Technovation 108 (2021) 102333

Contents lists available at ScienceDirect

Technovation

journal homepage: www.elsevier.com/locate/technovation

The impacts of democracy on innovation: Revisited evidence

Quan-Jing Wang [a], Gen-Fu Feng [b], Hai-Jie Wang [a], Chun-Ping Chang [c,*]

[a] Business School, Zhengzhou University, Zhengzhou, Henan, China
[b] School of Economics and Finance, Xi'an Jiaotong University, Xi'an, Shaanxi, 710061, PR China
[c] Department of Marketing Management, Shih Chien University, Kaohsiung, Taiwan

ARTICLE INFO

JEL classifications:
H11
P26
Q55

Keywords:
Democracy
Political regime
Innovation
Panel GMM

ABSTRACT

This research empirically tests the Popper hypothesis (2012) by utilizing panel data that cover 132 countries over the time period 1980–2017 and via panel GMM estimation in order to investigate the causal link from democracy to innovation, which is captured by two comprehensive variables, patent application and trademark application. Aside from the relationship between democracy and innovation, we further explore whether or not the change of democracy significantly influences innovation, whether the influence of democracy on innovation varies among different kinds of democracy or autocracy, and hence pay more attention on factors such as economic development level, economic performance, globalization, and international trade, and how do they change the democracy's impact on technical innovation. To confirm credibility, we carry out the robustness test by changing the measurement of democracy, the measurement of innovation and deleting extreme values. In summary, while democracy promotes innovation performance, autocracy generally exhibits lower technological innovation performance. This study provides evidence on the influence of democracy on innovation being affected by other factors such as those stated above.

1. Introduction

Cai and Zhang (2017) proposed that technical innovation lies at the core of economic performance, and thus factors affecting technological innovation have gained greater attention from scholars, firms, and governments. Most previous research stated that innovation is determined by inputs such as research and development (R&D), economic development, property right protection, education, quality of education, and government policy (Grande and Peschke, 1999; Acs et al., 2002; Furman et al., 2002; Varsakelis, 2001, 2006; Flanagan et al., 2011). However, very few articles have attached importance on the causal link from democracy to innovation, except for Popper (2005, 2012) who claimed that democracy may affect innovation positively. As a democratic regime improves economic freedom and property right protection, which are essential to the appearance and application of new technologies, it is reasonable to infer that democracy may influence innovation. This paper investigates whether democracy can influence innovation, thus filling the gap in the relationship between democracy and innovation among previous literature.

Based on the political economy and partisan theory, democracies tend to facilitate individual freedoms and offer property right protection, which eventually help promote innovation progress by building institutions that promote the application of new technologies. Popper (2005, 2012) stated that democratic countries experience better innovation performance due to developmental policy, individual freedom, and property protection. However, there lack an empirical test in Popper's studies, whereas most previous empirical studies attach more importance on the topic of democracy and economic development (Salahodjaev, 2015), democracy and economic freedom (Lipford and Yandle, 2015), and democracy and property rights (Leblang, 1997; Knutsen, 2013). Some scholars investigated the causal links between economic freedom and innovation (Lehmann and Seitz, 2017) and intellectual property protection and innovation (Hudson and Minea, 2013; Woo et al., 2015), and from these channels we infer that there exist some relations between democracy and innovation.

The main purpose of this study is to investigate the following questions. Is innovation influenced by the level of democracy? If it is, does the change in the level of democracy affect innovation as well? Once the influence of democracy on innovation is confirmed, is democracy's impact on innovation constant among different countries?

There are few empirical tests that explore what effects democracy exerts on innovation, except for Gao et al. (2017). Gao et al. (2017)

* Corresponding author.
E-mail address: cpchang@g2.usc.edu.tw (C.-P. Chang).

https://doi.org/10.1016/j.technovation.2021.102333
Received 5 April 2020; Received in revised form 30 May 2021; Accepted 22 June 2021
Available online 29 June 2021

tested Popper's hypothesis and investigated the causal link from democracy to innovation directly, observing that there is no reliable influence of democracy on innovation. However, the authors only used the index of patents to measure innovation performance, which may be influenced by the share of the manufacturing industry. It is thus hard to capture the innovation activities of the whole society due to some areas not being included in the patent count such as slogans and logos. Different with Gao et al. (2017), we employ the data of trademarks that cover whole countries in our empirical test and also employ more suitable estimations such as the system generalized method of moment (GMM) to include previous innovation performance into the model. Doing so allows us to consider that innovation covers the progress of accumulation while avoiding potential endogeneity.

The main contributions of this paper are as follows. First, our study investigates the effect of democracy on innovation by employing both trademark and patent application and democracy data provided by Bjørnskov and Rode (2019) which is an expansion of Cheibub et al. (2010), and including former innovation performance into the model by applying the system GMM method. Second, while we confirm the influence of democracy on technical progress, we further analyze whether the change of democracy influences innovation at the national level, which is ignored by previous studies. Third, given the form of politics, we also test whether the influence of democracy on innovation varies among different kinds of democracy, such as parliamentary democracy and majoritarian democracy. Fourth, we carry out several robustness tests, such as employing democracy data from Cheibub et al. (2010), Variety of Democracy, setting up a new dummy variable for democracy based on Polity IV, changing the database of innovation by utilizing WIPO database, and selecting the middle 60% sample after removing the influence of extreme values. The sample consists of updated panel data covering 132 countries versus past research that only utilizes data of fewer countries. Finally, we investigate whether such relationships will change under other considered factors such as economic development, industrial structure, dependence on trade openness, and level of globalization.

The remaining part of our study is organized as follows. Section 2 lists a brief literature review of political theory and innovation. Section 3 presents some details on the econometric model, variables, and data source. Section 4 provides the benchmark results of GMM, conducts the robustness test and offers a discussion. Section 5 gives some conclusions and specific policy implications.

2. Literature review

Most existing studies in the literature have pointed out that innovation does not occur in a vacuum, but instead is affected by the external environment (Bhattacharya et al., 2017), such as R&D expenditure, population, education, FDI, and economic development, which have gained more attention from scholars (Lau et al., 2015). If we further study what plays a major role in these factors, then we can conclude that it is related policies such as education policy, monetary policy, etc. (Wang et al., 2019). Specifically, the input of R&D expenditure is determined by a targeted policy on innovation activities (Samara et al., 2012), while economic development and education can be influenced by tax policy and education policy (Dolfsma and Velde, 2014; Baiardi et al., 2018). What determines these policies? Previous investigations on the political economy have presented a generally accepted conclusion that democratic and autocratic political regimes have obvious different preferential on government policy (Fredriksson and Wollscheid, 2007).

Previous studies often discuss democracy in a liberal sense. A democratic political regime is captured by the better protection of critical rights such as freedom and elections. Gerring et al. (2005) proposed the definition of political capital[1] and declared that it includes expansionary economic policy, public government with high efficiency, legal environment, and political stability. Hence, they further studied the relationship between democracy and political capital, indicating that a democratic country possesses greater political capital than autocratic ones. By browsing current studies, we hold that democracy may affect innovation by providing different forms of political capital such as freedom and property right protection.

Sturm and de Haan (2001) pointed out that the level of economic freedom is positively influenced by the level of democracy. Sirowy and Inkeles (1990) proposed that social conditions are beneficial to economic growth when the regime is democratic. Furthermore, de Haan and Sturm (2003) declared that if rapid growth can drive the dynamic elements to a specific status and make income independent from government, then political freedom is positively correlated with economic growth, which is brought by redistributing income towards powerful groups under different political regimes. Moreover, economic freedom and human capital formation are better in a democratic country than in an autocratic one (Doucouliagos and Ulubasoglu, 2008). We move a step forward to analyze the relationship between economic freedom and innovation. Recent theories agree that innovation does not occur in a vacuum, but is influenced by other social factors (Scott and Storper, (2003), Zheng, 2010). Florida (1995, 2014) argued that higher freedom results in higher innovation performance via the following channels: one is more talented people who engage in innovation activity and advanced technology and who are attracted by higher economic freedom; the other resides in higher freedom fostering knowledge flows, diversity, and creativity. Stiglitz (2007) declared that a peaceful environment is required for the appearance of new technologies as well as good economic conditions, while Gao et al. (2017) noted that a free environment also lies at the heart of promoting individual initiatives, which is important to bring out novel ideas and updated innovation activities. Similarly, de Haan and Sturm (2003) also stated that economic freedom, which can be captured by free markets and by focusing on the protection of property rights, can influence innovation by improving property rights protection and external market competition. Thus, we infer that economic freedom provided by democratic systems results in higher innovation performance.

As North (1993) put it, better organized property rights are only protected under an environment that can guarantee political and civil rights well; while arbitrary confiscation exerts a negative effect on it. In addition, Leblang (1997) showed that protection of private property rights is promoted by a democratic regime (compared to an autocratic government), because individual property rights are more likely to stimulate market activities such as the production and exchange of goods. Olson (1993) commented that while the government is characterized by protecting private property rights and the implementation of contracts, the country will obtain all potential gains brought by investment and long-term transactions. Olson (1993) also investigated different economic performances among countries with different political regimes simultaneously and pointed out that better property rights protection plays a major role in the better economic development of democratic countries. Interestingly, the author declared that conditions that require a lasting democracy usually imply individual property rights are exactly needed, and democratic countries have greater motivations to promote the protection of individual right and enforcement of contracts. Thus, compared to other countries, democratic governments often own a higher level of property protection. Similarly, de Haan and

[1] Political capital may be operationalized by various measures of the relative health of a polity - for example, bureaucratic capacity, low levels of corruption, political consensus, stability, legitimacy, trust, the wisdom and farsightedness of political leaders, and so forth.

Siermann (1996) held that since property lies at the heart of material progress, democracies possess better performance in property protection.

We therefore further study whether the protection of property rights incurs innovation. According to many scholars, the stock of intellectual property plays a major role in national innovation (Gao et al., 2017). The protection of property rights promotes the appearance and application of new technology by incentivizing inventors who participate in the field of innovation (Park and Ginarte, 1997; Kanwar and Evenson, 2003). Sweet and Maggio (2015) empirically tested the influence of intellectual property rights on innovation and concluded that there is a positive effect of property rights on technological innovation. The protection of property rights established by democratic governments provides a safe environment for new technologies or products to be produced by individuals or institutions, who are more likely to stimulate technical progress than that of autocratic political regimes.

