Foreign direct investment and innovation in Europe regions: The moderating role of institutional quality

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This paper examines the relationship between foreign direct investment (FDI) and innovation using country-level data for Europe regions. It also investigates the moderating role of institutional quality in this relationship. The results show that FDI is negatively associated with innovation in the host country. Moreover, the results reveal that institutional quality moderates this relationship. The findings point out that institutional items do not equally matter in the relationship between FDI and local innovation for Western Europe as for Eastern and Central Europe. This study highlights the channels through which institutions can boost innovation from FDI.

Keywords: Foreign direct investment; innovation; institutional quality; Europe
JEL Classifications: E02; F23; O3; O52

1 Introduction

The directive 2019/452 of the European Parliament and the Council, established on March 19th, 2019, provides a framework for the screening of FDI in the EU (see OJ L 079I, 21.3.2019)[1]. It describes FDI as a source of capital, technology transfer, or access to new markets that can increase competition, boost productivity, and provide incentives for domestic firms to innovate and remain competitive (Boghean and State, 2015; Chueng and Ping, 2004; Schrolec, 2009). Theoretically, FDI is expected to influence innovation through different channels (Görg and Greenaway, 2004).

Several studies have recognized the pivotal role of FDI (e.g., Hassen and Anis, 2012; Hayat, 2019; Liu et al., 2014; Soumaré, 2015) and innovation (Bouchmel et al., 2022, Diebolt and

[1] https://eur-lex.europa.eu/legal-content/FR/TXT/HTML/?uri=CELEX:32019R0452&from=EN

Hippe, 2019) in boosting business development and economic growth. Nevertheless, the empirical findings on the relationship between FDI and innovation remain inconsistent. For example, Masso et al. (2013) report a positive association between FDI and the innovative capacity of domestic firms, however this relationship disappears one firm's characteristics are controlled for. In contrast, Gorg and Greenwood (2004) find a negative association between FDI spillovers and host-country firms in their meta-analysis. According to Denisia (2010), the positive or negative FDI-innovation relationship may depend on the sector where investment takes place. To sum up, the relationship between FDI and innovation remains complex and continues to stir debate. This debate may depend on contextual factors, such as institutional environment.

The institutional quality of the host countries seems to play a key role in shaping the relationship between FDI and innovation. Indeed, institutional quality refers to the quality of a country's political, legal, and economic institutions, which could influence the business environment, the investment climate, and innovation ecosystem of the host country (Stern and Valero, 2021; Bloom et al., 2019; Aghion and Howitt, 2005). According to the national innovation systems theory (Freeman, 1987), public organizations and institutions play a crucial role in generating new knowledge, capable to explain the disparities in innovative activities across countries (Varsakelis, 2006). Empirical studies also suggest that FDI is an important channel through which institutional quality can foster economic growth of a country (Hayat, 2019). Moreover, several regional and world level research provide evidence highlighting the importance of institutions in attracting FDI inflows (e.g., Aziz, 2018; Jude and Levieuge, 2017; Kaushal, 2021; Shah et al., 2016).

Institutions can generate the level of economic uncertainty and determines whether FDI flows into the economy, as well as the creation of a new business or the development of a new project, which could potentially affect the level of innovation (Tondé et al., 2024; Chen and Cheng, 2023; Peiró-Palomino and Perugini, 2022; Dong et al. 2021; Rodríguez-Pose and Di Cataldo, 2015; Tebaldi and Elmslie, 2013). For instance, Peiró-Palomino and Perugini (2022) show that the quality of local institutions is the main and consistent driver of innovation and explain the differences in Italian regional innovation (NUTS3). Rodríguez-Pose and Di Cataldo (2015) studied the role of institution across the UE countries (NUTS3). Classifying the regions into two groups (Core and Periphery), the authors show that institutional quality has a positive impact on innovation, but the effect is less in the periphery. In a recent study, Donges et al.

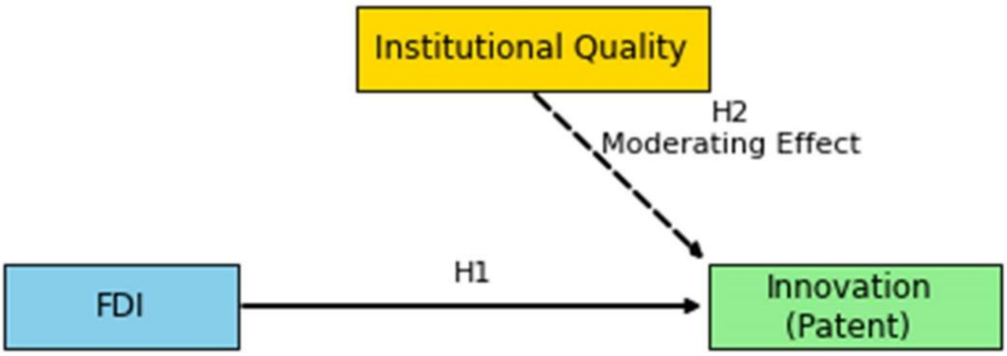
(2023) argue that institutions (inclusive) are a "first-order" determinant of innovation in German.

Figure 1 illustrates the hypothesized FDI–institutions–innovation relationship, based on the above reviewed literature. We also formulate the following hypotheses:

H1: There is an association between FDI and the innovation in the host country.

H2: Institutional quality has a moderating effect between FDI and innovation.

Figure 1. Conceptual framework



This study contributes to the literature in several ways. First, it enriches the empirical works that has emerged in the past decade and helps reduce ambiguity about the spillover effects of FDI. Second, it extends the existing literature by exploring the potential moderating role of institutional quality (Qu and Wei, 2017), using a composite index of six institutional dimensions: control of corruption, government effectiveness, political stability and absence of violence and terrorism, rule of law, voice and accountability, and regulatory quality in this relationship. Then, we assess the role of each institutional factor separately, providing a comprehensive study of the channels through which institutions may influence the relationship between FDI and innovation. Finally, this study adopts a broader, cross-country European perspective on the FDI–innovation nexus. This approach complements and extends previous region-specific analyses (i.e., Peiró-Palomino and Perugini, 2022; Rodríguez-Pose and Di Cataldo, 2015) by examining whether FDI influences innovation across diverse institutional and developmental contexts within Europe[2]. The continent encompasses a wide range of countries with varying levels of economic development, and difference in FDI attractiveness,

[2] For instance, we can find studies between EU countries (Rodríguez-Pose and Di Cataldo, 2015) or inside country (Peiró-Palomino and Perugini, 2022 or Donges et al., 2023). However, we did not find any work on the whole European continent.

institutional quality, and innovation capabilities, providing a relevant opportunity to explore how FDI and innovation relationship differs across contexts. In addition, Europe is recognized for its strong innovation ecosystem, with numerous research institutions, universities, and technology clusters. Such an environment can facilitate collaboration between foreign companies and local researchers, making Europe an interesting region to study the interaction among FDI, institutions, and innovation.

