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Another look at cultural and institutional determinants of R&D investment: an international study

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Abstract
We conduct mean comparison tests and regression analyses on a sample of 65 countries to explore the structural and cultural determinants of national R&D investment. We find a legal effect whereby structural drivers are effective only under a strong rule of law. Cultural openness and long-term orientation also show positive associations with R&D investment. While innovation efficiency attracts foreign R&D, innovation efficacy deters it, as profitable opportunities are usually exploited by domestic investors. Moreover, we identify a substitution effect in which governments offset insufficient domestic and foreign investment. Our findings have policy relevance, as we highlight underexplored enhancers of R&D beyond the usual financial or cost-related factors, providing new insights for designing more effective innovation and research strategies.

Keywords: culture, innovation, institutional framework, R&D investment
JEL Classification Codes: G32, O32

1. Introduction and motivation

Corporate innovation is one of the key drivers of economic growth and productivity. Given its importance, recent literature has examined several related issues, including the optimal rate of R&D investment, the non-financial determinants of corporate innovation, and the interaction between public and private investment. Coccia (2009; 2018) argue that the impact of R&D

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investment on economic growth is far from straightforward, and that excessively high levels of R&D intensity do not necessarily lead to optimal growth or productivity. Additionally, previous research has highlighted the role of culture and other informal factors in fostering innovation (Yan et al., 2021). The influence of cultural, legal, and institutional factors remains a subject of debate due to the complex interrelations among these elements.

Building on this base, we focus on non-financial barriers to innovation and examine how a country's cultural and structural characteristics serve as effective drivers to promote R&D expenditures and attract foreign R&D investment. Our objective is to identify institutional factors that stimulate both public and private R&D investment without imposing additional costs.

Our research is consistent with the findings of Vlachos (2022) and Özen et al. (2024), who demonstrate that a country's institutional quality significantly influences firms' R&D expenditure. We also draw on literature underlining the critical role of national culture—specifically dimensions such as individualism, masculinity, indulgence, and uncertainty avoidance—in shaping corporate innovation. Our primary contribution lies in advancing the identification of cultural and structural factors that interact with the institutional framework to foster R&D expenditures, as well as providing a more detailed examination of the interaction between foreign and domestic R&D investment, both public and private.

The impact of institutional and cultural factors on corporate innovation has been widely acknowledged in the literature (Chen et al., 2017; Choi, 2020; Özen et al., 2024). In fact, several studies have shown that the influence of formal institutional factors is contingent upon national culture. Coccia (2018) and Dalwai et al. (2025) demonstrate that the effects of formal institutions—such as property rights protection and governance quality—on firm-level R&D may depend on informal institutions, including barriers to investment and product market regulation. In a similar vein, Zhang and Huang (2022) show that governance quality can moderate the unintended effects of structural social capital. Moreover, this indirect effect of culture on innovation can be even stronger than its direct effect (Soloviov and Kaasa, 2023).

Consistently with this view, we posit that a country's openness helps mitigate asymmetric information problems and enhances visibility for foreign investors. In turn, the financial constraints on R&D can be alleviated by a culture of openness, characterized by lower uncertainty avoidance, a longer-term orientation, and a financial system where capital markets play a more prominent role than banks (Black and Moersch, 1998; Hofstede, 2001).

Similarly, we examine the relationship between different sources of R&D expenditure, a relevant issue for enhancing the complementarity between public and private funding. Coccia (2010; 2012) has shown that public R&D expenditure complements private investment, with the composition of both depending on the country's size and level of development. Interestingly, frictions may arise when R&D is primarily driven by government spending. This could be attributed to the fact that investors seek institutional conditions that mitigate the inherent risks of R&D investment. As a result, countries with stronger research institutions, greater innovation capacity, and higher competitiveness are better positioned to attract foreign R&D investment. Once the decision to invest has been made, investors tend to prioritize safer destinations, as well as countries where returns on investment can be realized more quickly. Thus, foreign investment is more likely to flow to countries with the most efficient R&D

infrastructures—those that require the least financial input to generate R&D output. In other words, R&D investment gravitates toward countries with superior institutional frameworks.

These ideas raise questions regarding countries with inefficient institutions or cultures less conducive to innovation. In such contexts, neither domestic nor foreign investors have sufficient incentives to invest in R&D. As a result, we anticipate that the government will assume a substitution role, increasing its R&D investment to compensate for the lower investment from other sources.