Arpino and Obydenkova (2019) investigated the influence of democracy on political trust from the perspective of national and international levels, by employing data of the European Union and United Nations, concluding that the impact of democracy on national trust is different from its impact on international trust after the great recession. In non-democratic countries, decentralization leads to additional rent-seeking, rather than improving the quality of governance (Libman and Obydenkova, 2014a). In other words, a democratic regime decreases rent-seeking, which improves entrepreneur activities such as technical innovation. Lankina et al. (2016) investigated the influence of the diffusion of democracy on regional democratic practices, pointing out that civil society is an important conduit for democratic influences. Aside from these, democracy may also change the government's choice. For instance, Obydenkova and Salahodjaev (2016) also supported that a democratic political regime is more likely to change government policies, such as promoting the ruling government to favor international environmental commitments. Similarly, Obydenkova and Salahodjaev (2017a) studied the influence of democracy and social cognitive capital on a government's choice about climate change and concluded that the increase of democracy pushes the government to carry out more sustainable development policies. Hence, referring to the effect of political institution on innovation, Obydenkova and Salahodjaev (2017b) provided that the size of political institution exerts a positive impact on lift satisfaction through its positive influence on intellectual property, which is a key factor of innovation.

For the influence of democracy on innovation, Nazarov and Obydenkova (2020) examined the impact of democracy on firm innovation by employing 25,000 establishments in 25 transition economies and concluded that there is a positive effect of democracy on firm innovation. After browsing previous studies, we find that few investigations have tested the causal link from democracy to innovation from the perspective of national level, except for Gao et al. (2017). Gao et al. (2017) employed the database of patent applications derived from the United States National Bureau of Economic Research and the democracy variable from the Polity IV project and carried out their empirical test by using multinational panel data and traditional ordinary least square techniques with fixed effects, concluding that democracy exerts no significant influence on innovation. However, there are several shortcomings: First, it is worth to note that although patent application is generally used as an indicator of technical innovation, there still exist some drawbacks. Specifically, because most patents occur in the manufacturing sector, patent applications may be the best proxy for innovation in the manufacturing sector, but they cannot cover the whole country, which may bring out biased results if we only capture innovation by patent applications (Audretsch et al., 2014). Conversely, trademark applications cover the whole economy much better due to the coverage of the service sector and can offer detailed information about service marks that are not considered by patent applications (Graham and Hancock, 2014). Third, Gao et al. (2017) measured the democracy by employing the data of Polity IV, but the Polity2 variable is not a good measure of democracy.[2]

In our study we use both patent applications and trademark applications from World Development Indicator (WDI) to measure innovation and further investigate the influence of democracy on innovation. Second, developing a new technology requires R&D and investment of course, but more than all, it requires time. The applications of patents or trademarks show progress of accumulation, and previous performance acts as a major role on their current behavior. Hence, innovation performance shows dynamic progress, and we should employ a variable that captures the earlier performance of innovation into the model. We solve this by applying the system generalized method of moment (GMM) in the empirical estimation, which can avoid bias caused by potential endogeneity.

3. Econometric methodology and data

3.1. Methodology

As Wooldridge (2015) proposed, panel regression is more efficient that time series estimations for several reasons; specifically, it can handle potential problems such as missing variables. Moreover, panel data offer more information about an individual factor's dynamic progress. Finally, the two dimensions of individual and time of panel data improve the panel sample's capacity, which eventually promotes the accuracy of the estimations. In line with the classic literature on innovation (Wang et al., 2019; Zheng et al., 2019a,b), our study employs multi-national panel data to conduct the empirical test.

Previous research studies have showed that innovation is not only affected by the current economic situation, but also depends on previous technical progress (Wang et al., 2019). In other words, innovation is a dynamic evolution process. Similar to Wang et al. (2019), we utilize the dynamic panel model and GMM estimation to investigate the impact of democracy on innovation. Blundell and Bond (1998) provided an alternative estimation of system generalized moment estimation (SYS-GMM). Through the Monte Carlo test, the estimator of SYS-GMM offers some advantages over that of DIF-GMM.[3] More detailed information about system GMM estimation is provided by Wang et al. (2019). Specifically, the model of system GMM is set as follows:

$$y_{it} = \alpha_1 y_{i,t-1} + \beta_1 X_{1,t} + \beta' X + u_i + u_t + \varepsilon_{it} \quad (1)$$

where y_{it} stands for technical innovation; $y_{i,t-1}$ is the first lag of the dependent variable; $X_{1,t}$ represents democracy; X is a vector of other explanatory variables; u_i and $u_t$measure the individual fixed effect and time fixed effect, respectively; ε_{it} is the error term; and $i = 1, 2, 3 \ldots N$ refers to the individual, whereas $t = 1, 2, 3 \ldots T$ represents year. Moreover, the lagged dependent variables incorporated into the estimations can address the problem of the selection of instrument variables and potential endogeneity. The lag term of innovation is employed into the GMM model.

[2] The Polity IV Manual states that a country is not a democracy unless the DEMOC variable is equal to or greater than 6. Moreover, a country is not really an autocracy unless the AUTOC variable is equal to or less than minus six. Values between −5 and +5 on all three of these variables (Polity2, DEOMC, and AUTOC) are defined by Polity IV as anocracies. Anocracies are neither democracies nor autocracies. What this means is that positive Polity2 scores <6 do not mean a country is a democracy, nor are improvements in the Polity2 score at anything < than 6 a measure of improvement in a country's democratic standing. Furthermore, the Polity IV definition of democracy in DEMOC and Polity2 is a minimalist definition of an electoral democracy. It does include civil or political rights as well as freedom of the press or association.

[3] 1) SYS-GMM is more accurate and powerful than DIF-GMM, while the time period is short. 2) System estimation is more valid if the variables present the characteristic of high persistence.

3.2. Data and variables

Patents or trademarks application are often utilized to capture a country's innovation (Pradhan et al., 2018; Wen et al., 2018). As suggested by Wang et al. (2019), we employ both the application of patents (denoted by *Patent*) and application of trademarks (denoted by *Trademark)* as two proxies for the degree of national innovation. More details of *Patent* and *Trademark* are provided as follows.

Patent: As Griliches (1990) noted, because a patent usually refers to something novel and useful, patent applications capture some details about what is going on, making them a good measurement of innovation activity. Apart from this, patent applications not only offer some evidence about the intermediate output of an innovative process (Acs et al., 2002), but also provide insight into the ultimate output of innovation (Jalles, 2010). Moreover, global patenting activity is highly related to a nation's innovative climate. It is thus generally accepted to utilize patents as a contribution to innovation (Roper and Hewitt-Dundas, 2015; Karafyllia and Zucchella, 2017). Finally, patent applications offer the advantage of large available databases over a long period of time, which is essential to investigate the dynamics of innovation (Wen et al., 2018). We measure innovation by total patent applications (denoted by *Patent*), which we obtain from the World Development Indicator (WDI) database by summing up the patent applications of residents and non-residents.[4]

Trademark: Some scholars have held that trademark applications are an effective index to measure innovation performance since it covers most fields of innovation, which contains a business model, manufacturing sectors, and service mark while patent applications only cover the sector that is relevant to patent protection such as the manufacturing industry.[5] Furthermore, it is easy to gain data of trademarks from numerous sources, because trademark applications have been collected continuously for decades (Duygun et al., 2016). Therefore, we utilize total trademark applications (*Trademark*) to capture the innovation level. Data concerning *Trademark* can be obtained from WDI as can that for *Patent*.

Democracy_BR: As Berdiev et al. (2013) suggested, the six-fold regime classification of political regime provided by Cheibub et al. (2010) can better capture the democracy or autocracy of a political regime. Since the data from Cheibub et al. (2010) for democracy are just available until 2008, we capture democracy by employing the database of Bjørnskov and Rode (2019), who expanded the data of Cheibub et al. (2010) to 2019 by following the same classification of Cheibub et al. (2010). Specifically, we construct a dummy variable of *Democracy_BR* based on the presentation of Bjørnskov and Rode (2019), where *Democracy_BR* $= 1$ if the regime qualifies as being democratic and otherwise *Democracy_BR* $= 0$.[6]

$\triangle$*Democracy_BR*: Since a stable political regime provides a reliable prediction, the change in the degree of democracy brings some difficulties for a better understanding of the policy environment, which plays a major role in innovation. Therefore, to test this concern we employ a variable that measures the democratic transition in our research, denoted by $\triangle$*Democracy_BR*. $\triangle$*Democracy_BR* is defined as the first-order difference in *Democracy_BR*. If $\triangle$*Democracy_BR* is 1, then the political regime switches from autocracy to democracy. If $\triangle$*Democracy_BR* is -1, then the political regime switches from democracy to autocracy. If $\triangle$*Democracy_BR* is 0, then the political regime is constant.

To control other shocks to innovation, we set up other explanatory variables such as economic performance (*GDP*), industrial structure (*Ind*), population (*Pop*), population density (*Density*), degree of openness (*Trade*), urbanization (*Urban*), education (*Education*), and inward foreign direct investment (*IFDI*). More details are given as follows.

(1) Economic performance (*GDP*): Kogan et al. (2017) pointed out that innovation performance may be promoted by higher economic performance, due to more financial resources being allocated into innovation activity caused by better economic performance. Feng et al. (2019) captured economic development by employing per capita real GDP. Similar with Arin et al. (2011), we measure economic performance by national per capita real GDP (denoted by *GDP*) and incorporate it into the estimation to control its influence on innovation.[7]

(2) Industrial structure (*Ind*): As an indicator for the composition of economic activity, Greunz (2004) suggested that industrial structure can shape knowledge spillovers and externalities, which are essential to innovation. By employing data of Mexico, Frías et al. (2012) concluded that innovation is positively affected by industrial structure. To control the influence of industrial structure on innovation, we include it as an explanatory variable measured by the proportion of value added of the manufacturing industry to GDP (denoted by *Ind*, which is in line with Wang et al. (2019).

