in terms of research funding and in the number of publications. The authors argue that autonomy creates managerial opportunities in reallocating and raising funds. De Boer et al. (2010) found that autonomy improves university research productivity and educational attainment through flexible operational management (staffing) and funding independence. However, Volkwein and Malik (1997) did not find any robust link between university autonomy in financial and teaching activities, and their performance.

Summarizing these four streams of the literature, the majority of studies on the autonomy of public organizations provide a comprehensive explanation of this complex construct. However, the empirical research linking it to the performance and efficiency goals of NPM reforms is limited. Most research barely takes into account the multidimensionality of autonomy, and only one attempt has been made to differentiate the effects of formal and informal autonomy in the formal legislation and real managerial practices. We fill the existing gaps in the literature on autonomy effects in the HE sector by accounting for the multi-component logic of university autonomy.

3. Background: autonomy of Russian HEIs

Since the collapse of the Soviet Union, the Russian HE system has experienced a considerable number of structural and institutional reforms. The marketization of HE resulted in considerable growth in the number of HEI, mostly in the private sector. Although the government implemented a range of measures (e.g. the unified federal monitoring of university performance) to control the quality of HEIs, the system is still vast and highly differentiated. Today the HE system in Russia comprises 1,417 universities in total, 766 of which are state universities, and one third of these are branches (i.e. subsidiaries of main campuses).

Another crucial aspect in terms of institutional management was the gradual introduction for some specific universities of additional funding, in order to increase the quality of teaching and research activities of Russian HEI. Among these are Federal Universities and National Research Universities, created in the late 2000s. Federal universities were generally created through merging regional HEI in federal centers. National research universities represent the first large-scale project to stimulate a limited number of competitively chosen universities to develop strategic plans and enhance research productivity. Another group was formed under the aegis of Project 5-100 which granted 15 universities in 2012, and 6 more universities in 2015, a subsidy and managerial support to internationalize, produce research and most importantly – enter the world university rankings. The last group has 33 universities which were granted special status and support in order to provide regional economic development and create links with local businesses and communities.

For the structural regulation, a number of Russian universities are subordinated to line ministries, e.g. the Ministry of Agriculture or the Ministry of Health, an even smaller number is subordinated to parliament, but most universities are subordinated to the Ministry of Higher Education and Science (MHES), which is the most important for educational standards and financing. Using a performance-based funding formula, introduced in 2015, the MHES determines the number of publicly funded places and the amount of public funding per place.

In the context of a highly regulated HE system, it is challenging to analyze (i) the degree of autonomy that different universities experience, and (ii) how the use of this autonomy results in different levels of performance and efficiency. There are two main laws that can help us to disentangle the autonomy of Russian universities: Federal Law №7 “On not-for-profit organizations” (1996) and the Federal Law №147 “On autonomous organizations” (2006). The former covers all not-for-profit organizations, e.g. museum, schools, universities, kindergartens. This law was created under the pressure of market reforms in order to create independent legal entities and create new streamlined funding schemes. Accompanied by federal laws on secondary and post-secondary education and the new Budget Code (2007), this law was most likely the first one to structure institutions in the public sector. With the new version of the Budget Code, public entities started to be financed according to “state orders” – the amount of services that an organization provides to public organizations. In line with the introduction of law №147, the then Ministry of Education (now separated into the Ministry of Education and the Ministry of Higher Education and Science), the Ministry of Finance and the Ministry of Economics reorganized the structure of their legal statuses. All three general forms were kept: “kazennoe”, budgetary and the autonomous, but the duties and privileges were reformed. During the very first period between the creation of law №147 and the new version of the Budget Code autonomous universities possessed more liberties than they do today, e.g. they could spend unused public money on their own needs,

but this lasted only 1-2 years. Now “kazennoe” universities are subordinated to military governmental authorities, budgetary universities compose the majority of the system, and there are 48 head state autonomous universities (which represent 10% of the total number of head public universities).

The disparities between different groups of universities are summarized in Table 1. The elements presented below are particularly important for characterizing the three groups of universities more in detail, as they summarize the relevant Russian legislation on distinguishing the rights and restrictions applied to HEI with differing legal statuses. The legislation providing a definition of autonomy mainly in regard to resource allocation such as the use of public funding, unspent funds, and the disposal of property.

The most crucial features that characterizes autonomous universities in the context of the specific regulation of the Russian HE system are:

- a) the presence of a supervisory board that is responsible for the approval of financial plans. The supervisory board can be composed of both internal staff (e.g. professors) and external persons (e.g. ministers). This board approves financial plans, public procurement and commercial deals, opening bank accounts and investments. In budgetary universities these activities shall be approved by the supervisory ministry, while in kazennoe HEIs these activities are not possible at all;
- b) autonomous universities can use privately raised money according to their needs and do not need to approve the redistribution of their financial assets through governmental authorities. Budgetary universities can do so only in exceptional cases and with the approval of the external governing body, an apparent example of an intermediary body (De Groof et al. 1998).

Other potential dimensions of university autonomy, such as academic freedom, or staff management are not regulated by Federal Law №7 or Federal Law №147. For instance, staff policy is regulated by the Labor Code and is universal for all higher education institutions. Regarding educational activities, Federal Law №237 “On education” obliges all HEI to comply with federal educational standards. However, a range of universities, mainly those with the leading status, have the right to develop advanced curricula on the basis of the universal ones.

[Table 1] around here

4. Conceptual framework

Autonomy can be regarded as one of the environmental factors that affect university activities and results. According to Bleiklie (2018), autonomy is closely linked to the enterprise-like transformations of universities which follow the general logic of NPM and the marketization of public services. Thus, institutional autonomy is the core mechanism for strategic development with respect to the diverse interests of public and private stakeholders and decision-making (De Boer and Enders, 2017).

In our study, we use two major theoretical approaches that provide arguments in favor of enhancing organizational autonomy in order to increase institutional performance: managerialism (Deem & Brehony, 2005) and neo-institutionalism (Jensen and Meckling, 1976; Pratt and Zeckhauser, 1985). Managerialism embodies the principle of “letting managers manage” (Van de Walle & Groeneveld, 2016) which means prioritizing managerial need over exhaustive bureaucratic

procedures (Hoggett, 1996). If bureaucratic regulation (typical of the public domain) is removed, public managers will behave like ones from the private sector. Managers will adopt advanced tools and techniques in order to stimulate an organization's performance and establish internal performance regulation procedures because they have a rational incentive to increase use of innovative techniques to enhance performance, and staff benefit from an organization's performance (Osborne and Gaebler, 1992). Under managerialism, we suppose that the innovative managerial tools used in an autonomous university will increase its efficiency through target setting, performance evaluation adoption, and resource reallocation (Schubert, 2009).

Institutionalism regards a public organization as an agent and the government authority as the principal. The agent provides public services on behalf of the principal, but they may have differing interests, and while information is asymmetric, agents may act independently and not in accordance with the principal's will. The principal, however, can develop rules, penalties and incentives in order to overcome this problem. Thus, the government can grant a public institution autonomy in decision-making in exchange for monitoring and control mechanisms, an increase in public managers' self-regulation is accompanied by increased accountability (Enders et al., 2013). The stimulus to overcome rigid managerial practices creates a favorable institutional setting to implement new practices, techniques and products (Dunleavy et al., 2006; Wynen et al., 2014). Higher-level managers will transmit the goals and priorities set by the principal to lower-level managers, and in order to monitor lower level organizational units, internal performance control is needed (Wynen and Verhoest, 2016). An increase in efficiency can be expected because the monolithic structure of a public organization will atomize into structures that are led by autonomous managers, free to deregulate the use of inputs and stimulated to maximize outputs.

In light of the discussion above, the general theories of management in organizations are well suited to the HE sector, firstly because they were mostly developed within the HE context, and secondly, major theoretical frameworks were built on empirical works on universities (Bastedo, 2012). Institutionalism is extensively used in studies on policy, reforms and management issues in HEI (Cai & Mehari, 2015). The managerialist conception of governing public services suits universities as well and managers in academia might acquire related principles and language (Deem & Brehony, 2005).

In this research, we use our theoretical arguments and suppose that some management practices are more relevant than others for the link between autonomy and performance/efficiency. First, we follow the previous research on autonomy (Christensen, 2011; Boer and Enders, 2018) and distinguish between formal institutional autonomy, i.e. that stated in the legislation, and informal autonomy (Fumasoli et al., 2014). However, it should be noted that some universities became autonomous after the 1990s, when the first law on not-for-profit organizations was introduced, other universities were transformed from budgetary into autonomous institutions when the next law on autonomous universities was implemented. The latter are mostly Federal universities which were created in 2006 through mergers. A small number of universities became autonomous between 2010 and 2017. We also have to address the multi-component logic of autonomy, inherent in the definition of autonomy in different types of public organizations. We propose a distinction between *financial*, *staffing* and *academic* autonomy which seems reasonable in the Russian context. On average, Russian universities depend significantly on government funding, which necessarily obliges extensive accountability. However, if a university is capable of raising private funds, it can invest in various activities ranging from student support to capital expenditure. Regarding staff policy,

each university is obliged to comply with general regulations on the staff/student ratio and salaries that cannot be lower than the average level in the region. Certain universities can invest more in human resources, e.g. hiring international researchers and rewarding highly productive employees. Finally, academic freedom directly influences two key university activities, teaching and research. In Russia, when developing curricula, all universities have to adhere to general educational standards, but some universities can make advancements in their courses or pay more attention to post-graduate studies in order to enhance research activity.