2. Materials and methods

We use data on national R&D investment provided by UNESCO and the World Bank. In addition to these two institutions, our data sources include the World Economic Forum, the Heritage Foundation, and KOF [1]. We collect a sample of 65 countries from different geographical areas, size and level of development[2]: Argentina, Armenia, Australia, Austria, Azerbaijan, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Croatia, Cyprus, Czech Republic, Denmark, Ecuador, Estonia, Finland, France, Greece, Germany, Guatemala, Hong Kong, Hungary, Iceland, India, Ireland, Israel, Italy, Japan, Kazakhstan, Kuwait, Kyrgyzstan, Latvia, Lithuania, Luxembourg, Madagascar, Malaysia, Malta, Mexico, Mongolia, Morocco, the Netherlands, New Zealand, Norway, Panama, Philippines, Poland, Portugal, Romania, Russia, Singapore, Slovakia, Slovenia, South Africa, Spain, Sweden, Switzerland, Thailand, Tunisia, Uganda, Ukraine, United Kingdom, and Uruguay.

We have built a panel dataset with 962 country-year observations from these countries from 1998 to 2012. Our time span aims to cover both the growth period of the early 21st century and the years of the 2007 financial crisis and its aftermath. This approach seeks to minimize potential biases associated with either economic expansion or contraction[3].

Our dependent variable (GERD) represents the gross domestic expenditures on research and development (R&D) as a percentage of a country's GDP for each year. National R&D investment encompasses contributions from the government, private firms, foreign entities, and other institutions. We define three additional variables (GFC, GFA, and GFG) based on the identity of the investor: GFC represents R&D expenditures funded by companies, GFA by foreigners, and GFG by the government. Additionally, we define %GFC, %GFA, and %GFG as the proportion of each respective investment relative to the total national R&D expenditure.

We employ four groups of independent country-level variables: culture, legal framework,

[1] The KOF Swiss Economic Institute (https://kof.ethz.ch) is a leading economic research center based at the Swiss Federal Institute of Technology (ETH Zurich) and widely recognized for its high-quality research, economic forecasts, and the development of various indices that measure different aspects of global and national economies (Gygli et al., 2019).

[2] We base on the World Bank Open Data and take all the countries for whom there was a long enough time series, and exclude only two countries from the analysis: the United States and Turkey. The United States was excluded to avoid potential overrepresentation and bias, as its R&D investment is nearly equivalent to that of the rest of the sample combined. Turkey was excluded due to the presence of extreme and unreliable data.

[3] Since April 2013, the expansionary policies implemented by the European Central Bank (ECB), including massive money issuance and the purchase of government bonds, would bias our analysis in two key ways. First, the perceived allocation risk is artificially reduced and, in a subsequent phase, the absolute investment values are artificially inflated due to inflation driven by monetary factors rather than by real economic growth.

R&D infrastructure, and R&D efficiency. Regarding national culture, we consider three indicators: GS (Global Socialization), LTP (Long-Term Perspective), and MVB (Market- vs. Bank-Oriented Financial Channels). The legal framework is assessed using the Legal Rights Index (LRI) published by the World Economic Forum. For R&D infrastructure, we utilize three measures: CI (Capacity for Innovation), QRI (Quality of R&D Institutions), and IC (Index of Competitiveness). R&D efficiency is evaluated through PRO (R&D expenditures per patent) and SPR (patents per capita). Additionally, we control for GDP per capita (PPC). A detailed description of all variables is provided in the Appendix I and the relationships among the main variables are illustrated graphically in Figure 1.

We conduct a two-step analysis. First, we perform a descriptive analysis, including descriptive statistics such as the mean, quartiles, and skewness and kurtosis coefficients along with a test for mean comparison. Second, we conduct an explanatory regression analysis. Additionally, we calculate the Variance Inflation Factor (VIF) to verify the absence of multicollinearity.

3. Results

In Table 1, we present the basic descriptive statistics (mean, the 25th, 50th, and 75th percentiles, and skewness and kurtosis coefficients) of the main variables. We then divide our sample into three groups based on the values of GERD. The three rightmost columns of Table 1 report the mean values for the two extreme groups, along with the p-value from the mean comparison test. While, as expected, R&D rates differ significantly between groups, what is particularly noteworthy is that these groups of countries also exhibit substantial differences in institutional and cultural dimensions, including socialization, long-term orientation, financial orientation, and institutional quality. These significant disparities suggest that any analysis of the determinants of R&D investment should take these differences into account.

