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REDISCOVERING BUREAUCRACY

Bureaucratic Professionalism, Impartiality, and Innovation

KOHEI SUZUKI

MEHMET AKIF DEMIRCIOGLU

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Department of Political Science
University of Gothenburg
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ABSTRACT

This study examines an empirical link between bureaucratic structures and country-level innovation outputs. Although there has been growing scholarly attention to public sector innovation, we still have a limited understanding of the relationship between the structures of public bureaucracies and country-level innovation. This paper emphasizes the importance of bureaucratic structure in explaining cross-national variations in country-level innovation outputs. It hypothesizes that countries where bureaucrats' careers are determined by merit-based recruitment rather than political appointees tend to record higher innovation outputs, controlling for other confounding factors. Countries with higher levels of impartiality of bureaucracies in decision-making also tend to have higher innovation outputs. Utilizing cross-national data from the Quality of Government Institute Expert Survey and Global Innovation Index, findings show that levels of innovation outputs are significantly higher in countries that have higher levels of professional and impartial bureaucracies. The results suggest the importance of administrative designs to promote innovative activities.

Key Words
Innovation; Weberian bureaucracy; Bureaucratic structure; Professionalism; Impartiality; Comparative public administration

Kohei Suzuki
The Quality of Government Institute
Department of Political Science
University of Gothenburg
kohei.suzuki@gu.se

Mehmet Akif Demircioglu
Lee Kuan Yew School of Public Policy
The National University of Singapore
mdemirci@indiana.edu

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Introduction

There has been growing scholarly attention to innovation in public organizations in recent years. [i] However, the focus of our paper is not public sector innovation, but the level of innovation in a country as a whole. In spite of an increasing number of studies on innovation, there have been few studies examining cross-national variations in innovation outputs at the national level. In particular, scant attention has been paid to how bureaucratic characteristics are associated with innovative activities within a country. This article examines a link between administrative designs of bureaucracy and country-level innovation by conducting a cross-national study of 108 countries. Although bureaucratic control and characteristics have been considered as having negative effects on innovation within the public and private sectors (Damanpor 1996; Dougherty and Corse 1995; Osborne and Gaebler 1992; Osborne and Plastrik 1997), recent studies show that Weber's model of public bureaucracy has positive impacts on country-level socio-economic development and possibly on innovation (Aucoin 2012; Dahlström, Lapuente, and Teorell 2010; Evans and Rauch 1999; Fukuyama 2013; Lodge and Gill 2011; Olsen 2006; Rauch and Evans 2000).

The recent development of a unique cross-national data set for bureaucratic structures presents tremendous opportunities to empirically test the relationship between variations in bureaucratic structures and various socio-economic outcomes (Teorell, Dahlström, and Dahlberg 2011; Dahlström et al. 2015). Taking advantage of such unique data sets, in this study we seek to contribute to the emerging literature on the effects of bureaucratic structures on social outcomes in a cross-national setting (Charron et al. 2017; Cho et al. 2013; Cornell and Grimes 2015; Dahlström, Lapuente, and Teorell 2012a; Dahlström and Lapuente 2012, 2017; Fernández-Carro and Lapuente-Giné 2016; Nistotskaya and Cingolani 2015).

We argue that bureaucratic structures and administrative designs are important explanatory factors for cross-national variations in innovation outputs. In particular, this article argues that countries where bureaucratic career system is characterized by merit-based recruitment and internal promotion rather than political appointees are likely to have higher innovation outputs. Likewise, those with impartial decision-making also tend to record higher innovation outputs. We test these propositions using a cross-national data set of bureaucratic structures from the Quality of Government Institute (QoG) Expert Survey (Dahlström et al. 2015) and Global Innovation Index (GII) (Cornell University, INSEAD, and WIPO 2016). Findings suggest that there is a strong link between profes-

sional and impartial bureaucracies and higher values of country-level innovation outputs, controlling for other confounding factors.

This study seeks to contribute to the existing literature in three ways. First, this study contributes to the literature on administrative designs and societal outcomes by examining the relationship between bureaucracy and innovation. Second, we incorporate administrative variables in the cross-national study of innovation and test their impacts. Third, this study contributes to the recent increased interest in contextual factors in public management and performance in a cross-national setting (Meier, Rutherford, and Avellaneda 2017; O'Toole and Meier 2014).

Theory and Hypotheses

Despite growing scholarly attention to innovation within the public sector, we still have a limited understanding of how differences in bureaucratic structures are associated with country-level innovation. In examining this question, we rely on concepts of bureaucratic incentives and motivation for promoting innovation (Berry, Berry, and Sabatier 2014; Teodoro 2009), as well as on business actors' incentives for innovation. Incentives to innovate matter for innovative actions and innovation outputs. For instance, in his widely-cited book, Easterly (2001) emphasizes the importance of incentives to innovate by arguing that "[p]rosperity happens when all the players in the development game have the right incentives. It happens when government incentives induce technological adaptation, high-quality investment in machines, and high-quality schooling" (Easterly 2001, p.289). Previous studies on public sector innovation suggest the importance of motivational factors for innovation. However, it is not certain whether such incentive structures within public organizations also affect innovation at the country-level. However, one can argue that bureaucratic incentives to innovate within public organizations can affect innovation outputs in the private sector. Although it is not widely acknowledged, studies on public sector innovation suggest that public sector innovation leads to innovations in private and nonprofit organizations (Julnes and Gibson 2016). When public organizations are innovative, such innovativeness may have a positive spillover effect on private organizations and eventually increase the overall country-level of innovation (Demircioglu 2017; Edler and Georghiou 2007). Bureaucrats also play an important role in increasing innovation outputs as a whole even though private firms are the engine for many innovation outputs (Edquist 2011; Edquist and Zabala-Iturriagagoitia 2012). Smith (2005) argues that building knowledge infrastructures within the bureaucracy through professionalism enhances innovation outputs and creative outcomes in the private sector.

Bureaucratic Professionalism and Impartiality

This paper hypothesizes that bureaucratic structures are associated with bureaucracies' and private actors' motivations to innovate, which leads to innovative activities in a country as a whole. In particular, we look at professional and impartial bureaucracies. We focus on professionalism and impartial public administration for several reasons. First, professionalism and impartial public administration are core elements of Weberian bureaucracy (Fukuyama 2013; Nelson 1993; Olsen 2006; Weber 2009). Wilson (1887) argues that a professionalism and impartial bureaucracy is necessary in order to eliminate conflict and increase efficiency in public services. Weberian bureaucracy, particularly in regards to impartiality and professionalism, is a crucial and important measure of the quality of governance. Therefore, analyzing how these elements affect social outcomes is important (Fukuyama 2013).