5. Data and Methodology

As anticipated in the Introduction, the methodology follows three steps. First, we build a composite synthetic indicator of autonomy, based on Benefit-of-the-Doubt (BoD) methodology (see section 5.1). Second, we calculate the efficiency of universities (section 5.2). Third, we combine information about the efficiency and autonomy of universities. Specifically, we statistically explore the relationship between the autonomy of universities, formal and informal, and their efficiency (section 5.3).

5.1. Measuring the autonomy of Russian universities

In order to evaluate informal autonomy, or the Autonomy-in-Use (AiU) index, we build a continuous measure through a composite index technique based on BoD methodology. The BoD composite indicator method (OECD, 2008) is based on non-parametric Data Envelopment Analysis (DEA) (Charnes et al., 1978) both operationally and conceptually. As DEA assumes that the production function of the observed units is not known, BoD helps to deal with the problem of when a measure should be multidimensional but the weight loadings for each component of the index are unknown (Cherchye et al., 2007), and extracts the relative measures using benchmarking. BoD is used widely, including in education (De Witte and Schiltz, 2018; Rogge, 2011; Szuwarzyński, 2018; Stumbriene et al., 2019), and HE in particular (De Witte and Hudrlikova, 2013; De Witte and Rogge, 2011).

The core idea behind the BoD-based index is in the comparison of the actual level of a certain indicator to the ideal, benchmark one. The benchmark can be either exogenously set or determined within the sample by maximizing problem solving, as suggest Cherchye et al. (2007). We use the BoD method as presented in OECD (2008):

$$CI_k = \frac{\sum_{c=1}^M I_{qc} w_{qc}}{\sum_{c=1}^M I_{qc}^* w_{qc}}, \quad (1)$$

where I_{qk} is the normalized score of university c indicator q , w_{qk} is the corresponding weight. The benchmark hypothetical score I_{qk}^* is obtained from the solution to the following maximization problem:

$$I^* = I^*(w) = \arg \max_{I_{k,k \in \{1, \dots, M\}}} (\sum_{q=1}^Q I_{qk} w_q), \quad (2)$$

where I^* is the university score which maximizes the overall performance in terms of the indicator and given the unknown set of weights w . Optimal weights are obtained from solving:

$$CI_c^* = \arg \max_{w_{qc}, q=1, \dots, Q} \left(\frac{\sum_{q=1}^Q I_{qc} w_{qc}}{\max_{I_k, k \in \{1, \dots, M\}} \sum_{q=1}^Q I_{qk} w_{qc}} \right) \text{ for } c = 1, \dots, M \quad (3)$$

The AiU index is calculated in two steps. We first measure the autonomy sub-components, and then use these to evaluate the final index. The descriptive statistics for the variables which depict each dimension of the autonomy index are presented in Table 2. The descriptive statistics for this step are presented in Table 3. We use an alternative method of constructing the composite indicator, the Mazziotta-Pareto index (Mazziotta and Pareto, 2013). When calculating the final index, we apply the minimal weight restrictions (20%) to provide more robustness. The variables used at the stage of sub-index calculation and the sub-indices used for the final index evaluation are normalized. Descriptive statistics are presented in Tables A1-A2 in the Annex.

[Table 2] around here

In order to measure the informal autonomy of a university, we suppose that the overall AiU is composed of three subscales: financial, staffing and academic. We measure the first sub-index using two variables, indicating the share of private income (privately funded student fees) in the total income from educational activities, and the share of private income in the total income from research activities. These two variables are particularly important for judging whether a university is financially independent of the government. Formally, all universities may undertake income-generating activities, and the more private resources which do not require strict reporting a university has, the more freedom it has to invest it in itself.

Academic freedom is measured through the share of masters and PhD students, which illustrates a university's capacity to provide advanced postgraduate programs. In addition, we use the right to determine educational standards. Finally, we use the number of dissertation committees, indicating a university's capacity to grant doctoral degrees independently from external organizations, e.g. the Russian Academy of Sciences.

The freedom of operational staff demonstrates a university's capacity to invest in its staff. We use the average salary of research and teaching staff as this demonstrates an organization's ability to surpass normative salary rates. Then, we use the share of international staff as this demonstrates a university's desire to internationalize and invest in staff who are more productive in international research. Lastly, the share of staff with advanced degrees is used as a measure of overall human capital quality. After each sub-index is calculated, it is used as a variable for the general AiU measurement.

5.2. Evaluating the efficiency of Russian universities

In order to measure the efficiency of universities, we address the non-parametric method of DEA which is widely used in the public sector in general (Chalos and Cherian, 1995; Agasisti et al., 2015) and educational studies particularly (Worthington, 2001; Johnes, 2006; Thanassoulis et al., 2016). The main advantage of this method is that it allows efficiency to be measured without knowing the exact functional form of the production function and does not require any assumptions about data distribution.

The method is based on Farrell's (1957) work on productive efficiency measurement which was developed by Charnes, Cooper and Rhodes (1978) and allows the efficiency of a decision-making unit to be measured both under constant and variable return to scale assumptions. There are two variations in the model. One addresses the input orientation which requires fixing the outputs and allows the obtained efficiency scores to be interpreted through a possible input reduction. The reverse logic of an output-oriented model requires the inputs to be fixed, and one should consider efficiency scores via a possible increase in outputs.

In this research we use the output-oriented model, as we are interested in how well universities are capable of allocating scarce resources in order to produce more. We also use the variable return to scale assumption based on previous studies on the production function of Russian universities (Abankina et al., 2013; Gromov, 2017; Agasisti et al., 2018). The linear programming model we address is presented in equations (4)-(7), as reported in Johnes (2006):

$$\begin{aligned} & \text{Maximize } \varphi_k + \varepsilon \sum_{r=1}^s s_r + \varepsilon \sum_{i=1}^m s_i \quad (4) \\ & \text{subject to } \varphi_k y_{rk} - \sum_{j=1}^n \lambda_j y_{rj} + s_r = 0, r = 1, \dots, s, \quad (5) \\ & x_{ik} - \sum_{r=1}^n \lambda_j x_{ij} - s_i = 0, r = 1, \dots, m, \quad (6) \\ & \sum_{j=1}^n \lambda_j = 1, \quad () \\ & \lambda_j, s_r, s_i \geq 0 \quad \forall j = 1, \dots, n; r = 1, \dots, s; i = 1, \dots, m, \quad (7) \end{aligned}$$

where s and m indicate outputs and inputs respectively, while y_{rk} and x_{ik} are the amount of output of type r produced and the amount of input of type i used by university k . s_r and s_i are the output and input slacks, and the technical efficiency of university k is measured as $1/\varphi_k$. The efficiency score is interpreted relative to 1. If an efficiency score equals 1, all slacks are zero (there is no underproduction and all resources are used completely), and the university is fully efficient. Scores below 1 indicate a degree of inefficiency of $1-1/\varphi_k$. In order to the enhance robustness of the efficiency score measurement, we address the bootstrapping procedure as reported in Simar and Wilson (1999) and use 1,000 replications in order to reduce bias caused by university heterogeneity and to obtain efficiency confidence intervals.

One of the most debated issues in measuring the efficiency and production function of such complex organization as universities is the variable selection (De Witte & López-Torres, 2017). We use a simplistic model that depicts a university's ability to transfer income and human resources in enrollment and research.

In our efficiency modeling we use two inputs: the total financial resources available to a university (including salary expenditure), and the average unified entrance exam score as a measure of students' ability. The first variable is often used in efficiency measurements as a universal indicator of an educational organization's capacity to invest and distribute money (Agasisti and Perez-Esparrells, 2010). Students' ability can be regarded as a resource available for a university as well (Hoxby, 1997; Johnes, 2013). We use the total number of students as one of the outputs which represents teaching activity instead of the more widely used number of graduates or graduation rate

(Agasisti and Johnes, 2015), because in Russia most enrolled students (about 80%, Gorbunova, 2018) successfully finish their studies. The total number of publications produced in a university is used as the research output to measure scientific productivity (Parteka and Wolszczak-Derlacz, 2013; Wolszczak-Derlacz, 2017). The descriptive statistics for the efficiency evaluation are presented in Tables A3-A4 in the Annex.