We provide a summary of all results in Appendix II, and detailed estimation outputs in Tables 2–5. We begin by analyzing the relationship between national culture and firms' R&D investment. Table 2 presents the estimates from separate regressions for countries with the highest and lowest levels of R&D expenditures. As shown in Column 1 of Table 2, which reports estimates for countries with higher R&D investment, R&D expenditures are positively associated with social openness (GS), long-term orientation (LTP), and the relative importance of capital markets compared to banks (MVP). However, these positive relationships hold only for this first group and not for countries with lower levels of R&D investment (Column 2). This asymmetry is consistent with Coccia (2010), who reports that the public and private investment in R&D depends on the level of country development. In addition, the differences between both columns suggest that cultural attitudes toward R&D investment become relevant only after a certain threshold of R&D expenditure is reached.

In columns 3 and 4 of Table 3, we confirm the asymmetric effect of the institutional setting since legal enforcement (LRI) affects firms' R&D expenditures only in countries with low levels of R&D. The lack of significance in R&D-intensive countries may be explained by the fact that these countries likely benefit from a high level of legal protection, making this factor less influential. Taken together, the results from Table 2 suggest that an open, long-term-oriented culture fosters R&D expenditures only in countries with high legal standards. In

contrast, in countries without sufficient legal safeguards, the cultural environment becomes negligible, as more fundamental first-order determinants of innovation, such as the availability of funds, take precedence. These results complement the findings of Yan et al. (2021), as they show that the effect of culture on R&D is more pronounced for firms located in regions with weak legal supervision, as if cultural factors compensate for the lack of legal assurance.

Table 1. Descriptive statistics: mean, quartiles, skewness and kurtosis coefficients of the main variables

Variable	Mean	Q25	Q50	Q75	Skewness	Kurtosis	High R&D	Low R&D	*p*-value
GFC	7.285	2.345	5.444	10.412	0.698	2.376	13.742	1.308	0.001
GFG	5.855	3.088	5.495	7.692	0.322	1.808	9.278	2.344	0.001
GFA	1.395	366	889	1.807	0.938	2.952	2.295	612	0.001
%GFC	41	29	44	53	-0.626	2.160	52	26	0.001
GS	65.328	48.120	70.707	82.548	-0.329	1.902	74.893	54.415	0.001
LTP	42.935	30.000	38.000	48.000	0.851	3.653	46.101	38.882	0.018
MVB	671	294	511	856	0.949	3.458	821	596	0.001
PPC	316.90	31.42	117.70	572.95	0.740	2.327	591.55	71.90	0.001
LRI	614	400	600	800	-0.077	2.285	637	571	0.017
CI	3.866	3.080	3.650	4.548	0.832	2.546	4.694	3.239	0.001
QRI	4.386	3.603	4.240	5.239	0.190	1.931	5.130	3.719	0.001
IC	4.568	4.125	4.433	5.115	0.253	2.176	4.981	4.207	0.001
PRO	1.738	286	677	2.314	0.616	3.835	1.709	741	0.001
SPR	165.23	20.40	61.86	192.95	0.873	3.356	335.10	96.95	0.001

Note: See Appendix for a description of the variables.

We now examine a country's attractiveness to foreign R&D investment. The underlying rationale is that, once investors decide to allocate funds to R&D, certain factors influence their choice of destination. Therefore, we analyze innovation capacity, the quality of innovation institutions, and national competitiveness as potential determinants of foreign R&D investment. The results presented in Table 3 confirm the importance of the innovation structure: innovation capacity (CI), the quality of R&D institutions (QRI), and the competitiveness index (IC) all emerge as significant determinants in the most R&D-intensive countries (Column 1). These results extend the findings of Zhang and Huang (2022) for Chinese provinces to an international context. In contrast, none of these factors are significant in countries with lower levels of R&D investment (Column 2). The negative influence of competitiveness (IC) may seem counterintuitive; however, a possible explanation lies in the subsidiary role of foreign investment. Specifically, domestic investment—whether from firms or governments—tends to seize the best opportunities in the most competitive economies. As

a result, foreign investors may be left with access only to less competitive countries, which could explain the negative coefficient of IC.

Table 2. *N*ational culture, legal framework and R&D

	(1) High R&D	(2) Low R&D	(3) High R&D	(4) Low R&D
GS	0.5075 ***	0.0190		
	(0.0843)	(0.0562)		
LTP	0.2404 ***	0.0212		
	(0.0577)	(0.0186)		
MVB	1.7052 ***	-1.5870		
	(0.3633)	(1.1791)		
LRI			-1.4505	1.7386 ***
			(2.5863)	(0.5525)
PPC	0.0127 ***	-0.0117	0.0200 ***	0.0042 ***
	(0.0021)	(0.0192)	(0.0035)	(0.0012)
# obs.	164	29	98	91
F-test	22.98 ***	5.62 ***	1.83 *	1.73 *
Adj-R^2	0.4811	0.6224	0.3855	0.0392
VIF	2.21	1.44	1.38	3.93

Note: The dependent variable is GERD (Gross domestic expenditure in R&D). GS stands for Global Socialization, LTP for long-term perspective, MVB for markets vs. banks, LRI for Legal Rights Index, and PPC for GDP per capita. Significant at a confidence level of ***99%; ** 95%; * 90%.

