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Financial deepening and innovation: The role of political institutions ☆

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ABSTRACT

This study investigates the effects of financial deepening on innovation for various democratic levels of political institutions using panel data from 74 countries spanning 1970–2010. Our results show that banking market deepening is associated with increased innovation only when political institutions are sufficiently democratic. In contrast, the enhancing effect of stock market deepening on innovation requires a lower level of political democracy. Further, we find that increasing the state's openness and competitiveness in the executive recruitment of leaders is the main channel through which political democratization promotes the role of banking and stock markets for financing innovation. Our results are robust to the use of the instrumental variable approach; alternative measures for financial deepening, democracy and innovation input; long-differenced variables; and alternative specifications.

1. Introduction

It is well known that innovation is a catalyst for sustainable economic growth, which is on the development agenda of numerous developed and developing countries (Aghion and Howitt, 1992; Grossman and Helpman, 1991; Romer, 1990). What can governments do to promote innovation? Consistent with the insight of Schumpeter (1911), recent empirical studies have determined that financial development promotes innovation (Ang, 2011; Ayyagari, Demirgc-Kunt, & Maksimovic, 2011; Hsu, Tian, & Xu, 2014). Because countries that have deeper financial systems are better at mobilizing resources, allocating funding and diversifying risks, they can channel more funding to profitable but risky innovation projects. Consequently, financial deepening increases the resources devoted to the research and development (R&D) sector in order to foster innovation (King and Levine, 1993b). Furthermore, recent studies have indicated that political institutions affect cross-country differences in financial development by instituting rules and regulations (Haber, North, & Weingast, 2007). Motivated by these two strands of literature, we examine how financial deepening and political institutions affect innovation.

Political institutions define the rules and policies that shape the interactions (e.g., the contractual relationships) between market participants, which in turn affect the incentives and expectations of investors and innovators. Democratic political institutions limit the power of the state by constraining executive authority and fostering political competition, which better protects investor and innovator gains (Jensen, 2008; Li, 2009).[1] We expect innovators to be more motivated to transform innovation input to innovation output under the influence of more democratic political institutions, indicating a positive relationship between political democracy and innovation output, i.e., the transformation rate from innovation input to innovation output.

While it may seem natural to argue that political democratization promotes innovation, we further examine whether countries

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[1] The former study demonstrates that democratic institutions are associated with lower levels of political risk (measured by the premiums multinationals pay for coverage against government expropriations and contract disputes), which is driven by constraints on the executive branch. The latter study demonstrates that democratic governments are much less likely to expropriate assets from investors (particularly foreign direct investments) because democratic governments generally impose more constraints on their leaders than autocratic regimes.

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with more democratic political institutions can exploit their financial systems more efficiently to generate new ideas. In particular, we argue that the political democracy of a country affects its capacity to allocate its financial resources efficiently in the generation of new ideas. Note that depth and efficiency are two different dimensions of financial development and that a country's financial depth can be measured by the size of its banks and/or stock market as a percentage of GDP. The efficiency of financial markets is harder to measure quantitatively and hence is usually insufficient for empirical research. Therefore, in an attempt to understand how political democracy affects the efficiency of financial markets in financing innovation, we examine the interactive effects of financial depth and political democracy in knowledge production.

First, we hypothesize that political democratization promotes the efficiency of the banking market to finance innovation, which would in turn promote the innovation-enhancing effect of banking market deepening. More democratic countries have lower ownership in their banking system and possess less power to restrict the entry of new financial intermediaries into the marketplace (La Porta, Lopez-de-Silanes, & Shleifer, 2002). Therefore, democratic political institutions limit the power of the state to control and repress the financial system, which reduces the opportunity for both predatory and opportunistic behavior (Sapienza, 2004) and generates a more competitive and more efficient banking system (Haber et al., 2007). A more competitive banking environment, in turn, is more strongly committed to terminating poor investment projects than a monopolistic banking environment. This commitment increases the ability of competitive banking environments to finance risky investments and promote innovation (Huang and Xu, 1999). However, a more competitive banking environment may not promote innovation if it shifts lending toward less risky firms and away from loan products requiring more soft information (Dell'Ariccia and Marquez, 2004) or if it reduces the supply of innovative small firms as targets for mergers (Cornaggia, Mao, Tian, & Wolfe, 2015).

Second, we hypothesize that political democratization would promote the innovation-enhancing effect of stock market deepening. Investors are able to extract the relevant but noisy information from equilibrium prices under rational expectations (Grossman, 1976). This information allows investors to make investment decisions regarding innovation projects. The information contained in equity prices also provides timely information to entrepreneurs about the prospects of their innovations, which in turn improves their investment decisions (Allen and Gale, 1999). We expect that more democratic political institutions that impose greater constraints on governments would be more likely to implement policies that improve information disclosure to investors. For example, Bushman, Piotroski, and Smith (2004) observed greater corporate transparency in countries where the state is less likely to expropriate firms' wealth. As a result, political democratization enhances the efficiency of stock markets for financing innovation because the quality of information produced by the stock market is improved in a more democratic political environment.

To test the above hypotheses regarding the direct and indirect effects of political democracy on innovation through financial deepening, we employ a panel data set encompassing 74 countries over the period 1970–2010; the countries vary greatly in terms of the degree of financial depth and political democracy. We measure each country's innovation output by the number of patents granted by the United States Patent and Trademark Office (USPTO). We employ three measures of financial deepening. The depth of the banking market is measured by the ratio of private credit by banks to gross domestic product (GDP); the depth of the formal financial intermediaries is measured by the ratio of their liquid liabilities to GDP; and the depth of the stock market is measured by the ratio of stock market capitalization to GDP. We operationalize the concept of political democratization at the country level using quantitative measures of institutionalized democracy, i.e., the polity score provided by the Polity IV Project (Marshall and Jaggers, 2011) and the Political Rights (PR) index published by Freedom House (2011).

Our empirical model is derived from a knowledge production function that links a country's innovation output to innovation input and other factors. We estimate our model using lagged explanatory variables as instrumental variables (IVs) in alignment with the general method of moments (GMM) approach (Arellano and Bond, 1991; Blundell and Bond, 1998) to address the potential issue of endogeneity. Furthermore, we incorporate a full set of country and year fixed effects and a set of time-varying control variables, such as R&D inputs measured by the number of R&D researchers per capita, to address the potential issue of omitted variables.

Our empirical analysis leads to several conclusions. First, we find a positive effect of political democratization on innovation. Second, and more importantly, we demonstrate that the deepening of both the banking market and formal financial intermediaries has a positive and significant effect on innovation only when a threshold level of the polity score has been attained. To clarify, the deepening of the banking market and formal financial intermediaries causes innovation input to be allocated more efficiently among innovative projects only when a country has a sufficiently high level of political democracy. Conversely, there is a lower requirement for the polity score to allow stock market deepening, thus promoting innovation. These results are consistent with our hypothesis that political democratization has an indirect effect on innovation through financial deepening.

Third, we find that increasing the state's openness and competitiveness in the executive recruitment of leaders is the main channel through which political democratization promotes the role of banking and stock markets for financing innovation. Finally, our results are robust to the use of alternative measures of financial deepening, political democracy and innovation input, long-differenced variables, and alternative specifications.

Our study extends the growing literature on the relationship between political institutions, financial development, and innovation with cross-country data. Recent studies, such as Huang (2010), show that political democracy promotes financial development. Other studies have concluded that higher quality political institutions promote innovation (Varsakelis, 2006) and that higher levels of financial development promote innovation (Ayyagari et al., 2011; Ang, 2011). Our paper adds to this literature by showing the interactive effect of political democracy and financial development on innovation.

Further, closely related to our work, Hsu et al. (2014) demonstrate that the development of the stock market is more important than that of the banking market for promoting patents filed in the U.S. Our study differs from this study in two aspects. First, we focus on how political democracy affects the financial development of innovation, whereas Hsu et al. (2014) focus on the direct effect of financial development in innovation. Second, we show that bank-based financial systems require a higher level of political democracy than market-based financial systems for promoting innovation. As a result, on average, bank-based financial systems have a weaker positive effect on innovation than market-based financial systems, which reconciles the results reported in Hsu et al. (2014).

The remainder of the paper is organized as follows. Section 2 presents the empirical model, and Section 3 describes the data. Section 4 reports the empirical results with various robustness checks, and Section 5 presents potential channels. The final section concludes.

2. Model and estimation methodology

2.1. Model

The approach we use to examine innovation in different countries is based on the knowledge production function that has been widely used for endogenous growth theory. In alignment with Ha and Howitt (2007), we specify a production function for technological innovations as follows:

$$\Delta A_{it} = \delta(F_{it}, P_{it}) A_{it}^{\varphi} (R_{it}/Q_{it})^{\sigma},$$

$$Q_{it} \propto L_{it}^{\beta} \text{ in steady state}, \quad (1)$$

where country and year are denoted by i and t, respectively. ΔA_{it} represents the flow of new knowledge, A_{it} represents the stock of existing knowledge available to produce new knowledge, R_{it} represents the R&D inputs devoted to knowledge production, Q_{it} is the product variety that counterbalances the innovation-enhancing effect of R&D inputs, and L_{it} is employment or population. The focus of our study is the function of innovation output $\delta(F_{it}, P_{it})$, which is the transformation rate of innovation input to new knowledge. Clearly, we assume that innovation output is related to the levels of financial deepening (F_{it}) and political democracy (P_{it}).