5.3. Estimating the robust relationship between university autonomy, and performance and efficiency

To empirically analyze the effect of both formal autonomy and the AiU, we employ a fixed-effects regression. First, our data has a panel structure, which means that observations on universities are repeated over time. The between variation is exogenous, and in order to solve the problem of unobserved heterogeneity due to universities' individual characteristics, we apply within variation in the efficiency estimation and infer a causal effect of autonomy from it (Best and Wolf, 2014).

The multi-dimensional structure of AiU allows us to suppose that some sub-indices may lead to higher levels of efficiency, because some managerial practices are more effective than the others. Thus, in our analysis we use the following specification of regression model:

$$y_{it} = x_{it}\beta + \alpha_i + \epsilon_{it} \quad (8),$$

where y_{it} is the observed outcome of university i at time t , x_{it} is the $(1 \times K)$ vector of covariates of this university, and β is the corresponding $(K \times 1)$ vectors of coefficients to be estimated. α_i are stable university-specific unobserved characteristics which capture time-constant individual heterogeneity. ϵ_{it} is the error term that varies across universities and over time.

In our case, we use the number of publications indexed in Web of Science/Scopus per academic staff member as a measure of performance, and the DEA-estimated score as a measure of university efficiency as the dependent variable and the following predictors and control variables:

- *Formal autonomy* – a binary variable that indicates whether a university possessed autonomous status in a certain year;
- *AiU* – an index that depicts informal, de-facto autonomy and its subcomponents: financial autonomy, operational (staff) management and academic freedom;
- *Leading status* – a binary variable that illustrates whether a university is a leading university, which includes the excellence initiative participants, national research and federal universities, Moscow and Saint Petersburg State universities;
- *Leading status##AiU/Sub-indices* – an interaction term between leading status that presupposes universities having advanced managerial practices and the informal autonomy or its subcomponents;
- *Formal autonomy##AiU/Sub-indices* – an interaction term between formal autonomy and informal autonomy or its subcomponents, which illustrates whether a formally autonomous university is actually using its rights;
- *Unified state exam score, the share of full-time students* – control variables for the human capital quality of students enrolled;
- *The total number of teaching and research staff; Total number of students* – size control variables;

- *The share of research and development income* – a control variable that illustrates the extent to which a university is oriented towards research rather than teaching.

A methodological note is important here. Following Gunnarsson et al. (2009) and Contreras (2015) we make an attempt to account for the possible endogeneity which can arise in measuring the relationship between institutional efficiency and performance in the following way. An educational entity's informal autonomy might become a moderating mechanism for exhibiting managerial practices referring to institutional AiU. In our paper, we use the legally guaranteed status of autonomy as an instrument for the composite measurement of autonomy and therefore estimate the impact of AiU on institutional efficiency by employing a regression based on instrumental variables. In such an analysis, we rely on the same control variables as for the robust relationship measurement: the unified state exam score, the share of full-time students, the total number of students, the total number of teaching and research staff. The panel structure of our data and the presence of fixed effects means we use the fixed-effect instrumental variable estimator (FE2SLS) as proposed in Wooldridge (2002).

$$\text{Consider } y_{it} = x_{it}\beta + c_i + u_{it} \quad (9),$$

where y_{it} , x_{it} and β stand for the same variables as in (8), c_i is a time-constant unobservable, u_{it} is the error term which varies across universities and over time. In order to estimate β , within-transformation should be applied to (8) by first averaging it over $t = 1, \dots, T$:

$$\bar{y}_i = \bar{x}_i\beta + c_i + \bar{u}_i \quad (10),$$

where $\bar{y}_i = T^{-1} \sum_{t=1}^T y_{it}$, $\bar{x}_i = T^{-1} \sum_{t=1}^T x_{it}$, $\bar{u}_i = T^{-1} \sum_{t=1}^T u_{it}$. Subtracting (10) from (8) for each t gives the following equation with the removed individual c_i :

$$y_{it} - \bar{y}_i = (x_{it} - \bar{x}_i)\beta + u_{it} - \bar{u}_i \quad (11)$$

Estimating (11) by pooled 2SLS using time-varying instruments $\check{z} \equiv z_{it} - \bar{z}_i$, a $1 \times L$ with $L \geq K$ vector, we obtain the FE2SLS estimator, as $\forall i \sum_{t=1}^T z'_{it} (x_{it} - \bar{x}_i) = \sum_{t=1}^T (z_{it} - \bar{z}_i)' (x_{it} - \bar{x}_i)$ and $\sum_{t=1}^T z'_{it} (y_{it} - \bar{y}_i) = \sum_{t=1}^T (z_{it} - \bar{z}_i)' (y_{it} - \bar{y}_i)$.

5.4. Data sources and descriptive statistics

The main data source we use in this research comes from the monitoring of HEI, conducted by MHES. This survey is a self-reported administrative survey on several indicators, organized thematically: finance, internationalization, teaching, research, human resources, capital and infrastructure. Each public university has to complete the monitoring every year. Due to data availability our dataset covers from the 2014/2015 to the 2017/2018 academic years and illustrates the activity of 385 head public universities, including 42 formally autonomous (as of 2017/2018). We excluded branch, private, sports and culture universities due to their differing production functions and the non-uniformity of data collection methodology. Descriptive statistics for the variables used in building the AiU index, measuring efficiency and estimating the robust relationship between autonomy and performance/efficiency are presented in Tables A2-A6 in the Annex.

The descriptive analysis of variables employed in estimating the AiU index and the efficiency analysis provides a preliminary comparison between the mean values of the formally

autonomous and non-autonomous universities. In our sample, the share of formally autonomous universities is no more than 11%. On average formally autonomous universities are much wealthier in terms of total income and accumulate more staff and student human resources. Although on average autonomous universities produce more publications (in total and per staff member) than their counterparts, non-autonomous institutions demonstrate higher average efficiency scores. Another feature of formally autonomous universities is that these institutions on average accumulate students with higher entrance exam scores and are more likely to be research-oriented universities.

6. Results

6.1 The autonomy of Russian universities

The AiU index is a robust measure of the organizational informal autonomy of universities. Pairwise correlations of indices calculated using the BoD and the AMPI methods are statistically significant over time (Figure 1 in the Annex). We applied minimal weight restrictions in order to include all of the sub-indices in the final index evaluation, 20% minimal weights preserved the maximum observations. University financial independence remained the key component of informal autonomy, weighting 42% in 2014/2015 and 44% in 2017/2018. Staff management average weighting in informal autonomy decreased over time (from 34% to 25%), while academic freedom average weights remained stable (Figure 1).

The descriptive statistics of the AiU index by formal autonomy status (Table 3) illustrates that formally non-autonomous universities tend to be slightly more autonomous informally. This may be explained because the group of formally autonomous universities is heterogeneous in terms of resources available, size and other institutional characteristics, as this status acquisition happened in two major waves, rather vague in time and differing in formal reasons and requirements for universities.

[Figure 1 and Table 3] around here

6.2 The efficiency of Russian universities

The descriptive analysis of the variables used for the efficiency estimation reveals that the universities in our sample received the same average amount of total funding at current prices and lost their funding at constant prices. They also managed to considerably increase research productivity in terms of the number of publications. On average, formally autonomous universities obtained 2.8 times more financing in 2014/15 than the formally non-autonomous ones and this did not change by 2017/18. Comparable differences are present in terms of the total number of students and publications: in 2017/18 formally autonomous universities had 1.9 times more students and produced 2.5 times more publications. This balance of resources might indicate that the group of formally autonomous universities is likely to include a large proportion of leading research-intense universities which attract a large proportion of the student body. In addition, descriptive statistics for the group of formally non-autonomous universities shows some universities in this group can be wealthier than the best resourced formally autonomous institutions.

DEA estimations of university efficiency resulted in normally distributed efficiency scores (Figure 2). The descriptive analysis of the discrepancies between formally autonomous and non-autonomous universities in terms of efficiency demonstrates that formally autonomous ones are not more efficient on average (descriptive statistics for DEA scores are presented in Tables 4 and 5). The intuition is that this might happen for two mutually reinforcing reasons: first, formally autonomous universities are diverse and gained this legal status under varying circumstances; secondly, a large sub-group of formally autonomous universities are leading institutions that operate on larger scales, and as we allow the variable return to scale assumption to be true, these universities might demonstrate comparatively lower efficiency scores if there are decreasing returns to scale. A reverse scenario was observed in 2015/2016, when there was a new wave of the Russian Excellence Initiative (for details see Agasisti et al., 2019) which coincided with the acquisition of formal autonomous status by two more universities. This might demonstrate that some large leading and formally autonomous universities tried to join the excellence race by demonstrating better results. It is important to notice that as formally non-autonomous universities demonstrated higher maximum values for resources and outputs, the same holds for the efficiency analysis: the group of non-autonomous universities tends to be less efficient on the minimal edge and more efficient on the maximum edge of the efficiency score distribution, which shows that formally autonomous universities are a less heterogeneous group. Analyzing the potential relationship between efficiency scores and informal autonomy (the AiU index) does not demonstrate any association between the two institutional characteristics (Figures A2 and A3 in the Annex).