The rest of the paper is organized as follows: Section 2 presents the data set and motivate the choice of variables. Section 3 reports the descriptive statistics and the correlation matrix. Section 4 exhibits empirical methodology, and section 5 focuses on the baseline results. Section 6 focuses on the robustness test, and section 7 concludes.

2 Sample and data collection

The sample consists of a panel of 34 European countries (EU27, Iceland, Montenegro, Norway, Russian Federation, Serbia, Turkey, and UK) for the period between 2008 and 2019. Data are collected from the European Patent Office and the World Bank data bank.

The dependent variable represents the number of applications for patent protection. The existing literature has primarily measured innovation using three variables: the number of innovations, the number of patents, and R&D expenditure (Morck and Yeung, 2001). Moser (2013) argues that the lack of systematic data on the number of innovations often leads to the use of patents as a standard measure. In the same vein, Morck and Yeung (2001) admit that the number of patents is more realistic indicator than R&D expenditure. Based on this literature, we use the number of patents as a principal proxy of innovation. We also employ R&D expenditure (RDEX) as an alternative measure in the robustness tests, and the findings remain consistent with the baseline results.

Table 1: Variables definitions and measurement

Variable	Symbol	Variable explanation
Foreign Direct Investment	FDI	FDI net inflows (% of GDP)
Patent	PAT	The number of applications for patent protection of an invention
Research and Development	RDEX	R&DEX expenses
Control of Corruption	CC	Percentile Rank
Government Effectiveness	GE	Percentile Rank
Political Stability and Absence of Violence/Terrorism	PS	Percentile Rank
Regulatory Quality	RQ	Percentile Rank
Rule of Law	RL	Percentile Rank
Voice and Accountability	VA	Percentile Rank

Note: FDI net inflows is the new investment inflows less disinvestment in the reporting economy from foreign investors divided by GDP.

Based on previous studies (e.g., Kuzey et al., 2021), we measure institutional quality using a composite index derived from Worldwide Governance Indicators (WGI). In addition, six individual dimensions are separately used: Control of Corruption, Political Stability and Absence of Violence, Regulatory Quality, Rule of Law, Government effectiveness, and Voice and Accountability. Moreover, FDI represents the foreign direct investment net inflows as a proportion of the gross domestic product. Finally, we use research and development expenses (RDEX) and gross domestic product per capita (GDP) and year dummy as control variables. Table 1 introduces these variables.

3 Descriptive statistics

Table 2 summarizes the descriptive statistics for all variables. The Mann-Whitney U test is highly significant supporting the regional disparity that may exist between the two groups of countries. This allows us to examine in depth whether there is a regional disparity between the two groups: Western Europe, and non-Western (East and Central) Europe. Figures 2-4 also illustrate the disparity among European regions.

Figure 2 compares patents, FDI, R&D expenditures (RDEX), and GDP distributions between Western Europe and non-Western countries (Central and Eastern Europe). Regarding patent, Western economies show a highly concentrated distribution, with a few leaders (Germany, France, Netherlands, UK) posting extreme counts, while most others remain at low-to-medium levels (Figure 3). By contrast, non-Western countries display much lower, thinner patent distributions, reflecting weaker innovation capacity. In terms of FDI, Western countries cluster around low inflows with limited volatility, as mature economies rely less on large inflows. However, non-Western distributions are more stretched, with some attracting very high inflows but others very little, indicating greater volatility and heterogeneity. For R&D expenditures, Western countries spend significantly more (1.5–3% of GDP), reflecting sustained commitment to innovation. Conversely, non-Western countries spend less (mostly under 1%), with narrower distributions and few heavy investors. Finally, GDP distributions reveal a clear structural divide: Western economies cluster at higher income levels with less spread, whereas nonWestern countries display lower and more dispersed GDP, reflecting both persistent gaps and more varied development paths.

Figure 4 compares six institutional quality indicators across Western and non-Western countries. The figure reveals a systematic divergence, with Western countries consistently outperforming non-Western countries. The most pronounced disparities are observed in corruption control and rule of law, while differences in government effectiveness and regulatory quality remain significant though comparatively narrower. Political stability exhibits higher variation within both groups while, voice and accountability show persistent cross-regional contrasts, reinforcing evidence of persistent institutional asymmetries between the two blocs.

Finally, the Pearson correlation matrix (see Table 3) shows that, overall, correlation coefficients below 0.7 (see Kevin, 1992 and Khenissi et al., 2022) suggesting a weak association between the explanatory variables, except for the correlation between the institutional variables. Patent and FDI show a weak negative correlation (–0.08), indicating that FDI may not directly drive innovation, and that the institutional quality may play a more significant role. In addition, patent correlate moderately with institutional variables (0.28–0.32), while R&D and GDP may also contribute. Similarly, patent and R&D are moderately correlated (0.45), suggesting that R&D expenditures lead to greater patents outputs. Finally, R&D strongly correlates with governance indicators (0.58–0.70), implying that well-governed environments may support research through property rights, efficient institutions, and transparent policies. Governance indices (RQ, CC, PS, RL, VA, GE) are highly intercorrelated (up to 0.94), showing that governance quality is multidimensional and coherent, with improvements in one area likely linked to others. Consequently, we investigate each institutional variable separately. The composite index aligns strongly with individual measures, validating its use as a single metric for cross-country governance comparisons. However, the differences across individual components should be interpreted carefully due to their high correlations reported in the correlation matrix.