(3) Population (*Pop*): While we analyze the influence of population on innovation, there are two kinds of viewpoint. First, a larger population may exert a negative effect on innovation, because the low cost of labor force usually means an insufficient need and motivation to pursue new technologies (Parrotta et al., 2014). Another strand of the literature has held that there is a positive link from greater population to better innovation performance through channels such as promoting communication with each other, stimulating novel ideas, and new inspiration (Dong and Martin, 2017). To control the potential effect of population on innovation, we set it as an explanatory variable defined as the total population (denoted by *Pop*).

(4) Population density (*Density*): As Kremer (1993) provided, a higher population density may stimulate innovation progress by implementing more novel ideas. Moreover, the application and spread of new technologies or products are promoted by a higher population density; from this perspective, population density exerts a positive effect on innovation. Therefore, we set it as an explanatory variable measured by the number of people per square km (denoted by *Density*) to capture the accumulation and exchange frequency of knowledge and novelty idea, as suggested by Wang et al. (2019).

(5) Degree of openness (*Trade*): It is worth noting that international trade often brings spillover effects of advanced technologies, as well as an increase of absorptive capability, which promotes domestic innovation in a country (Gao et al., 2017). Thus, we measure economic openness by the share of exports and imports to GDP, to control for the influence of economic openness on innovation.

(6) Urbanization (*Urban*): A higher level of urbanization usually means a stronger agglomeration effect and effect from knowledge spillovers, leading to more novelty ideas, which play a major role in promoting innovation (Andersson et al., 2009). Hence, we capture the level of urbanization by the share of residents in the

[4] Both *Patent* and *Trademark* are obtained from World Development Indicator measures for the total number of patents or trademarks applied to State Patent Offices.

[5] Service mark is a mark distinguishing the services of one company from those of another provider, such as slogans.

[6] As defined by Cheibub et al. (2010), the regime is democratic if the mode of effective executive selection is a direct election, and the mode of legislative selection is elective, and the legislature is elected, and multiple parties are legally allowed, and multiple parties exist, and multiple parties exist outside of the regime front, and the legislature has multiple parties and do not violate the "alternation" rule, and incumbents do not close the lower house or rewrite the rules in their favor.

[7] Following the method of Arin et al. (2017), we obtain GDP per capita in constant 2000 US dollars from WDI to present real GDP per capita.

urban sector to total population to measure the access of public infrastructure and to control the influence of urbanization on innovation.

(7) Education (*Education*): Education promotes innovation progress by stimulating knowledge accumulation, which is essential for absorbing knowledge and improving the flow of knowledge (Roper et al., 2017). Similar with Arin et al. (2015), we capture education as an explanatory variable by the gross secondary school enrollment rate (hereafter *Education*)

(8) Inward foreign direct investment (*IFDI*): Perri and Peruffo (2016) suggested that inflows of FDI bring more input to innovation, because it promotes the economic performance of the host country by offering more resources such as capital, technologies, and updated management. Belloumi (2014) held that IFDI exerts no influence on innovation since most technologies brought by IFDI have no spillover effect as the purpose of it is to expand the market or seek cheaper labor force. Therefore, we cannot predict whether IFDI influences innovation, and thus to control for the potential influence of IFDI, we employ the ratio of net IFDI to GDP to measure the dependence of IFDI (denoted by *IFDI*), which is in line with Wang et al. (2019).

The data of the abovementioned variables are obtained from WDI, except for *Democracy_BR*, and △*Democracy_BR*.[8] Data of *Democracy_BR* and △*Democracy_BR* are collected from the website of Bjørnskov and Rode (2019).[9] All variables in our study are transformed into their natural logarithms, except for *Democracy_BR* and △*Democracy_BR*. We obtain unbalanced panel data with the time period is from 1980 to 2017 due to data limitation.[10]

4. Empirical result and discussion

4.1. Data description

Table 1 provides the basic distribution of the variables. For the variable of innovation, we obtain that the minimum of *Patent* is 0.69, the maximum of it is 15.40, whereas the mean, standard deviation (S.D.), and median of it are 9.33, 2.374, and 9.08, respectively; for *Trademark*, the minimum and maximum of it are 0.69 and 15.42, respectively, while the mean, S.D and median are 9.34, 2.398, and 9.09, respectively. The S.D. of *Patent* and *Trademark* shows that there exists a big difference of innovation among these countries.

Table 1
Data descriptive.

Variable	N	Mean	S.D	Min	Median	Max
Patent	4907	9.33	2.374	0.69	9.08	15.40
Trademark	5188	9.34	2.398	0.69	9.09	15.42
Democracy_BR	4010	0.63	0.483	0.00	1.00	1.00
ΔDemocracy_BR	4010	0.01	0.130	−1.00	0.00	1.00
GDP	5028	8.68	1.452	5.19	8.69	12.17
Ind	4531	3.33	0.352	1.12	3.35	4.32
Pop	5187	16.91	2.682	9.10	16.60	22.73
Density	5143	4.29	1.423	0.76	4.29	9.97
Trade	4808	4.16	0.556	0.16	4.14	6.09
Urban	5188	3.98	0.495	1.68	4.11	4.62
Education	4197	4.26	0.500	1.27	4.44	5.11
IFDI	4775	1.13	0.811	−4.78	1.09	7.16

We now move to the variable of democracy, in which the mean of *Democracy_BR* is 0.63, implying that the share of democratic countries is greater than that of autocratic ones. For △*Democracy_BR*, the mean of it is 0.01, with a S.D. of 0.19, suggesting that the level of democracy is constant in most sample countries during 1980–2017. Next, we provide some details about other variables. For *GDP*, the minimum and maximum of it are 5.19 and 12.17, respectively, where the mean and median are 8.68 and 8.69, respectively. The S.D. of 1.452 suggests that *GDP* differs among the sample countries. When we see the description of *Trade*, we find that the minimum and maximum of it are 0.16 and 6.09, respectively, whereas the mean and median of it are 4.16 and 4.14, respectively. Moreover, the standard deviation of it is 0.556, indicating most countries own similar levels of economic openness.

4.2. Benchmark results

Table 2 displays the benchmark GMM results about the effect of democracy on innovation. *Patent* is utilized as the dependent variable in columns (1) and (2), whereas that of columns (3)–(4) is *Trademark*. *Democracy_BR* is the independent variable in columns (1) and (3), as is △*Democracy_BR* in columns (2) and (4). First, we analyze the effect of democracy on *Patent*. Taking column (1), the coefficient of *Democracy_BR* is 0.218, which passes the statistical significance test at the 1% level. The symbol is positive, indicating that a democratic political regime promotes innovation progress, which is similar to Popper (2012).

We next turn to examine that whether innovation is affected by the change of democracy. Specifically, the coefficient of △*Democracy_BR* is 0.261, which is statistically significant and positive at the 1% level, implying that when the political regime switches to a democratic one,

Table 2
GMM estimator for the full sample.

	(1) Patent	(2) Patent	(3) Trademark	(4) Trademark
Lag Dependent Variable	0.855***	0.864***	0.863***	0.844***
	(47.96)	(66.76)	(66.69)	(67.15)
Democracy_BR	0.218***		0.170***	
	(8.62)		(6.88)	
ΔDemocracy_BR		0.261***		0.221***
		(7.22)		(5.45)
GDP	−0.014	0.014	0.002	0.021***
	(-1.23)	(1.57)	(0.15)	(2.72)
Ind	−0.048**	−0.047**	0.005	−0.008
	(-2.46)	(-2.32)	(0.22)	(-0.42)
Pop	0.107***	0.081***	0.090***	0.088***
	(7.31)	(6.48)	(9.54)	(8.01)
Density	0.013	0.002	0.012	0.002
	(1.42)	(0.27)	(1.64)	(0.35)
Trade	0.083***	0.008	0.060**	0.005
	(3.49)	(0.34)	(2.57)	(0.23)
Urban	0.228***	0.202***	0.118***	0.121***
	(3.92)	(4.88)	(2.61)	(4.36)
Education	0.050*	0.055**	0.108***	0.149***
	(1.76)	(2.53)	(4.20)	(7.36)
IFDI	−0.068***	−0.050***	−0.073***	−0.061***
	(-6.99)	(-5.26)	(-7.32)	(-6.66)
Year	yes	yes	yes	yes
Cons	−1.715***	−1.091***	−1.463***	−1.217***
	(-5.70)	(-4.23)	(-7.34)	(-5.47)
N	2170	2170	2282	2282
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.282	0.267	0.267	0.255
Hansen-P	0.224	0.254	0.175	0.221

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

[8] Resources of WDI are obtained from the following website: http://databank.worldbank.org/data/reports.aspx?source=wdi-database-archives-(beta).

[9] Data of Bjørnskov and Rode (2019) is obtained from the following website http://www.christianbjoernskov.com/bjoernskovrodedata/.

[10] The variable R&D contains many missing values. Since R&D expenditure lies at the heart of technical progress, it is suitable for being captured in the model, but results in a sharp decrease of our observations.

the country experience higher innovation performance. Hence, we present an analysis when innovation is measured by *Trademark*. Column (3) provides that the coefficient of *Democracy_BR* is 0.170, which is statistically significant and positive at the 1% level. The result of column (3) provides strong evidence that if a country is democratic, then its innovation level is higher. The reason for this conclusion is that the economic freedom and property rights protection supported by democratic political regimes increase the incentives of inventors to participate in the production of new products and technologies.

Our finding supports Popper's hypothesis, who declared that democratic countries have advantages at fostering innovation performance. However, our empirical findings run contrary to the conclusion of Gao et al. (2017), who argued that democracy exerts an insignificant effect on innovation. The main reasons for this paradox are that the GMM model we employ is still valid when there is endogeneity and observations in our panel data are omitted. Gao et al. (2017) ignored the influence of dynamic performance and used the OLS estimation technique, which may be biased if there exists endogeneity. Moreover, innovation is a dynamic progress, and previous innovation performance is incorporated in our study. Equation (1) in our study is also a traditional dynamic equation, which is not considered in Gao et al. (2017).