[Figure 2, Table 4 and Table 4] around here

6.3 Estimating the robust relationship between university autonomy and efficiency

6.3.1 The effects on publication activity

The fixed effects regression analysis shows that formal autonomy can be regarded as a negative predictor of publication performance. When considering the number of publications per staff member, the effect of formal autonomy is not associated with higher publication activity. This might corroborate our assumption on the heterogeneity of formally autonomous universities which brings together universities that vary drastically in their size, financial resources and mission. The AiU index and academic freedom are negative and significant predictors of the number of publications. Academic freedom, if taken together with the formal autonomy or leading status, cannot be regarded as a significant predictor of publication performance. This might happen because the academic freedom sub-index is not a valid predictor of having more capacity, financial or managerial, to transfer their educational activity into publications. However, a higher quality of enrollees is a powerful predictor of higher academic institutional performance (see Models 2-1, 2-2, 2-3 and 2-4 in Table A7 in the Annex).

The financial independence sub-index has no positive or statistically significant effect on publication performance. This sub-index does not distinguish formally autonomous and non-autonomous universities, or leading and non-leading ones. Although financial independence is thought to be the general source of investment in higher performance that does not necessitate such

strong accountability and is more flexible in timing; it might be the case that relative financial independence does not guarantee the capacity to invest in higher publication performance.

The staff management sub-index evaluates a university's capacity to invest in staff. This sub-index is the only positive and statistically significant predictor of higher publication performance (the effect size varies from 7.06 to 10.73, see Table 7 in the Annex). This might indicate that better human capital together with greater investment in rewarding academic staff leads to an average increase in total staff productivity. However, we find that together with formal autonomy, this index predicts a negative change in publication activity. The same holds for the interaction term between leading status and informal autonomy, which is counterintuitive and might indicate the presence of inefficient staff expenditure or an oversaturation of formally advanced staff in leading universities. This assumption is tested in the following section, which looks at the relationship between university autonomy and efficiency.

6.3.2 The relationship between university autonomy and efficiency

The AiU index is a statistically significant predictor of efficiency; a 1-point increase in informal autonomy is associated with a 5% gain in efficiency (Table A8 in the Annex). Academic freedom alone can result in an 8% rise in institutional efficiency, while financial independence has a positive but not statistically significant effect. We suppose that academic freedom can be a strong predictor of market power in accumulating more high-performing students, institutional prestige and better performance. Universities which demonstrate this dimension of informal autonomy are more likely to have certain organizational features allowing them to manage their activity in a more efficient way. These might include sophisticated contracting schemes or specific rules of relations between scientific and teaching departments. Again, higher values of average entrance exam scores predict higher institutional efficiency. The staff management sub-index shows a statistically significant relationship with the institutional efficiency (the effect is 0.42-0.45): a higher quality of teaching and research staff, more rewards and greater internationalization in leading universities contributes to more the efficient conversion of total funds into teaching and research outputs.

As anticipated in the methodology section (5.3), we also conduct further analysis to identify a possible causal relationship between autonomy and efficiency, by means of an Instrumental Variable (IV) strategy. The findings, reported in Table A9 (in the Annex), corroborate those presented here. Informal autonomy has a positive (0.56), but not statistically significant effect on institutional efficiency in the Russian context.

7. Discussion and policy implications

Russian legislation provides a puzzling case of regulating not-for-profit organizational autonomy. In this research, we studied two main research issues relating to HE organizations in Russia: (i) HE institutional differentiation in terms of formal and informal autonomy; (ii) the presence of a statistical relationship between institutional autonomy (both formal and informal) and university efficiency and publication performance. We first made a distinction between formal autonomy (regulated by Russian legislation) and the level of autonomy actually used by university management (Christensen, 2001; Boer and Enders, 2018). For this purpose, we apply BoD

methodology (Cherchye et al., 2007) to derive a composite indicator of AiU. This indicator relies on three sub-dimensions of institutional autonomy that are the most relevant for the Russian context, according to the literature: (i) academic freedom, (ii) financial independence and (iii) staff management. Second, we estimate institutional efficiency by employing non-parametric DEA, treating the amount of total funds available as the input and total number of students along with the total number of academic publications as the output. Third, we use panel fixed effect regressions in order to trace the relationship between university autonomy (both formal and informal), university efficiency and performance (in terms of the number of publications per staff member). Lastly, we attempt to provide a causal analysis of the impact of informal autonomy on efficiency by means of an instrumental variable approach, considering the formal autonomy status as the instrument for the actual use of autonomy – as operationalized through the AiU index.

The main results of our analysis can be summarized in four core messages. First, the descriptive analysis of the AiU index and the efficiency evaluation results demonstrate that formal autonomous status does not necessarily imply the subsequent, actual use of autonomy, nor it is associated with higher levels of performance or efficiency. Second, AiU and its academic freedom sub-index are negatively associated with the number of publications per staff member. A likely explanation for this is that the right to relative self-determination in teaching and research activities does not imply the availability of sufficient resources and managerial capacity to invest in publications. Third, autonomy in staff management is positively associated with publication performance: highly rewarded, skilled and internationalized staff are more productive. Fourth, contrary to performance, actual autonomy is positively associated with institutional efficiency, the same holds for the AiU sub-indices of academic freedom and staff management. We cannot demonstrate that this link is causal, because the instrumental variable analysis failed to provide sufficient evidence for this. Nevertheless, we believe that higher levels of exhibited autonomy are inherent in universities which apply innovative management practices which lead to an increase in the efficiency of resource management.

The high heterogeneity of formally autonomous universities might indicate the involution of criteria according to which universities were selected to be granted autonomy privileges. A lack of legislative updates makes this status archaic and might inhibit institutional development in HE. Financial independence, as BoD weights depicted, was considered to be the main component of informal autonomy. Nevertheless, this dimension was not associated with higher publication performance or higher efficiency. Such a lack of correlation might arise because universities, enjoying formal autonomy or not, are subject to strict accountability, even with regard to how privately acquired resources are redistributed. As a consequence, universities interested in raising their efficiency and performance should search for more opportunities in operations (staff and academic activities) than finance.

A final note is about the limitations of the study, which pave the way to further research in this area. Firstly, we operate with limited data, as we study a short period of time that is remote from both waves of granting formal autonomy. This could be a reason for the instrumental variable approach failing and the lack of division between formally autonomous and non-autonomous universities. Another limitation is the lack of in-depth information on management practices, which

would be relevant for actually used autonomy. This specific issue could be subject to future studies in the field of operational management in HE.

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Tables and Figures of the paper “Autonomy, performance and efficiency: an empirical analysis of Russian universities in 2014-2018”

Agasisti, T. & Shibanova, E.* (2020)

Table 1. The autonomy of different types of Russian HEIs

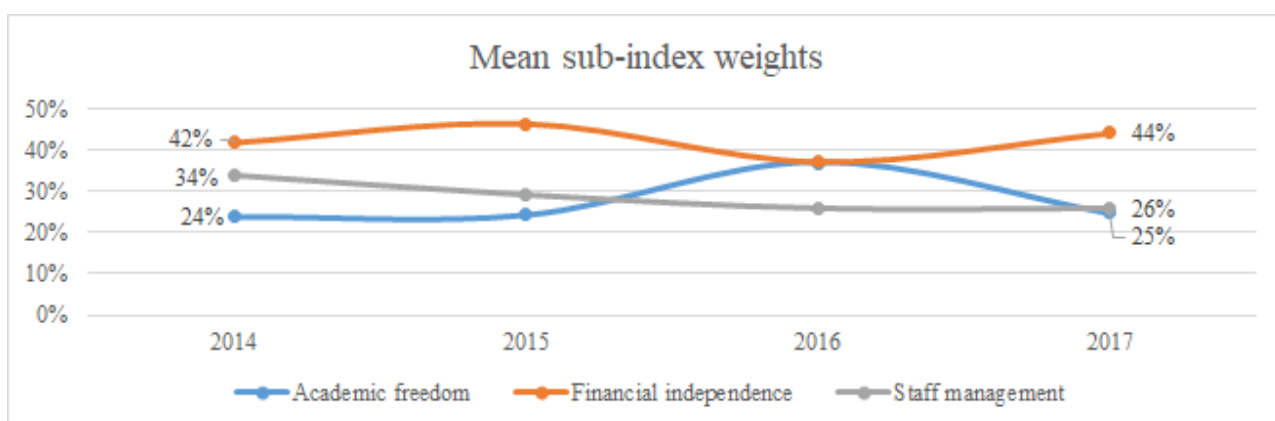
Kazeno	Budgetary	Autonomous
Public funding scheme		
Are financed through strictly regulated monolet state subsidy. The subsidy is estimated by the supervisory ministry based on a normative budget scheme.	Educational activities are financed through performance-based funding scheme (since 2015): each student is financed based on performance and correction coefficients with respect to the field of study. The total number of publicly funded students is determined on the basis of performance as well. Research activities are finance through subsidies.	The same regulation as for budgetary HEIs is applied.
Unspent public funding		
HEI cannot voluntarily transfer financial resources from one activity to another. All unspent balance must be transferred to the founder's (supervising ministry) budget.	Formally, all unspent income from public sources can be redistributed 1) after the founder's agreement and 2) if the state task is completely fulfilled. However, HEIs are not interested in not spending all the subsidy, because in that case they will not receive as much financing in the next year.	The same regulation as for budgetary HEIs is applied.
Private income		
HEI can lead income-generating activities if a right to generate income is fixed in the institution's constituent document.	Such activities must comply with the main goals of the HEI, set in the constituent documents and can be led upon supervisory ministry approval.	The same regulation as for budgetary HEIs is applied.
Use of private income		
All income generated is transferred to the budget of the founding governmental structure (ministry).	All income generated remains in HEI's disposal but can be used only upon approval of the supervisory ministry.	All non-state task income can be redistributed to the next period and reinvested into financial assets upon supervisory board approval.
Commercial deals and procurement		
Major deals and procurement of amount higher than 50 thousand rubles (approximately \$700) can be settled after	The same regulation as for kazeno HEIs is applied.	Major deals can be settled under supervisory board's consent only. The limit of public procurement deal that does not need