Table 2: Descriptives statistics

Variables	Panel A: All countries					Panel B: Western Europe			Panel C: Non-Western (Eastern and Central) Europe			Mann-Whitney U test
	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	P-value
PAT	408	2009.018	4749.452	0	27328	228	3531.232	5929.613	180	80.880	103.944	0.000***
FDI	393	10.165	29.449	-41.063	280.132	213	8.152	19.546	180	12.547	37.898	0.000***
RQ	408	80.967	14.160	31.250	100	228	87.375	10.636	180	72.850	13.924	0.000***
CC	408	75.442	19.632	11.005	100	228	86.195	14.549	180	61.821	16.554	0.000***
PS	408	68.909	20.478	4.762	100	228	73.199	22.026	180	63.476	16.886	0.000***
RL	408	78.465	18.173	18.750	100	228	87.832	13.362	180	66.600	16.468	0.000***
VA	408	79.274	18.592	17.734	100	228	88.705	14.406	180	67.327	16.307	0.000***
GE	408	79.414	14.962	39.713	100	228	87.473	11.149	180	69.201	12.800	0.000***
ln GDP	408	10.616	1.794	8.628	18.788	228	11.092	1.676	180	10.014	1.763	0.000***
RDEX	408	1.502	0.853	0.310	3.730	228	1.924	0.834	180	0.968	0.508	0.000***

Figure 2. The distribution of patent, FDI, RDEX (R&D) and GDP distributions by country and by group