Second, bureaucratic professionalism and impartiality are the two core ideas of the post-NPM and neo-Weberian administration (Lodge and Gill 2011). The central goal of the post-NPM and neo-Weberian administration is to overcome the limitations of NPM's specialization, fragmentation, and marketization. Third, how to achieve a professional and impartial bureaucracy is an important research topic for some countries, particularly formerly socialist countries. Following their argument, Neshkova and Kostadinova (2012, p.325) argue that two major goals of the administrative reforms in the postcommunist Eastern European countries are depoliticization, which is similar to impartiality, and professionalization of bureaucracies. Their study suggests that these bureaucratic reforms were very beneficial for reducing public sector corruption and increasing foreign direct investments (FDI).

a. Bureaucratic Professionalism

The first dimension of bureaucratic structures we examine is professionalism (Dahlström, Lapuente, and Teorell 2012a; Silberman 1993), which refers to the degree of meritocracy and politicization in bureaucracies. Professional bureaucracy is characterized by merit-based recruitment and internally recruited senior officials rather than political appointee or political network-based recruitment (Dahlström, Lapuente, and Teorell 2010, 2012b). Higher levels of professionalism indicate more professionally-oriented bureaucracies rather than politicized bureaucracies. Modern bureaucratic structures bring about more professionalism, which may affect social outcomes (Egeberg

2012). However, the level of professionalism in each country is different. Such professionalism can enhance employee motivation to innovate (Demircioglu 2017).

How is bureaucratic professionalism associated with bureaucrats' motivation for supporting and promoting innovation? In a meritocratic recruitment system, public sector organizations can select more competent and skillful bureaucrats than they can in a politicized one. Bureaucracy can "recruit the best possible personnel, and merit recruitment is the logical means of filling positions with the best qualified personnel" (Peters 2010, p.83). In contrast, a lack of professional public administration reduces chances for the hiring of employees who are knowledgeable and expert in policy areas with higher commitment to their jobs. In addition, politicized bureaucracies tend to be unstable (e.g. with high turnover, particularly for talented employees), which reduces bureaucrats' motivations to engage in projects and perform well (Cornell 2014).

Furthermore, when bureaucrats are professional, business actors can invest in innovative activities with less fear or uncertainty because bureaucratic professionalism increases business actors' trust in government policies and regulations, which subsequently increases innovative activities in a society (Fukuyama 1995). Likewise, professional bureaucrats with skills and expertise increase business actors' trust in the government and create an environment in which business actors are willing to invest in innovation (Fukuyama 1995).

In sum, public officials in more professional bureaucratic structures are likely to have more expertise, long-term perspective, and are less influenced by patronage and political interests than those in more politicized system where political and personal connections matter. They are also less likely to be willing to act on behalf of short-term political interests. Therefore, professional bureaucracies are likely to be correlated to innovation in society. Accordingly,

H1: Bureaucratic professionalism is positively associated with country-level innovation outputs.

b. Impartial Bureaucracy

Impartiality has two meanings. Citizens should "be treated impartially in the administration of public affairs," and public servants should "not act in ways that advantage or disadvantage the partisan-political interests of any political party, including the governing party or parties" (Aucoin 2012, p.179). Weber states that bureaucracy needs to be impartial, and bureaucrats should be appointed

and function as "personally free and subject to authority only with respect to their impersonal official obligations" (Weber, 1968, 333). The impartial bureaucracy provides consistency and the generalizability of the rules and applications; therefore, it increases fairness and justice (Peters 2010). Impartial bureaucracy affects bureaucrats' motivations to work and perform better (Peters 2010), which can also have positive spillover effects on business and society.

Easterly (2001) states that the public sector should create incentives with democratic and well-established institutions so that the private sector can grow. For instance, Nistotskaya and Cingolani (2015) argue that meritocratic recruitment and tenure protection of public bureaucracies assure impartiality and stability in the implementation of rules for entrepreneurs. Their work empirically demonstrates a link between meritocratic recruitment and entrepreneurship and individual choices to engage in new businesses. In fact, bureaucratic impartiality helps business actors make investments in innovation. Overall, bureaucracies can increase private actors' incentives for innovation by using policy tools, such as legal and administrative regulations and R & D programs, leading to an increase in the overall innovation outputs of a country (Smith 1997). Impartiality can also increase trust, and trust can lead to a more innovative bureaucracy (Fukuyama 1995).

Finally, since the late 1980s, public services in general and public procurement in particular has moved from supply-side to demand-side approaches (Petersen et al. 2016). It has been found that demand-side approaches such as citizens' demands for government services can boost innovation outputs in the private sector (Edquist and Zabala-Iturriagagoitia 2012). In this regard, when bureaucracies are professional and impartial, private actors can ask for more government support and resources for innovation without fear, which encourages more innovative activities. Taken together, these insights and findings from the existing literature lead us to hypothesize:
H2: Impartial public administration is positively associated with country-level innovation outputs.

Research Design

Data Collection

Cross-national comparison is very common as a research method in the field of political science. However, unfortunately, little comparative research has been done in the study of public administration and bureaucracy (Dahlström, Lapuente, and Teorell 2012b; Eglene and Dawes 2006; Fitzpatrick et al. 2011; Sundell 2014). In this study, we utilize data from the Quality of Government (QoG) Institute Expert Survey II (Dahlström et al. 2015), which is a novel cross-national data set

of bureaucratic structures collected from country expert surveys. One of the novel contributions of the QoG Expert Survey is that it provides a quantitative assessment of Weberian bureaucracy, which has been empirically overlooked (Dahlström, Lapuente, and Teorell 2010). The survey was designed based on pioneering work on mapping the bureaucratic structure in 35 less-developed countries by Peter Evans and James Rauch (Evans and Rauch 1999; Rauch and Evans 2000). The first version of the survey was conducted by a group of researchers at the QoG Institute in 2008-2012, which led to the first Expert Survey data set (Teorell, Dahlström, and Dahlberg 2011). The Expert Survey II was carried out in 2014. The Expert Survey II data was collected from survey responses from 1,294 country experts covering 159 countries. The survey asks for expert perceptions of the current status and characteristics of a country's public bureaucracy. The survey questions are mainly centered on bureaucratic structures such as recruitment and career system. The QoG Expert Survey data has been used in many academic publications, including top public administration journals.[ii] This confirms the validity and reliability of the datasets.

Our main dependent variable is country-level of innovation outputs. The data is obtained from the database GII (Cornell University, INSEAD, and WIPO 2014). The GII has been established as a leading reference on innovation at the country level since the late 2000s. It ranks the innovation performance of countries and economies around the world. The GII project was launched by INSEAD (Institut Européen d'Administration des Affaires) in 2007. The 2014 report covers 143 economies around the world. Data contained in the report were gathered from various existing statistical data. The GII report is published annually, and the latest version was released in 2016. The dependent variables are obtained from the online database of the GII (Cornell University, INSEAD, and WIPO 2016). We utilized data in the 2014 report for the dependent variables and the 2013 report for control variables.

The data set contains two aspects of innovation: innovation input and innovation output. The innovation input index captures various national factors that enable innovative activities, including institutions, human capital and research, infrastructure, market sophistication, and business sophistication. The innovation output index looks at the results of innovative activities in a country, focusing on knowledge and technology outputs and creative outputs. Given the purpose of our research, which assess the impact of bureaucratic structure at the country-level of innovation, we focus on the output aspect of innovation. Several academic researchers on innovation have utilized the GII data (Crespo and Crespo 2016; Meissner 2015; Sohn, Kim, and Jeon 2016; Zhan,

Bendapudi, and Hong 2015). We also utilize the QoG Standard Dataset 2017 (Teorell et al. 2017) [iii] and GII report 2013 (Cornell University, INSEAD, and WIPO 2016) for control variables. The QoG Expert Survey II, which provides independent variables, was carried out in 2014. Our dependent variable, innovation output scores, is obtained from the GII 2014 report data.