The parameter σ is the duplication parameter and ranges from 0 if all innovations are duplicates to 1 if no innovation is duplicated. The parameter φ characterizes the return to scale effect of the existing knowledge stock on producing new knowledge. β is the parameter of product proliferation and captures whether the effectiveness of R&D is diluted due to the proliferation/complexity of products as technology deepens. Although there is an ongoing debate in the literature regarding the values of parameters φ and β, we aligned with the semi-endogenous growth models (e.g., Jones, 1995; Kortum, 1997; Segerstrom, 1998) to assume $\varphi < 1$ and $\beta = 0$. As such, R&D must continuously increase to sustain a positive growth rate of knowledge.

2.2. Estimation methodology

We hypothesize that the level of political democracy of a country affects its capacity to utilize its financial deepening in generating new ideas. This hypothesis implies there is an interaction between financial deepening and political democracy in the production function for technological innovation. Therefore, we log-linearize Eq. (1) to obtain the following empirical specification:

$$\ln(\Delta A_{it}) = \beta_0 + \beta_1 F_{it} + \beta_2 P_{it} + \beta_3 F_{it} \times P_{it} + \beta_4 lnA_{it} + \beta_5 lnR_{it} + \alpha_i + \alpha_t + u_{it}, \quad (2)$$

The dependent variable ΔA_{it} represents the patents granted by the USPTO to each country in year t. For a long period of time, patents have been widely used, not without controversy, as a measure of innovation output (Kamien and Schwartz, 1975; Griliches, 1990).[2] Although not all inventions are patented, those that are patented must meet minimal standards of novelty, originality and potential use. Therefore, patents are an appropriate proxy for economically significant innovation. We use the patents granted by the USPTO as a proxy for the flow of new knowledge to avoid concerns that the measurement is incomparable across countries because domestic patent offices across countries do not exhibit uniform standards in granting patents.[3]

The primary explanatory variables of interest are F_{it}, P_{it} and the interactions between them. In alignment with the seminal study conducted by King and Levine (1993a), we use three measures of financial deepening. First, we use the ratio of private credit to GDP to measure the banking market depth of a country. Second, we use the ratio of liquid liabilities to GDP to measure a country's depth of formal financial intermediaries. Third, we use the ratio of stock market capitalization to GDP to measure the stock market depth of a country. Higher ratios of private credit, liquid liabilities and stock market capitalization to GDP indicate a higher level of financial depth.

We employ the polity score as our primary measure of country-level institutionalized political democracy. This score is based on a weighted score of the state's openness and competitiveness in executive recruitment of a country's leaders, the constraints on its executive authority and the competitiveness of its political participation. A higher score indicates a more democratic institution, which creates greater constraints on the government by introducing more open and competitive executive recruitment for a country's leaders, imposing tighter constraints on executive authority and promoting more competitive political participation (Marshall and Jaggers, 2011). The interaction term between financial deepening and political democratization demonstrates how the effects of financial deepening on knowledge accumulation vary across countries with different levels of political democracy. A positive coefficient of the interaction term indicates that financial deepening contributes more to knowledge accumulation when it operates in more democratic institutions. To ensure that the interaction term does not proxy for the level of financial deepening or political democracy, both of the latter variables (F_{it} and P_{it}) are included in the regression independently.

We employ the total number of R&D researchers as our primary measure for R_{it} and the total R&D expenditures as an alternative measure. These variables have often been used in empirical studies to proxy the direct effect on innovation. We use R&D expenditures as an alternative measure of R_{it} only for a robustness check because this specification does not allow political democratization to enhance the effect of financial deepening on knowledge accumulation through altering R&D expenditures. This exclusion may omit an important channel through which financial deepening affects knowledge accumulation.

We control the existing knowledge stock with the stock of patents granted by the home patent office. Specifically, we align with Hall, Jaffe, and Trajtenberg (2005) and use the perpetual inventory model with a depreciation rate of 15% to account for the effect of depreciation on the stock of patents. We believe patent stock granted by the home patent office to be a better measure of existing knowledge stock because inventors usually apply for patents in their country (OECD, 2009). However, inventors apply for patents abroad, including in the U.S., for a fraction of their inventions that have commercial value in other countries. Previous cross-countries studies also use patents granted by the home patent office to measure the aggregate innovation of a country (Furman, Porter, & Stern, 2002; Hsu, 2009).

Furthermore, we include two time-varying control variables. First, we include intellectual property rights (IPR) protection at the country-level to control for the institutions that directly interfere with innovation (Hudson and Minea, 2013). As a result,

[2] Kamien and Schwartz (1975, Page 5)) summarize: "Nevertheless, systematic study of patenting behavior has led Schmookler, Scherer and others to conclude that the number of patents granted a firm is a usable proxy for inventive outputs".

[3] If domestics firms filing patents in the USPTO were larger (i.e., less financially constrained), they might not need to finance their innovation through banking and stock markets. Accordingly, our model would produce a conservative estimate of how political democratization affects the role of banking and the stock market in financing innovation.

the variable P_{it} only captures the effects of political democratization on knowledge accumulation through channels other than developing and enforcing IPR. Second, a disadvantage of using patents granted by the USPTO to measure patent output is selection bias because domestic innovators apply for patents in the USPTO if they need patent protection in the United States. To address this selection bias, we include the log of exporting volume per capita of each country to the United States in our empirical model. We employ this variable to partially capture the time-varying shocks to the application of domestic innovators in the USPTO. To clarify, in Eq. (3), we assume that

$$u_{it} = v_{it} + \beta_6 IPR_{it} + \beta_7 lnTRADE_{it} \quad (3)$$

where IPR_{it} denotes the IPR of country i in year t, and $TRADE_{it}$ denotes the log of exporting volume per capita of country i to the United States at year t.

Eq. (2) also includes a full set of country dummy variables, α_i, which capture time-invariant country characteristics that affect the equilibrium levels of knowledge accumulation. For example, these dummy variables eliminate the effect of constant, potentially historical factors. Additionally, a full set of time dummy variables, α_t, is included to capture common shocks to knowledge accumulation in all countries. For example, these dummy variables eliminate the spillover effect from patent stocks across the globe. The error term $u_{it,}$ captures all of the other omitted idiosyncratic factors, where $E[v_{it}] = 0$ for all i and t.

To control for the potential endogeneity of explanatory variables, including F_{it}, $F_{it}{}^{*}P_{it}$, lnR_{it}, IPR_{it} and $lnTRADE_{it}$, we use the lagged explanatory variables as instrumental variables (IVs), in alignment with the system GMM approach (Arellano and Bond, 1991; Blundell and Bond, 1998), to estimate our empirical model.

3. Data and descriptive statistics

We compile a large international panel of data for empirical analysis from various sources, including the WIPO Statistics Database and USPTO Patent Statistics for patent data, the World Bank for private credit, liquid liabilities and stock market capitalization data, Marshall and Jaggers (2011) for polity scores, Freedom House (2011) for political rights indices, Lederman and Saenz (2005) for R&D researchers and R&D expenditures as a percent of GDP for the time period 1965–2000, UNESCO for R&D researchers and R&D expenditures as a percent of GDP for the time period 2001–2005, Park (2008) for a measure of IPR protection, and the Penn World Table 7.1 for real GDP per capita and total population. The sample includes 74 countries (see Appendix 1 for the entire list of sample countries) covering the time period 1970–2010; the time periods correspond to five-year intervals.

Summary statistics are reported in Table 1 (see Appendix 2 for variable definitions). Table 2 reports the correlation matrix of the key variables, which indicates that positive and statistically significant pairwise correlations exist between knowledge accumulation and financial deepening and between knowledge accumulation and polity scores.

4. Empirical results

4.1. Benchmark results

Table 3 reports the empirical results of Eq. (2). Columns 1 and 3 report the direct effects of financial deepening and political democratization on knowledge accumulation without including the interaction term between financial deepening and political democracy. Columns 4 and 6 report the results from the full model including the interaction term. The bottom of Table 3 provides the results of the Hansen test and the serial correlation test. The null hypothesis of the Hansen test is that the instruments used are not correlated with the residuals. The null hypothesis of the serial correlation test is that the errors in the first-difference regression exhibit no second-order serial correlation. Both tests failed to reject the null hypothesis and supported the validity of our results obtained using the system GMM estimation.

Columns 1 and 3 of Table 3 indicate that the coefficients of F_{it} are positive and significant regardless of which measure of financial deepening is used. Political democracy has a positive effect on knowledge accumulation, but not all results are significant at the 10% level. It suggests that there is a weak positive direct effect of political democracy on innovation. The coefficients of the other variables in all the regressions are of the expected signs. The coefficient of lnA_{it} is positive (between zero and one) and significant, suggesting that there is a decreasing return to scale for knowledge. The coefficient of lnR_{it} is positive and significant, suggesting that not all new knowledge duplicates existing knowledge. The coefficients of IPR_{it} and $lnTRADE_{it}$ are positive and significant, suggesting that countries that have a stronger domestic IPR protection and export to the United States are granted more patents by the USPTO.