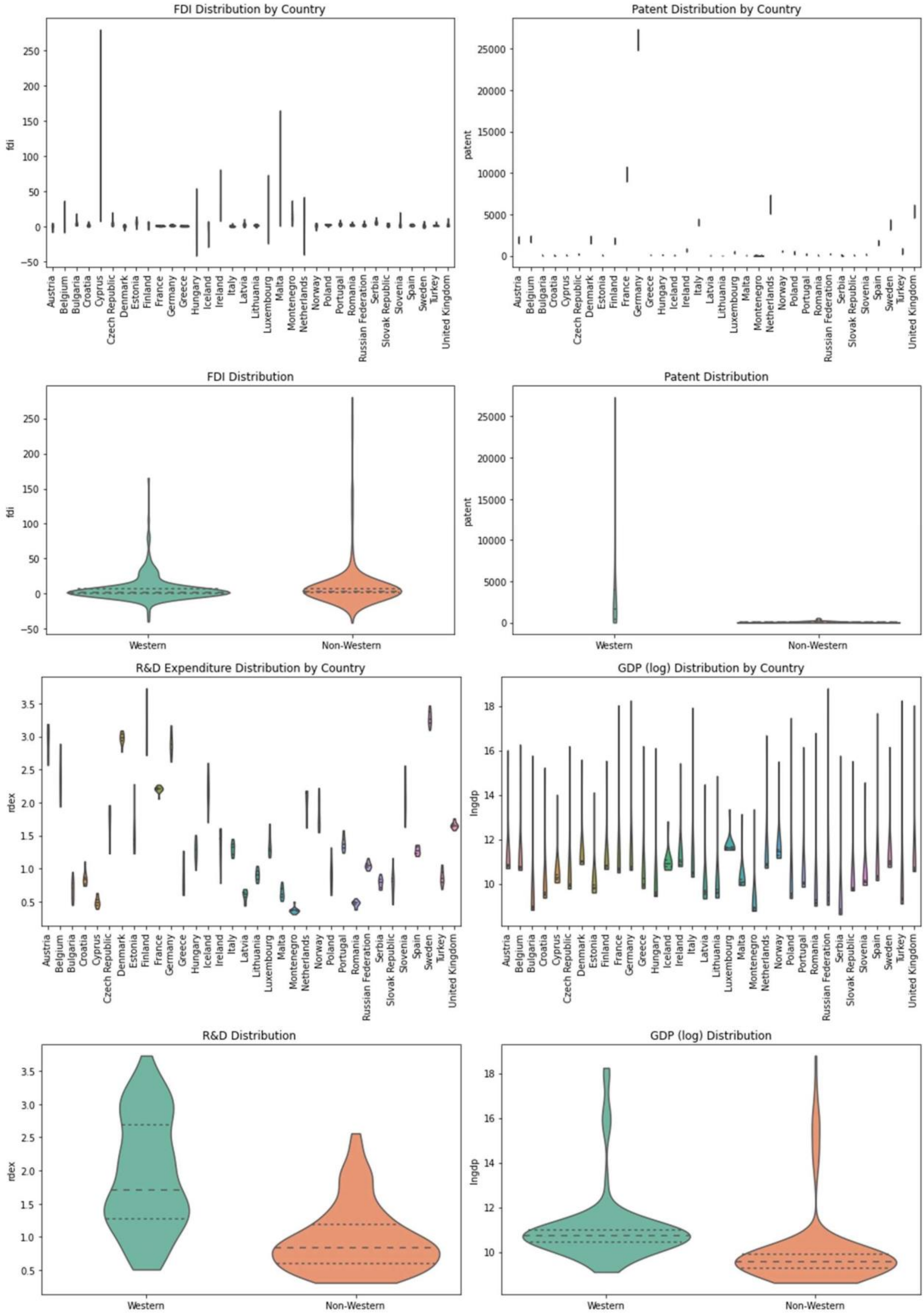


Figure 3. Patent and the composite index of the WGI

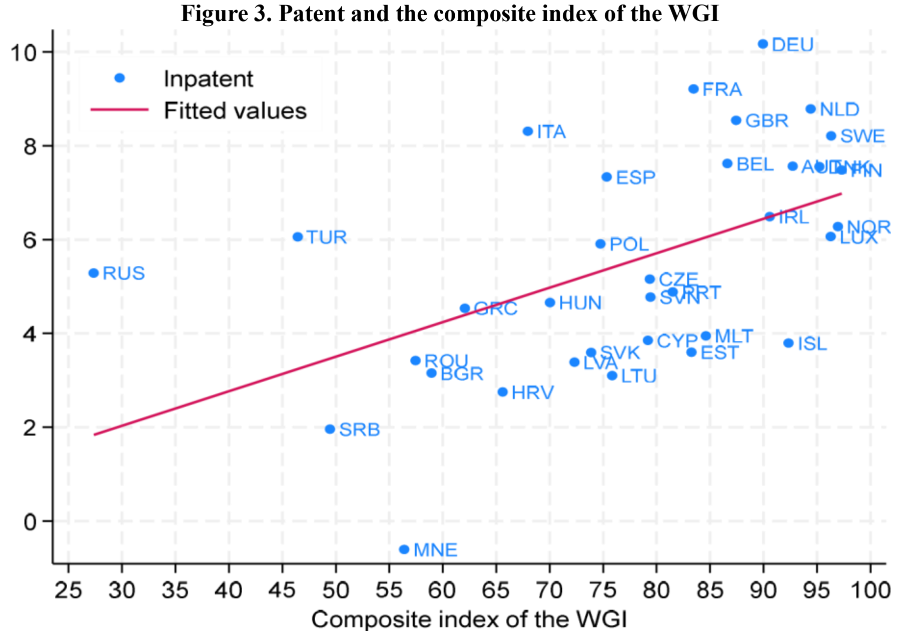
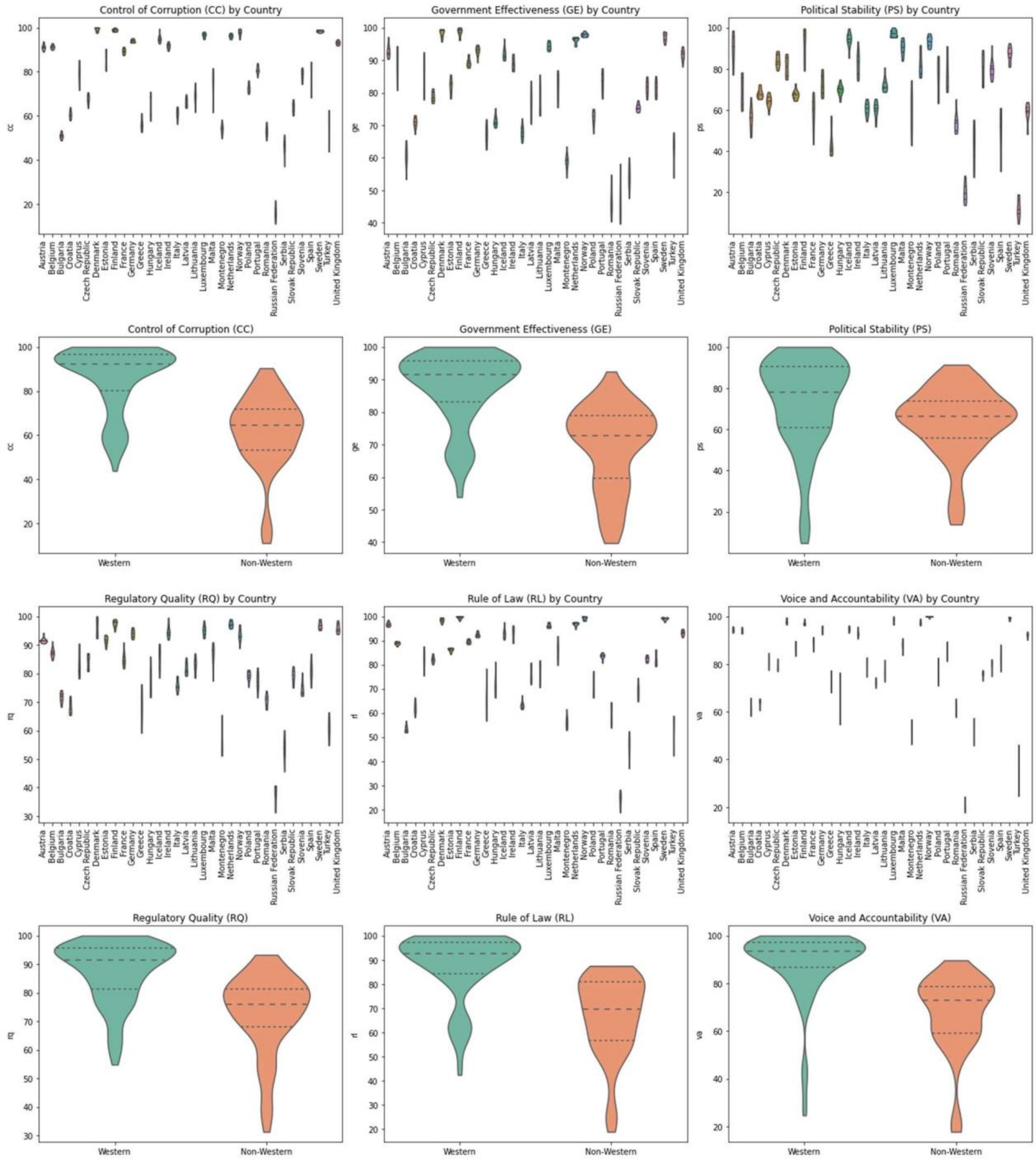


Table 3: Pearson correlation matrix (coefficients and P-values)

Variables	PAT	RDEX	FDI	ln GDP	RQ	CC	PS	RL	VA	GE	COMPOSITE
PAT	1.000										
RDEX	0.454	1.000									
	(0.000)										
FDI	-0.083	-0.226	1.000								
	(0.102)	(0.000)									
ln GDP	0.161	0.296	0.019	1.000							
	(0.001)	(0.000)	(0.704)								
RQ	0.304	0.581	0.093	0.289	1.000						
	(0.000)	(0.000)	(0.064)	(0.000)							
CC	0.327	0.682	0.083	0.285	0.917	1.000					
	(0.000)	(0.000)	(0.102)	(0.000)	(0.000)						
PS	0.035	0.442	0.069	0.196	0.717	0.701	1.000				
	(0.476)	(0.000)	(0.175)	(0.000)	(0.000)	(0.000)					
RL	0.281	0.658	0.098	0.287	0.940	0.968	0.750	1.000			
	(0.000)	(0.000)	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)				
VA	0.291	0.614	0.067	0.272	0.923	0.937	0.784	0.949	1.000		
	(0.000)	(0.000)	(0.182)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
GE	0.316	0.700	0.106	0.307	0.887	0.943	0.711	0.948	0.900	1.000	
	(0.000)	(0.000)	(0.035)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
COMPOSITE	0.268	0.648	0.090	0.287	0.947	0.965	0.836	0.981	0.972	0.950	1.000
	(0.000)	(0.000)	(0.075)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Figure 4. The distribution of the six WGIs by country and by group