4.3. Robustness test

For the credibility of our benchmark results, we carry out several robustness tests as follows. To begin with, following the research of Gao et al. (2017), we measure democracy based on the database of POLITY™ IV, which is in line with the presentation of Marshall et al. (2018). Similar to Gao et al. (2017) and based on the variable of *Polity2* in POLITY™ IV, we set up a binary index, *Democracy_Polity2*. Specifically, in line with the definition of POLITY™ IV, if *Polity2* is 6 or greater, then *Democracy_Polity2* is assigned 1 and otherwise 0.[11] We further construct the variable of $\triangle$*Democracy_Polity2* to measure the change of democracy. If *Democracy_Polity2* changes from 0 to 1, then $\triangle$*Democracy_Polity2* = 1; if *Democracy_Polity2* changes from 1 to 0, then $\triangle$*Democracy_Polity2* = −1 and otherwise 0.

Table 3 presents the regression results when the measurement is a binary index. *Democracy_Polity2* is the independent variable in columns (1) and (3), while $\triangle$*Democracy_Polity2* is that in columns (2) and (4). When *Democracy_Polity2* is the independent variable, such as in column (1), the coefficient of *Democracy_Polity2* is 0.181, which is statistically significant at the 1% level, suggesting that a democratic political regime promotes innovation performance. Column (3) also illustrates this idea. When we investigate whether the change of democracy exerts an effect on innovation, for instance the result of column (2), then the coefficient of $\triangle$*Democracy_Polity2* is 0.135, which is statistically significant at the 1% level, implying that if the country turns from autocratic to democratic, then innovation performance is promoted, which is supported by column (4).

Since the data that we utilize in our earlier empirical test are expanded by Bjørnskov and Rode (2019), to guarantee the reliability of the benchmark results we employ the original database provided by Cheibub et al. (2010) (CVG) to carry out the empirical test. Based on the database of CVG, the dummy variable of *Democracy_CVG* is coded 1 if the regime qualifies as democratic and otherwise *Democracy_CVG* = *0*.[12]

Table 3
Robustness test - using the polity IV database (binary variable).

	(1) Patent	(2) Patent	(3) Trademark	(4) Trademark
Lag Dependent Variable	0.853***	0.879***	0.887***	0.868***
	(50.91)	(48.56)	(37.56)	(45.22)
Democracy_Polity2	0.181***		0.113***	
	(10.26)		(5.70)	
ΔDemocracy_ Polity2		0.135***		0.198***
		(4.23)		(4.74)
GDP	0.003	0.012	0.011	0.011
	(0.35)	(1.26)	(1.12)	(1.34)
Ind	0.080**	−0.024	0.139***	0.092***
	(2.48)	(-0.83)	(4.60)	(3.63)
Pop	0.094***	0.087***	0.053***	0.058***
	(5.99)	(5.69)	(2.59)	(4.50)
Density	−0.022	−0.008	0.003	−0.021*
	(-1.53)	(-0.57)	(0.25)	(-1.66)
Trade	0.019	0.039	−0.028	−0.066**
	(0.59)	(1.26)	(-0.73)	(-2.29)
Urban	0.112**	0.127***	−0.034	0.070*
	(2.49)	(3.32)	(-0.60)	(1.82)
Education	0.062**	0.088***	0.141***	0.153***
	(2.01)	(3.86)	(4.65)	(6.26)
IFDI	−0.064***	−0.054***	−0.071***	−0.036***
	(-4.58)	(-4.23)	(-5.89)	(-3.03)
Year	yes	yes	yes	yes
Cons	−1.165***	−1.213***	−0.665	−0.605**
	(-3.38)	(-4.13)	(-1.53)	(-2.30)
N	2005	1996	2116	2107
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.330	0.474	0.297	0.307
Hansen-P	0.909	0.987	0.980	0.996

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

The impacts of democracy on innovation when democracy is measured by *Democracy_CVG* are offered in Panel A of Table 4.[13] *Democracy_CVG* is the independent variable in columns (1) and (3), while $\triangle$*Democracy_CVG* is that in columns (2) and (4). If the independent variable is *Democracy_CVG*, such as in column (1), then the coefficient of *Democracy_CVG* is 0.324, which is statistically significant at the 1% level, suggesting that a democratic government will still bring about better innovation performance. A similar conclusion can be obtained from column (3). When we test whether the change of democracy exerts an effect on innovation, taking column (2) for instance, the coefficient of $\triangle$*Democracy_CVG* is 0.062, which passes the statistical significance test at the 1% level, offering some evidence on the statement that if a country turns from lower democracy to higher democracy, then its innovation performance is better, which is suggested by column (4).

To assure the credibility of our benchmark results, similar to Coppedge et al. (2019), we carry out another robustness test by changing the database of democracy from V-DEM. In line with the aim of our study, we use the liberal democracy index to measure the democracy of political regime, denoted by *Democracy_VDEM*. If the political regime is democratic, then *Democracy_VDEM* = = 1 and otherwise *Democracy_VDEM* = 0. Same as the earlier variables, *Democracy_VDEM* and $\triangle$*Democracy_VDEM* are utilized to measure democracy and the change of democratic democracy, respectively.

[11] The Polity IV Manual states that a country is not a democracy unless the DEMOC variable is equal to or greater than 6. What this means is that positive Polity2 scores <6 do not mean a country is a democracy. This database is based on the POLITY™ IV PROJECT. The source and detailed information of the POLITY™ IV PROJECT can be obtained at the following website: http://www.systemicpeace.org/inscrdata.html. Here, we are thankful for the valuable suggestions of the reviewers.

[12] It is worth noting that the data of Cheibub, et al. (2010) are available to 2008, and so we conduct the GMM regression based on the data from 1980 to 2008.

[13] It is worth noting that we incorporate the control variables and year fixed effect into our estimation, in order to save the space, we do not display the results of control variables, but are available upon request.

Table 4
Robustness test - changing the measurement of democracy.

	(1) Patent	(2) Patent	(3) Trademark	(4) Trademark
Panel A: CVG				
Lag Dependent Variable	0.785***	0.830***	0.845***	0.872***
	(65.48)	(50.34)	(50.02)	(47.36)
Democracy_CVG	0.324***		0.225***	
	(14.59)		(11.09)	
ΔDemocracy_CVG		0.062***		0.090*
		(3.56)		(1.93)
Control variables & year	yes	yes	Yes	yes
N	1510	1510	1581	1581
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.410	0.416	0.300	0.321
Hansen-P	0.401	0.405	0.801	0.737
Panel B: V-DEM				
Lag Dependent Variable	0.852***	0.835***	0.866***	0.862***
	(55.32)	(47.97)	(48.11)	(41.37)
Democracy_VDEM	0.321***		0.229***	
	(6.40)		(3.53)	
ΔDemocracy_VDEM		0.252**		0.359*
		(2.40)		(1.92)
Control variables & year	yes	yes	Yes	yes
N	2133	2133	2246	2246
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.271	0.268	0.257	0.269
Hansen-P	0.378	0.531	0.380	0.509

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. It is worth noting that we incorporate the control variables and year fixed effect into our estimation. In order to save space, we do not display the results of the control variables, but they are available upon request.

Panel B of Table 4 presents the regression results when the database of V-DEM is utilized. *Democracy_VDEM* is the independent variable in columns (1) and (3), while △*Democracy_VDEM* is that in columns (2) and (4). When *Democracy_VDEM* is the independent variable, such as in column (1), the coefficient of *Democracy_VDEM* is 0.321, which is statistically significant at the 1% level, again suggesting that a democratic political regime promotes innovation performance, which can be derived from column (3) as well. When we move to the relationship between innovation and the change of democracy, we find that the coefficient of △*Democracy_BR* in column (2) is 0.062, which passes the significance test at the 5% level, offering some evidence that if the country turns to be democratic, then innovation performance is higher than before. The results in column (4) also support this viewpoint. In summary, when we change the database of democracy, the empirical results are in line with our benchmark finding, showing that the findings of our paper are valid. It is worth noting that this supplements Gao et al. (2017), who did not utilize the database of V-DEM.

Similar to Wen et al. (2018), we measure the innovation by utilizing the data obtained from World Intellectual Property Organization (WIPO). Specifically, we measure the innovation by the total patents application and trademark registration given by WIPO, denoted by *Patent_WIPO* and *Trademark_WIPO*. The results are listed in Table 5.[14]

Democracy_BR is the independent variable in columns (1) and (3), while △*Democracy_BR* is that in columns (2) and (4). When *Democracy_BR* is the independent variable, such as in column (1), the coefficient of *Democracy_BR* is 0.174, which is statistically significant at the 1% level, again suggesting that a democratic political regime promotes innovation performance, which can be derived from column (3) as well.

Table 5
Robustness Test- Data from WIPO Database.

	Panel A: *Patent_WIPO*		Panel B: *Trademark_WIPO*	
	(1)	(2)	(3)	(4)
Lag Dependent Variable	0.771***	0.799***	0.625***	0.652***
	(51.39)	(53.33)	(29.10)	(35.55)
Democracy_BR	0.174***		0.898***	
	(4.20)		(18.84)	
ΔDemocracy_BR		0.485***		0.249***
		(6.24)		(4.50)
Control variables & year	yes	yes	yes	yes
N	2434	2434	2808	2808
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.216	0.204	0.309	0.291
Hansen-P	0.105	0.171	0.236	0.232

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. It is worth noting that we incorporate the control variables and year fixed effect into our estimation. In order to save space, we do not display the results of the control variables, but they are available upon request.

When we move to the relationship between innovation and the change of democracy, we find that the coefficient of △*Democracy_BR* in column (2) is 0.485, which passes the significance test at the 1% level, offering some evidence that if the country turns to be democratic, then innovation performance is higher than before. The results in column (4) also support this viewpoint. In summary, when we change the database of innovation, the empirical results are in line with our earlier findings.

In line with Wang et al. (2019), to remove the potential bias caused by extreme values, we set up a new database by deleting observations that possess the first 20% and the last 20% of *Patent* or *Trademark* and re-conduct the empirical test. The results are in Table 6 and are similar with those in Table 2.[15] These provide strong evidence that a democratic political regime promotes innovation progress, and that a change from lower democratic to higher democratic also results into higher innovation performance.

Table 6
Robustness test - results by using the middle 60% sample.