Dependent Variables

The dependent variable is the overall level of innovation output in each country. Innovation output is a common measure used by most studies of innovation (Smith 1997). In order to measure the degree of innovation output, we use innovation output scores from the GII. Specifically, we look at 1) knowledge and technology output and 2) creative output. In each area of innovation, an output score is calculated. In GII, each innovation output score is divided into three sub-components. The knowledge and technology output score consists of three sub-components: 1) knowledge creation, 2) knowledge impact, and 3) knowledge diffusion. Each sub-component is made from four to five individual indicators. The list of indicators included in each category is listed in table A1 in the appendix.

Each sub-component score is calculated as the weighted average of its individual indicators. Then, the knowledge and technology output score is calculated as the weighted average of its sub-component score. The resulting score ranges from 11.2 to 60.9 in the 108 countries in our sample. [iv] The creative output category consists of three sub-components: 1) intangible assets, 2) creative goods and services, and 3) online creativity. The creative output score is calculated in a similar way. The creative output score in our sample ranges from 0.6 to 66.1.[v] The distribution of each score is reported in the appendix.

Independent Variables

The independent variable is structure of public bureaucracy. In particular, we focus on 1) bureaucratic professionalism and 2) bureaucratic impartiality. To measure bureaucratic structure, the independent variables from the QoG Expert Survey look at the employment system in the public sector, which is a core concept of Weberian bureaucracy.

The first independent variable is bureaucratic professionalism. The QoG Expert Survey data set contains an index of bureaucratic professionalism, which is constructed from the following four questions: 1) "When recruiting public sector employees, the skills and merits of the applicants decide who gets the job," 2) "When recruiting public sector employees, the political connections of

the applicants decide who gets the job," 3) "The top political leadership hires and fires senior public officials," 4) "Senior public officials are recruited from within the ranks of the public sector." Respondents are asked to select a scale from 1 (hardly ever) to 7 (almost always). The data set reverses the scale of the second and third questions, therefore higher values mean more professionalism. The professional bureaucracy index is constructed by using the mean value for each responding expert of the four questions. Higher values in the bureaucratic professionalism index indicate more professional-oriented bureaucrats rather than political-oriented ones.

The second independent variable is bureaucratic impartiality. We rely on the index of impartiality contained in the QoG Expert Survey. This index measures the degree of impartiality of bureaucracies in decision-making. Higher values mean higher impartial exercise of power.[vi] The index is constructed based on the mean values of the following five survey items. 1) "Firms that provide the most favorable kickbacks to senior officials are awarded public procurement contracts in favor of firms making the lowest bid," 2) "When deciding how to implement policies in individual cases, public sector employees treat some groups in society unfairly," 3) "When granting licenses to start up private firms, public sector employees favor applicants with whom they have strong personal contacts," 4) "Generally speaking, how often would you say that public sector employees today, in your chosen country, act impartially when deciding how to implement a policy in an individual case?" and 5) "Hypothetically, let's say that a typical public sector employee was given the task to dis-tribute an amount equivalent to 1000 USD per capita to the needy poor in your country. According to your judgement, please state the percentage that would reach: The needy poor." The cross-country variations in the above two measurements are presented in Figures A3 and A4 in the appendix.

Control Variables

This study controls for other factors that are expected to be correlated to country-level innovation. A small sample size does not allow us to include a large number of controls. Therefore, we limit the number of controls to five important factors. We control for 1) GDP per capita (Current Prices) (ln), 2) GDP growth (%), 3) country-level of democracy, 4) government fractionalization, and 5) number of researchers per million population. The first four variables are obtained from the QoG Standrad Dataset (Teorell et al. 2017), and the last variable is from the GII report 2013 (Cornell University, INSEAD, and WIPO 2016).

We control GDP per capita and GDP growth because previous research shows that these variables affect innovations at the national level (Fagerberg and Srholec 2008; Lee et al. 2016; Wong, Ho, and Autio 2005). Country-level of democracy and government fractionalization may affect country-level of innovation. As Acemoglu and Robinson (2006) argue, national elites may hamper innovations because of their fear of replacement. Innovations may erode the advantage of the incumbent political elites and increase chances of replacement. When political competition is limited, elites may be unwilling to initiate changes in the economy and other institutions. We use a simple dichotomous democracy measurement as well as fractionalization in government.[vii] The government fractionalization measures "[t]he probability that two deputies picked at random from among the government parties will be of different parties" (Dahlberg et al. 2017b, p.52).

Because of the high correlations to our independent variables and other control variables such as GDP per capita, we do not include control variables that are related to input aspects of innovation, such as government expenditure on R&D, quality of scientific research institutions, and university-industry collaboration in R&D. We do not include the government expenditures on R&D because this input measure is highly correlated with innovation output measures such as our dependent variables. For instance, Wong, Ho, and Autio (2005) state that some scholars have used either input measures (e.g. R& D expenditures) or output measures (e.g. number of innovations), but not both in the same model. Likewise, Lee et al. (2016) find that innovation input (R&D) and output are highly correlated, as seen in the case of Japan, which is ranked highly for both measures. In addition, professional bureaucracy and impartial bureaucracy are also highly associated with variables of resources and infrastructure for innovation, which may cause multicollinearity.

The summary statistics of the variables used in our study are reported in Table 1. Correlation matrix is reported in Table 2. We conducted collinearity diagnostics using VIF based on our main models with two samples (all countries and OECD). The highest VIF score for the independent and control variables in all of the models is 3.41 (GDP per capita). This means that the models do not have problems in terms of multicollinearity. For the purpose of a further robustness check, we ran analysis for the same model without the variable causing high correlation.

TABLE 1, DESCRIPTIVE STATISTICS

Variable	Mean	Std. Dev.	Min	Max
Dependent variables				
Knowledge and technology outputs	31.43	12.29	11.2	60.9
Creative outputs	34.27	12.84	0.6	66.1
Independent variables				
Bureaucratic professionalism (H1)	3.93	0.96	2.0	6.19
Bureaucratic impartiality (H2)	3.99	1.22	1.6	6.29
Control variables				
GDP per Capita (Current Prices)	15,489.90	14,321.64	332.27	57,634.77
GDP Growth (%)	3.37	3.13	-6.979	11.91
Dichotomous democracy measure	0.71	0.46	0	1
Government Fractionalization Index	0.23	0.28	0	0.82
Researchers, headcounts/mn pop	18.46	22.27	0.10	100.00

TABLE 2, CORRELATION MATRIX

		1	2	3	4	5	6	7	8	9
1	Knowledge and technology outputs	1								
2	Creative outputs	0.77	1							
3	Bureaucratic professionalism (H1)	0.59	0.56	1						
4	Bureaucratic impartiality (H2)	0.68	0.78	0.79	1					
5	GDP per Capita (Current Prices)	0.81	0.80	0.67	0.80	1				
6	GDP Growth (%)	-0.42	-0.38	-0.31	-0.39	-0.46	1			
7	Dichotomous democracy measure	0.35	0.50	0.33	0.47	0.38	-0.38	1		
8	Government Fractionalization Index	0.34	0.38	0.20	0.22	0.25	-0.36	0.31	1	
9	Researchers, headcounts/mn pop	0.71	0.78	0.63	0.74	0.84	-0.50	0.34	0.40	1