The primary results are reported in Columns 4 and 6. There is no qualitative change in the coefficients of the other variables, except for P_{it} and F_{it}, after the interaction term between P_{it} and F_{it} is included. The coefficients of the interaction term between P_{it} and F_{it} are positive and significant, but the coefficients of P_{it} and F_{it} are insignificant. Our results support the hypothesis that political democracy has indirect effects on innovation through financial deepening. To clarify, political democratization promotes innovation primarily by improving the financing role of banking and stock markets for financing innovation. In other words, the role of financial development on innovation depends on political democracy, i.e., $\beta_1 + \beta_3 P_{it}$.

The top graph in Fig. 1 shows that the effect of banking market deepening on innovation is positive only when the polity score $P_{it,}$ is greater than 2.223. In addition, the last row of Table 3 reports that the threshold 2.223 is significantly larger than the lower bound on the polity score, i.e., −10. These results suggest that there could exist a threshold of polity scores above which banking market deepening enhances innovation.

Based on the magnitudes of the coefficient estimates of β_1 and β_3 reported in Column 4 of Table 3 and holding other factors constant, the patents granted to a country with a polity score at the 25th percentile (6) would increase by 44% ($=-0.502 \times 0.52 + 0.226 \times 6 \times 0.52$) if its banking market development improved from the 25th percentile (0.22) to the 75th percentile (0.74) in our sample. Conversely, holding other factors constant, the patents granted to a country with a polity score at the 75th percentile (10) would increase by 91% ($=-0.502 \times 0.52 + 0.226 \times 10 \times 0.52$) if its banking market development improved from the 25th percentile (0.22) to the 75th percentile (0.74) in our sample. The difference between these two numbers is economically large, which suggests that there is a significant divergence in innovation among countries with different levels of political democracy as their banking markets deepen.

Interestingly, compared with the deepening of the banking market, stock market deepening requires a much lower threshold of polity scores to enhance innovation output (see Column 6 of Table 3). The bottom graph in Fig. 1 shows that the effect of stock market deepening on innovation is positive only when the polity score $P_{it,}$ is greater than −0.398. To clarify, the positive effect of stock market deepening on innovation output applies to a wider set of countries. This result is consistent with Hsu et al. (2014), who demonstrated that on average, stock market deepening exhibits a more positive impact on promoting innovation.

Based on the magnitudes of the coefficient estimates of β_1 and β_3 reported in Column 6 of Table 3 and holding other factors

Table 1
Variable definitions and summary statistics.

Variables	Obs.	Mean	SD	Min	P25	Median	P75	Max
ΔA	299	765.04	3185.92	0	2	24	313	31,295
Alternative measures for financial development								
PC	299	0.51	0.38	0.02	0.22	0.39	0.74	1.9
LL	295	0.57	0.36	0.05	0.31	0.51	0.74	2.39
STOCK	291	0.27	0.44	0	0	0.07	0.35	2.46
VC2	163	0.50	0.14	0.18	0.40	0.50	0.61	0.80
VC1	139	0.10	0.50	0	0	0.02	0.06	5.84
IPO	123	0.73	1.49	0	0.07	0.36	0.78	13.38
Alternative measures for democracy								
POLITY	299	6.05	6	−10	6	9	10	10
EXREC	299	7.1	1.82	1	8	8	8	8
EXCONST	299	5.75	1.87	1	5	7	7	7
POLCOMP	299	7.87	3.03	1	7	9	10	10
PR	291	2.4	1.84	1	1	1	3	7
Control variables								
A (Local)	299	33128.6	84021.2	0	999.23	9391.82	24387.7	796,138
A (US)	299	4140.51	17578.19	0	10.14	121.77	1576.06	195,741
R = RDPER	299	51,080	127,830	18	3658	11,935	34,847	1,118,698
R = RDEXP	342	5,873,629	1.5E+07	146	195,144	1,197,422	4,627,459	1.33E+08
IPR	299	2.99	1.15	0	2.16	3.11	4	4.67
TRADE	299	0.31	0.65	0	0.03	0.1	0.28	4.7

Note: Each observation represents one country over the period of a year. Variable definitions are provided in Appendix 2.

Table 2
Correlation matrix for key variables.

	ΔA	PC	LL	STOCK	POLITY	PS	RDPER	RDEXP	IPR
PC	0.4314***	1							
LL	0.5843***	0.8658***	1						
STOCK	0.1883***	0.5207***	0.4222***	1					
POLITY	0.1455**	0.3088***	0.2196***	0.1383**	1				
A	0.9321***	0.416***	0.5636***	0.1478**	0.1757***	1			
RDPER	0.6239***	0.3507***	0.4674***	0.139**	−0.0114	0.6744***	1		
RDEXP	0.9073***	0.4942***	0.6211***	0.2208***	0.1313**	0.8952***	0.8191***	1	
IPR	0.2439***	0.5298***	0.4095***	0.4874***	0.5142***	0.2685***	0.2361***	0.3275***	1
TRADE	0.1335**	0.3088***	0.2762***	0.3654***	0.1049*	0.1622***	0.0432	0.131**	0.26***

Note: Number of observations = 299 (295 for LL, 291 for STOCK, 285 for RDEXP). Each observation represents one country over the period of a year.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

constant, the patents granted to a country with polity score at the 25th percentile (6) would increase by 24% (=0.0429 × 0.35 + 0.108 × 6 × 0.35) if its stock market development improved from the 25th percentile (0) to the 75th percentile (0.35) in our sample. Conversely, holding other factors constant, the patents granted to a country with polity score at the 75th percentile (10) would increase by 39% (=0.0492 × 0.35 + 0.108 × 10 × 0.35) if it stock market development improved from the 25th percentile (0) to the 75th percentile (0.35) in our sample. Hence, stock market deepening has an economically large effect on innovation only when a county's political institutions are highly democratic. Overall, political democratization promotes the innovation-enhancing effect of banking and stock market deepening.

It is worth discussing the unexpected effect that financial deepening reduces innovation when polity scores are low (see Fig. 1). Nonetheless, banks and stock markets only represent the formal financial sector of a country. In many developing countries, the informal financial sector commonly coexists with and complements the formal sector by serving private and small enterprises. The informal financial sector is perceived as having a comparative advantage in enforcement capacity and monitoring private and small enterprises (Stiglitz, 1990). Expansion of the formal financial sector may worsen the terms of credit that are offered by the informal financial sector. From this perspective and in light of the cross-country evidence that private enterprises rely more on informal financing and are more innovative than state-owned enterprises (Ayyagari et al., 2011), the impact of a deepening formal financial sector on innovation may be negative for developing countries that have a larger informal financial sector and a low level of political democracy.

4.2. Robustness checks

The previous sub-section demonstrates that financial deepening requires a threshold polity score to foster innovation output. This sub-section performs a series of robustness checks.

4.2.1. Alternative measures of financial deepening

For the first robustness check, we estimate Eq. (2) with the ratio of liquid liabilities owed by financial intermediaries to GDP as our measure of banking market deepening, as in King and Levine (1993a, 1993b). Liquid liabilities include currency held outside the banking system plus demand and interest-bearing liabilities of banks and non-bank financial intermediaries. A higher ratio of liquid liabilities to GDP usually indicates a higher level of banking market deepening. However, a caveat of this measure is that, unlike the ratio of private credit to GDP, it does not contain the information about who receives the financial services provided by banks and non-bank financial intermediaries.

Table 3
Benchmark results.

	(1) F = PC	(2) F = LL	(3) F = STOCK	(4) F = PC	(5) F = LL	(6) F = STOCK
F	1.434***	1.421***	0.566**	−0.502	0.0343	0.0429
	[0.266]	[0.334]	[0.254]	[0.814]	[0.509]	[0.373]
P	0.0342	0.0501**	0.0357	−0.0485	−0.0620	0.0143
	[0.0251]	[0.0223]	[0.0277]	[0.0451]	[0.0430]	[0.0337]
F*P				0.226***	0.190***	0.108***
				[0.0781]	[0.0589]	[0.0393]
LnA	0.215	0.189	0.257*	0.320**	0.248**	0.312**
	[0.133]	[0.127]	[0.136]	[0.133]	[0.116]	[0.133]
LnR	0.519***	0.529***	0.498***	0.527***	0.582***	0.481***
	[0.120]	[0.130]	[0.127]	[0.136]	[0.131]	[0.150]
IPR	0.810***	0.753***	0.717***	0.568***	0.519***	0.611***
	[0.172]	[0.196]	[0.205]	[0.186]	[0.196]	[0.223]
LnTRADE	0.228**	0.263**	0.354***	0.296***	0.348***	0.349***
	[0.0955]	[0.109]	[0.111]	[0.101]	[0.108]	[0.131]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	299	295	291	299	295	291
Number of country	74	73	73	74	73	73
Number of Instruments	162	162	141	162	162	141
Hansen Test (p-value)	1.000	1.000	1.000	1.000	1.000	1.000
AR 2 test (p-value)	0.249	0.465	0.317	0.348	0.489	0.424
Threshold				2.223***	−0.180***	−0.398***
				[2.952]	[2.699]	[3.548]

Note: Figures in parentheses are standard errors corrected for heteroskedasticity. The political democracy P is the polity score. The RD input is the number of R&D researchers. For the threshold of the polity score, we conduct a two-sided hypothesis test with H_0: Threshold ≤ -10 versus H_1: Threshold > -10.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