	(1) Patent	(2) Patent	(3) Trademark	(4) Trademark
Lag Dependent Variable	0.815***	0.828***	0.774***	0.776***
	(37.55)	(34.64)	(27.05)	(29.25)
Democracy_BR	0.062**		0.073*	
	(2.28)		(1.90)	
ΔDemocracy_BR		0.043***		0.071**
		(2.73)		(2.19)
Control variables & year	yes	yes	yes	yes
N	2013	2013	1807	1807
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.384	0.390	0.308	0.338
Hansen-P	0.913	0.906	0.998	0.992

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. It is worth noting that we incorporate the control variables and year fixed effect into our estimation. In order to save space, we do not display the results of the control variables, but they are available upon request.

[14] It is worth noting that we incorporate the control variables and year fixed effect into our estimation, in order to save the space, we do not display the results of control variables, but are available upon request.

[15] It is worth noting that we incorporate the control variables and year fixed effect into our estimation, in order to save the space, we do not display the results of control variables, but are available upon request.

4.4. Mediating effect

Once the effect of democracy on innovation is verified, we further query what factors can change democracy's impact on innovation. As Wang et al. (2019) pointed out, the stage of economic development and economic performance can change the government ideology's impact on innovation. Compared to non-OECD countries, OECD countries possess higher levels of property rights protection (Ginarte and Park, 1997), implying that no matter if the ruling party is democratic or autocratic, individual rights are well protected in OECD countries, which help promote innovation. From this mechanism, we infer that democracy's positive impact on innovation is weakened in OECD countries. To investigate whether economic development changes the influence of democracy on innovation, we take the different degree of economic development as a binary variable in the Organization for Economic Co-operation and Development (*OECD*), defined as follows: if the sample country is a member of OECD, then *OECD* is 1 and otherwise 0. We include two interactive items, *Democracy_BR *OECD* and $\triangle$*Democracy_BR *OECD*, into our basic model for investigating the potential change caused by economic development. The results are in Panel A of Table 7.[16] When the dependent variable is *Patent*, such as in column (1), the coefficient of *Democracy_BR*OECD* is −0.317, which is statistically significant at the 1% level, implying that compared to OECD countries, democracy's positive effect on patent applications is greater in non-OECD countries. This idea is also supported by column (2). For *Trademark*, the result in column (3) shows that the coefficient of *Democracy_BR *OECD* is −0.354, which is statistically significant at the 1% level, providing some proof on the idea that compared to OECD countries, democracy's positive effect on trademarks is greater in non-OECD countries, which can also be concluded from columns (4). Contrary to previous studies that only compare the difference of innovation between OECD and non-OECD (Ulku, 2007), our study discerns whether OECD countries affect their innovation by a change in democracy's impact on innovation. As a supplementary to Gao et al. (2017), our findings explain whether democracy's impact on innovation is changed by economic development, which fills the gap in the literature that studies the relationship among democracy, economic development, and innovation, and offers implications to researchers in this field of study.

If a country exhibits better economic performance, then it is further likely that more materials and funds will be invested into R&D activities, which lead to the appearance and application of new technologies (Taalbi, 2017). As Ginarte and Park (1997) suggested, the level of property rights is positively influenced by GDP per capita, meaning that better economic performance brings about a higher level of property rights protection, which can weaken the effect of democracy on it, which may eventually change democracy's impact on innovation. Hence, we include two interactive items, *Democracy_BR *GDP* and $\triangle$*Democracy_BR *GDP*, into our basic model for investigating the potential change caused by economic performance.

Panel B of Table 7 provides the results. If the dependent variable is *Patent*, such as in column (1), then the coefficient of *Democracy_BR* is 1.004, which is significantly positive at the 1% level. It implies democracy exerts a significantly positive effect on innovation. At the same time, the coefficient of *Democracy_BR*GDP* is −0.100, which is statistically significant at the 1% level, suggesting that while economic performance is better, democracy's positive impact on patent is weakened. This finding can be obtained from column (2). For *Trademark*, the results in column (3) and column (4) show similar conclusions as with *Patent*. We thus conclude that compared to countries with better economic performance, other countries possess a higher positive impact of democracy on innovation.

From the results in Panel B, we find that when economic performance is higher, the positive influence of democracy on innovation is inhibited. Moreover, the variable of *GDP* is positive, suggesting that higher economic growth brings about better innovation performance. When well-developed democracies positively impact innovation, this weakens the positive effect of democracy on innovation, indicating that the total effect of well-developed democracies on innovation is positive, which is higher than its counterparts. However, if the cross term of democracy and *GDP* is negative, implying that the influence of democracy on innovation depends on the economic performance, then the positive impact of developed democracies on innovation may be higher than that of less-developed democracies. This finding offers strong evidence that better economic performance can promote innovation directly, as well as promote innovation indirectly by strengthening the positive effect of democracy on innovation.

With the deepening of globalization, the communication among different countries is now deeper and more frequent than it was before, and social-economic globalization presents an important challenge on innovation systems (Castellaci et al., 2005). As Ginarte and Park (1997) suggested, the level of property rights is positively influenced by openness, meaning that a higher level of globalization brings about a higher level of property rights protection (Zheng et al., 2019), which can weaken the effect of democracy on property rights protection. If one country owns a higher level of globalization, then economic freedom and property rights protection are in line with the international criteria and are less affected by the democracy of the domestic government. From this, we infer that globalization may weaken democracy's positive impact on innovation. To examine whether globalization changes democracy's impact on innovation, we set two interactive items, *Democracy_BR * Globalization* and $\triangle$*Democracy_BR * Globalization*, into the basic model for testing the potential change caused by globalization. The results are in Panel C of Table 7. If the dependent variable is *Patent*, such as in column (1), then the coefficient of *Democracy_BR * Globalization* is −0.766, which is statistically significant at the 1% level, suggesting that higher globalization reduces the degree of positive effect of democracy on innovation. Similar conclusion can be obtained from column (2) as well as from columns (3)–(4), which measure the innovation by *Trademark*.

Aside from the globalization index, we also capture globalization by the share of foreign trade to GDP. Libman and Obydenkova (2014b) suggested that large international trade partners are more likely to prefer smaller local companies outside of government control as well as to favor the political regime in the region if it is committed to democracy promotion. Therefore, trade dependence may also change the influence of democracy on innovation. Similar to the earlier analysis, we set two interactive items, *Democracy_BR * Trade* and $\triangle$*Democracy_BR * Trade*, into the basic model for testing the potential change caused by Trade. The results are in Panel D of Table 7. If the dependent variable is *Patent*, such as in column (1), then the coefficient of *Democracy_BR * Trade* is −0.147, which is statistically significant at the 1% level, suggesting that higher trade openness reduces the degree of positive effect of democracy on innovation. A similar conclusion can be obtained from column (2) as well as from columns (3)–(4), which measure the innovation by *Trademark*.

4.5. The influence of different democracies and autocracies

A growing body of literature prefers that the kinds of autocracies and democracies extant in the world influence economic development, rather than democracy or autocracy. For example, Persson and Tabellini (2003) and Haggard and Kaufman (1995) demonstrated that some forms of democracy are much better at delivering development than others. Given this, we move a further step to test whether the different forms of democracy or autocracy can affect innovation.

In line with the definition of Persson and Tabellini (2006), we use

[16] It is worth noting that we incorporate the control variables and year fixed effect into our estimation, in order to save the space, we do not display the results of control variables, but are available upon request.

Table 7
GMM estimator - four mediate variables.

	(1) Patent	(2) Patent	(3)Trademark	(4)Trademark
Panel A: OECD				
Lag Dependent Variable	0.857***	0.863***	0.851***	0.848***
	(57.70)	(68.19)	(67.87)	(57.86)
Democracy_BR	0.252***		0.232***	
	(9.21)		(10.33)	
*Democracy_BR*OECD*	−0.317***		−0.354***	
	(-2.61)		(-2.79)	
ΔDemocracy_BR		0.384***		0.305***
		(9.59)		(6.76)
*ΔDemocracy_BR*OECD*		−1.702***		−1.222***
		(-4.70)		(-3.16)
OECD	0.019	−0.115***	0.129	−0.145***
	(0.17)	(-3.13)	(1.11)	(-3.92)
Control variables & year	yes	yes	yes	yes
N	2170	2170	2282	2282
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.287	0.263	0.256	0.231
Hansen-P	0.539	0.383	0.347	0.395
Panel B: GDP				
Lag Dependent Variable	0.846***	0.875***	0.852***	0.848***
	(75.20)	(67.38)	(53.85)	(64.77)
Democracy_BR	1.004***		0.919***	
	(7.10)		(6.48)	
Democracy_BR GDP*	−0.100***		−0.092***	
	(-5.77)		(-5.33)	
ΔDemocracy_BR		3.137***		2.395***
		(8.25)		(6.36)
*ΔDemocracy_BR*GDP*		−0.404***		−0.296***
		(-7.65)		(-5.65)
GDP	0.096***	0.016*	0.093***	0.022***
	(4.40)	(1.78)	(4.73)	(2.63)
Control variables & year	yes	yes	yes	yes
N	2170	2170	2282	2282
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.289	0.387	0.257	0.363
Hansen-P	0.321	0.000	0.218	0.310
Lag Dependent Variable	0.850***	0.876***	0.844***	0.848***
	(66.79)	(56.09)	(55.55)	(58.79)
Democracy_BR	3.210***		3.140***	
	(9.75)		(8.75)	
*Democracy_BR*Globalization*	−0.766***		−0.764***	
	(-9.13)		(-8.41)	
ΔDemocracy_BR		4.169***		4.048***
		(4.85)		(6.47)
*ΔDemocracy_BR*Globalization*		−1.040***		−0.996***
		(-4.61)		(-6.24)
Globalization	0.312**	−0.097	0.434***	−0.020
	(2.44)	(-1.13)	(2.97)	(-0.22)
Control variables & year	yes	yes	yes	yes
N	2170	2170	2282	2282
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.232	0.334	0.215	0.302
Hansen-P	0.395	0.476	0.366	0.349
Lag Dependent Variable	0.853***	0.867***	0.861***	0.844***
	(61.69)	(62.93)	(55.77)	(60.53)
Democracy_BR	0.820***		0.568***	
	(6.82)		(3.77)	
Democracy_BR Trade*	−0.147***		−0.099***	
	(-5.39)		(-2.81)	
ΔDemocracy_BR		1.041***		0.779***
		(6.15)		(4.25)
ΔDemocracy_BR Trade*		−0.208***		−0.141***
		(-4.85)		(-3.21)
Trade	0.173***	0.015	0.113***	−0.014
	(6.66)	(0.61)	(3.54)	(-0.63)
Control variables & year	yes	yes	yes	yes
N	2170	2170	2282	2282
AR (1)-P	0.000	0.000	0.000	0.000
AR (2)-P	0.283	0.332	0.267	0.287
Hansen-P	0.314	0.169	0.295	0.233

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis; ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. It is worth noting that we incorporate the control variables and year fixed effect into our estimation. In order to save space, we do not display the results of the control variables, but they are available upon request.

two binary variables to capture the difference among democracies: one is parliamentary democracy vs. presidential democracy (*Parliamentary*) for the form of government, and the other is majoritarian democracy vs. proportional democracy (*Majoritarian*) for electoral rule. By employing these 2 dummy variables to measure democracy, we examine the influence of different democracies on innovation, with the results listed in Table 8. The dependent variable in Panel A of Table 8 is *Patent*, while the independent variables for columns (1) and (2) are *Parliamentary* and *Majoritarian*, respectively. In column (1) of Panel A, the coefficient of *Democracy_BR* is 0.245, passing the significance test at the 1% level, which is similar to our earlier results. The coefficient of *Parliamentary* is 0.032, which is statistically significant at the 5% level, implying that parliamentary democracies benefit innovation. The coefficient of *Majoritarian* in column (2) is 0.169, which is significantly positive at the 1% level, indicating that the majoritarian democracies tend to be better for innovation than proportional democracies.