4 Methodology

The Poisson pseudo-maximum likelihood (PPML) estimator (with multiple high-dimensional fixed effects) is used rather than other log-linear estimators for three main reasons (Correia et al., 2020). Firstly, the number of patent applications (Y) is a discrete value. Poisson regression is therefore the most adaptable (Gourieroux et al. 1984, Cameron and Trivedi, 2013). Secondly, it can naturally include zero observations, whereas such observations are excluded from other models as log zero is undefined (Silva and Tenreyo, 2006; Silva and Tenreyro, 2011). Thirdly, the PPML estimator provides consistent parameter estimates even when errors are heteroskedastic and is robust to measurement errors in the dependent variable (Santos Silva and Tenreyo, 2006). Finally, using a Poisson regression with robust standard errors may be preferable to estimating a log-linear model using other estimators (Motta, 2019).

The Poisson regression model is defined by:

$$\Pr(Y_{it} = k/X_{it}) = \frac{e^{\lambda}\lambda^{k}}{k!}, k = 0,1,2, \dots \quad (1)$$

Where X is a vector of explanatory variables and $\lambda = e^{X'_{it}\beta} = e^{\beta_0+\beta_1 X_{1it}+\beta_2 X_{2it}+\cdots}$

The panel PPML can be estimated by maximizing the Poisson likelihood function for the model parameters, transforming equation (1) as follows:

$$Y_{it} = \exp\left[\beta_1 FDI_{it} + \beta_2 (FDI * INST)_{it} + \beta_3 INST_{it} + \beta_4 RDEX_{it-1} + \beta_5 \ln GDP_{it} + \gamma T\right] + \epsilon_{it} \quad (2)$$

In equation (2), the variable *INST* represents each institutional item, and the other variables are defined as previously stated. The variable $FDI * INST$ captures the combined effect of foreign direct investment and each institutional variable on innovation. ∈ defines the error term and T represent year dummy variables. i represents each country and t is the period.

We checked that all variables are stationary and cointegrated and reported the marginal effects of the Poisson pseudo-maximum likelihood estimator with multiple high-dimensional fixed effects.

5 Empirical findings

Table 4 reports the marginal effect of the regression results testing the FDI–institutions–innovation relationship for all European countries. To deepen our analysis, we split the full sample into two sub-samples Western and non-Western (Central and Eastern) Europe. Tables 5 and 6 report the marginal effect of the regression results for the first and second subsamples, respectively.

Overall, the coefficient of FDI is negative and statistically significant, suggesting that FDI is negatively associated with the level of local innovation when institutional variables are not considered. This finding is consistent with those of previous studies (García et al., 2013;

Cheung and Lin, 2004; Schrolec, 2008) highlighting the detrimental consequences of FDI on the innovativeness of the host countries. A possible explanation of this result is that FDI stimulate competition between foreign and local companies, which can drive out local companies that are unable to compete and limit, subsequently, the potential of the host countries to develop their own innovation capacity. Another possible explanation is that foreign companies can be poorly embedded in a local innovation system (Günther et al., 2011) due to their difference in various aspects (i.e., language, culture, management...). This constrains the cooperation/ (interaction) between foreign investors and local skills and limits the knowledge spillover which, in turn, reduces the innovation capacity of the host countries.