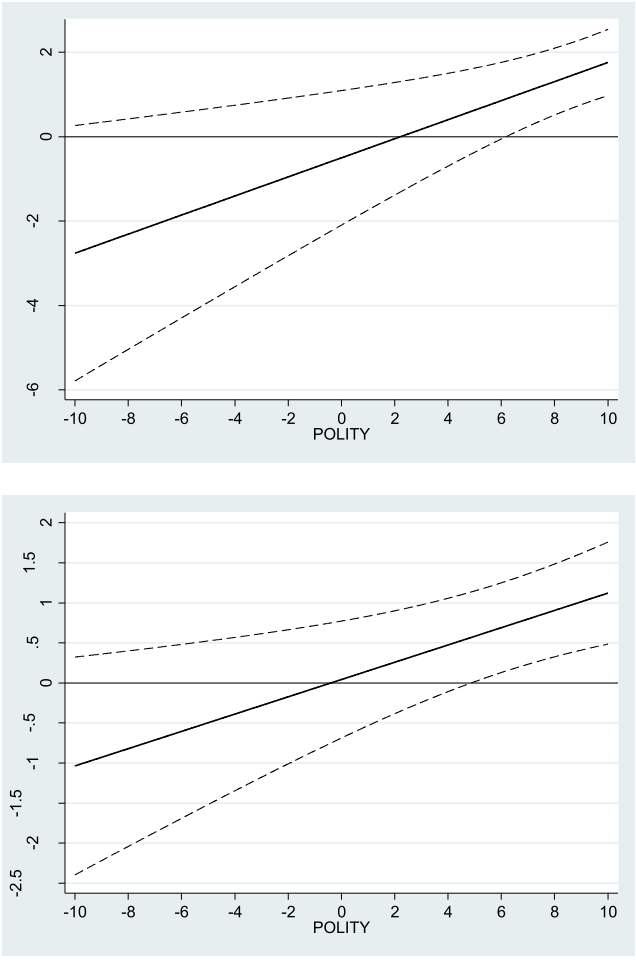

Fig. 1. The effect of financial deepening on innovation for different levels of POLITY.

Columns 2 and 5 of Table 3 report the results from Eq. (2) without and with the interaction term between financial deepening and political democracy, respectively. We obtain results that are similar to those reported in Columns 1 and 4 of Table 3. For the remaining empirical analysis, we report the results based on the ratio of liquid liabilities owed by financial intermediaries to GDP as an alternative measure for banking market deepening under Column F = LL.

Further, we estimate Eq. (2) using the depth of risk capital markets as an alternative measure of financial deepening.[4] Venture capital investment and venture capital-backed initial public offerings (IPOs) are two important components in risk capital markets to finance innovation. Venture capitalists can efficiently solve the corporate governance problem faced by young and innovative firms through various control mechanisms, such as active screening and monitoring, proper syndication, and investment staging (Gompers and Lerner, 2001). Some empirical studies suggest that venture capital does indeed spur innovation (Kortum and Lerner, 2000; Ang and Madsen, 2012).

To examine whether the effect of risk capital on innovation varies across countries with different political institutions, we use three measures for the depth of risk capital markets. First, we measure the depth of risk capital markets with the average score of responses to a question about how readily venture capital is available for business development, reported in the World Economic Forum's Executive Opinion Survey. Second, following Ang and Madsen (2012), we measure the depth of risk capital markets with the ratio of venture capital investment to GDP (VC2) and the ratio of the value of IPOs to GDP (IPO).

Columns 1–3 of Table 4 report the results from Eq. (2) with the various depth measures of venture capital markets as the measure of financial deepening. The results are similar to those reported in Columns 4–6 of Table 3. The coefficients of the interaction term between P_{it} and F_{it} are positive and significant, but the coefficients

[4] We thank an anonymous referee for suggesting this extension.

Table 4
Alternative Variable Measures.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	F = Risk Capital			P = PR Index			R = R&D Expenditure		
	F = VC1	F = VC2	F = IPO	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK
F	−2.042	−0.901	−1.863**	−0.764	−0.853	−0.577	−0.141	−0.279	0.00156
	[3.927]	[0.673]	[0.880]	[0.940]	[0.899]	[0.677]	[0.679]	[0.717]	[0.405]
P	−0.197	0.0433	−0.00375	−0.0778	−0.0656	−0.0231	0.00792	−0.0335	0.0472
	[0.194]	[0.0613]	[0.0863]	[0.123]	[0.145]	[0.0964]	[0.0347]	[0.0422]	[0.0298]
F*P	0.748*	0.110*	0.181**	0.357**	0.353*	0.248*	0.135*	0.180**	0.0902*
	[0.419]	[0.0611]	[0.0876]	[0.170]	[0.190]	[0.138]	[0.0745]	[0.0750]	[0.0503]
LnA	0.511**	0.617***	0.153	0.340**	0.272**	0.435***	0.242***	0.244**	0.248**
	[0.194]	[0.134]	[0.168]	[0.132]	[0.108]	[0.134]	[0.0873]	[0.0947]	[0.105]
LnR	0.268	0.510**	0.915***	0.523***	0.622***	0.383**	0.483***	0.522***	0.464***
	[0.183]	[0.230]	[0.201]	[0.124]	[0.143]	[0.147]	[0.123]	[0.125]	[0.161]
IPR	−0.125	0.649**	0.839**	0.626***	0.497**	0.705***	0.399**	0.349*	0.512**
	[0.261]	[0.263]	[0.338]	[0.211]	[0.200]	[0.174]	[0.174]	[0.191]	[0.194]
LnTRADE	0.691***	0.585***	0.582***	0.320**	0.427***	0.337**	0.291***	0.289***	0.312**
	[0.238]	[0.166]	[0.177]	[0.125]	[0.142]	[0.130]	[0.0955]	[0.0714]	[0.128]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	163	139	123	291	287	283	342	340	334
Number of country	61	52	45	75	74	74	75	74	74
Number of Instruments	70	82	81	155	155	134	162	162	141
Hansen Test (p-value)	0.980	1.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000
AR 2 test (p-value)	0.0811	0.673	0.691	0.267	0.496	0.362	0.108	0.119	0.156
Threshold	2.728***	8.203***	10.264***	2.14	2.414*	2.33	1.049**	1.546***	−0.017**
	[3.879]	[2.943]	[0.893]	[1.815]	[1.445]	[1.735]	[4.550]	[3.447]	[4.489]

Note: Figures in parentheses are standard errors corrected for heteroskedasticity. The political democracy P is the polity score, except for Columns 4–6. The RD input is the number of R&D researchers, except for Columns 7–9. For the threshold of the polity score, we conduct a two-sided hypothesis test with H_0: Threshold ≤ -10 versus H_1: Threshold >-10. For the threshold of the PR index, we conduct a two-sided hypothesis test with, H_0: Threshold ≤ 0 versus H_1: Threshold >0.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

of F_{it} are negative. Our results suggest that the positive effect of risk capital on innovation depends on the level of political democracy. The polity thresholds for having a positive effect of risk capital on innovation are all significantly larger than the lower bound of the polity score, which reflects the importance of political democracy in directing risk capital to innovative projects.

4.2.2. Alternative measure of political democracy

For the second robustness check, we estimate Eq. (2) with another commonly used measure of political democracy, the PR index published by Freedom House (2011). For instance, Acemoglu, Johnson, Robinson, and Yared (2008) use this variable, together with polity scores, to measure political democracy. The PR index measures the degree of freedom in the electoral process, political pluralism and participation, and government functioning. This index ranges from 1 to 7; a rating of 7 represents the most political freedom, and a rating of 1 represents the least political freedom.[5] A rating of 7 indicates free and fair elections, political competition, and autonomy for all citizens, including minority groups. A rating of 6 indicates that a country is less free, and corruption, violence, political discrimination against minorities as well as military influence on politics may exist. These same factors play a progressively larger role in countries with ratings of 3, 4, or 5: citizens of these countries typically experience certain political rights (e.g., freedom to organize somewhat controversial groups, reasonably free referenda) along with more damaging influences (e.g., civil war, heavy military involvement, one-party dominance). Countries and territories with political rights rated 2 are ruled by military juntas, one-party dictatorships, religious hierarchies, or autocrats; there may be a few local elections or limited minority representation. The political rights of countries with a rating of 1 are basically nonexistent due to extremely oppressive regimes, civil war, extreme violence, or warlord rule.

The empirical results are provided in Columns 4–6 of Table 4. The use of the PR Index slightly reduces our sample size because the PR index has only been available since 1975. The empirical results estimated with the PR index are consistent with those estimated using the polity score reported in Columns 4–6 of Table 3. The coefficients of the interaction term between P_{it} and F_{it} are positive and significant. These results again suggest that financial deepening (in terms of the banking sector, formal financial intermediary sector and stock market) is associated with greater innovation only when a country has a sufficient level of political freedom. In particular, the thresholds of the PR index for all measures of financial deepening between 2 and 3.

4.2.3. Alternative measure of R&D input

For the third robustness check, we estimate Eq. (2) using R&D expenditures per capita to measure R_{it}. These results are reported in Columns 7–9 of Table 4, which are similar to those reported in Columns 4–6 of Table 3. Specifically, the results again suggest that bank market and formal financial intermediary sector deepening requires sufficiently democratic institutions to foster innovation output; however, stock market deepening requires a much lower or nonexistent democratic level of political institutions to foster innovation output.

4.2.4. Confounding factors

For the fourth robustness check, we examine the impacts of potential confounding factors on our results.