the founding ministry's consent only.		consent is extended compared to other HEIs.
Property		
Does not possess and cannot acquire the property.	Can manage its property, but real estate and valuable movable property can be managed with the consent of the founder only.	The same regulation as for budgetary HEIs is applied.
Special governing bodies		
Not applicable	Not applicable	A supervisory board regulates financial plans, deals, procurement, opening of bank accounts, and property; approves the rector.

Table 2. Variables used for building the Autonomy-in-Use (AiU) index

Sub-index	Academic freedom	Financial Independence	Operational staff management
Variables	Share of master and PhD students	Share of private income in income from educational activities	Average research and teaching staff salary
	Right to determine educational standards	Share of private income in income from research activities	Share of international staff
	Numbers of dissertation (thesis) committees		Share of staff with advanced degrees

Figure 1. Weights obtained for universities' autonomy sub-indexes, 2014/15-2017/18



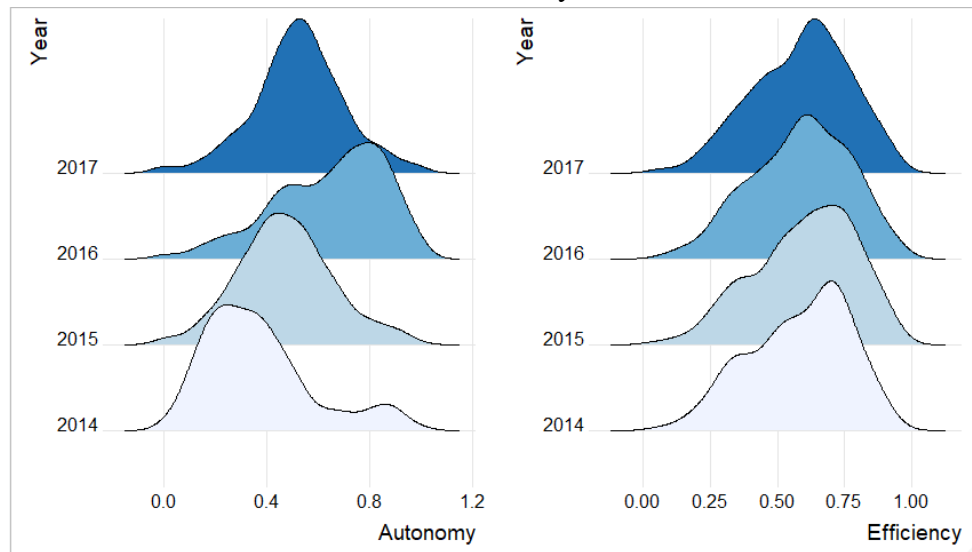
Source: authors' calculations based on MoP

Table 3. Descriptive statistics of universities' AiU index by formal autonomy status, 2014/15-2017/18

Variable	Year	Formally autonomous universities					Formally non-autonomous universities				
		Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
AiU	2014/15	37	0.61	0.26	0.02	0.92	348	0.34	0.19	0.00	1.00
	2015/16	39	0.60	0.24	0.00	0.93	346	0.46	0.17	0.00	1.00
	2016/17	41	0.71	0.20	0.00	1.00	344	0.64	0.22	0.00	1.00
	2017/18	42	0.63	0.24	0.00	0.98	343	0.51	0.16	0.00	1.00

Source: authors' calculations based on MoP

Figure 2. Distributions for DEA universities' efficiency and AiU index, 2014/15-2017/18



Source: authors' calculations based on MoP

Table 4. DEA efficiency scores general descriptive statistics, 2014/15-2017/18

Variable	Year	Obs	Mean	SD	Min	Max
DEA Scores	2014/15	385	0.566	0.184	0.044	0.981
	2015/16	385	0.341	0.182	0.020	0.930
	2016/17	385	0.585	0.183	0.060	0.970
	2017/18	385	0.592	0.180	0.050	0.970

Source: authors' calculations based on MoP

Table 5. Descriptive statistics of universities' efficiency AiU index by formal autonomy status, 2014/15-2017/18

Variable	Year	Formally autonomous universities					Formally non-autonomous universities				
		Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
DEA Efficiency, %	2014/15	37	49.37	19.74	7.53	87.91	348	57.37	18.07	4.38	98.15
	2015/16	39	41.33	20.53	10.00	80.00	346	33.30	17.79	2.00	93.00
	2016/17	41	51.22	18.25	16.00	82.00	344	59.31	18.10	6.00	97.00
	2017/18	42	51.71	18.57	20.00	83.00	343	60.13	17.69	5.00	97.00

Source: authors' calculations based on MoP

Annexes of the paper “Autonomy, performance and efficiency: an empirical analysis of Russian universities in 2014-2018”

Agasisti, T. & Shibanova, E.* (2020)

Table A1. Variables used for measuring universities’ autonomy: descriptive statistics

Year	VARIABLES	N	Mean	SD	Min	Max
2014/15	Share of master and PhD students, %	385	7.874	7.116	0	74.94
	Numbers of dissertation (thesis) committees	385	4.19	7.321	0	104
	Research and teaching staff salary, thousand rubles	385	46.81	20.89	0	154.7
	Share of private income in income from educational activities, %	385	58.49	28.52	0	100
	Share of private income in income from research activities, %	385	30.65	15.93	1.54	89.68
	Share of international staff, %	385	0.522	1.159	0	14.46
	Share of staff with advanced degrees, %	385	72.42	9.123	24.43	98.52
2015/16	Share of master and PhD students, %	385	12.34	7.348	0	56.32
	Numbers of dissertation (thesis) committees	385	3.943	7.474	0	108
	Research and teaching staff salary, thousand rubles	385	48.98	19.31	17.23	127.9
	Share of private income in income from educational activities, %	385	32.25	16.01	2.16	89.38
	Share of private income in income from research activities, %	385	62.97	29.59	0	100
	Share of international staff, %	385	0.555	1.044	0	8.08
	Share of staff with advanced degrees, %	385	73.67	9	41.64	100
2016/17	Share of master and PhD students, %	385	56.65	31.75	0	100
	Numbers of dissertation (thesis) committees	385	3.686	7.27	0	102
	Research and teaching staff salary, thousand rubles	385	53.06	22.1	17.23	140.1
	Share of private income in income from educational activities, %	385	33.61	16.17	3.23	85.11
	Share of private income in income from research activities, %	385	64.95	29.25	0	100
	Share of international staff, %	385	0.543	1.17	0	13.68
	Share of staff with advanced degrees, %	385	74.94	8.683	44.78	100
2017/18	Share of master and PhD students, %	385	14.01	7.542	0	47.62
	Numbers of dissertation (thesis) committees	385	3.699	6.226	0	85
	Research and teaching staff salary, thousand rubles	385	62	26.23	23.26	156.7
	Share of private income in income from educational activities, %	385	33.62	16.17	2.81	81.84
	Share of private income in income from research activities, %	385	63.89	30.49	0	100
	Share of international staff, %	385	0.645	1.437	0	13.15
	Share of staff with advanced degrees, %	385	76.14	8.88	44.68	99.5

Source: authors' calculations based on the MoP

Table A2. Variables used for measuring universities' autonomy: descriptive statistics by formal autonomy status, 2014/15-2017/18