Table 4: Marginal effects of the PPML estimator with multiple high-dimensional fixed effects for the full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	-1.735	-86.127**	-112.327**	-94.245**	-10.167	-127.906**	-77.149**	-154.404***
	(3.688)	(40.419)	(51.555)	(37.789)	(8.421)	(49.575)	(35.265)	(58.940)
INST	-4.871***	-4.976***	17.038	6.042	-27.161***	-20.623***	7.316	-6.201
	(1.115)	(1.072)	(10.841)	(8.164)	(3.333)	(6.584)	(5.855)	(11.059)
FDI*INST		0.157**	1.158**	1.002**	0.160	1.370**	0.796 **	1.654**
		(0. 077)	(0.564)	(0.424)	(0.125)	(0.547)	(0.392)	(0.646)
ln GDP	966.175***	879.539***	398.549 **	441.499***	755.637***	749.898***	456.608***	587.679***
	(133.740)	(133.110)	(158.570)	(164.60)	(84.839)	(125.860)	(132.480)	(157.72)
lag RDEX	920.070***	907.346***	704.836***	754.928***	604.039***	897.437***	769.849***	811.768***
	(162.600)	(161.700)	(151.530)	(160.180)	(112.010)	(170.800)	(159.96)	(0.150)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Marginal effects of the PPML estimator with multiple high-dimensional fixed effects for Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	11.632	-528.657**	-1063.860***	-1221.167***	91.389	-866.554***	-1197.477***	-1193.501***
	(17.838)	(263.460)	(327.88)	(284.240)	(96.191)	(298.750)	(323.410)	(298.950)
INST	-17.095***	-99.959***	96.078**	4.772	-110.525***	-78.782***	10.180	-28.952
	(5.419)	(30.632)	(45.620)	(28.727)	(13.388)	(26.978)	(31.493)	(35.070)
FDI*INST		5.812**	11.003***	12.968***	-0.762	9.243***	12.427***	12.739 **
		(2.848)	(3.440)	(3.020)	(1.088)	(3.162)	(3.354)	(3.156)
ln GDP	732.807	402.339	-2127.870**	-1401.608*	2378.602***	-149.040	-1428.348	-767.833
	(551.690)	(514.440)	(1022.500)	(717.010)	(523.17)	(421.660)	(946.770)	(558.440)
lag RDEX	2850.839***	2755.068***	1404.638***	1697.613***	2643.812***	2591.509***	1877.158***	2007.693***
	(567.060)	(569.14)	(417.670)	(448.05)	(392.540)	(579.200)	(458.700)	(531.360)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Marginal effects of the PPML estimator with multiple high-dimensional fixed effects for Non-Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	-0.225	-9.962**	-6.733***	-4.359**	-8.395	-8.833***	-4.456*	-5.820**
	(0.162)	(4.301)	(2.540)	(2.179)	(5.898)	(3.367)	(2.690)	(2.313)
INST	-0.610	-1.029***	-0.798**	-0.706*	-0.720	-1.099***	-0.681*	-1.206**
	(0.443)	(0.381)	(0.398)	(0.391)	(0.483)	(0.255)	(0.377)	(0.485)
FDI*INST		0.122**	0.076***	0.051**	0.124	0.103***	0.053	0.065**
		(0.053)	(0.029)	(0.025)	(0.087)	(0.039)	(0.033)	(0.025)
ln GDP	36.156***	39.152***	37.348***	37.106***	42.496***	38.216***	37.002***	38.368***
	(9.354)	(8.388)	(8.668)	(8.925)	(9.037)	(8.688)	(9.063)	(8.260)
lag RDEX	40.145***	35.684***	32.440***	38.493***	31.911***	39.327***	37.224***	41.287***
	(11.231)	(11.058)	(9.713)	(11.107)	(12.123)	(10.937)	(11.017)	(10.975)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Regarding institutional variables, there are negative and significant coefficients for the composite governance index (see H1). Unlike the study of Tebaldi and Elmslie (2013), our findings demonstrate that controlling for the institutional context is significant in explaining patent production. This is confirmed for all studied samples. These results are consistent with those of Rodríguez-Pose and Di Cataldo (2015) showing that institutional quality enhances patenting across European regions. However, the marginal effect reported in Table 4 reveal differences within the six dimensions of the WGIs. This implies that institutional pillars do not equally influence the innovation level of all European countries. These results are corroborated by those reported in Tables 5 and 6, which indicate differences in the coefficients of institutional items among Western and non-Western Europe. For Western Europe, we record positive and significant coefficients for RQ while the coefficients of RL and PS are negative and significant. However, for non-Western Europe, the coefficients are negative for the six dimensions of the WGIs and RQ, RL and GE are significant. Our results suggest that the relationship between institutional factors and national innovation varies across Europe regions. Regarding the interaction term FDI*INST, Table 4 shows a positive coefficient significant suggesting that the relationship between FDI and the number of patents is strong and positive when the institutional quality is considered. Accordingly, institutional environment plays a moderating role in the relationship between FDI and the patent production in the host countries (see H2). Moreover, the magnitude of the FDI*INST coefficient is slightly higher for Western Europe than for non-Western Europe, the moderating role of institutional quality is stronger for Western Europe compared to Eastern and Central Europe.

With regards to control variables, the RDEX have positive and significant coefficients suggesting that R&D expenditures patenting in Europe. The impact of RDEX is more significant for Western European countries than for non-Western European countries. This is consistent with previous studies (e.g., Rodríguez-Pose and Di Cataldo, 2015). Besides, our findings indicate a positive influence of GDP growth on the relationship between patent and FDI in Europe in general. This effect is particularly pronounced in Central and Eastern European countries, where GDP growth exhibits a positive and statistically significant impact.

6 Robustness tests

We conducted additional analyses to test the robustness of our results Robustness. These robustness checks include using of alternative metrics for innovation, employing EU core–periphery subsamples, and controlling for outliers and dynamic effects to ensure the reliability of our findings.

First, we used R&D expenditures (RDEX) as an alternative measure of innovation (Morck and Yeung, 2001), which served as the dependent variable. Fixed effect and PPML regressions are performed to assess the robustness of our baseline results. The results, reported in Tables 7 – 10 show negative coefficients for FDI and positive coefficients for the interaction terms between FDI and the WGIs[3]. These findings suggest that FDI has a negative direct relationship with innovation, but a positive indirect relationship. Overall, they corroborate the baseline results, supporting the robustness of the study's conclusions.

Table 7: Robustness test with RDEX using panel fixed effect for Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	-0.135	-4.44**	-2.100	-0.613	-1.810**	-5.090**	-3.770*	-2.210
	(0.085)	(1.900)	(1.510)	(0.861)	(0.765)	(2.230)	(2.090)	(1.580)
INST	0.054	0.033	0.620	0.522	-0.148	-0.290	0.285	-0.385
	(0.132)	(0.131)	(0.582)	(0.550)	(0.231)	(0.601)	(0.545)	(0.549)
FDI*INST		0.008**	0.021	0.006	0.018**	0.053**	0.039*	0.023
		(0.003)	(0.016)	(0.009)	(0.008)	(0.024)	(0.022)	(0.017)
ln GDP	-71.400****	-72.000***	-81.300***	-73.700***	-66.500***	-67.100***	-71.600***	-70.200***
	(14.700)	(14.500)	(16.200)	(14.600)	(14.100)	(14.200)	(14.100)	(14.200)
lead PAT	0.008**	0.008**	0.008**	0.008**	0.007*	0.008**	0.007*	0.008**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Constant	900.800***	920.500***	980.800***	909.900***	888.900***	910.900***	908.900***	950.800***
	(155.400)	(153.800)	(157.300)	(154.300)	(152.100)	(155.200)	(156.800)	(159.400)
Observations	209	209	209	209	209	209	209	209
R2	0.174	0.198	0.188	0.179	0.196	0.196	0.191	0.183

lead PAT = PATt+1; Robust standard errors in parentheses. All coefficients and standard errors are multiplied by 10^2 for better presentation.
*** p<0.01, ** p<0.05, * p<0.1

[3] 3 Apart from PS.