Empirical Strategy

Given the cross-sectional nature of our dataset, our purpose is not to make causal arguments but to identify an empirical association between them. Given the nature of the dependent variable, we employ OLS regression analysis. The independent variables are bureaucratic structures. Since correlations among the independent variables are high, we are not able to include two independent variables in a single model. Thus, we test the following three models for each of our two independent

variables. In the first model (Models 1 and 4), we investigate the bivariate relationship between bureaucratic structure and innovation outputs. In the second model (Models 2 and 5), we include control variables that may affect the dependent variables. This is to test alternative explanations for the effects on innovation. Control variables, including GDP per capita, GDP growth, and democracy measure, are included. In the third model (Models 3 and 6), further control variables, government fractionalization index and researcher headcounts, are included to show the robustness of our analysis. The fractionalization index is included as an additional control for political competitiveness. We use the researcher headcount variable as one of the infrastructure variable for innovation. We run a same set of models for two dependent variables.

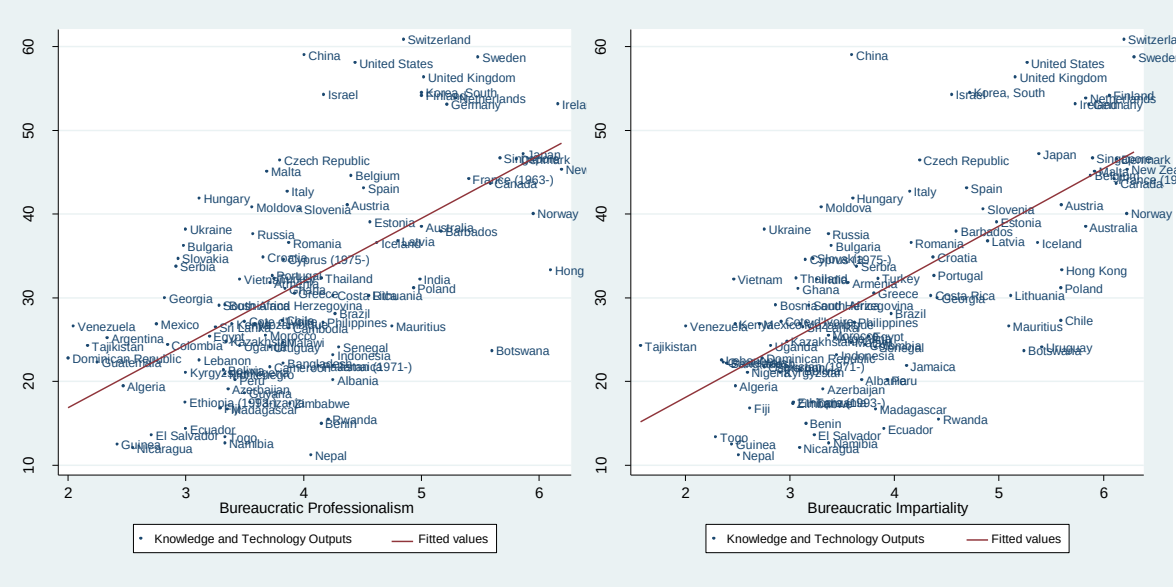
We test our hypotheses in two samples. One uses all the country samples. The other uses only OECD member countries. We conduct two separate analyses for the following reasons. First, the association between bureaucratic structure and country-level innovation may differ depending on levels of economic development and other unobservable factors. Second, bureaucratic professionalism and impartiality are highly correlated to levels of economic development measured by GDP per capita (correlation coefficients are 0.67 and 0.80). Therefore, in order to test the robustness of our assessment, we conduct an analysis using only samples from developed economies.

To demonstrate the robustness of our results, we conducted the following robustness strategy. First, we estimated Huber-White sandwich estimators in all main models, responding to issues of heterogeneity and lack of normality. Second, we re-ran all models for each independent variable with a jack-knife estimator in order to address the concern of influential observations. Third, we re-ran the same models without the GDP per capita variable, which is highly correlated to most of our independent variables. Collinearity diagnostics show no serious problems regarding multicollinearity. However, as a further robustness check, we estimated the same models without GDP per capita. Results of the robustness check are reported in the appendix.

Analysis and Results

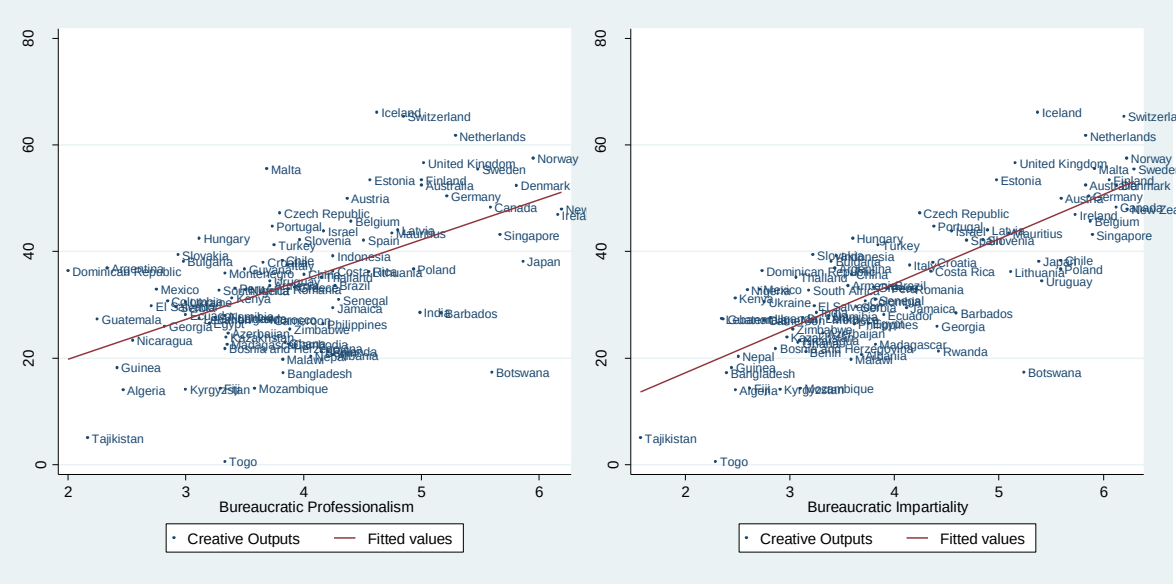
Figures 1 and 2 show a bivariate relationship between bureaucratic characteristics and country-levels of innovation. We present these figures mainly to show how these two factors are associated. As shown from these figures, countries with higher levels of professionalism and impartiality tend to record higher levels of innovation measured by knowledge and technology outputs as well as creative outputs.

FIGURE 1, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS



Note: Samples are based on model 1.

FIGURE 2, BUREAUCRATIC STRUCTURES AND CREATIVE OUTPUTS



Note: Samples are based on model 1.

