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The Effect of Regulations on Technology Innovation: The Case of Korea*

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This study comprehensively assessed how the 11 detailed regulation affects technology innovation. The Probit model is adopted to estimate the effects with the Korea Innovation Survey 2018 and the VALUESearch (financial statement database). Empirical results show that the government support system and total innovation expenditure intensity have positive impact on innovation, whereas regulations, firm age, and CR3 have negative impact. Among the detailed government regulations, those related to start-up eligibility, restrictions on private sector entry into public goods/services, regulations on industries eligible for SMEs, and price limits, in that order, have a negative impact on innovation. The fact that the largest positive and negative effects are the government support system and regulations respectively imply that government's intervention policy played a very important role.

JEL Classification: O38, O31, O30
Keywords: innovation, regulation, government, support, Korea

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1. INTRODUCTION

Korea is experiencing slow productivity growth, driven by challenges such as an investment slump, low fertility rates, and an aging population.[1] Technological innovation is critical for revitalizing productivity and strengthening the economy,[2] particularly in the context of the 4th Industrial Revolution. Understanding firm-level drivers of innovation is vital, as innovation becomes a cornerstone of sustainable economic development. While regulations are often seen as constraints, well-designed frameworks can transform them into catalysts for innovation, fostering progress and resilience in Korea's evolving economic landscape.

Looking at the relationship of regulation and innovation, the OECD (1996) considered regulations as economic, social, and administrative forms that influence market behaviors, resource allocation, and firm dynamics. Their impact on innovation is inherently dualistic, functioning both as a constraint and a stimulus. Stewart (2010) supports this duality by mentioning that compliance burdens can divert resources away from innovation, while regulations can also incentivize firms to innovate to meet new standards. Jaffe and Palmer (1997) also explained that while compliance costs can increase R&D investments, their direct effect on patent outputs is limited. Similarly, Blind (2012) highlights how economic, social, and institutional regulations can differentially affect innovation across industries, depending on their design and implementation. Their findings underscore the importance of tailoring regulatory frameworks to maximize their potential for fostering innovation while minimizing compliance costs.

To take a close look at the multifaceted aspects of the relationship between regulation and innovation, three relevant areas, including entrepreneurship theory, industrial economics, and evolutionary economics, have been examined from different perspectives. Entrepreneurship theory examines how firms respond to regulatory environments at the micro level. Regulations shape entrepreneurial ecosystems by influencing firm decisions, resource allocation, and innovation trajectories. Firth and Mellor (1999) emphasize the systemic ripple effects of regulations, demonstrating that their impacts often extend beyond immediate compliance. Porter (1991) views environmental regulation may have a positive effect on the performance of domestic firms and suggests that stringent but well-structured regulations can drive firms to innovate, particularly in environmentally sensitive sectors (Jiang et al., 2018; Feng and Chen, 2018).

From the perspective of industrial economics, regulations serve as macroeconomic tools to address market failures, foster competition, and improve efficiency. Blind (2012) highlights the sector-specific impacts of regulation in OECD countries, showing

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[1] Oh and Kim (2015).

[2] Kim et al. (2015) and Oh and Yoo (2022) emphasize the importance of innovation to reduce CO2 emissions.

that competitive pressures from economic regulations often spur process innovation, while social regulations may encourage sustainability-oriented innovation. Bazilinska (2022) further illustrates the synergy between anti-corruption measures and investment incentives, fostering compliance and innovation simultaneously. However, poorly designed regulations can impose excessive compliance costs, stifling innovation and diverting resources away from R&D.

Evolutionary economics provides a dynamic, systemic perspective on regulation and innovation. Evolutionary economics views economic systems as evolving entities shaped by technological change and institutional development. Wilson and Gowdy (2013) describe regulation as a selection pressure that drives technological and institutional adaptations to meet societal goals. Frenken and Boschma (2007) conceptualize innovation as a branching process, where new technologies and processes create growth opportunities for firms and regions.

Despite their differing emphases, all of the three areas recognize the dual role of regulation as both a constraint and an enabler of innovation. Effective regulatory frameworks create incentives for technological advancement, while minimizing barriers to compliance. At the same time, the frameworks diverge in their focus. Entrepreneurship theory prioritizes firm-level dynamics, industrial economics examines market structures and competition, and evolutionary economics emphasizes systemic and long-term processes. These differences offer complementary insights and highlights the critical role of well-designed regulatory policies in fostering sustainable economic growth and technological progress.

Existing studies tend to examine the determinants of technology innovation in Korean firms (Sung, 2005; Song and Oh, 2010; 2015). Other studies treat regulation as a single, monolithic concept, despite the multifaceted aspects of the relationship between regulation and innovation. Most of prior research deals with a specific regulatory area (e.g., environmental or intellectual property) or consider all regulatory measures together.