4.2.4.1. Quality of government. Some recent studies find that government quality is important for explaining innovation (Varsakelis, 2006). This brings up one concern, namely that government quality rather than the degree of democracy promotes the

[5] We transform the index by subtracting 7 from the original PR index.

innovation-enhancing effect of financial deepening, and that our main results only reflect the positive correlation between government quality and political democratization.

To address this concern, we take two variables from the International Country Risk Guide (ICRG) to measure government quality. We take the variable Corruption to measure corruption in political systems, and the variable Law and Order to measure the strength and impartiality of the legal system and the popular observance of law. A higher value of Corruption means less corruption in the political system, and a higher value of Law and Order means a stronger legal system and more observance of law. We then use each of these as a confounder and add it and its interaction term with F into our main specification.

Columns 1–3 in Table 5 present the estimation results for corruption. We find that the coefficient on $Corruption_{it}$ is positive in Columns 1 and 3, which is consistent with the findings of Varsakelis (2006). The coefficient on F_{it}*$Corruption_{it}$ are statistically insignificant. On the other hand, the coefficients of the interaction term between P_{it} and F_{it} are still positive, mostly statistically significant, and have a similar magnitude as the benchmark results. Columns 4–6 in Table 5 present the estimation results for law and order. We find that the coefficient on Law and $Order_{it}$ is positive in Columns 1 and 3, which is consistent with the findings of Varsakelis (2006). The coefficients on F_{it}*Law and $Order_{it}$ are statistically insignificant. On the other hand, the coefficients of the interaction term between P_{it} and F_{it} are still positive and mostly statistically significant and have similar magnitudes to the benchmark results. These results suggest that although both government quality and political democratization have direct effects on innovation, only political democratization moderates the effect of financial deepening on innovation.

4.2.4.2. Political uncertainty. Some recent studies find that political uncertainty is important for explaining corporate investment and innovation (Bhattacharya, Hsu, Tian, & Xu, 2017), which raises the concern that the degree of political uncertainty rather than the degree of democracy promotes the innovation-enhancing effect of financial deepening and that our main results only reflect the positive correlation between political certainty and political democratization.

To address this concern, we construct a variable PU_{it} to measure political uncertainty and use it as a confounder by adding it and its interaction term with F into our main specification. Following Bhattacharya et al. (2017), we define the political uncertainty variable PU_{it} as a dummy variable that equals one if country *i* holds any presidential election for countries adopting the presidential system in year *t,* or parliamentary election for countries adopting the parliamentary or assembly-elected presidential system, and zero otherwise.

Columns 7–9 in Table 5 present the estimation results. We find that the coefficient of PU_{it} is negative though statistically insignificant, which is consistent with the findings of Bhattacharya et al. (2017). The coefficient on F_{it}*PU_{it} is positive and statistically insignificant. By contrast, the coefficients of the interaction terms between P_{it} and F_{it} are still positive and statistically significant and have a similar magnitude as the benchmark results. These results suggest that although both political certainty and political democratization have direct effects on innovation, only political democratization moderates the effect of financial deepening on innovation.

4.2.4.3. Enforcement of intellectual property rights. Another potential concern is that our main results may be confounded by the degree of enforcement of intellectual property laws. The law and finance literature (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1998) suggest that law enforcement is equally important to legal doctrine. Although we have controlled for intellectual property rights protection by using Park (2008), we need to make sure that it is the degree of political democracy rather than the degree of enforcement of intellectual property laws that drives our results.

We exploit one element of Park (2008) to address this concern. Specifically, we add a variable IPRE, which is a component that Park (2008) uses to capture the enforcement of intellectual property laws, and its interaction term with F is incorporated into our main specification as confounders. Columns 10–12 of Table 5 presents the estimation results. Column 12 shows that the coefficient of the interaction term between F_{it} and $IPRE_{it}$ is positive and statistically significant, suggesting that the enforcement of intellectual property laws is indeed another factor that moderates the effect of stock market deepening on innovation. However, we also notice that the coefficients of the interaction term between P_{it} and F_{it} are positive and statistically significant and have similar magnitude to the benchmark results, demonstrating that a spurious correlation does not drive our benchmark results.

4.2.5. Time-interval for differencing

For the fifth robustness check, we address the endogeneity issue due to cyclicality. Although political institutions are likely to be exogenous to economic fluctuations, economic fluctuations may affect both innovation and financial development. In order to reduce this endogeneity bias, we take a long-difference for each variable over a ten-year interval to filter out the effect of economic fluctuations on our estimates. We estimate Eq. (2) with the long-differenced variables. These results are reported in Columns 1–3 of Tables 6, which are similar to those reported in Columns 4–6 of Table 3. This indicates that our results are robust to alternative time intervals for differencing.

4.2.6. Alternative samples

For the sixth robustness check, we estimate Eq. (2) with alternative samples and report in Columns 4–9 of Table 6. We first take G7 countries out of the sample to make sure that our results are not dominantly influenced by the countries in which R&D activities are concentrated. Second, we exclude countries that have undergone a considerable change in regard to their political institutions during the sample period. This exclusion ensures that our results are not driven by just a few counties with volatile political democracies. Specifically, we remove the countries whose standard deviation in POLITY series over time is at least 1.5 times greater than the standard deviation of POLITY of the whole sample. Encouragingly, all the coefficients of F*P still show a positive sign and remain statistically significant.

4.2.7. Alternative specifications

For the final set of robustness checks, we estimate our empirical model with alternative specifications. First, we exploit that the coefficients of $\ln A_{it}$ reported in Tables 3 and 4 are between zero and one, thus the growth rate of knowledge accumulation ($\Delta A_{it}/A_{it}$) is stationary. In a steady state of this model, the stock of knowledge converges to a stochastic balanced growth path:

$$A_{it} = \delta(F_{it}, P_{it})^{1/(1-\varphi)} R_{it}^{\sigma/(1-\varphi)}, \tag{4}$$

where F_{it}, P_{it} and R_{it} are the long-run forcing variables that explain the behavior of A_{it}. We log-linearize Eq. (4) to obtain an alternative specification:

$$\ln A_{it} = \beta_0 + \beta_1 F_{it} + \beta_2 P_{it} + \beta_3 F_{it} \times P_{it} + \beta_4 \ln R_{it} + \alpha_i + \alpha_t + u_{it}, \tag{5}$$

We estimate Eq. (5) and report the results in Columns 1–3 of Tables 7. Most of the coefficients are similar to those reported in Columns 4–6 of Table 3, indicating that our results are robust to alternative specification.

Table 5
Confounding factors.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Confounder = Corruption			Confounder = Law and Order			Confounder = Pol. Uncertainty			Confounder = IPR Enforcement		
	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK
F	−0.0414	−0.0763	−0.352	−1.004	−2.105	−1.139	−0.783	−0.0115	−0.0741	−0.488	−0.421	−2.360***
	[1.207]	[1.185]	[0.759]	[1.671]	[1.800]	[0.708]	[1.073]	[0.697]	[0.458]	[0.784]	[0.541]	[0.808]
P	−0.0824*	−0.114**	−0.00813	−0.115**	−0.116**	−0.0160	−0.0425	−0.0458	0.0319	−0.0395	−0.0311	0.0255
	[0.0455]	[0.0561]	[0.0352]	[0.0497]	[0.0455]	[0.0344]	[0.0428]	[0.0461]	[0.0293]	[0.0433]	[0.0510]	[0.0325]
F*P	0.237***	0.237***	0.104	0.300***	0.222***	0.127**	0.234**	0.195***	0.104**	0.216***	0.168**	0.120***
	[0.0872]	[0.0861]	[0.0731]	[0.0950]	[0.0752]	[0.0499]	[0.104]	[0.0673]	[0.0422]	[0.0768]	[0.0684]	[0.0453]
Confounder	0.388**	0.335	0.277**	0.399***	0.219	0.291**	−0.316	−0.278	−0.239	−0.400	−0.434	−0.160
	[0.180]	[0.202]	[0.123]	[0.138]	[0.155]	[0.134]	[0.353]	[0.396]	[0.322]	[0.642]	[0.702]	[0.511]
F*Confounder	−0.257	−0.123	0.0814	−0.165	0.235	0.205	0.189	0.127	0.165	0.131	0.679	2.468**
	[0.236]	[0.272]	[0.202]	[0.300]	[0.324]	[0.173]	[0.410]	[0.486]	[0.578]	[0.801]	[0.644]	[1.007]
LnA	0.240**	0.220*	0.268**	0.348**	0.328**	0.409***	0.408***	0.315**	0.334**	0.328***	0.283**	0.374***
	[0.115]	[0.129]	[0.127]	[0.133]	[0.141]	[0.140]	[0.127]	[0.123]	[0.130]	[0.105]	[0.117]	[0.124]
LnR	0.630***	0.616***	0.501***	0.526***	0.510***	0.282**	0.493***	0.548***	0.490***	0.471***	0.534***	0.425***
	[0.138]	[0.125]	[0.144]	[0.136]	[0.145]	[0.120]	[0.131]	[0.154]	[0.121]	[0.144]	[0.124]	[0.140]
IPR	0.421**	0.377**	0.530***	0.282	0.327	0.469***	0.401**	0.417**	0.499**	0.641**	0.541*	0.579*
	[0.166]	[0.180]	[0.198]	[0.194]	[0.202]	[0.157]	[0.200]	[0.190]	[0.189]	[0.279]	[0.296]	[0.298]
LnTRADE	0.380***	0.377***	0.358***	0.416***	0.390***	0.322**	0.368***	0.368***	0.411***	0.339***	0.356***	0.331**
	[0.105]	[0.115]	[0.110]	[0.117]	[0.112]	[0.133]	[0.115]	[0.121]	[0.141]	[0.0967]	[0.132]	[0.143]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	229	225	221	229	225	221	299	295	291	299	295	291
Number of country	68	67	67	68	67	67	74	73	73	74	73	73
Number of Instruments	148	148	131	148	148	131	182	182	161	189	189	168
Hansen Test (p-value)	1	1	1.000	1	1	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AR 2 test (p-value)	0.215	0.196	0.315	0.253	0.217	0.441	0.500	0.645	0.717	0.335	0.498	0.459