Knowledge and technology outputs

Having presented scatterplots of the correlation between independent and dependent variables, we now present the results of regression analysis for all country samples in table 3. As seen from the table, bureaucratic professionalism and impartiality variables consistently have a strong association with the knowledge and technology outputs score at more than 95% level of confidence. In the bureaucratic professionalism model (Models 1-3), Model 1, which only has the professionalism variable, explains 35% of the variation in the model. The professionalism variable is positive and statistically significant at the 99% level. Country-levels of innovation should be correlated to economic development and democracy. Higher levels of developed economies tend to have larger and high-quality resources and infrastructure for innovation, such as financial resources, good research institutions, and qualified researchers in both the private and public sectors. Therefore, controlling GDP captures these factors as well. When we add GDP per capita, GDP growth, and democracy measure variables, R-Squared increases to 65%. Coefficient of the professional bureaucracy variable drops from 7.54 to 3.96; however, it is still significant at the 99% level of confidence after controlling these factors. In Model 3, we add two further control variables, government fractionalization and number of researchers per population in million. Bureaucratic professionalism is still positive and significant at the 99% level even after controlling these additional factors that may potentially affect the dependent variable.

In Models 4-6, we test the impact of bureaucratic impartiality on knowledge and technology outputs. Here, results show a strong association between these two variables. Bureaucratic impartiality alone explains 45 of the variation in Model 4. Impartiality is positive and statistically significant at the 99% level. Coefficient drops from 6.75 to 2.76 in Model 5 after we add three control variables. In Model 6, which includes additional control variables, impartiality is still positive and significant at the 95 % level. Therefore, bureaucratic impartiality positively influences knowledge and technology outputs.

TABLE 3, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (ALL COUNTRY SAMPLES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	7.54***	3.96***	3.32***			
	(0.90)	(0.75)	(0.97)			
Bureaucratic impartiality (H2)				6.75***	2.76***	2.04**
				(0.66)	(0.78)	(0.98)
Controls						
GDP per Capita (ln)		5.92***	5.23***		5.68***	5.10***
		(0.81)	(0.98)		(0.84)	(0.95)
GDP Growth (%)		-0.44	-0.21		-0.46	-0.22
		(0.34)	(0.34)		(0.35)	(0.36)
Dichotomous democracy measure		-1.33	-2.31		-1.54	-3.07
		(1.88)	(2.12)		(1.89)	(2.09)
Government Fractionalization			5.13*			5.84**
			(2.72)			(2.80)
Researchers, headcounts/mn pop			0.05			0.07
			(0.07)			(0.07)
Constant	1.80	-35.19***	-28.44***	4.70*	-28.12***	-22.50***
	(3.46)	(7.37)	(8.65)	(2.64)	(6.78)	(8.06)
Observations	108	100	81	107	99	83
R-squared	0.35	0.65	0.69	0.45	0.63	0.67

Robust standard errors in parentheses

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

Table A2 and A3 in the appendix report results of the same model estimations with jack-knifed estimates as well as those without GDP per capita. We reran the same models with jack-knifed estimator responding to the concern for influential observation. We also reran the models without GDP per capita to address the concern of high correlation between this variable and independent variables. Results with jack-knifed estimations are almost identical to those in our regular models in terms of direction of coefficients and statistical significance (see Table A2). Coefficients of bureaucratic variables increase in our models without GDP per capita, as we expect. Statistical significances do not change from the main models. Significance of the impartiality variable even increases in Model 6. To summarize the results of the models using all country samples, results of OLS regression analysis show that bureaucratic professionalism and impartiality are positively associated with innovation measured by technology and knowledge outputs. Bureaucracies with either of these characteristics tend to have higher levels of innovation as a nation, controlling for other factors.

Table 4 reports estimation results of models with only OECD member countries. Recall that we conducted a separate analysis using only OECD country samples to see if the results change in more developed settings. Bureaucratic professionalism and impartiality are positive and significant at the 99% level of confidence in our first model (Models 1 and 4). This is the same result as the

models with all country samples. However, these variables lost statistical significance in Models 2-3 and 5-6, which are more restricted. It is not surprising because the sample size is between 28 and 33.

We conducted the same set of robustness checks, namely models with jack-knifed estimators and models without GDP per capita variable. Models with jack-knifed estimates show almost identical results with our main models in terms of direction and statistical significance of coefficients of the independent variables (Table A4 in appendix). This confirms the robustness of our results. In models without GDP per capita (Table A5 in the appendix), bureaucratic professionalism is positive and statistically significant at the 99 level in all models (Models 1-3). The same goes for bureaucratic impartiality (Models 4-6). Bureaucratic professionalism and impartiality are positively associated with innovation. However, the same result is confirmed in our main models using OECD samples (Table 4).

TABLE 4, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (OECD COUNTRY SAMPLES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	5.32***	0.03	2.26			
	(1.30)	(1.30)	(1.92)			
Bureaucratic impartiality (H2)				4.66***	-0.41	1.20
				(1.20)	(1.33)	(1.67)
Controls						
GDP per Capita (ln)		19.50***	14.45*		20.36***	17.01**
		(5.18)	(6.99)		(5.30)	(6.44)
GDP Growth (%)		0.35	0.03		0.38	0.09
		(0.49)	(0.51)		(0.50)	(0.49)
Dichotomous democracy measure		-	-		-	-
Government Fractionalization			9.63			7.45
			(5.72)			(5.01)
Researchers, headcounts/mn pop			-0.08			-0.07
			(0.06)			(0.06)
Constant	19.32***	-157.63***	-116.34*	20.04***	-164.31***	-138.02**
	(6.19)	(50.23)	(65.06)	(6.07)	(50.83)	(60.50)
Observations	33	33	28	33	33	28
R-squared	0.26	0.51	0.63	0.23	0.51	0.61

Robust standard errors in parentheses

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

Creative outputs

Now, we will look at the impacts of bureaucratic structures on innovation measured by creative outputs in our global sample. Recall that the dependent variable is the creative outputs score, which assesses country-levels of intangible assets, creative goods and services, and online creativity (See Table A1 in the appendix). Bureaucratic professionalism is positive and statistically significant in Models 1-2. When we add further control variables to the model, its coefficient is still positive, but its significance drops to the 90% level. Therefore, it is safe to say that it is not certain whether there is a significant empirical link between professionalism and creative outputs. In Models 4-6, we test how bureaucratic impartiality is associated with innovation. Impartial implementation of public policies increases fairness and justice, which subsequently leads to business investment for innovative activities. Although coefficients of impartiality are reduced as we add more control variables, they are positive and significant consistently across three models. This means that bureaucracies which have more impartial decision-making tend to have higher levels of innovation.

As a robustness check, we repeated the same procedure that we performed for the first dependent variable. Models with jack-knifed estimates show almost identical results with respect to bureaucratic impartiality (See Table A6 in the appendix). Results of models without GDP per capita also show similar results with our main models (Table A7). Bureaucratic impartiality is positive and statistically significant at the 99% level. Its coefficient increases to 7.5 (Model 5) and 4.66 (Model 6). This confirms the robustness of our results. To summarize our analysis of all samples, results suggest that bureaucratic impartiality tends to have a positive influence on innovation operationalized by creative outputs.