To fill the gap, this study aims to evaluate and compare the effects of regulations on the technology innovation in Korea, focusing on the government total regulation and 11 detailed regulations on innovation. This study analyzes the effects of the explanatory variables including government support system, total innovation expenditure intensity, CR3, operating income to sales, initial public offering. This study also uses the datasets by combining the Korea Innovation Survey 2018 (KIS 2018) and VALUESearch[3)] (financial statements database) to provide a more robust empirical result. Furthermore, while existing studies tend to focus on cases in the US or Europe, this study adopts a Korean case uniquely. Korea is a highly industrialized, export-oriented economy with strong policy involvement in innovation. The results of this study will inform Korean policymakers as well as those in other emerging and advanced economies dealing with similar challenges.

[3)] Formerly KISVALUE.

This study is organized as follows. Section 2 explains methodology and data. Section 3 presents empirical results. Section 4 provides conclusion and policy implications.

2. METHODOLOGY AND DATA

2.1. Methodology[4)]

This study uses the existence of innovation as a dependent variable. It has a value of 1 when innovation exists and 0 otherwise. Because the dependent variable is a binary variable, this study analyzes the determinants of innovation by using a Probit model that has been used in previous research, for instance Bhattacharya and Bloch (2004), Majumdar (2011), Shin (1999), Sung (2005) and Song and Oh (2010).

The Probit model is described as the relationship between the explanatory variables and the dependent variable that has a value of 0 or 1. The following equation (1) indicates that the existence of the performance of innovation for a firm is used as the explanatory variable during a certain period of time. At this point, the dependent variable and the explanatory variables will have nonlinear relationships with each other.

$$P(y = 1) = F(x\beta),$$
$$P(y = 0) = 1 - F(x\beta), \quad (1)$$

where P is the probability, F is the probability distribution function, y is the dependent variable, x is explanatory variables, and ß is parameter.

In equation (1), the probability of y=1; that is, the presence of the performance of innovation, appears as a function of xß, so the equation is called the Probit model when $f(\bullet)$ is a normal probability distribution function. ß are the coefficients of the explanatory variables (x) that determine the probability that innovation will occur.

$$P(y = 1) = \int_{-\infty}^{x\beta} \varphi(t)dt = \Phi(x\beta), \quad (2)$$

where $\phi(\bullet)$ is the standard normal probability distribution function and $\Phi(\bullet)$ is the standard cumulative probability distribution function, thus the estimate of ß can be obtained by maximizing the likelihood function of the equation (2).

In the case of the general linear model, $E(y|x)$ is xß, so ß represent the marginal effect on the dependent variable x. However, in the Probit model, the standard normal cumulative distribution function is an increasing function and $E(y|x)$ is $F(x\beta)$, so that ß

4) This part is based on Song and Oh (2015).

itself no longer represents the marginal effect. The sign of ß simply shows positive or negative effects on the probability that a company's innovation activity will take place.

Thus, the marginal effect should be measured separately in the empirical analysis using the Probit model, which presents the change of the expected value of the dependent variable according to changes of the explanatory variables. In other words, it illustrates how much the probability of innovation will increase on average whenever the explanatory variables increase by one unit; hence, the differentiation of the expected value of the dependent variable (y) by the explanatory variables (x) can be measured as follows:

$$\frac{\partial E(y|x)}{\partial x} = \varphi(x\beta)\beta, \tag{3}$$

where ϕ is standard normal probability density function.

2.2. Data

The primary data source is the Korea Innovation Survey: Manufacturing Sector (KIS 2018, hereafter).[5] The KIS 2018 is designed on the basis of the fundamental formation of the OECD (2005) and CIS (Community Innovation Survey) questionnaire of EUROSTAT. The KIS 2018 covers three years from 2015 to 2017. The KIS 2018 used a stratified multi-stage sampling methodology and selected the final sample of companies via random sampling. The companies belonged to sections 10-33 (excluding 12, tobacco manufacturing) in the 9th edition of Korean Standard Industrial Classification and had more than 10 permanent employees at the time of the survey. In the end, a total of 3,500 private companies responded to the survey.

From the KIS 2018, we obtain the innovation output (existence of innovation), sales, age, total innovation expenditure (TIE), initial public offering, total government support system, and 11 detailed regulations. This study uses TIE as a main measure of R&D activities to examine the effect of R&D activities on innovation. The OECD Oslo Manual (2005) mentions TIE as the current and capital expenditure on various innovation activities such as research and experimental development, activities for product and process innovations as well as activities for marketing and organizational innovations.[6] So TIE can be viewed as a better indicator for studying the relationship between R&D activities and innovation.

As the KIS 2018 is the first survey on regulation, three types of regulations in KIS 2018 are used, which is displayed in Table 1: economic regulation, social regulation, and administrative regulation. Each regulation has detailed regulations: economic regulation with five detailed regulations; social regulation with four detailed regulations,

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[5] The statistics was approved as official statistics in 2003 (Part No. 39501) by Statistics Korea, a government organization for statistics.