Year	VARIABLES	Formally autonomous universities					Formally non-autonomous universities				
		Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
2014/15	Share of master and PhD students, %	37	13.00	7.64	0.36	36.31	348	7.33	6.85	0.00	74.94
	Numbers of dissertation (thesis) committees	37	8.41	7.98	0.00	27.00	348	3.74	7.11	0.00	104.00
	Research and teaching staff salary, thousand rubles	37	61.50	28.69	0.00	154.74	348	45.25	19.29	12.86	145.48
	Share of private income in income from educational activities, %	37	47.73	25.53	1.21	100.00	348	59.64	28.61	0.00	100.00
	Share of private income in income from research activities, %	37	30.62	19.24	5.99	89.68	348	30.66	15.57	1.54	89.62
	Share of international staff, %	37	0.86	1.02	0.00	5.59	348	0.49	1.17	0.00	14.46
	Share of staff with advanced degrees, %	37	70.48	7.71	56.65	93.37	348	72.63	9.25	24.43	98.52
2015/16	Share of master and PhD students, %	39	16.91	9.13	0.26	41.19	346	11.82	6.95	0.00	56.32
	Numbers of dissertation (thesis) committees	39	8.31	8.55	0.00	28.00	346	3.45	7.19	0.00	108.00
	Research and teaching staff salary, thousand rubles	39	63.23	23.61	26.60	117.06	346	47.37	18.11	17.23	127.93
	Share of private income in income from educational activities, %	39	33.58	20.32	9.72	89.06	346	32.10	15.48	2.16	89.38
	Share of private income in income from research activities, %	39	50.23	27.57	0.00	100.00	346	64.40	29.50	0.00	100.00
	Share of international staff, %	39	1.20	1.26	0.00	5.57	346	0.48	0.99	0.00	8.08
	Share of staff with advanced degrees, %	39	70.74	10.14	43.00	100.00	346	74.00	8.82	41.64	96.45
2016/17	Share of master and PhD students, %	41	55.42	30.19	10.73	100.00	344	56.80	31.97	0.00	100.00
	Numbers of dissertation (thesis) committees	41	8.46	8.37	0.00	30.00	344	3.12	6.92	0.00	102.00
	Research and teaching staff salary, thousand rubles	41	67.16	26.05	28.80	118.02	344	51.38	21.00	17.23	140.06
	Share of private income in income from educational activities, %	41	34.95	19.33	7.17	82.71	344	33.45	15.78	3.23	85.11
	Share of private income in income from research activities, %	41	49.67	28.08	0.00	100.00	344	66.78	28.89	0.00	100.00
	Share of international staff, %	41	1.67	2.41	0.00	13.68	344	0.41	0.83	0.00	6.88
	Share of staff with advanced degrees, %	41	71.33	9.54	49.67	100.00	344	75.37	8.49	44.78	96.78
2017/18	Share of master and PhD students, %	42	20.13	10.19	0.00	47.62	343	13.26	6.80	0.00	47.09
	Numbers of dissertation (thesis) committees	42	9.02	8.46	0.00	30.00	343	3.05	5.57	0.00	85.00
	Research and teaching staff salary, thousand rubles	42	80.07	32.31	33.87	140.16	343	59.79	24.55	23.26	156.67
	Share of private income in income from educational activities, %	42	32.74	17.91	6.46	77.69	343	33.73	15.97	2.81	81.84
	Share of private income in income from research activities, %	42	51.38	29.17	0.22	100.00	343	65.42	30.34	0.00	100.00
	Share of international staff, %	42	1.91	2.44	0.00	13.15	343	0.49	1.18	0.00	13.04
	Share of staff with advanced degrees, %	42	72.07	8.91	47.95	99.50	343	76.64	8.76	44.68	96.88

Source: authors' calculations based on MoP

Table A3. Variables used for measuring universities' efficiency: descriptive statistics

Year	VARIABLES	N	Mean	SD	Min	Max
2014/15	Total income, thousand rubles	385	1,509,000.00	2,104,000.00	75,843	21,780,000.00
	Total number of bachelor, specialist, masters students	385	5,467	4,160	146.00	28,713
	Number of publications indexed in Scopus or Web of Science or RSCI	385	1,364	1,609	56.01	10,472
2015/16	Total income, thousand rubles	385	1,559,000.00	2,209,000.00	77,195	23,010,000.00
	Total number of bachelor, specialist, masters students	385	5,272	4,199	196.00	28,431
	Number of publications indexed in Scopus or Web of Science or RSCI	385	1,771	2,075	0.00	15,025
2016/17	Total income, thousand rubles	385	1,570,000.00	2,205,000.00	75,684	23,380,000.00
	Total number of bachelor, specialist, masters students	385	584.00	668.80	37.80	8,871
	Number of publications indexed in Scopus or Web of Science or RSCI	385	2,258	3,003	78.00	29,473
2017/18	Total income, thousand rubles	385	1,652,000.00	2,432,000.00	72,419	25,420,000.00
	Total number of bachelor, specialist, masters students	385	549.30	640.40	35.30	8,818
	Number of publications indexed in Scopus or Web of Science or RSCI	385	5,511	4,667	284.00	33,242

Source: authors' calculations based on MoP

Table A4. Variables used for measuring universities' efficiency: descriptive statistics by formal autonomy status, 2014/15-2017/18

Year	VARIABLES	Formally autonomous universities					Formally non-autonomous universities				
		Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
2014/15	Total income, thousand rubles	37	3,598 757.00	2,792,730.00	75,843.26	11,100,000.00	348	1,286,500.00	1,890,975.00	100,431.10	21,800,000.00
	Total number of bachelor, specialist, masters students	37	9,351.28	6,762.81	512.55	24,004.05	348	5,054.14	3,552.91	146.00	28,713.15
	Number of publications indexed in Scopus or Web of Science or RSCI	37	2,488.10	2,375.72	97.95	9,555.72	348	1,244.52	1,459.07	56.01	10,472.19
2015/16	Total income, thousand rubles	39	3,643,064.00	2,866,630.00	77,195.21	11,500,000.00	346	1,324,593.00	1,994,782.00	93,316.28	23,000,000.00
	Total number of bachelor, specialist, masters students	39	8,980.94	6,879.58	453.90	24,199.55	346	4,853.39	3,560.78	196.00	28,430.65
	Number of publications indexed in Scopus or Web of Science or RSCI	39	3,265.83	2,824.51	118.00	10,739.10	346	1,602.70	1,905.85	0.00	15025.41
2016/17	Total income, thousand rubles	41	3,562,058.00	2,781,654.00	75,684.22	10,200,000.00	344	1,332,712.00	2,002,824.00	83,669.61	23,400,000.00
	Total number of bachelor, specialist, masters students	41	1,108.40	851.80	37.80	3,111.70	344	521.51	615.92	43.00	8,871.18
	Number of publications indexed in Scopus or Web of Science or RSCI	41	4,497.59	4,231.34	179.00	16,933.93	344	1,990.84	2,708.32	78.00	29,472.73
2017/18	Total income, thousand rubles	42	3,933,055.00	3,360,326.00	72,418.96	14,800,000.00	343	1,372,536.00	2,137,878.00	89,731.28	25,400,000.00
	Total number of bachelor, specialist, masters students	42	9,722.30	7,218.98	503.90	26,197.90	343	4,995.42	3,969.74	284.00	33,241.70
	Number of publications indexed in Scopus or Web of Science or RSCI	42	5,049.59	4,932.38	77.00	21,801.78	343	2,032.33	2,607.56	31.00	25,172.23

Source: authors' calculations based on MoP

Table A5. Variables used for regression analysis: descriptive statistics

VARIABLES	N	Mean	SD	Min	Max
Leading status	1,540	0.107	0.309	0	1
Formal autonomy	1,540	0.103	0.304	0	1
AiU, %	1,540	50.38	22.2	0	100
VRS DEA scores, %	1,540	58.98	18.5	3.107	97.41
Number of publications per staff capita	1,540	334.82	1386.69	0.00	20600.20
Academic freedom subindex, %	1,527	27.5	15.49	20	60
Financial independence subindex, %	1,527	42.46	19.53	20	60
Staff management subindex, %	1,527	30.04	16.91	20	60
Average unified state exam score	1,540	66.70	10.26	44.81	100
Share of R&D income, %	1,540	9.381	8.636	0	57.88
Share of full-time students, %	1,540	62.62	16.2	19.97	100
Total number of staff	1,540	1,817	3,165	35.3	31,585
Total number of students	1,540	4,208	4,319	37.8	33,242
Number of id	384	384	384	384	384