TABLE 5, BUREAUCRATIC STRUCTURES AND CREATIVITY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (ALL COUNTRY SAMPLES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	7.48***	3.33***	2.24*			
	(1.21)	(0.81)	(1.12)			
Bureaucratic impartiality (H2)				8.30***	5.06***	3.87***
				(0.72)	(0.73)	(1.07)
Controls						
GDP per Capita (ln)		5.83***	3.50***		4.03***	2.52**
		(1.00)	(1.31)		(0.89)	(1.09)
GDP Growth (%)		-0.09	0.31		-0.03	0.24
		(0.25)	(0.25)		(0.22)	(0.24)
Dichotomous democracy measure		6.99***	6.37***		4.82***	4.57**
		(1.92)	(2.13)		(1.69)	(1.88)
Government Fractionalization			3.60			4.65
			(3.23)			(3.01)
Researchers, headcounts/mn pop			0.21***			0.16**
			(0.06)			(0.07)
Constant	4.87	-36.59***	-16.44	0.70	-26.18***	-12.34
	(4.72)	(9.21)	(11.95)	(2.96)	(7.25)	(9.75)
Observations	94	88	72	92	86	73
R-squared	0.31	0.68	0.75	0.61	0.75	0.78

Robust standard errors in parentheses

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

Finally, we look at the results of the same models, but with only the OECD member countries. Table 6 reports results of OLS regression analysis on creative outputs. Unlike the result from the global sample analysis, bureaucratic impartiality is no longer significant in the most restricted model (Model 6) even though it is significant at the 90% level in Model 5.

[Table 6 about here]

Discussion and Conclusions

Although there are an increasing number of studies on innovation, the analysis for most of these studies occurs at the organizational level. There have been only a few cross-national studies that examine factors affecting innovation across countries. Although ideas of bureaucratic structure go back to Max Weber in the last century, we still have a very limited understanding of how bureaucratic structures are associated with innovative activities at the country level. By relying on concepts of bureaucratic motivation for innovation, this paper contributes to filling this research gap.

In this study, we hypothesized that there is an empirical link between administrative structures of public bureaucracy and country-level innovation outputs. We expected this link based on previous studies and theory of bureaucratic structure and public sector innovation. We argued that recruitment and promotion rules affect work-related behavior of public sector employees, which subsequently affects levels of innovation outputs within a country. In professional bureaucracy, bureaucrats are recruited and promoted based on merit and expertise rather than political connections. In such an administrative structure, bureaucrats entering the public sector are likely to have higher expertise and skills than those who are hired through political connections. Therefore, such individuals with higher skills are likely to be more motivated to be innovative than those who are in politicized administrative structures. They might be more likely to learn about new tools and ideas and take a long-term perspective, which contribute to innovation. In addition, employees in more professional-oriented bureaucracies tend to be insulated from patronage and political interests (Dahlström, Lapuente, and Teorell 2012a). Therefore, bureaucrats in a professional system tend to be free from political discretion and can implement programs to promote innovation. In impartial bureaucracies, bureaucrats are expected to implement policies with fairness. Such impartial decision-making and policy implementation creates trust among private actors, which positively affects innovation outputs. In addition, a high level of neutrality in administrative decision-making deters bureaucrats from corruption. Such favorable bureaucratic characteristics for innovation should help private actors to achieve more innovative outputs.

The analyses demonstrate that administrative structures matter for the variation in levels of innovation outputs across countries. When using all country samples, results show that countries with higher levels of professional and impartial bureaucracies are likely to have higher knowledge and technology outputs. When we restrict our samples to OECD member countries, we find that these bureaucratic characteristics are no longer as significant. With respect to the creative outputs, we demonstrate that impartiality is positively correlated to innovation in our global sample analysis. This confirms our impartiality hypothesis. When we use OECD samples, we do not find statistically significant relationships between any of the administrative variables and creative outputs. The above results are consistent with findings from previous empirical studies that show a string empirical link between professional and impartial bureaucracies and social outcomes. This study contributes to previous studies by testing the relationship between bureaucratic structures and innovation outputs.

It is important to recognize the limitations of this research. First, given the cross-national nature of our dataset, we do not claim a causal relationship. Even though it is unlikely that bureaucratic structures change within a short period of time, our analyses show results of a snapshot of bureaucratic structures and innovation outputs at a given time period, without considering factors that change across time (Evans 2002). Second, we did our best to incorporate various control factors into our analysis with the limited sample size of countries. However, we cannot completely rule out the possibility that other unobservable country-level factors affect the bureaucratic structure-innovation relationship. These weaknesses should be further compensated for by testing the external validity of the results through conducting subnational studies, in which researchers account for more variables as well as collect and analyze time series data of bureaucratic structures and innovation.

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APPENDIX

TABLE A1, LIST OF INDICATORS IN THE DEPENDENT VARIABLES

Knowledge and technology outputs	Indicator	Creative outputs	Indicator
Knowledge creation	Domestic resident patent app/bn PPP$ GDPa	Intangible assets	Domestic res trademark app/bn PPP$ GDP
	PCT resident patent app/bn PPP$ GDPa		Madrid trademark applications/bn PPP$ GDP
	Domestic res utility model app/bn PPP$ GDP		ICTs & business model creation
	Scientific & technical articles/bn PPP$ GDP		ICTs & organizational model creation
	Citable documents H index	Creative goods and services	Cultural & creative services exp., % total tradea
Knowledge impact	Growth rate of PPP$ GDP/worker, %		National feature films/mn pop. 15–69
	New businesses/th pop. 15–64		Global ent. & media output/th pop. 15–69
	Computer software spending, % GDP		Printing & publishing manufactures, %
	ISO 9001 quality certificates/bn PPP$ GDP		Creative goods exports, %
	High- & medium-high-tech manufactures, %	Online creativity	Generic TLDs/th pop. 15–69
Knowledge diffusion	Royalty & license fees receipts, % total trade		Country-code TLDs/th pop. 15–69
	High-tech exports less re-exports, % tot. Trade		Wikipedia monthly edits/mn pop. 15–69
	Comm., comp. & info. services exp., % tot. Trade		Video uploads on YouTube/pop. 15–69
	FDI net outflows, % GDP		

FIGURE A1, PERCENT SUMMARY OF THE KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE

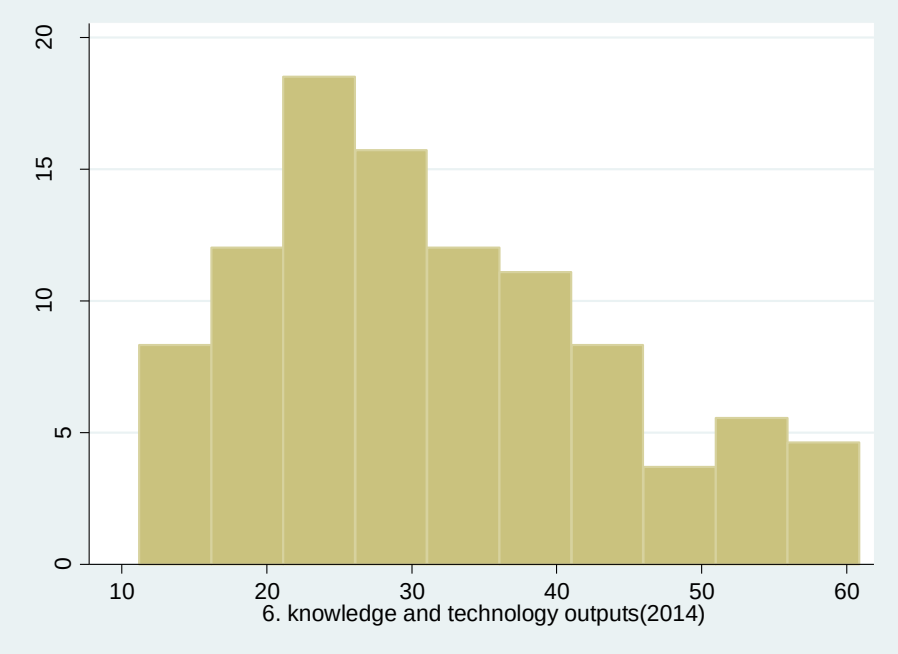


FIGURE A2, PERCENT SUMMARY OF THE CREATIVE OUTPUTS SCORE

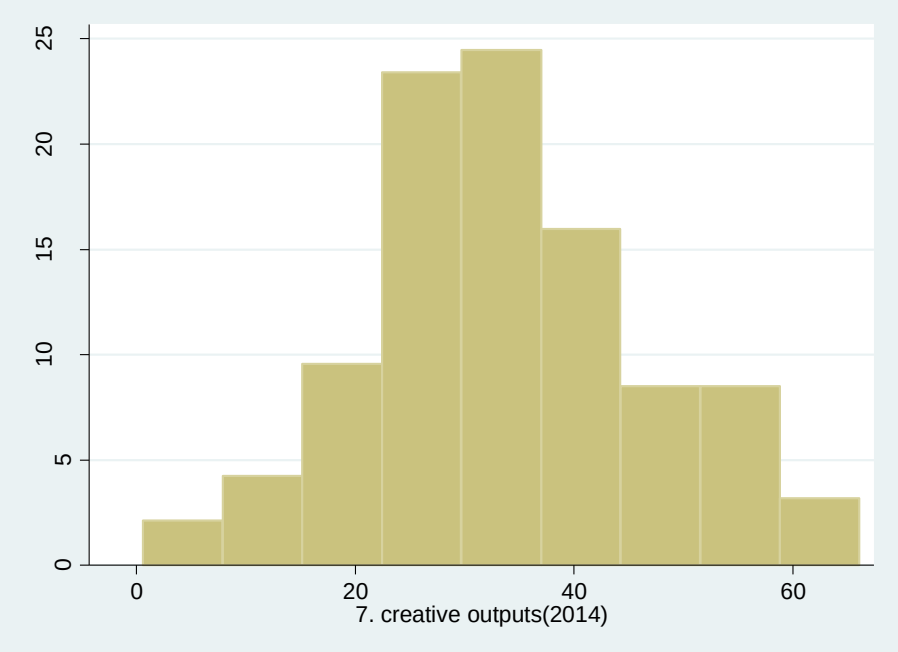
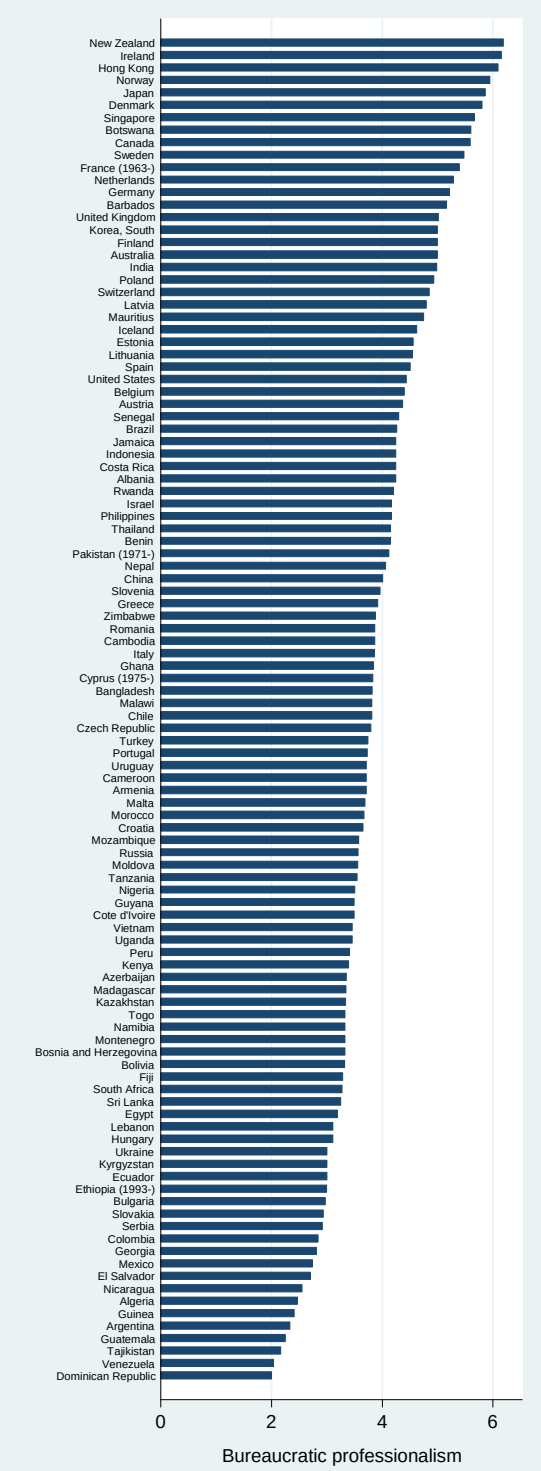
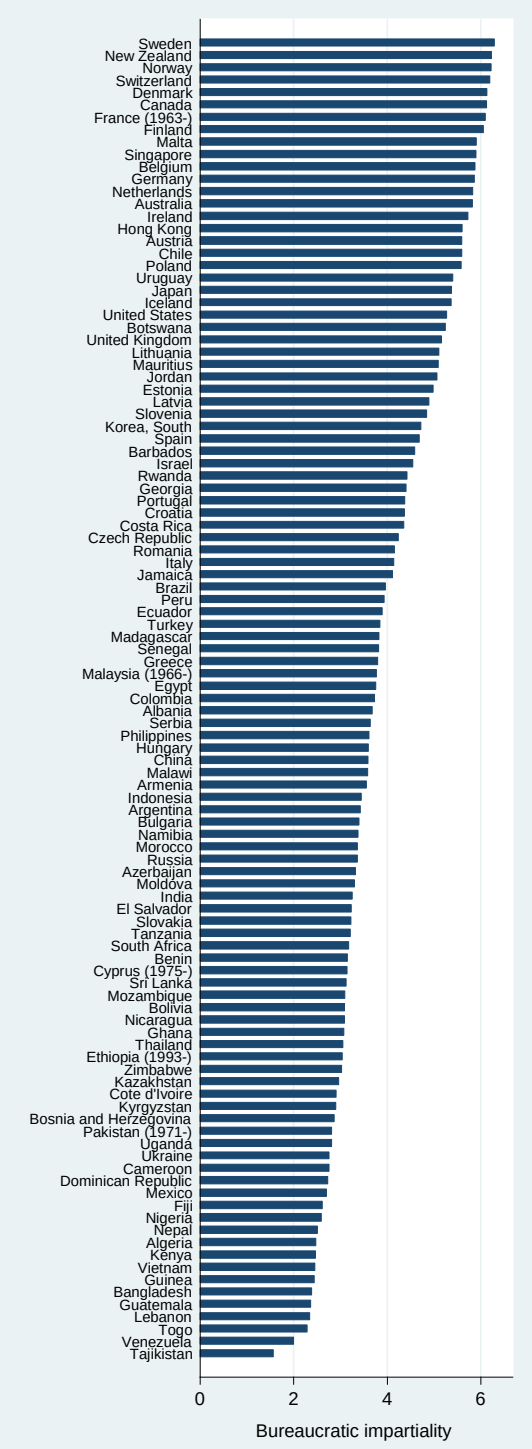


FIGURE A3, VARIATIONS IN BUREAUCRATIC PROFESSIONALISM



Note: 108 countries in model 1 are included in the above figure.