Note: Figures in parentheses are standard errors corrected for heteroskedasticity. The political democracy P is the polity score. The RD input is the number of R&D researchers.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

Table 6
Robustness checks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ten-year Intervals			Exclude G7			Exclude countries with volatile P		
	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK
F	−0.455	0.181	−0.200	0.261	0.557	0.317	−0.469	−0.0451	−0.0540
	[1.382]	[0.821]	[0.591]	[0.687]	[0.541]	[0.424]	[0.797]	[0.491]	[0.450]
P	−0.0383	−0.0508	0.0218	−0.0328	−0.0720*	0.00944	−0.0327	−0.0509	0.0246
	[0.0490]	[0.0462]	[0.0412]	[0.0456]	[0.0383]	[0.0391]	[0.0481]	[0.0445]	[0.0335]
F*P	0.244*	0.209**	0.160**	0.136**	0.183***	0.0859*	0.193**	0.184***	0.110**
	[0.127]	[0.0791]	[0.0666]	[0.0599]	[0.0532]	[0.0435]	[0.0799]	[0.0596]	[0.0548]
LnA	0.354***	0.323**	0.364**	0.283**	0.278**	0.310**	0.359***	0.331**	0.338**
	[0.134]	[0.122]	[0.169]	[0.126]	[0.118]	[0.134]	[0.134]	[0.147]	[0.141]
LnR	0.592***	0.561***	0.499**	0.456***	0.480***	0.367**	0.484***	0.449***	0.431***
	[0.158]	[0.158]	[0.189]	[0.115]	[0.108]	[0.142]	[0.134]	[0.139]	[0.140]
IPR	0.442*	0.482*	0.717***	0.641***	0.551**	0.591***	0.661***	0.692***	0.772***
	[0.263]	[0.252]	[0.270]	[0.159]	[0.214]	[0.219]	[0.169]	[0.152]	[0.222]
LnTRADE	0.252*	0.338**	0.324*	0.302***	0.307**	0.350***	0.257***	0.231**	0.258**
	[0.145]	[0.162]	[0.172]	[0.0962]	[0.121]	[0.127]	[0.0884]	[0.0900]	[0.107]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	178	175	174	267	263	263	277	273	269
Number of country	71	70	70	69	68	69	67	66	66
Number of Instruments	76	76	67	162	162	141	162	162	141
Hansen Test (p-value)	0.539	0.547	0.340	1.000	1.000	1.000	1.000	1.000	1.000
AR 2 test (p-value)	0.810	0.679	0.927	0.260	0.436	0.264	0.239	0.245	0.332
Threshold	1.869**	−0.866**	1.249***	−1.917	−3.040**	−3.686	2.430***	0.245***	0.491***
	[4.771]	[4.148]	[3.354]	[5.744]	[3.323]	[6.180]	[3.218]	[2.622]	[3.917]

Note: Figures in parentheses are standard errors corrected for heteroskedasticity. The political democracy P is the polity score. The RD input is the number of R&D researchers. For the threshold, we conduct a two-sided hypothesis test with H_0: Threshold ≤ -10 versus H_1: Threshold > -10.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

Table 7
Specification checks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Steady State Specification			Schumpeterian Specification			Schumpeterian Specification		
	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK	F = PC	F = LL	F = STOCK
F	−0.526	−0.711	0.386	1.153***	1.246***	0.703**	−0.169	−0.142	−0.0432
	[0.826]	[0.714]	[0.407]	[0.367]	[0.318]	[0.307]	[0.692]	[0.552]	[0.344]
P	0.0201	−0.0197	0.0946***	0.0524**	0.0499**	0.0466	−0.0198	−0.0493	0.0183
	[0.0331]	[0.0413]	[0.0325]	[0.0214]	[0.0247]	[0.0321]	[0.0446]	[0.0373]	[0.0277]
F*P	0.193**	0.228***	0.115***				0.162**	0.195***	0.104***
	[0.0804]	[0.0732]	[0.0399]				[0.0654]	[0.0561]	[0.0357]
LnA				0.214**	0.237*	0.219*	0.286**	0.310**	0.314***
				[0.105]	[0.130]	[0.123]	[0.111]	[0.121]	[0.118]
LnR	0.791***	0.930***	0.788***	0.446***	0.475***	0.526***	0.490***	0.490***	0.500***
	[0.118]	[0.116]	[0.0920]	[0.124]	[0.146]	[0.137]	[0.126]	[0.131]	[0.125]
IPR	0.708***	0.582***	0.742***	0.708***	0.684***	0.685***	0.503**	0.497***	0.568***
	[0.254]	[0.205]	[0.219]	[0.201]	[0.175]	[0.205]	[0.232]	[0.173]	[0.186]
LnTRADE	0.434***	0.398***	0.393***	0.336***	0.355***	0.374***	0.389***	0.390***	0.374***
	[0.129]	[0.104]	[0.131]	[0.107]	[0.113]	[0.130]	[0.110]	[0.0984]	[0.141]
LnL				0.0901	0.0434	0.0459	0.0770	−0.0186	−0.0485
				[0.147]	[0.149]	[0.195]	[0.208]	[0.185]	[0.179]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	299	295	291	299	295	291	299	295	291
Number of country	74	73	73	74	73	73	74	73	73
Number of Instruments	135	135	114	162	162	141	162	162	141
Hansen Test (p-value)	1.000	1.000	0.999	1.000	1.000	1.000	1.000	1.000	1.000
AR 2 test (p-value)	0.853	0.513	0.846	0.359	0.524	0.232	0.385	0.463	0.408
Threshold	2.731***	3.113***	−3.369				8.541***	6.899***	−2.426**
	[3.233]	[2.448]	[4.328]				[1.052]	[2.743]	[4.185]

Note: Figures in parentheses are standard errors corrected for heteroscedasticity. The political democracy P is the polity score. The RD input is the number of R&D researchers. For the threshold, we conduct a two-sided hypothesis test with H_0: Threshold ≤ -10 versus H_1: Threshold > -10.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

Second, our empirical analysis relies on the semi-endogenous growth framework to explain innovation. Drawing on the literature, such as Madsen, Ang, and Banerjee (2010), that uses the Schumpeterian framework in the spirit of Aghion and Howitt (1992) to explain innovation, we perform a robustness check to show the appropriateness of a semi-endogenous growth framework for our dataset.

The Schumpeterian growth models maintain the assumption that $\varphi = 1$ and $\beta = 1$. As such, to sustain a positive growth rate of knowledge, R&D must increase over time to counteract the increasing range and complexity of products that decrease the productivity of R&D inputs. In this case, we add the logarithm of population ($\ln L_{it}$) in Eq. (2) to proxy product variety and report the empirical results in Columns 4–9 of Table 7. The coefficients of A_{it} are between zero and one, and the coefficients of $\ln L_{it}$ are insignificant. This supports the use of a semi-endogenous growth model for our sample, where the parameters of Eq. (1) are assumed to be $\varphi < 1$ and $\beta = 0$.

5. Potential channels

This section explores the channels through which political democratization promotes knowledge accumulation through financial deepening. Addressing this issue is important to help policy makers be more effective in reforming political institutions and to facilitate innovation. Financial deepening is conductive to innovation and further facilitates economic growth mainly because an efficient financial market alleviates asymmetric information problems and reduces the wedge between a firm's cost of external and internal financing (Levine, 2005). However, the extent to which a financial market promotes innovation depends on both the efficiency of the financial market and the severity of the agency problem.

We hypothesize that executive recruitment is an important channel through which political democratization moderates the positive effect of financial deepening on innovation for the following three reasons. First, non-democratic governments tend to form a dictatorial coalition and establish more state-owned enterprises (SOEs) to control resources (Haber, 2006). More importantly, executive recruitment of SOEs in non-democracies is less transparent. The recruitment procedure is not open to the public, and a person is often appointed as an SOE executive because of a close relationship with the dictatorial coalition rather than a higher ability. As a result, SOE executives must give political tasks first priority and have fewer incentives to pursue innovative activities (Shleifer and Vishny, 1994; Shleifer, 1998).

Second, previous studies find that government ownership of banks is negatively correlated with political rights and democracy (La Porta et al., 2002). The executive recruitment of state-owned banks is more opaque in non-democratic countries than in democratic countries. As a result, executives of banks with high state ownership in non-democratic countries are reluctant and less competent in financing innovative projects (Barth, Caprio, & Levine, 2006; Lerner, 2009); they also tend to favor SOEs, which, as we have discussed, have weaker incentives to pursue innovative activities.