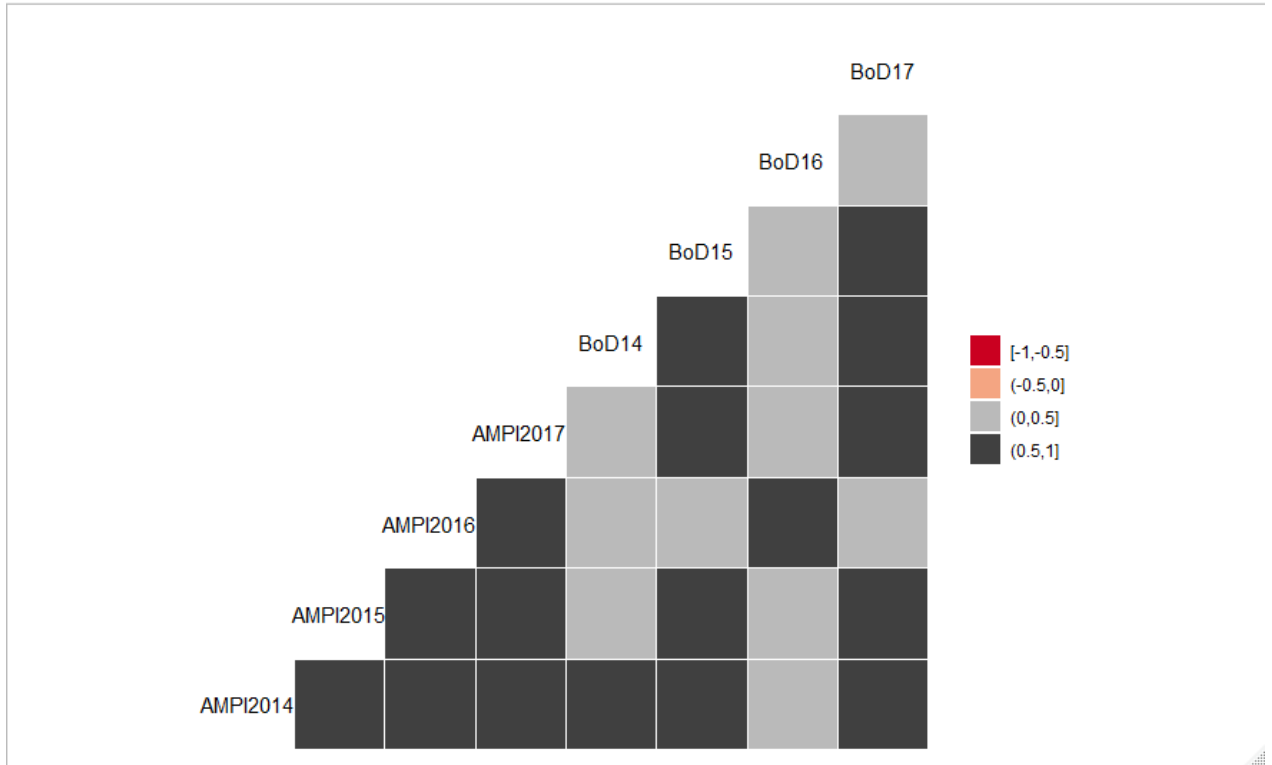
Source: authors' calculations based on MoP

Table A6. Variables used for regression analysis: descriptive statistics by formal autonomy status, 2014/2015 and 2017/2018

Year	VARIABLES	Formally autonomous universities					Formally non-autonomous universities				
		Obs	Mean	SD.	Min.	Max.	Obs	Mean	SD	Min.	Max.
2014/2015	AiU, %	37	0.61	0.26	0.02	0.92	348	0.34	0.19	0.00	1.00
	VRS DEA scores, %	37	49.37	19.74	7.53	87.91	348	57.37	18.07	4.38	98.15
	Number of publications per staff capita	37	272.36	349.98	0.00	1341.36	348	46.50	233.74	0.00	3824.04
	Academic freedom subindex, %	37	0.43	0.20	0.20	0.60	345	0.22	0.08	0.20	0.60
	Financial independence subindex, %	37	0.29	0.16	0.20	0.60	345	0.43	0.19	0.20	0.60
	Staff management subindex, %	37	0.29	0.16	0.20	0.60	345	0.35	0.18	0.20	0.60
	Unified state exam	37	71.11	9.90	48.15	100.00	348	64.94	10.20	45.54	100.00
	Share of R&D income	37	16.75	13.95	0.54	50.77	348	8.68	8.21	0.11	57.88
	Share of students paying tuition fee	37	65.71	19.45	21.26	100.00	348	61.68	16.90	27.49	100.00
	N of Staff	37	1148.73	868.14	45.75	3138.75	348	569.59	649.99	43.49	9708.16
N of Students	37	9351.28	6762.81	512.55	24004.05	348	5054.14	3552.91	146.00	28713.15	
2017/2018	AiU, %	42	0.6264501	0.2384177	0	0.9828936	343	0.513313	0.163753	0	1
	VRS DEA scores, %	42	51.71429	18.56995	20	83	343	60.12536	17.68963	5	97
	Number of publications per staff capita	42	734.34	866.68	2.00	2695.02	343	113.06	398.94	0.00	6301.44
	Academic freedom subindex, %	40	0.42	0.20	0.20	0.60	341	0.23	0.10	0.20	0.60
	Financial independence subindex, %	40	0.29	0.17	0.20	0.60	341	0.46	0.19	0.20	0.60
	Staff management subindex, %	40	0.29	0.17	0.20	0.60	341	0.31	0.18	0.20	0.60
	Unified state exam	42	73.48	9.92	53.49	95.80	343	66.93	10.02	48.28	96.98
	Share of R&D income	42	16.06	12.39	0.98	48.69	343	8.39	7.34	0.54	45.62
	Share of students paying tuition fee	42	69.59	20.22	21.67	100.00	343	62.23	18.67	21.77	100.00
	N of Staff	42	1043.94	765.29	35.30	2885.59	343	488.71	597.15	43.50	8818.13
N of Students	42	9722.30	7218.98	503.90	26197.90	343	4995.42	3969.74	284.00	33241.70	

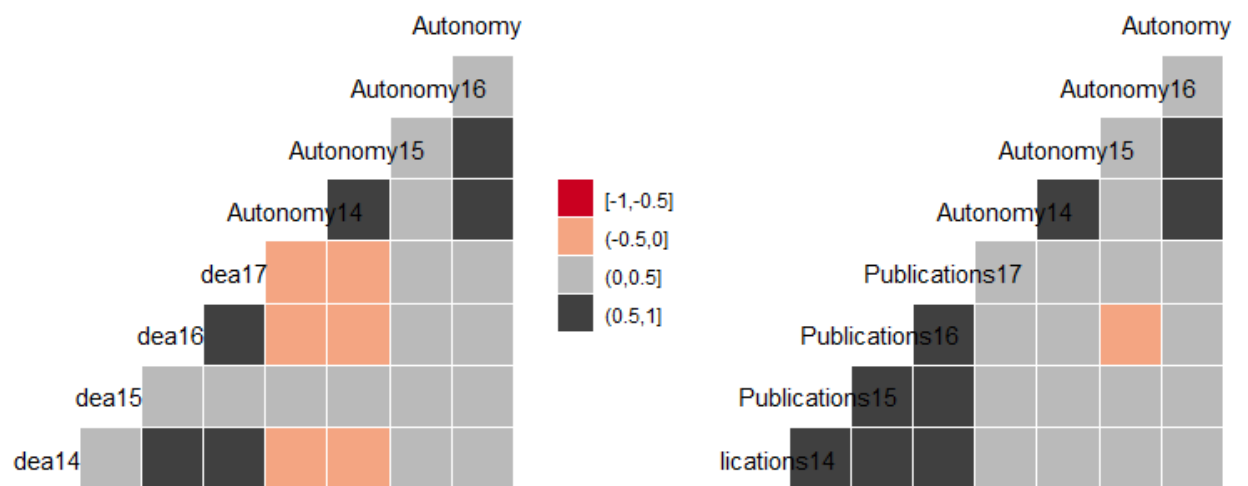
Source: authors' calculations based on MoP

Figure A1. AiU robustness check: correlation matrix of Benefit-of-the-Doubt and Adjusted Mazziotta-Pareto Index - calculated universities' autonomy