FIGURE A4, VARIATIONS IN BUREAUCRATIC IMPARTIALITY



Note: 107 countries in model 7 are included in the above figure.

TABLE A2, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (ALL SAMPLES, JACKKNIFED ESTIMATES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	7.54***	3.96***	3.32***			
	(0.92)	(0.77)	(1.05)			
Bureaucratic impartiality (H2)				6.75***	2.76***	2.04*
				(0.67)	(0.82)	(1.07)
Observations	108	100	81	107	99	83
R-squared	0.35	0.65	0.69	0.45	0.63	0.67

Standard errors in parentheses

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

Note: Control variables are not reported.

TABLE A3, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (ALL SAMPLES, WITHOUT GDP PER CAPITA)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	7.54***	6.98***	4.11***			
	(0.90)	(0.92)	(1.36)			
Bureaucratic impartiality (H2)				6.75***	6.19***	3.61***
				(0.66)	(0.83)	(1.26)
Observations	108	101	81	107	100	83
R-squared	0.35	0.45	0.58	0.45	0.49	0.57

Robust standard errors in parentheses

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

Note: Control variables are not reported.

TABLE A4, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (OECD SAMPLES, JACKKNIFED ESTIMATES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	5.32***	0.03	2.26			
	(1.37)	(1.43)	(2.16)			
Bureaucratic impartiality (H2)				4.66***	-0.41	1.20
				(1.27)	(1.51)	(2.06)
Observations	33	33	28	33	33	28
R-squared	0.26	0.51	0.63	0.23	0.51	0.61

Standard errors in parentheses

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

Note: Control variables are not reported.

TABLE A5, BUREAUCRATIC STRUCTURES AND KNOWLEDGE AND TECHNOLOGY OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (OECD SAMPLES, WITHOUT GDP PER CAPITA)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	5.32***	5.31***	5.71***			
	(1.30)	(1.30)	(1.38)			
Bureaucratic impartiality (H2)				4.66***	4.65***	4.58***
				(1.20)	(1.23)	(1.61)
Observations	33	33	28	33	33	28
R-squared	0.26	0.27	0.53	0.23	0.23	0.45

Robust standard errors in parentheses

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

Note: Control variables are not reported.

TABLE A6, BUREAUCRATIC STRUCTURES AND CREATIVE OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (ALL SAMPLES, JACKKNIFED ESTIMATES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	7.48***	3.33***	2.24*			
	(1.24)	(0.84)	(1.20)			
Bureaucratic impartiality (H2)				8.30***	5.06***	3.87***
				(0.73)	(0.77)	(1.16)
Observations	94	88	72	92	86	73
R-squared	0.31	0.68	0.75	0.61	0.75	0.78

Standard errors in parentheses

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

Note: Control variables are not reported

TABLE A7, BUREAUCRATIC STRUCTURES AND CREATIVE OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (ALL SAMPLES, WITHOUT GDP PER CAPITA)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	7.48***	6.29***	2.80**			
	(1.21)	(0.93)	(1.17)			
Bureaucratic impartiality (H2)				8.30***	7.50***	4.66***
				(0.72)	(0.69)	(1.10)
Observations	94	89	72	92	87	73
R-squared	0.31	0.50	0.71	0.61	0.68	0.76

Robust standard errors in parentheses

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

Note: Control variables are not reported.

TABLE A8, BUREAUCRATIC STRUCTURES AND CREATIVE OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (OECD SAMPLES, JACKKNIFED ESTIMATES)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	4.67***	-0.15	-0.08			
	(1.34)	(2.10)	(2.09)			
Bureaucratic impartiality (H2)				5.54***	2.57	1.32
				(0.89)	(1.63)	(1.64)
Observations	30	30	27	30	30	27
R-squared	0.25	0.45	0.65	0.40	0.49	0.66

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*
Note: Control variables are not reported.

TABLE A9, BUREAUCRATIC STRUCTURES AND CREATIVE OUTPUTS SCORE, RESULTS OF OLS REGRESSION ANALYSIS (OECD SAMPLES, WITHOUT GDP PER CAPITA)

	Professionalism model			Impartiality model		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Independent variables						
Bureaucratic professionalism (H1)	4.67***	4.68***	2.07			
	(1.27)	(1.30)	(1.60)			
Bureaucratic impartiality (H2)				5.54***	5.54***	2.64*
				(0.87)	(0.88)	(1.42)
Observations	30	30	27	30	30	27
R-squared	0.25	0.25	0.61	0.40	0.40	0.63

Robust standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*
Note: Control variables are not reported.

[i] See, for example, De Vries, Bekkers, and Tummers (2015) and Walker (2014).

[ii] See, for example, Boräng, Nistotskaya, and Xezonakis (2017); Charron, Dahlström, and Lapuente (2016); Cho et al. (2013); Cornell (2014); Cornell and Grimes (2015); Dahlström and Lapuente (2017); Fernández-Carro and Lapuente-Giné (2016); Gustavson and Sundström (2016); Kopecký et al. (2016); Nistotskaya and Cingolani (2015); Sundell (2014); Schuster (2016); Van de Walle et al. (2016); Versteeg and Ginsburg (2016); Van de Walle, Steijn, and Jilke (2015).

[iii] As for the data year of control variables from Teorell et al. (2017), the dataset mainly uses data from 2013. If data for 2013 is missing, data for 2014 is included. Then when no data exists for 2014, data for 2012 is included.

[iv] Number of sample is based on model 1 with the knowledge and technology outputs as a dependent variable.

[v] Number of sample is based on model 1 with the creative outputs as a dependent variable.

[vi] The impartiality is defined as "[w]hen implementing laws and policies, government officials shall not take into consideration anything about the citizen/case that is not beforehand stipulated in the policy or the law" (Rothstein and Teorell 2008, p.170).

[vii] We tested the mean of the Freedom House and Polity scales, which ranges from 0 to 10 contained in the QoG Basic Dataset 2017 (Dahlberg et al. 2017a). However, the variable is highly correlated to bureaucratic impartiality (pairwise correlation coefficient is 0.61). Therefore, we decided to use a dichotomous variable for democracy (the highest correlation coefficient, which is one with impartiality is 0.46).