Table 8: Robustness test with RDEX using panel fixed effect for Non-Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	-0. 019	-0.524	-0.911	-1.190**	0.469	-0.553	-0.448	-0.938
	(0.051)	(0.872)	(0.663)	(0.529)	(0.515)	(0.753)	(0.670)	(0.621)
INST	-0.437***	-0.446***	-0.905*	-2.310***	-0.439*	-0.545	-0.989**	-1.380***
	(0.106)	(0.108)	(0.471)	(0.474)	(0.244)	(0.491)	(0.441)	(0.489)
FDI*INST		0.001	0.010	0.014**	-0.008	0.006	0.005	0.011
		(0.002)	(0.008)	(0.006)	(0.008)	(0.009)	(0.008)	(0.007)
ln GDP	-13.100	-14.200	-26.100	-7.180	-36.800**	-29.700*	-29.800*	-28.800*
	(15.400)	(15.500)	(16.900)	(11.300)	(15.300)	(16.700)	(15.400)	(15.700)
lead PAT	0.091**	0.092***	0.096***	0.172***	0.077**	0.096***	0.093**	0.105***
	(0.034)	(0.035)	(0.036)	(0.035)	(0.037)	(0.037)	(0.036)	(0.036)
Constant	397.100***	411.800***	412.900***	294.200***	479.700***	418.900***	448.200***	468.400***
	(140.200)	(142.800)	(154.600)	(107.300)	(148.100)	(154.000)	(147.400)	(150.200)
Observations	165	165	165	165	165	165	165	165
R2	0.386	0.388	0.331	0.232	0.339	0.318	0.336	0.349

lead PAT = PATt+1; Robust standard errors in parentheses. All coefficients and standard errors are multiplied by 10^2 for better presentation.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Margins effect of the PPML robustness test with RDEX for Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	-0.0020**	-0.0619***	-0.0304**	-0.0111	-0.0181***	-0.0755***	-0.0591***	-0.0401**
	(0.0008)	(0.0202)	(0.0145)	(0.0083)	(0.0063)	(0.0011)	(0.0215)	(0.0175)
INST	0.0002	-0.0006	0.0011	0.0008	0.0003	-0.0109	0.0010	-0.0053
	(0.0013)	(0.0013)	(0.0049)	(0.0052)	(0.0023)	(0.0067)	(0.0053)	(0.0054)
FDI*INST		0.0001***	0.0003*	0.0001	0.0002**	0.0008***	0.0006***	0.0004**
		(0.00004)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
ln GDP	-0.6201***	-0.6006***	-0.6344***	-0.6167***	-0.6049***	-0.5731***	-0.6037***	-0.6096***
	(0.1186)	(0.1187)	(0.1269)	(0.1125)	(0.1212)	(0.1089)	(0.1120)	(0.1112)
lead patent	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**	0.0001**	0.0001***	0.0001***
	(0.00003)	(0.00003)	(0.00002)	(0.00002)	(0.00003)	(0.00002)	(0.00002)	(0.00002)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 10: Margins effect of the PPML robustness test with RDEX for Non-Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
FDI	-0.0007**	-0.0103***	-0.0064**	-0.0084***	0.0026	-0.0065	-0.0047**	-0.0081**
	(0.0002)	(0.0034)	(0.0028)	(0.0018)	(0.0034)	(0.0048)	(0.0019)	(0.0038)
INST	-0.0037***	-0.0039***	-0.0128***	-0.0186***	-0.0033	-0.0019	-0.0106***	-0.0086**
	(0.0008)	(0.0007)	(0.0036)	(0.0033)	(0.0021)	(0.0032)	(0.0024)	(0.0038)
FDI*INST		0.00002***	0.00006**	0.00009***	-0.00006	0.00007	0.00005*	0.00008**
		(0.00001)	(0.00003)	(0.00002)	(0.00006)	(0.00006)	(0.00003)	(0.00004)
ln GDP	-0.0211	-0.0315	-0.0410	-0.0546	-0.1036	-0.1215	-0.1209	-0.1114
	(0.0719)	(0.0716)	(0.0780)	(0.0684)	(0.0717)	(0.0781)	(0.0749)	(0.0745)
lead patent	0.0013***	0.0013***	0.0013***	0.0016***	0.0012***	0.0013***	0.0013***	0.0015***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Second, we apply an alternative EU core –periphery[4] grouping to assess whether our results are sensitive to classification. The robustness tests indicate that, for Core Europe, the main variables (FDI, INST, and FDI*INST) retain both their signs and their levels of significance. Specifically, FDI*INST remains positive and significant in all cases, except for RQ and PS, which are positive but not significant (PS was also not significant in the initial model). In Periphery Europe, all variables similarly maintain the sign of their coefficients and their significance levels. Accordingly, our results are robust to the grouping effect.

Table 11: Margins effect of the PPML robustness test for Core Europe

	(1) COMPOSITE	(2) COMPOSITE	(3) RQ	(4) CC	(5) PS	(6) RL	(7) VA	(8) GE
FDI	41.5	-816.278	-464.176	-2219.432***	-33.126	-1058.715**	-1654.183***	-1171.387**
	(29.966)	(504.88)	(423.8)	(626.78)	(160.91)	(520.32)	(526.49)	(574.69)
INST	-72.381	-72.586	143.630***	86.820***	-142.601***	-59*	102.7073	38.04372
	(65.264)	(65.42)	(50.765)	(32.557)	(29.176)	(34.131)	(78.811)	(42.763)
FDI*INST		9.229*	4.986	23.687***	1.210	11.539**	17.378***	12.616**
		(5.352)	(4.463)	(6.632)	(1.876)	(5.426)	(5.37532)	(6.013)
ln GDP	-7320.59***	-7860.283***	-10682.09***	-11111.67***	-3744.341**	-8072.582***	-10524.13***	-8953.381***
	(1796.1)	(1778)	(1876.8)	(1793.1)	(1629.6)	(1524)	(1895.4)	(1720.4)
lag RDEX	3071.207***	3006.232***	1814.567***	1659.59***	3980.962***	2881.204***	1963.81***	2098.157***
	(865.09)	(888.38)	(527.4)	(599.48)	(654.66)	(769.4)	(700.31)	(718.24)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 12: Margins effect of the PPML robustness test for Periphery Europe