Third, equity markets facilitate innovation by providing timely equilibrium security prices that reveal information about the prospects of innovative activities (Allen and Gale, 1999). However, a well-functioning equity market entails huge administrative and legal requirements (La Porta, Lopez-de-Silanes, & Shleifer, 2006). In non-democratic countries, the protection of property rights is often weak (North and Weingast, 1989). This problem is exacerbated by the fact that executives of regulatory agencies of equity markets in non-democratic countries are often appointed directly by the dictatorial coalition and thus are easily captured by the

Table 8
Potential channels.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	F = PC				F = LL				F = STOCK			
F	−3.311	−2.934**	−2.306*	−5.311**	−3.224**	−2.353**	−1.454	−3.867***	−4.313**	−0.765	−0.539	−4.402*
	[2.145]	[1.149]	[1.223]	[2.089]	[1.436]	[1.059]	[1.007]	[1.274]	[1.641]	[0.785]	[0.685]	[2.256]
EXREC	−0.164			−0.478**	−0.212**			−0.343	−0.0628			−0.231
	[0.113]			[0.234]	[0.104]			[0.233]	[0.101]			[0.185]
EXCONST		−0.138		−0.175		−0.198		−0.256		0.0561		−0.00133
		[0.132]		[0.182]		[0.137]		[0.197]		[0.108]		[0.158]
POLCOMP			−0.0627	0.349**			−0.0881	0.280**			0.0522	0.189
			[0.0668]	[0.166]			[0.0734]	[0.139]			[0.0600]	[0.123]
F*EXREC	0.610**			0.879*	0.604***			0.465	0.616***			0.726*
	[0.273]			[0.510]	[0.189]			[0.346]	[0.208]			[0.408]
F*EXCONST		0.663***		0.619		0.610***		0.647		0.227*		−0.183
		[0.178]		[0.478]		[0.170]		[0.442]		[0.128]		[0.313]
F*POLCOMP			0.386***	−0.476			0.348***	−0.268			0.188**	0.0554
			[0.128]	[0.390]			[0.099]	[0.233]			[0.0857]	[0.154]
LnA	0.302**	0.338**	0.329**	0.355***	0.303***	0.281**	0.232**	0.321***	0.342**	0.326***	0.269**	0.342***
	[0.124]	[0.130]	[0.133]	[0.0936]	[0.106]	[0.114]	[0.116]	[0.106]	[0.136]	[0.123]	[0.122]	[0.113]
LnR	0.536***	0.492***	0.539***	0.438***	0.536***	0.522***	0.602***	0.482***	0.466***	0.458***	0.512***	0.460***
	[0.142]	[0.103]	[0.108]	[0.108]	[0.132]	[0.116]	[0.129]	[0.127]	[0.146]	[0.101]	[0.157]	[0.115]
IPR	0.613***	0.645***	0.488***	0.373**	0.576**	0.623***	0.532**	0.451**	0.630***	0.708***	0.633***	0.422*
	[0.183]	[0.179]	[0.159]	[0.147]	[0.266]	[0.180]	[0.212]	[0.189]	[0.189]	[0.173]	[0.160]	[0.239]
LnTRADE	0.291***	0.305***	0.330***	0.368***	0.260***	0.334***	0.336**	0.380***	0.417***	0.354***	0.314**	0.394***
	[0.0968]	[0.107]	[0.0995]	[0.101]	[0.0975]	[0.1000]	[0.143]	[0.125]	[0.133]	[0.130]	[0.155]	[0.111]
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	299	299	299	299	295	295	295	295	291	291	291	291
Number of country	74	74	74	74	73	73	73	73	73	73	73	73
Hansen Test (p-value)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
AR 2 test (p-value)	0.301	0.286	0.296	0.420	0.252	0.450	0.476	0.597	0.369	0.343	0.690	0.527

Note: Figures in parentheses are standard errors corrected for heteroskedasticity. The political democracy P is the polity score. The RD input is the number of R&D researchers.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

coalition. Therefore, rent-seeking activities are pervasive and the information-gathering function of the equity market is greatly weakened.

To test the above hypothesis, we exploit that the polity score is composed of three components, specifically, the country's openness and competitiveness in the executive recruitment of leaders, the constraint on executive authority, and the competitiveness of political participation. Specifically, we estimate Eq. (2) with the components of polity scores, including executive recruitment (EXREC), executive constraint (EXCONST), and political competition (POLCOMP). The empirical results are reported in Table 8.

Columns 1–3 of Table 8 indicate that all components of the polity score have positive indirect effects on innovation output when F_{it} is measured by the ratio of private credit by banks to GDP. Turning to our preferred specification in Column 4 of Table 8, when all three components of the polity score enter into our estimating equation, only EXREC has an indirect effect on innovation through banking system deepening. Our results suggest that increasing a government's openness and competitiveness in the executive recruitment of leaders is more effective in fostering the innovation-enhancing effect of banking market deepening. However, when we use the ratio of liquid liabilities to GDP as an alternative measure of banking market deepening, we obtain similar results in Column 8 of Table 8 for the interaction term between F_{it} and $EXREC_{it}$, but the significance is weaker. Further, when we use the ratio of stock market capitalization to GDP to measure F_{it}, Column 12 of Table 8 reports that the coefficient of the interaction term of F_{it} and $EXREC_{it}$ is positive and significant. It suggests that increasing a government's openness and competitiveness in executive recruitment for leaders is more effective in fostering the positive effect of stock market deepening.

Overall, among the components of the polity score, we demonstrate that executive recruitment is the main channel through which political democratization promotes the role of financial deepening on innovation. A higher score in executive recruitment is associated with more openness and competitiveness in recruiting executives, such as transparency in executive recruitment and candidates competing for positions in all important aspects, which could hinder political leaders from developing large networks of power and restrict entry of financial intermediation into the marketplace because of self-interest. As a result, our results suggest that improving the openness and competitiveness of executive recruitment is a more effective method for countries to reform their political institutions to sustain economic growth by enhancing their innovation.

6. Conclusions

This study analyzes a large international panel of data to examine the effects of financial deepening and political democratization on innovation. We demonstrate that financial deepening promotes innovation only when a country's political institutions are sufficiently democratic. Further, we find that increasing the state's openness and competitiveness in executive recruitment of leaders is the main channel through which political democratization promotes the role of banking and stock markets for financing innovation.

Our analysis provides new information regarding how developing countries can sustain their economic growth, as the endogenous growth models suggest that the growth rate of output per worker depends on the growth rate of innovation along a balanced growth path. Asian economies such as Japan, Korea, Singapore and Taiwan developed into high-income economies with high innovative capacities after World War II. However, other Asian economies appear to suffer from the symptoms of the middle-income trap. Agenor (2017) argues that Malaysia (with a real GDP per capita

of approximately $11,000 in 2005 in constant 2005 international dollars) employs a growth strategy that does not encourage innovation, which hinders its ability to overcome the middle-income trap.

Malaysia's private-credit-to-GDP ratio increased from 1.018 in 2005 to 1.051 in 2010. Our results support this conclusion because the polity score remained unchanged between 2005 and 2010 at the value of 3, and the growth rate of innovation increased by only 0.6% (=-0.502×0.033). Banking market deepening slightly increases innovation because the polity score is only slightly higher than the threshold. If the polity score had increased from 3 to 10 during 2005–2010, the growth rate of innovation could have increased by 5.8% (=$-0.502 \times 0.033 + 0.226 \times 0.033 \times 10$). Consequently, the economic performance of Malaysia could have been greatly enhanced through greater innovation growth.

The policy implications of our analysis indicate the benefits of reforming political institutions, such as liberalizing the executive recruitment process, in promoting innovation. Specifically, if a country that has a bank-based financial system seeks to promote innovation, it is important for this country to enhance its political democracy and deepen its financial system.

Conflict of interest

None.

Appendix A

Appendix 1
Sample countries.

Country	Country	Country	Country	Country
Algeria	Denmark	Ireland	Nigeria	Sudan
Argentina	Ecuador	Israel	Norway	Swaziland
Australia	Egypt	Italy	Pakistan	Sweden
Austria	El Salvador	Jamaica	Panama	Switzerland
Bangladesh	Ethiopia	Japan	Paraguay	Thailand
Belgium	Finland	Jordan	Peru	Trinidad &Tobago
Bolivia	France	Korea	Philippines	Tunisia
Brazil	Ghana	Lithuania	Poland	Turkey
Bulgaria	Greece	Madagascar	Portugal	Uganda
Canada	Guatemala	Malaysia	Russian	Ukraine
China	Hungary	Mauritius	Singapore	United Kingdom
Colombia	India	Mexico	Slovak Republic	Uruguay
Costa Rica	Indonesia	Netherlands	South Africa	Vietnam
Cyprus	Iran	New Zealand	Spain	Zambia
Czech Republic	Iraq	Nicaragua	Sri Lanka	

Appendix 2
Variable definitions.