Similar to Hadenius et al. (2017) and Wilson and Piazza (2013), we use the 4 binary variables to capture the differences among autocracies: *Monarchy*, *Military, Party* (party-based autocracy) and *Non-party* (non-party autocracy).[17] Aside from such 4 variables, we further include a dummy variable (*Eastasia*) to capture the difference between East Asian developmental autocracies and their counterparts, because East Asian developmental autocracies stand out compared to their autocratic counterparts in the rest of the world.[18]

By employing these 5 dummy variables to measure the differences among autocracies, we examine the influence of different autocracies on innovation, with the results listed in Table 8. From column (3), we find that the coefficient of *Monarchy* is −0.049, which is significantly negative at the 5% level, suggesting that when the political regime is a monarchy, the negative influence of autocracy on innovation is stronger. In column (4), the coefficient of *Military* is 0.002, which is not significant at the 10% level, implying that a military political regime cannot change the influence of autocracy on innovation. In column (5), the coefficient of *Party* is 0.22, passing the significance test at the 1% level with a negative symbol, implying that when the political regime is a party-based autocracy, the influence of autocracy on innovation experiences a decrease. The result in column (6) shows that the coefficient of *Non-party* is −0.321, which is significantly negative at the 1% level, implying that when the political regime is a non-party autocracy, the negative influence of autocracy on innovation is stronger. From column (7), we find that the coefficient of *Eastasia* is 0.860, which is significantly positive at the 1% level, suggesting that East Asian autocracies benefit innovation. When we utilize *Trademark* to measure innovation, the results are listed in Panel B of Table 8, and they are in line with those in Panel A, except for the influence of monarch and military autocracies on trademark applications, confirming the influence of different democracies and autocracies on innovation.

From the results in Table 8, we find that the influence of democracy on innovation varies among different kinds of democracies. Compared to presidential democracies, parliamentary ones are more beneficial for innovation. Furthermore, comparing with proportional democracies, majoritarian ones tend to promote innovation. These findings are similar to the results of Haggard and Kaufman (1995) as well as Persson and Tabellini (2003) who argued that majoritarian democracies tend to be better for economic growth. Similarly, different autocracies also exert varying influences on innovation, as non-party ones are less likely to engage in innovation, while party-based autocracies spur innovation. The main reason for this runs as follows. Wilson and Piazza (2013) argued that compared to other autocracies, party-based autocracies use institutions which are similar to democratic ones and are more likely to leave office regularly and inhibit international challenges, as well as attract more investment. Party-based autocracies that form a stable economic and policy environment can attract more investment, which is critical to innovation. Moreover, East Asia autocracies tend to be better for innovation versus their non-East Asia counterparts. One potential reason for this is that East Asian autocracies are more sympathetic to capital owners (Gehlbach and Keefer, 2012), they do not fear technical competence, and these autocracies promote officials with technical competence (Lee and Schuler, 2020).

4.6. The differences in innovation among democracies

Our earlier results suggest that democracies tend to be better for innovation than autocracies, however, the baseline results offer no evidence on whether innovation varies among democracies. Based on this, we further test the difference in innovation among democracies, as well as the difference in innovation among OECD democracies.

Referring to the statistical test method for the difference among multiple groups, the analysis of variance test and non-parametric rank sum test are generally utilized.[19] For the credibility of our finding, we utilize the Kruskal-Wallis rank sum test to study the difference in innovation among democracies, particularly among OECD democracies.[20]

We first select those countries that have always been democracies during the period 1980–2017, to better discern the difference in innovation among democracies. [21]Second, we further test whether the innovation varies among those democracies, listing the results in Table 9. When we capture innovation by *Patent*, column (1) shows that the statistic of χ^2 is 630.755, which passes significance at the 1% level, suggesting that the null hypothesis that all groups own the same

[17] Following Hadenius et al. (2017), monarchies are defined as those regimes in which a person of royal descent has inherited the position of head of state in accordance with accepted practice and/or the constitution. If the political regime is a monarchy, then *Monarchy* = 1 and otherwise 0. Referring to military regimes, where the armed forces may exercise political power either directly or indirectly, *Military* = 1 and otherwise 0. For the party-based regime, when elections are held and parties (or at least one) are authorized, then *Party* = 1 and otherwise 0. For the no-party regime, when elections are held, but all political parties (or at least any candidate representing a party) are prohibited, then *Non-party* = 1 and otherwise 0.

[18] Similarly, the literature on East Asia's capitalist developmental states (Rock et al., 2017; Wade, 2003; Amsden, 1994) demonstrates that some kinds of autocracies are much better at delivering development than others. Here, we are thankful to the reviewers for their valuable suggestions. If one country belongs to East Asian developmental autocracies, then *Eastasia*=1 and otherwise 0.

[19] The analysis of variance runs under assumption of independence, normality, and homogeneity of variance; if not, then this method's result is not reliable. Once the assumption for analysis of variance is not established, the method of a non-parametric test, such as Kruskal-Wallis rank sum test, can be employed. The advantages of this rank sum test are as follows. First, if the variable's distribution is unclear, this method can better study the difference among multiple groups. Second, once the homogeneity of variance is not confirmed, the result of the Kruskal-Wallis rank sum test is still reliable. The null hypothesis of this test is that all groups own the same distribution. We first use the analysis of variance test to study the differences among democracies, however, the Bartlett test for equal variance (Chi 2 statistic is 447.11 with p-value of 0.000) rejects the null hypothesis that all groups present equal variance, implying that the homogeneity of variance is not confirmed. To save space, we do not report the results for analysis of variance, but they are available upon request.

[20] After the rank sum test, we also carry out Dunn's Pairwise Comparison for two democracies. Most results suggest that there is a significant difference in innovation between two countries. To save space, we do not report these results, but they are available upon request.

[21] Such 37 countries including Antigua and Barbuda, Australia, Austria, Bahamas, Barbados, Belgium, Belize, Botswana, Canada, Colombia, Costa Rica, Dominica, Dominican Republic, Denmark, Finland, France, Greece, Iceland, India, Ireland, Israel, Italy, Jamaica, Malta, Mauritius, New Zealand, Norway, Papua New Guinea, Portugal, Spain, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Sweden, Switzerland, United Kingdom and United States.

Table 8
GMM estimator - different forms of democracy and autocracy.

Panel A: *Patent*							
	Different Democracies		Different Autocracies				
	(1)Parliamenstary	(2)Majoritarian	(3)Monarchy	(4)Military	(5) Party	(6)Non-party	(7)Eastasia
L.Patent	0.799***	0.770***	0.746***	0.744***	0.735***	0.751***	0.772***
	(192.72)	(180.69)	(126.11)	(177.58)	(113.52)	(147.51)	(137.97)
Democracy_BR	0.245***	0.141***	0.314***	0.306***	0.414***	0.299***	0.238***
	(37.93)	(16.02)	(40.69)	(41.79)	(83.00)	(45.80)	(33.65)
Parliamentary Democracy	0.032**						
	(2.16)						
Majoritarian Democracy		0.169***					
		(10.42)					
Monarchy			−0.049**				
			(-2.09)				
Military				0.002			
				(0.15)			
Party					0.220***		
					(19.52)		
Non-party						−0.321***	
						(-7.82)	
Eastasia							0.860***
							(11.66)
N	2170	2066	1902	1902	1902	1902	2170
AR (1)-P	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2)-P	0.503	0.425	0.398	0.401	0.352	0.417	0.517
Hansen-P	0.865	0.959	0.783	0.767	0.757	0.833	0.851
Panel B: *Trademark*							
	Different Democracies		Different Autocracies				
	(1)Parliamentary	(2)Majoritarian	(3)Monarchy	(4)Military	(5) Party	(6) Non-party	(7) Eastasia
L.Trademark	0.784***	0.780***	0.769***	0.766***	0.751***	0.774***	0.779***
	(162.01)	(140.75)	(139.54)	(145.54)	(98.20)	(165.85)	(169.62)
Democracy_BR	0.211***	0.065***	0.219***	0.189***	0.344***	0.209***	0.222***
	(35.57)	(4.95)	(28.46)	(23.69)	(31.18)	(44.88)	(24.56)
Parliamentary Democracy	0.120***						
	(7.75)						
Majoritarian Democracy		0.207***					
		(13.41)					
Monarchy			0.038				
			(1.58)				
Military				−0.099***			
				(-7.06)			
Party					0.250***		
					(19.21)		
Non-party						−0.161***	
						(-2.92)	
Eastasia							0.587***
							(11.42)
N	2282	2174	2002	2002	2002	2002	2282
AR (1)-P	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR (2)-P	0.459	0.406	0.333	0.345	0.299	0.349	0.471
Hansen-P	0.788	0.931	0.664	0.695	0.646	0.722	0.724

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications. Z-statistics are in parenthesis. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. It is worth noting that we incorporate the control variables into our estimation. To save space, we do not display the results of control variables, but they are available upon request.