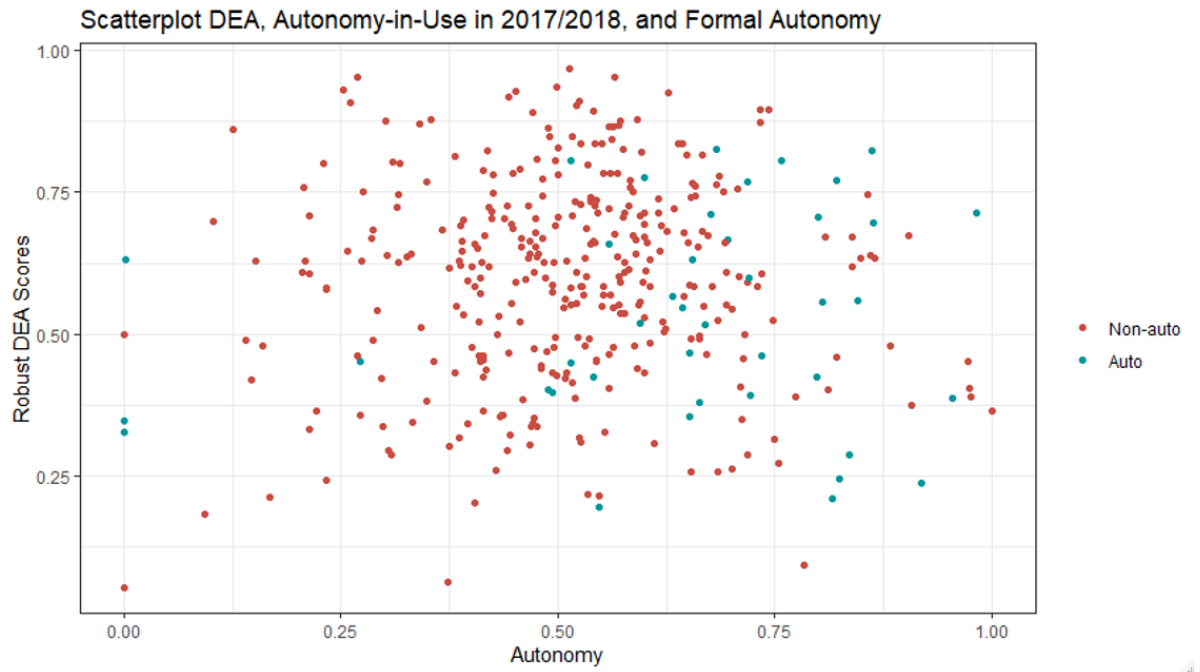
Source: authors' calculations based on MoP

Figure A2. Correlation matrices of DEA universities' efficiency and AiU index, DEA universities' efficiency and their publication performance, 2014/15-2017/18



Source: authors' calculations based on MoP

Figure A3. AiU index vs universities' efficiency scores and Formal autonomy, 2017/18



Source: authors' calculations based on MoP

Table A7. Regression analysis results: Publication activity explained through the Formal autonomy and the AiU index and its sub-indexes

VARIABLES	Autonomy = AiU				Autonomy = Academic freedom				Autonomy = Financial independence				Autonomy = Staff management				
	Model 1_1	Model 1_2	Model 1_3	Model 1_4	Model 1_5	Model 2_1	Model 2_2	Model 2_3	Model 2_4	Model 3_1	Model 3_2	Model 3_3	Model 3_4	Model 4_1	Model 4_2	Model 4_3	Model 4_4
Formal autonomy		-3.409	70.46	70.46			-25.96	-203.1	-29.03		-48.5	-106.1	-51.11		-5.356	1,450*	-193.5
		-480.9	-597.5	-597.5			-484.7	-557.2	-484.9		-495.4	-802.8	-495.8		-495.5	-766.9	-497.6
Autonomy ⁴	-9.487***		-9.359***	-9.359***	-9.112***	-8.960***	-8.970***	-9.162***	-8.968***	-0.763	-0.789	-0.817	-0.686	7.096*	7.06	10.44**	10.73**
	-1.761		-1.818	-1.818	-1.787	-1.247	-1.249	-1.284	-1.249	-1.967	-1.97	-1.994	-2.026	-4.302	-4.312	-4.513	-4.463
Formal autonomy##Autonomy			-1.801	-1.801				2.728				0.869				-28.76**	
			-6.1	-6.1				-4.229				-9.524				-11.59	
Leading status					1,424		325.8	342.3	678.7		263.8	255.7	398.6		214.5	500.4	3,657***
					(1,044)		-669.1	-669.8	(1,114)		-684.3	-690.3	-920.1		-683.5	-691.7	(1,322)
Leading status##Autonomy					-14.43				-5.634				-1.783				-43.97***
					-10.75				-14.22				-8.133				-14.47
Constant	-1,275	-1,443*	-1,268	-1,268	-1,249	-1,384*	-1,409*	-1,426*	-1,394*	-1,416*	-1,434*	-1,426	-1,450*	-1,976**	-1,991**	-2,230**	-2,291**
	-846.8	-857.1	-848.1	-848.1	-849.4	-838.3	-840.7	-841.3	-841.9	-859.7	-862	-866.7	-865.2	-914.9	-917.2	-920.2	-919.2
Observations									1,540								
R-squared	0.37	0.354	0.37	0.37	0.371	0.382	0.382	0.382	0.382	0.354	0.355	0.355	0.355	0.356	0.356	0.359	0.361
Number of id									385								

*** p<0.01, ** p<0.05, * p<0.1

Source: authors' calculations based on MoP

⁴ AiU index is used as “Autonomy” variable in models 1_1-1_5. Academic freedom, Financial independence and Staff management sub-indices are used as “Autonomy” in models 2_1-2_4, 3_1-3_4, and 4_1-4_4 respectively. Control variables coefficients are eliminated from the table.

Table A8. Regression analysis results: Institutional efficiency explained through the Formal autonomy and the AiU index and its sub-indexes

VARIABLES	Autonomy = AiU				Autonomy = Academic freedom				Autonomy = Financial independence				Autonomy = Staff management				
	Model 5_1	Model 5_2	Model 5_3	Model 5_4	Model 5_5	Model 6_1	Model 6_2	Model 6_3	Model 6_4	Model 7_1	Model 7_2	Model 7_3	Model 7_4	Model 8_1	Model 8_2	Model 8_3	Model 8_4
Formal autonomy		-1.937	-2.339	-2.339			-1.509	-0.665	-1.59		-1.258	-0.037	-1.305		1.187	11.24	-0.355
		-7.663	-9.622	-9.622			-7.84	-9.015	-7.843		-7.891	-12.79	-7.896		-7.773	-12.06	-7.829
Autonomy ⁵	0.059 **		0.059 **	0.0589 **	0.062 **	0.081 ***	0.081 ***	0.082 ***	0.081 ***	0.034	0.034	0.035	0.036	0.423 ***	0.424 ***	0.448 ***	0.454 ***
	-0.028		-0.029	-0.029	-0.029	-0.020	-0.020	-0.021	-0.020	-0.031	-0.031	-0.032	-0.032	-0.068	-0.068	-0.071	-0.0702
Formal autonomy##			0.0103	0.0103				-0.013					-0.018				-0.199
Autonomy			-0.098	-0.098				-0.068					-0.152				-0.182
Leading status					1.485		-4.236	-4.315	4.998		-4.004	-3.833	-1.55		-5.975	-4	22.24
					-16.83		-10.82	-10.84	-18.03		-10.9	-10.99	-14.66		-10.72	-10.87	-20.8
Leading status##					-0.081				-0.147				-0.033				-0.36
Autonomy					-0.173				-0.23				-0.13				-0.228
Constant	9.356	10.49	9.397	9.397	10.02	9.873	10.28	10.36	10.69	9.216	9.581	9.413	9.301	-21.38	-21.05	-22.7	-23.51
	-13.64	-13.66	-13.66	-13.66	-13.69	-13.56	-13.6	-13.61	-13.62	-13.69	-13.73	-13.8	-13.78	-14.35	-14.39	-14.47	-14.46
Observations									1,540								
R-squared	0.068	0.065	0.068	0.068	0.069	0.078	0.078	0.078	0.078	0.066	0.066	0.066	0.066	0.096	0.096	0.097	0.098
Number of id									385								

*** p<0.01, ** p<0.05, * p<0.1

Source: authors' calculations based on MoP

⁵ AiU index is used as “Autonomy” variable in models 5_1-5_5. Academic freedom, Financial independence and Staff management sub-indices are used as “Autonomy” in models 6_1-6_4, 7_1-7_4, and 8_1-8_4 respectively. Control variables coefficients are eliminated from the table.

Table A9. Instrumental variable regression analysis results. DEA efficiency explained through AiU index

Dependent variable: DEA Efficiency	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
AiU (instrumented)	0.557	2.203	0.250	0.801	-3.765	4.879
Unified state exam	-0.001	0.023	-0.050	0.961	-0.047	0.044
Share of R&D income	-0.003	0.002	-1.640	0.101	-0.006	0.001
Share of students paying tuition fee	0.001	0.009	0.130	0.898	-0.017	0.019
N of Staff	0.000	0.000	2.830	0.005	0.000	0.000
N of Students	0.000	0.000	0.860	0.389	0.000	0.000
Cons	0.006	0.412	0.010	0.989	-0.803	0.815
Sigma u	0.181					
Sigma e	0.157					
rho	0.570					

*** p<0.01, ** p<0.05, * p<0.1

Source: authors' calculations based on MoP