Variable	Definition	Source
ΔA	The number of patents granted by the USPTO from 1883 to each country in the current year	USPTO Patent Statistics
Alternative measures for financial development		
PC	The ratio of private credit by deposit money banks to GDP	Database of Financial Development and Structure provided by the World Bank (November 2013 version)
LL	The ratio of liquid liabilities to GDP	Same as above
STOCK	The ratio of stock market capitalization to GDP	Same as above
VC1	Average score of responses to a question about how readily venture capital is available for new business development from the World Economic Forum's annual Executive Opinion Survey (EOS)	World Competitiveness Report (1990), World Competitiveness Report (1995), Global Competitiveness Report (2000), Global Competitiveness Report (2005)
VC2	The ratio of venture capital investment to GDP	Thomson One Banker
IPO	The ratio of initial public offerings value to GDP	Bloomberg
Alternative measures for democracy		
POLITY	The Polity score	Polity IV: Political Regime Characteristics and Transitions, 1800–2010 (Marshall and Jaggers, 2011)
EXREC	A component of POLITY: The state's openness and competitiveness in executive recruitment	Same as above
EXCONST	A component of POLITY: The constraint on executive authority	Same as above
POLCOMP	A component of POLITY: The competitiveness in political participation	Same as above
PR	The Political Rights (FHPR) Index	Freedom House (2011)
Control variables		
R = RDPER	Number of R&D researchers	Lederman and Saenz (2005) and UNESCO
R = RDEXP	R&D expenditures (in $1000)	Same as above
IPR	Intellectual property rights protection index (range 0–5)	Park (2008)
TRADE	Exporting volume to the United States (US) (normalized by total population; in $1000)	Database of US Census Bureau and the database of the Center for International Data of UC Davis

References

Acemoglu, D., Johnson, S., Robinson, J., & Yared, P. (2008). Income and democracy. *American Economic Review, 98*, 808–842.

Agenor, P.-R. (2017). Caught in the middle? The economics of middle-income traps. *Journal of Economic Survey, 31*(3), 771–791.

Aghion, P., & Howitt, P. (1992). A model of growth through creative destruction. *Econometrica, 60*, 323–351.

Allen, F., & Gale, D. (1999). Diversity of opinion and financing of new technologies. *Journal of Financial Intermediation, 8*, 68–89.

Ang, J. B. (2011). Financial development, liberalization and technological deepening. *European Economic Review, 55*, 688–701.

Ang, B. J., & Madsen, J. B. (2012). Risk capital, private credit, and innovative production. *Canadian Journal of Economics, 45*(4), 1608–1639.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies, 58*, 277–297.

Ayyagari, M., Demirgc-Kunt, A., & Maksimovic, V. (2011). Firm innovation in emerging markets: The role of finance, governance, and competition. *Journal of Financial and Quantitative Analysis, 46*, 1545–1580.

Barth, J. R., Caprio, G., & Levine, R. (2006). *Rethinking bank regulation: Till angels govern*. New York: Cambridge University Press.

Bhattacharya, U., Hsu, P., Tian, X., & Xu, Y. (2017). What affects innovation more: Policy or policy uncertainty? *Journal of Financial and Quantitative Analysis, 52*(5), 1869–1901.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics, 87*(1), 115–143.

Bushman, R. M., Piotroski, J. D., & Smith, A. J. (2004). What determines corporate transparency? *Journal of Accounting Research, 42*(2), 207–252.

Cornaggia, J., Mao, Y., Tian, X., & Wolfe, B. (2015). Does banking competition affect innovation? *Journal of Financial Economics, 115*, 189–209.

Dell'Ariccia, G., & Marquez, R. (2004). Information and bank credit allocation. *Journal of Financial Economics, 72*, 185–214.

Furman, J. L., Porter, M. E., & Stern, S. (2002). The determinants of national innovative capacity. *Research Policy, 31*(6), 899–933.

Gompers, P., & Lerner, J. (2001). The venture capital revolution. *Journal of Economic Perspectives, 15*(2), 145–168.

Griliches, Z. (1990). Patent statistics as economic indicators: A survey. *Journal of Economic Literature, 28*(4), 1661–1707.

Grossman, S. (1976). On the efficiency of competitive stock markets where trades have diverse information. *Journal of Finance, 31*(2), 573–585.

Grossman, G. M., & Helpman, E. (1991). *Innovation and Growth in the Global Economy*. Cambridge: MIT Press.

Ha, J., & Howitt, P. (2007). Accounting for trends in productivity and R&D: A Schumpeterian critique of semi-endogenous growth theory. *Journal of Money Credit and Banking, 39*, 733–774.

Haber, S. (2006). Authoritarian government. In Barry Weingast & Donald Wittman (Eds.), *The oxford handbook of political economy* (pp. 693–707). New York: Oxford University Press.

Haber, S., North, D., & Weingast, B. (2007). *Political institutions and financial development*. Stanford, CA: Stanford University Press.

Hall, B. H., Jaffe, A. B., & Trajtenberg, M. (2005). Market value and patent citations. *Rand Journal of Economics, 36*, 16–38.

House, Freedom (2011). *Freedom in the World*. Washington, DC: Website and Book.

Hsu, P.-H. (2009). Technological innovations and aggregate risk premiums. *Journal of Financial Economics, 94*(2), 264–279.

Hsu, P.-H., Tian, X., & Xu, Y. (2014). Financial development and innovation: Cross-country evidence. *Journal of Financial Economics, 112*, 116–135.

Huang, Y. (2010). Political institutions and financial development: An empirical study. *World Development, 38*(12), 1667–1677.

Huang, H., & Xu, C. (1999). Institutions, innovations, and growth. *American Economic Review, Papers and Proceedings, 89*, 438–444.

Hudson, J., & Minea, A. (2013). Innovation, intellectual property rights and economic development: A unified empirical investigation. *World Development, 46*, 66–78.

Jensen, N. M. (2008). Political risk, democratic institutions, and foreign direct investment. *Journal of Politics, 70*(4), 1040–1052.

Jones, C. (1995). R&D based models of economic growth. *Journal of Political Economy, 103*, 739–784.

Kamien, M. I., & Schwartz, N. L. (1975). Market structure and innovation: A survey. *Journal of Economic Literature, 13*(1), 1–37.

King, R., & Levine, R. (1993a). Finance and growth: Schumpeter might be right. *Quarterly Journal of Economics, 108*(3), 717–737.

King, R., & Levine, R. (1993b). Finance, entrepreneurship, and growth. *Journal of Monetary Economics, 32*, 513–542.

Kortum, S. (1997). Research, patenting, and technological change. *Econometrica, 65*(6), 1389–1419.

Kortum, S., & Lerner, J. (2000). Assessing the contribution of venture capital to innovation. *RAND Journal of Economics, 31*, 674–692.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2002). Government ownership of banks. *Journal of Finance, 57*, 265–301.

La Porta, R., Lopez-de-Silanes, F., & Shleifer, A. (2006). What works in securities laws? *Journal of Finance, 61*, 1–32.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R. (1998). Law and finance. *Journal of Political Economy, 106*, 1113–1155.

Lederman, D., & Saenz, L. (2005). *Innovation and development around the world, 1960–2000. Policy Research Working Paper 3774*. The World Bank.

Lerner, J. (2009). *Boulevard of Broken Dreams*. Princeton, New Jersey: Princeton University Press.

Levine, R. (2005). Finance and growth: Theory and evidence. In P. Aghion & S. Durlauf (Eds.), *Handbook of economic growth, Chapter 12*. The Netherlands: Elsevier Science.

Li, Q. (2009). Democracy, autocracy, and expropriation of foreign direct investment. *Comparative Political Studies, 42*(8), 1098–1127.

Madsen, J. B., Ang, J. B., & Banerjee, R. (2010). Four centuries of British economic growth: The roles of technology and population. *Journal of Economic Growth, 15*, 263–290.

Marshall, M. G., & Jaggers, K. (2011). *Polity IV project: Political regime characteristics and transitions, 1800-2010*. University of Maryland.

North, D. C., & Weingast, B. R. (1989). Constitutions and commitment: The evolution of institutional governing public choice in seventeenth-century England. *Journal of Economic History, 49*(4), 803–832.

OECD (2009). OECD Patent Statistics Manual. Paris.

Park, W. (2008). International patent protection: 1960–2005. *Research Policy, 37*, 761–766.

Romer, P. M. (1990). Endogenous technological change. *Journal of Political Economy, 98*(5), S71–S102.

Sapienza, P. (2004). The effects of government ownership on bank lending. *Journal of Financial Economics, 72*, 357–384.

Schumpeter, J. A. (1911). *The theory of economic development*. Oxford: Oxford University Press.

Segerstrom, P. (1998). Endogenous growth without scale effects. *American Economic Review, 88*(5), 1290–1310.

Shleifer, A. (1998). State versus private ownership. *Journal of Economic Perspectives, 12*, 133–150.

Shleifer, A., & Vishny, R. W. (1994). Politicians and firms. *Quarterly Journal of Economics, 109*, 995–1025.

Stiglitz, J. (1990). Peer monitoring and credit markets. *World Bank Economic Review, 4*(3), 351–366.

Varsakelis, N. C. (2006). Education, political institutions and innovative activity: A cross-country empirical investigation. *Research Policy, 35*(7), 1083–1090.

World Economic Forum (1990). *The world competitiveness report 1990, World Economic Forum*. Lausanne: Geneva; Institute for Management Development.

World Economic Forum (1995). *The world competitiveness report 1995, World Economic Forum*. Lausanne: Geneva; Institute for Management Development.

World Economic Forum (2000). *The global competitiveness report 2000*. Oxford: Oxford University Press.

World Economic Forum (2005). *The global competitiveness report 2005–2006*. Basingstoke: Palgrave Macmillan.