	(1) COMPOSITE	(2) COMPOSITE	(3) RQ	(4) CC	(5) PS	(6) RL	(7) VA	(8) GE
FDI	-0.220	-13.572***	-11.694***	-7.479**	-3.700***	-14.097***	-6.859**	-10.819***
	(0.165)	(4.459)	(3.734)	(3.054)	(1.195)	(4.298)	(3.069)	(3.604)
INST	-2.144***	-2.633***	-2.204***	-1.542***	-2.078***	-2.248***	-2.181***	-2.673***
	(0.411)	(0.427)	(0.418)	(0.299)	(0.264)	(0.364)	(0.353)	(0.592)
FDI*INST		0.166***	0.133***	0.0887**	0.051***	0.165***	0.083**	0.123**
		(0.054)	(0 .042)	(0.036)	(0.017)	(0.050)	(0.037)	(0.040)
ln GDP	22.327***	26.861***	23.319***	25.067***	21.123***	26.705***	23.881***	26.960***
	(7.784)	(6.861)	(7.808)	(7.985)	(5.861)	(7.255)	(7.333)	(7.095)
lag RDEX	42.874***	39.430***	21.650**	30.363***	51.084***	34.705***	40.050***	38.477***
	(10.048)	(9.592)	(9.268)	(10.238)	(9.912)	(9.776)	(9.423)	(7.095)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[4] **Core Europe** includes Germany, France, United Kingdom, Netherlands, Belgium, Luxembourg, Austria, Denmark, Sweden, Finland, Norway, Ireland, Italy, and Spain

Finally, we control for time-invariant unobserved heterogeneity by employing fixed effects. To further account for potential outliers and dynamic effects, we incorporate the logarithmic transformations of patents, FDI, and GDP, as well as the lagged logarithm of FDI, into our specification as an additional robustness check. The robustness of our results is particularly substantial in this context. FDI and INST exhibit negative and statistically significant coefficients, except in the case of CC, where the coefficient remains negative but not statistically significant for Western Europe. The interaction term between FDI and INST is consistently positive and significant across all model specifications. Overall, lagged FDI inflows appear to have no significant effect on innovation (see columns 1 and 2).

Table 13: Margins effect of the PPML robustness test for outliers and Dynamic Effects for Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
lag ln FDI	-0.047	-0.088	-0.279***	-0.161*	0.009	-0.132	-0.141	-0.175*
	(0.097)	(0.091)	(0.087)	(0.090)	(0.111)	(0.091)	(0.088)	(0.091)
ln FDI	-0.048	-1.459***	-2.505***	-1.301***	-0.304	-1.332***	-2.038***	-1.878***
	(0.105)	(0.471)	(0.721)	(0.369)	(0.469)	(0.415)	(0.528)	(0.515)
INST	-0.006***	-0.008***	0.038*	-0.011	-0.047***	-0.028**	-0.034***	-0.016
	(0.002)	(0.002)	(0.021)	(0.015)	(0.006)	(0.012)	(0.007)	(0.018)
ln FDI*INST		0.002***	0.026***	0.014***	0.004	0.014***	0.022***	0.021***
		(0.001)	(0.008)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
ln GDP	0.922***	0.795***	0.065	0.425**	- 1.142***	0.608***	0.728***	0.468***
	(0.269)	(0.214)	(0.235)	(0.165)	(0.355)	(0.148)	(0.154)	(0.145)
lag RDEX	1.463***	1.631***	0.873***	1.270***	1.592***	1.429***	1.385***	1.270***
	(0.206)	(0.211)	(0.244)	(0.254)	(0.192)	(0.230)	(0.188)	(0.253)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 14: Margins effect of the PPML robustness test for outliers and Dynamic Effects for Non-Western Europe

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	COMPOSITE	COMPOSITE	RQ	CC	PS	RL	VA	GE
lag ln FDI	-0.074	-0.195	-0.193	-0.205*	-0.096	-0.191	-0.202*	-0.170
	(0.126)	(0.121)	(0.128)	(0.124)	(0.120)	(0.123)	(0.120)	(0.124)
ln FDI	-0.057	-2.304***	-2.031***	-1.803***	-1.705***	-1.911***	-2.001***	-2.954***
	(0.125)	(0.435)	(0.412)	(0.354)	(0.339)	(0.389)	(0.391)	(0.501)
INST	-0.0004	-0.005***	-0.022***	-0.028***	-0.024***	-0.027***	-0.025***	-0.048***
	(0.0014)	(0.001)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)	(0.009)
ln FDI*INST		0.005***	0.025***	0.024***	0.025***	0.025***	0.026***	0.037***
		(0.0009)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)	(0.006)
ln GDP	0.764***	0.832***	0.791***	0.821***	0.911***	0.813***	0.876***	0.726***
	(0.178)	(0.107)	(0.113)	(0.114)	(0.142)	(0.112)	(0.116)	(0.120)
lag RDEX	0.822***	0.694***	0.616***	0.781***	0.696***	0.758***	0.672***	0.912***
	(0.182)	(0.170)	(0.162)	(0.168)	(0.167)	(0.172)	(0.171)	(0.162)

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.

7 Conclusion

This study set out to identify the key country-level factors that drive the innovation capacity. While FDI is negatively associated with the patent production in the host countries, the interaction between FDI and WGIs is positively related to innovation. We conducted several robustness tests using RDEX as an alternative innovation metric, examined grouping (Western and East and Central Europe vs Core and Periphery Europe) and dynamic effects, and found that the results remain largely consistent. The results suggest that the quality of government institution matter in the relationship between FDI and the innovation level in the host countries. An effective government system appears to reduce the detrimental consequences of FDI on local innovation and reap FDI spillover benefits.

The findings of this study provide valuable insights for policy and practice. First, they suggest that attracting foreign investment alone is not sufficient; host countries also need a strong institutional environment that encourages meaningful collaboration between local and foreign firms, thereby supporting innovation. Enhancing governance and ensuring accountable institutions can strengthen the association between FDI and innovation outcomes.

Second, the study highlights that institutional factors influence the FDI–innovation relationship differently across European regions, indicating that strong local innovation can play a useful role in the association between FDI–innovation.

Finally, the results imply that host countries aiming to boost innovation through FDI should foster closer engagement with foreign investors to generate new knowledge and fully leverage the benefits of investment. Similarly, foreign firms can optimize their strategies by aligning with the local institutional context and tapping into skilled labor capable of driving innovative activities.

This study has one limitation. It examines innovation without observing their aspects (i.e., product innovation, technological innovation, marketing innovation, eco-innovation. etc.). Other potential future revenue of research could be running the models considering firms-level variables.

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