Table 9
Kruskal-Wallis test for difference in innovation among democracies.

	Difference among democracies		Difference among OECD democracies	
	(1) Patent	(2) Trademark	(3) Patent	(4) Trademark
χ^2	630.755	675.648	413.842	443.753
χ^2 with ties	630.755	675.648	413.842	443.753
df	35	36	19	19
P-value	0.0001	0.0001	0.0001	0.0001

Notes: *Patent* presents the total number of patent applications. *Trademark* denotes the total number of trademark applications.

innovation is rejected, as well as suggesting that there are significant differences among democracies. The result in column (2), which measures innovation by *Trademark*, also confirms this conclusion. Third, we study whether there exist significant differences among OECD democracies.[22] When we utilize *Patent* to measure innovation, the χ^2*-value* of the Kruskal-Wallis test in column (3) is 398.451, supporting that there are significant differences in innovation among OECD democracies. The result in column (4) also offers a similar idea when we capture

[22] The OECD democracies have always been democracies during 1980–2017, including 19 countries such as Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States. Because Israel has formally become an OECD Member since 2010, we do not include it while we test the differences in innovation among OECD democracies.

innovation by *Trademark*. The results in Table 9 support that there are significant differences in innovation among democracies, as well as among OECD democracies.

5. Concluding remarks

From the perspective of the political economy, this study mainly tests the effect of democracy on innovation, specifically investigating whether the change in democracy can affect innovation and further investigating what factors can change such connections for 132 countries during 1980–2017. From the benchmark result, we find that democracy exerts a significant influence on innovation. Specifically, a democratic country owns better innovation performance, whereas an autocratic political regime inhibits innovation, thus providing strong evidence for the hypothesis of Popper (2012). This runs contrary to Gao et al. (2017) who argued that democracy exerts no significant influence on innovation. Moreover, on the basis of Gao et al. (2017), we conduct several empirical estimations to investigate the credibility of our findings, for instance, by employing the variables of Cheibub et al. (2010), Polity IV and V-DEM to change the measurement of democracy, which show that democratic countries promote innovation progress. Other robustness tests are also carried out by employing WIPO database to change the measurement of innovation, and setting up a new middle 60% sample, which offer a clear conclusion.

We also explore what factors can change the impact of democracy on innovation. Specifically, we introduce two interactive terms of democracy variables and OECD to test whether economic development can change democracy's impact on innovation and conclude that compared to OECD countries, the positive effect of democracy on innovation applications is stronger in non-OECD ones. Moreover, two interactive terms of democracy variables and GDP are also employed into the empirical test to investigate the influence of economic performance, which indicate that democracy's positive impact on innovation is weakened in countries with better economic performance. By setting up two interactive terms of democracy variables and globalization into the basic model, we confirm that a higher level of democracy inhibits the positive effect of democracy on innovation. We also study whether the influence of democracy on innovation is similar among countries with different degree of trade openness by setting two interactive terms of democracy variables and trade openness, and conclude that if the countries own a higher degree of trade openness, then the positive effect of democracy on innovation is weakened. Aside from these, we further study whether the influence of democracy on innovation varies among different kinds of democracy and autocracy, finding that parliamentary democracies and majoritarian democracies tend to be better for innovation than presidential or proportional democracies. Comparing to other autocracies, party-based autocracies and East Asian autocracies are more beneficial for innovation. Finally, we test the difference in innovation among democracies, particularly among OECD democracies by employing rank sum test, the results suggest that there exists difference in innovation among democracies, as well as among OECD democracies.

Our study offers some policy implications to ruling governments, due to technical innovation playing a major role in economic development, which should be paid more attention to by authorities. However, versus an autocratic regime, a democratic one promotes innovation performance better, and so autocratic governments should take more effort to improve innovation. Specifically, since freedom and intellectual property rights protection caused by a political regime exert a significantly positive effect on innovation, both democratic and autocratic governments should take effective measures to improve social freedom and economic freedom and carry out stronger property protection that stimulates the incentives that spur inventors to engage into innovation activities.

It is also worth noting that the influences of democracy on innovation differ among countries under different economic development. The positive effect of democracy is higher in countries that possess lower economic development. The governments of highly developed countries should pay more attention to innovation so as to maintain their national competitiveness. Feasible measures include encouraging firms, individuals, and institutions to undertake more production of new technology by providing subsidies for research and development, enforcing communication between schools and firms, etc. Moreover, our findings argue that the share of the manufacturing industry weakens the impact of democracy on innovation. Since a political regime is generally constant at most times, for countries with lower democracy, an effective way to achieve higher innovation performance is to improve their industrial structure and promote the development of the manufacturing industry. Similarly, autocratic countries can also increase the proportion of inward foreign direct investment as well as improve the level of globalization so as to weaken the negative effect of autocracy on innovation.

Acknowledgement

The authors are very grateful to two anonymous reviewers and editor for their insightful comments that helped us sufficiently improve the quality of this paper. Hai-Jie Wang is grateful to the National Social Science Foundation of China for the grant number 20BJY094.

References

Acs, Z.J., Anselin, L., Varga, A., 2002. Patents and innovation counts as measures of regional production of new knowledge. Res. Pol. 31 (7), 1069–1085.
Amsden, A.H., 1994. Why isn't the whole world experimenting with the East Asian model to develop?: Review of the East Asian miracle. World Dev. 22 (4), 627–633.
Andersson, R., Quigley, J.M., Wilhelmsson, M., 2009. Urbanization, productivity, and innovation: evidence from investment in higher education. J. Urban Econ. 66 (1), 2–15.
Arpino, B., Obydenkova, A.V., 2019. Democracy and political trust before and after the great recession 2008: the European Union and the United Nations. Soc. Indicat. Res. 1–21.
Arin, K.P., Berlemann, M., Koray, F., Kuhlenkasper, T., 2011. The Taxation-Growth-Nexus Revisited (No. 104). Hamburg Institute of International Economics (HWWI) Research paper.
Arin, K.P., Braunfels, E., Doppelhofer, G., 2017. Revisiting the Growth Effects of Fiscal Policy: A Bayesian Model Averaging Approach (No.2017-68). Centre for Applied Macroeconomic Analysis, Crawford School of Public Policy, the Australian National University.
Arin, K.P., Huang, V.Z., Minniti, M., Nandialath, A.M., Reich, O.F., 2015. Revisiting the determinants of entrepreneurship: a Bayesian approach. J. Manag. 41 (2), 607–631.
Audretsch, D.B., Lehmann, E.E., Wright, M., 2014. Technology transfer in a global economy. J. Technol. Tran. 39 (3), 301–312.
Baiardi, D., Profeta, P., Puglisi, R., Scabrosetti, S., 2018. Tax policy and economic growth: does it really matter? Int. Tax Publ. Finance 1–35.
Belloumi, M., 2014. The relationship between trade, FDI and economic growth in Tunisia: an application of the autoregressive distributed lag model. Econ. Syst. 38 (2), 269–287.
Berdiev, A.N., Kim, Y., Chang, C.P., 2013. Remittances and corruption. Econ. Lett. 118 (1), 182–185.
Bhattacharya, U., Hsu, P.H., Tian, X., Xu, Y., 2017. What affects innovation more: policy or policy uncertainty? J. Financ. Quant. Anal. 52 (5), 1869–1901.
Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. Econ. Pap. 87 (1), 115–143.
Bjørnskov, C., Rode, M., 2019. Regime types and regime change: a new dataset on democracy, coups, and political institutions. The Review of International Organizations 1–21.
Cai, F., Zhang, X., 2017. Structural reform for economic growth. Aust. Econ. Rev. 50 (4), 450–459.
Castellaci, F., Grodal, S., Mendonca, S., Wibe, M., 2005. Advances and challenges in innovation studies. J. Econ. Issues 39 (1), 91–121.
Cheibub, J.A., Gandhi, J., Vreeland, J.R., 2010. Democracy and dictatorship revisited. Publ. Choice 143 (1), 67–101.
Coppedge, M., Gerring, J., Knutsen, C.H., Lindberg, S.I., Teorell, J., Marquardt, K.L., Wilson, S.L., 2019. In: V-dem methodology v9. V-Dem Working Paper Forthcoming.
de Haan, J., Siermann, C.L., 1996. New evidence on the relationship between democracy and economic growth. Publ. Choice 86 (1–2), 175–198.
de Haan, J., Sturm, J.E., 2003. Does more democracy lead to greater economic freedom? New evidence for developing countries. Eur. J. Polit. Econ. 19 (3), 547–563.
Dolfsma, W., Velde, G.V.D., 2014. Industry innovativeness, firm size, and entrepreneurship: schumpeter mark III? J. Evol. Econ. 24 (4), 713–736.
Dong, R.R., Martin, A., 2017. Research on barriers and government driving force in technological innovation of architecture based on BIM. Eurasia J. Math. Sci. Technol. Educ. 13 (8), 5757–5763.