Columns 3 and 4 of Table 3 confirm the relevance of the efficiency of the national R&D system to draw foreign investment. The innovation system efficiency is measured through R&D efficiency (PRO) and patent applications (SPR). These variables capture the average cost per patent and the number of patents per capita, respectively. Our findings indicate that more efficient R&D systems (i.e., those with lower PRO and higher SPR) tend to reduce foreign investment in R&D. This may be attributed to a 'crowding-out' effect, whereby national investors capitalize on the most promising R&D opportunities by leveraging their knowledge, proximity, influence, and superior access to information.

To assess the subsidiary role of foreign investment, we examine the relationship between a country's competitiveness and the share of total R&D expenditures accounted for by domestic firms (Table 4). The results show a positive and significant relationship between national competitiveness and firms' R&D investment in the most R&D-intensive countries. This suggests the presence of a 'crowding-out' effect, whereby domestic investors seize R&D investment opportunities first, leaving only limited opportunities for foreign investors. The comparison between the two columns of Table 4 indicates that this structural determinant is significant only in countries with high levels of R&D, reinforcing the idea that it plays a

second-order role—becoming relevant only once other institutional factors are firmly in place.

Table 3. Innovation infrastructure, R&D efficiency, and foreign R&D

	(1) High R&D	(2) Low R&D		(3) High R&D	(4) Low R&D
CI	1.6332 ***	0.1417	PRO	0.2251 ***	0.0318
	(0.4925)	(0.1293)		(0.0955)	(0.0209)
QRI	1.6334 ***	-0.0537	SPR	-0.0016 ***	-0.0023
	(0.3681)	(0.0948)		(0.0006)	(0.0012)
IC	-4.6563 ***	-0.1748			
	(0.9898)	(0.1844)			
PPC	0.0021 ***	0.0010 **		0.0030 ***	0.0047 ***
	(0.0008)	(0.0006)		(0.0007)	(0.0018)
# obs.	94	104		213	155
F-test	3.83 ***	3.64 ***		4.95 ***	1.28
Adj-R^2	0.3889	0.4289		0.1582	0.2437
VIF	3.07	4.78		2.03	1.92

Note: The dependent variable is GFA (Expenditure in R&D by foreigners). CI stands for capacity of innovation, QRI for quality of R&D institutions, IC for the index of competitiveness, PRO for R&D efficiency, SPR for patents applications, and PPC for GDP per capita. Significant at a confidence level of ***99%; ** 95%; * 90%.

Table 4. Competitiveness and firm R&D

	(1) High R&D	(2) Low R&D
IC	0.0077 ***	0.0032
	(0.0031)	(0.0035)
PPC	0.0001 ***	0.0001
	(0.0001)	(0.0001)
# obs.	98	97
F-test	10.80 ***	1.55
Adj-R^2	0.2728	0.0513
VIF	4.71	5.42

Note: The dependent variable is GFC (Expenditure in R&D by firms). IC stands for the index of competitiveness, and PPC for GDP per capita. Significant at a confidence level of ***99%; ** 95%; * 90%.

Finally, we address the complementarity vs. substitution effect that there can be among the different sources of R&D investment. To do so, we decompose gross R&D expenditure into the shares contributed by firms, the government, and foreign investors. As expected, and as

reported in Table 5, these proportions are negatively correlated with one another, with most relationships being statistically significant. This set of results further supports the presence of a 'crowding-out' effect, as firms' investment (GFC) negatively impacts R&D spending by both the government and foreign investors. Likewise, as shown in Column 3, foreign investment is adversely affected by the other two sources of R&D funding. A summary of all the results is provided in Appendix II.

Table 5. R&D efficiency and foreign R&D

	(1) %GFC	(2) %GFG	(3) %GFA
GFC		-0.0011 ***	-0.0003 ***
		(0.0001)	(0.0001)
GFG	-0.0002		-0.0004 ***
	(0.0002)		(0.0001)
GFA	-0.0013 ***	-0.0018 ***	
	(0.0003)	(0.0003)	
PPC	0.0001 ***	0.0001 **	0.0001 **
	(0.0001)	(0.0001)	(0.0001
# obs.	580	570	583
F-test	3.02 ***	13.25 **	7.38 **
Adj-R^2	0.0705	0.3236	0.1338
VIF	2.20	2.12	2.21

Note: The dependent variable is %GFA (proportion of all expenditure in R&D accounted by firms) in column 1, %GFG (proportion of all expenditure in R&D accounted by the government) in column 2, and %GFA (proportion of all expenditure in R&D accounted by foreigners) in column 3. GFC (GFG, GFA) stands for the expenditure in R&D by firms (government, foreigners) over GDP, and PPC for GDP per capita. Significant at a confidence level of ***99%; ** 95%; * 90%.

4. Conclusions

In this paper, we examine the influence of national culture and innovation efficiency on R&D investment. Our empirical analysis shows that long-term orientation, capital markets, and R&D efficiency are only significant in the most R&D-intensive countries. In such economies, legal protection—considered a first-order determinant—is taken for granted, allowing second-order factors to exert their influence. These second-order factors are positively associated with both domestic R&D expenditures and the country's attractiveness to foreign R&D investment. We also find evidence of a 'crowding-out' effect, whereby domestic firms outcompete foreign investors by leveraging their privileged position, superior access to information, and other structural advantages to capitalize on the most promising R&D opportunities. Additionally, we identify a 'substitution effect', as governments tend to compensate for the lack of private-sector investment in R&D.

Regarding the theoretical implications, we posit that structural determinants can be classified into first- and second-order factors, with the latter becoming relevant only once the former are in place. In this framework, culture and institutional quality function as second-order determinants that influence R&D investment only when a solid legal system is established. As for policy implications, our findings may help address the widespread concern that private R&D investment often falls short of socially optimal levels. By emphasizing the role of culture, institutions, and the legal environment, our results suggest potential ways to stimulate R&D investment without imposing additional financial burdens on firms or governments.

Our study has certain limitations that suggest several avenues for future research. One promising direction would be to examine more deeply the complementary versus substitutive roles of cultural and legal factors in fostering R&D investment. Given the multiple dimensions embedded in each set of factors, future research should aim to identify which dimensions are most relevant under different contextual conditions. Another direct extension would be to test whether the relationships observed still hold in more recent years. We have deliberately focused on a sample period ending in 2012 to avoid the distorting effects of the global liquidity glut. Future studies could explore whether legal and institutional factors continue to shape R&D decisions in an environment of abundant liquidity and whether this has helped level the playing field across countries.

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Appendix

Table 6. List of variables and definitions

Abbrev.	Name	Definition	Source
GERD	Expenditure in R&D	Gross domestic expenditure in R&D over GDP	UNESCO
GFC	Expenditure in R&D by firms	Expenditure in R&D by firms over GDP (%)	UNESCO
GFA	Expenditure in R&D by foreigners	Expenditure in R&D by foreigners over GDP (%)	UNESCO
GFG	Expenditure in R&D by the Government	Expenditure in R&D by the Government over GDP (%)	UNESCO
%GFC	% of total R&D investment done by firms	Expenditure in R&D by firms over total R&D expenditure (%)	UNESCO
%GFA	% of total R&D investment done by foreigners	Expenditure in R&D by foreigners over total R&D expenditure (%)	UNESCO
%GFG	% of total R&D investment done by the Government	Expenditure in R&D by the Government over total R&D expenditure (%)	UNESCO
GS	Global socialization	33% personal contact + 33% information flows +33% cultural proximity	KOF
LTP	Long term perspective	Society long term orientation	Hofstede dataset
MVB	Market vs. bank orientation	Stock market capitalization over domestic credit to private sector	World Bank
LRI	Legal rights index	Legal rights index	World Economic Forum
CI	Capacity of innovation	Capacity of innovation score (from 1 to 7)	World Economic Forum
QRI	Quality of R&D institutions	Quality of institutions (from 1 to 7)	World Economic Forum
IC	Index of competitiveness	Global competivity index (from 1 to 7)	World Economic Forum
PRO	R&D efficiency	R&D expenditures over patents	UNESCO and World Economic Forum
SPR	Patents application	Registered patents/Population	World Bank
PPC	GDP per capita	GDP per capita (USD)	World Bank

Table 7. Summary of results

	High R&D countries	Low R&D countries
Table 2: Expenditure in R&D		
Socialization	+	Not significant (n.s.)
Long term	+	n.s.
Markets vs. banks	+	n.s.
Legal framework	n.s.	+
Table 3: Foreing investment		
Capacity of innovation	+	n.s.
Quality of institutions	+	n.s.
Competitiveness	-	n.s.
R&D efficiency	+	n.s.
Patents applications	-	n.s.
Table 4: domestic firm investment		
Competitiveness	+	n.s.

Figure 1. Determinants of R&D expenditure