Doucouliagos, H., Ulubaşoğlu, M.A., 2008. Democracy and economic growth: a meta-analysis. Am. J. Polit. Sci. 52 (1), 61–83.
Duygun, M., Sena, V., Shaban, M., 2016. Trademarking activities and total factor productivity: some evidence for British commercial banks using a metafrontier approach. J. *Bank. Finance* 72, S70–S80.
Feng, G.F., Wang, Q.J., Chu, Y., Wen, J., Chang, C.P., 2019. Does the shale gas boom change the natural gas price-production relationship? Evidence from the US market. Energy Economics.
Fredriksson, P.G., Wollscheid, J.R., 2007. Democratic institutions versus autocratic regimes: the case of environmental policy. Publ. Choice 130 (3–4), 381–393.
Flanagan, K., Uyarra, E., Laranja, M., 2011. Reconceptualising the 'policy mix' for innovation. Res. Pol. 40 (5), 702–713.
Florida, R., 1995. Technology policy for a global economy. Issues Sci. Technol. 11 (3), 49–56.
Florida, R., 2014. The creative class and economic development. Econ. Dev. Q. 28 (3), 196–205.
Frías, J.A., Kaplan, D.S., Verhoogen, E., 2012. Exports and within-plant wage distributions: evidence from Mexico. Am. Econ. Rev. 102 (3), 435–440.
Furman, J.L., Porter, M.E., Stern, S., 2002. The determinants of national innovative capacity. Research policy 31 (6), 899–933.
Gao, Y., Zang, L., Roth, A., Wang, P., 2017. Does democracy cause innovation? An empirical test of the popper hypothesis. Res. Pol. 46 (7), 1272–1283.
Gehlbach, S., Keefer, P., 2012. Private investment and the institutionalization of collective action in autocracies: ruling parties and legislatures. J. Polit. 74 (2), 621–635.
Gerring, J., Bond, P., Barndt, W.T., Moreno, C., 2005. Democracy and economic growth: a historical perspective. World Polit. 57 (3), 323–364.
Ginarte, J.C., Park, W.G., 1997. Determinants of patent rights: a cross-national study. Res. Pol. 26 (3), 283–301.
Graham, S.J.H., Hancock, G., 2014. The USPTO economics research agenda. J. Technol. Tran. 39 (3), 335–344.
Grande, E., Peschke, A., 1999. Transnational cooperation and policy networks in European science policy-making. Res. Pol. 3246 (49), 43–61.
Greunz, L., 2004. Industrial structure and innovation-evidence from European regions. J. Evol. Econ. 14 (5), 563–592.
Griliches, Z., 1990. Patent statistics as economic indicators: a survey. J. Econ. Lit. 28 (4), 1661–1707.
Hadenius, A., Teorell, J., Wahman, M., 2017. Authoritarian regimes data set, version 6.0. Codebook. J. Democr. 18 (1), 143–156.
Haggard, S., Kaufman, R.R., 1995. The Political Economy of Democratic Transitions. Princeton University Press.
Hudson, J., Minea, A., 2013. Innovation, intellectual property rights, and economic development: a unified empirical investigation. World Dev. 46, 66–78.
Jalles, J.T., 2010. How to measure innovation? New evidence of the technology–growth linkage. Res. Econ. 64 (2), 81–96.
Kanwar, S., Evenson, R., 2003. Does intellectual property protection spur technological change? Oxf. Econ. Pap. 55 (2), 235–264.
Karafyllia, M., Zucchella, A., 2017. Synergies and tensions between and within domestic and international market activities of firms. Int. Bus. Rev. 26 (5), 942–958.
Knutsen, C.H., 2013. Democracy, state capacity, and economic growth, 43. World Development, pp. 1–18.
Kogan, L., Papanikolaou, D., Seru, A., Stoffman, N., 2017. Technological innovation, resource allocation, and growth. Q. J. Econ. 132 (2), 665–712.
Kremer, M., 1993. Population growth and technological change: one million B.C. to 1990. Q. J. Econ. 108 (3), 681–716.
Lankina, T., Libman, A., Obydenkova, A., 2016. Authoritarian and democratic diffusion in post-communist regions. Comp. Polit. Stud. 49 (12), 1599–1629.
Lau, C.K.M., Yang, F.S., Zhang, Z., Leung, V.K., 2015. Determinants of innovative activities: evidence from Europe and central Asia region. Singapore Econ. Rev. 60 (1), 1550004.
Leblang, D.A., 1997. Political democracy and economic growth: pooled cross-sectional and time-series evidence. Br. J. Polit. Sci. 27 (3), 453–472.
Lee, D.S., Schuler, P., 2020. Testing the "China model" of meritocratic promotions: do democracies reward less competent ministers than autocracies? Comp. Polit. Stud. 53 (3–4), 531–566.
Lehmann, E.E., Seitz, N., 2017. Freedom and innovation: a country and state level analysis. J. Technol. Tran. 42 (5), 1009–1029.
Libman, A., Obydenkova, A., 2014a. Governance of commons in a large nondemocratic country: the case of forestry in the Russian Federation. Publius 44 (2), 298–323.
Libman, A., Obydenkova, A., 2014b. International trade as a limiting factor in democratization: an analysis of subnational regions in post-communist Russia. Stud. Comp. Int. Dev. 49 (2), 168–196.
Lipford, J.W., Yandle, B., 2015. Determining economic freedom: democracy, political competition, and the wealth preservation struggle. J. Priv. Enterprise 30 (3).
Marshall, M.G., Gurr, T.D., Jaggers, K., 2018. Polity IV Project. Political Regime Characteristics and Transitions. Dataset users' manual. Center for Systemic Peace, 1800–2017.
North, D.C., 1993. The Paradox of the West. Economics Working Paper Archive, Washington University—St. Louis, Missouri.
Nazarov, Z., Obydenkova, A.V., 2020. Democratization and firm innovation: evidence from European and Central Asian post-communist states. Post Commun. Econ. 32 (7), 833–859.
Obydenkova, A., Salahodjaev, R., 2016. Intelligence, democracy, and international environmental commitment. Environ. Res. 147, 82–88.
Obydenkova, A.V., Salahodjaev, R., 2017a. Climate change policies: the role of democracy and social cognitive capital. Environ. Res. 157, 182–189.
Obydenkova, A.V., Salahodjaev, R., 2017b. Government size, intelligence and life satisfaction. Intelligence 61, 85–91.
Olson, M., 1993. Dictatorship, democracy, and development. Am. Polit. Sci. Rev. 87 (3), 567–576.
Park, W.G., Ginarte, J.C., 1997. Intellectual property rights and economic growth. Contemp. Econ. Pol. 15 (3), 51–61.
Parrotta, P., Pozzoli, D., Pytlikova, M., 2014. The nexus between labor diversity and firm's innovation. J. Popul. Econ. 27 (2), 303–364.
Perri, A., Peruffo, E., 2016. Knowledge spillovers from FDI: a critical review from the international business perspective. Int. J. Manag. Rev. 18 (1), 3–27.
Persson, T., Tabellini, G., 2003. The Economic Effects of Constitutions. MIT Press, Cambridge, Mass.
Persson, T., Tabellini, G., 2006. Democracy and development: the devil in the details. Am. Econ. Rev. 96 (2), 319–324.
Popper, K., 2005. The Logic of Scientific Discovery. Routledge, New York.
Popper, K., 2012. The Open Society and its Enemies. Routledge, New York.
Pradhan, R.P., Arvin, M.B., Nair, M., Bennett, S.E., Bahmani, S., Hall, J.H., 2018. Endogenous dynamics between innovation, financial markets, venture capital and economic growth: evidence from europe. J. Multinatl. Financ. Manag. 45, 15–34.
Rock, M.T., Ling, O.G., Kimm, V., 2017. Public Policies to Promote Cleaner Shared Industrial Growth in East Asia. In: Asia's Clean Revolution. Routledge, pp. 88–103.
Roper, S., Hewitt-Dundas, N., 2015. Knowledge stocks, knowledge flows and innovation: evidence from matched patents and innovation panel data. Res. Pol. 44 (7), 1327–1340.
Roper, S., Love, J.H., Bonner, K., 2017. Firms' knowledge search and local knowledge externalities in innovation performance. Res. Pol. 46 (1), 43–56.
Salahodjaev, R., 2015. Democracy and economic growth: the role of intelligence in cross-country regressions. Intelligence 50, 228–234.
Samara, E., Georgiadis, P., Bakouros, I., 2012. The impact of innovation policies on the performance of national innovation systems: a system dynamics analysis. Technovation 32 (11), 624–638.
Scott, A., Storper, M., 2003. Regions, globalization, development. Reg. Stud. 37 (6–7), 579–593.
Sirowy, L., Inkeles, A., 1990. The effects of democracy on economic growth and inequality: a review. Stud. Comp. Int. Dev. 25 (1), 126–157.
Stiglitz, J.E., 2007. Economic foundations of intellectual property rights. Duke Law J. 57 (6), 1693–1725.
Sturm, J.E., de Haan, J., 2001. How robust is the relationship between economic freedom and economic growth? Appl. Econ. 33 (7), 839–844.
Sweet, C.M., Maggio, D.S.E., 2015. Do stronger intellectual property rights increase innovation? World Dev. 66, 665–677.
Taalbi, J., 2017. What drives innovation? Evidence from economic history. Res. Pol. 46 (8), 1437–1453.
Ulku, H., 2007. R&D, innovation and output: evidence from OECD and nonOECD countries. Appl. Econ. 39 (3), 291–307.
Varsakelis, N.C., 2001. The impact of patent protection, economy openness and national culture on R&D investment: a cross-country empirical investigation. Res. Pol. 30 (7), 1059–1068.
Varsakelis, N.C., 2006. Education, political institutions and innovative activity: a cross-country empirical investigation. Res. Pol. 35 (7), 1083–1090.
Wade, R.H., 2003. What strategies are viable for developing countries today? The World Trade Organization and the shrinking of 'development space. Rev. Int. Polit. Econ.10 (4),, 621–644.
Wang, Q.J., Feng, G.F., Chen, Y.E., Wen, J., Chang, C.P., 2019. The impacts of government ideology on innovation: what are the main implications? Res. Pol. 48 (5), 1232–1247.
Wen, J., Wang, Q.L., Feng, G.F., Chen, S.W., Chang, C.P., 2018. Corruption and innovation: linear and non-linear investigations of OECD countries. Singapore Economic Review.
Wilson, M.C., Piazza, J.A., 2013. Autocracies and terrorism: conditioning effects of authoritarian regime type on terrorist attacks. Am. J. Polit. Sci. 57 (4), 941–955.
Woo, S., Jang, P., Kim, Y., 2015. Effects of intellectual property rights and patented knowledge in innovation and industry value added: a multinational empirical analysis of different industries. Technovation 43, 49–63.
Wooldridge, J.M., 2015. Introductory econometrics: a modern approach. Nelson Education.
Zheng, W., 2010. A social capital perspective of innovation from individuals to nations: where is empirical literature directing us? Int. J. Manag. Rev. 12 (2), 151–183.
Zheng, M., Feng, G.F., Feng, S., Yuan, X., 2019a. The Road to Innovation vs the Role of Globalization: A Dynamic Quantile Investigation. Economic Modelling.
Zheng, M., Feng, G.F., Wen, J., Chang, C.P., Chen, Y.E., 2019b. The Assessment of Globalization on Innovation in Chinese Manufacturing Firms, *Structural Change and Economic Dynamics*. forthcoming.