[6] OECD (2005, pp. 98-99) explains the four innovations: product, process, organization and marketing innovation.

and administrative regulation with two detailed regulations. Note that OECD (1996) report discussed three general types of regulation, all of which have effects on innovation. Economic regulation is intended to ensure the efficiency of markets, partly through promoting adequate competition among actors in the marketplace. Social regulation is intended to promote the internalization of all relevant costs by these actors. Administrative regulation can be said to aim at ensuring the smooth functioning of public- and private-sector operations.

Table 1 Types of Regulations

Regulations		Promotion of innovation		Neutral	Interruption to innovation	
		Highly	Slightly	No influence	Slightly	Highly
Economic regulations	1) Competition restrictions by monopoly related regulations	2	1	0	−1	−2
	2) Price limit	2	1	0	−1	−2
	3) Private sectors' entry restrictions to public goods/services	2	1	0	−1	−2
	4) Regulations on SMEs eligible industries	2	1	0	−1	−2
	5) Financial market regulations and the separation of banking and commerce	2	1	0	−1	−2
Social regulations	6) Regulations on environments	2	1	0	−1	−2
	7) Regulations on industrial safety and health	2	1	0	−1	−2
	8) Regulations on consumer safety and hygiene	2	1	0	−1	−2
	9) Labor (employment/labor) standards and regulations	2	1	0	−1	−2
Administrative regulations	10) Regulations on start-up eligibilities	2	1	0	−1	−2
	11) Protection of intellectual property (patent, intellectual property, trademark, etc.)	2	1	0	−1	−2

Another data source is VALUESearch which is a financial database for firms. From the database, we obtain sales, sales by industry, and operating income to sales. The dependent variable in this study uses the existence of innovation output as in Bhattacharya and Bloch (2004), Sung (2005), and Song and Oh (2010, 2015). The explanatory variables in this study are sales, sales square, market concentration (by concentration ratio

3), operating income to sales (operating income/sales), initial public offering, government support system and regulations.

We include the sales square to check whether there is an inverted U-shaped relationship between firm size and innovation. If sales have a plus sign and sales square has a minus sign, then we could say that there is an inverted U-shaped relationship between firm size and innovation output. In this case, the innovation will increase as sales increase to a certain level. After that, innovation tends to decrease once the firm's size passes to a certain level. In other words, the possibility of innovation will not increase proportionally with sales.

3. EMPIRICAL RESULTS

Table 2 shows descriptive statistics and Table 3 shows the correlations among variables.

Table 2 Descriptive Statistics

	Mean	Std. Dev.	Maximum	Minimum
INNO	0.6351	0.4818	1	0
SALE	290557.8	1088120	22503171	2130.045
SALEQ	1.27E+12	2.08E+13	5.06E+14	4537093
AGE	23.4534	12.0937	77	5
CR3	28.0212	17.7585	62.3000	8.83337
TIEINT	0.0377	0.0953	1.7633	0
OPR	0.0685	0.2184	3.0849	−0.6773
IPO	0.1675	0.3737	1	0
SUPPORT	0.9273	0.2598	1	0
REGUAVE	0.1313	0.5930	1.91	−2
REGU1	0.0995	0.6448	2	−2
REGU2	0.0395	0.7356	2	−2
REGU3	0.0932	0.8010	2	−2
REGU4	0.0600	0.8130	2	−2
REGU5	0.0079	0.7965	2	−2
REGU6	0.1106	0.7592	2	−2
REGU7	0.2370	0.8329	2	−2
REGU8	0.2970	0.9381	2	−2
REGU9	0.2480	0.9531	2	−2

REGU10	0.0300	0.6637	2	−2
REGU11	0.2212	0.8992	2	−2

Notes: Concentration ratio (CR3) = the market shares of the three largest firms,
TIEINT = total innovation expenditure intensity = total innovation expend/sales,
OPR=operating income to sales = operating income/sales, IPO = initial public offering,
SUPPORT = government support system, REGUAVE = average of REGU1~REGU11
REGU1 = competition restrictions by monopoly related regulations
REGU2 = price limit
REGU3 = private sectors' entry restrictions to public goods/services
REGU4 = regulations on SMEs eligible industries
REGU5 = financial market regulations and the separation of banking and commerce
REGU6 = regulations on environments
REGU7 = regulations on industrial safety and health
REGU8 = regulations on consumer safety and hygiene
REGU9 = labor (employment/labor) standards and regulations
REGU10 = regulations on start-up eligibilities
REGU11 = protection of intellectual property (patent, intellectual property, trademark, etc.).

Table 3 Correlations among Variables

	INNO	REGUAVE	REGU1	REGU2	REGU3	REGU4	REGU5	REGU6	REGU7	REGU8	REGU9	REGU10	REGU11
INNO	1.00	−0.28	−0.19	−0.27	−0.33	−0.31	−0.28	−0.24	−0.14	−0.09	−0.03	−0.30	−0.16
REGUAVE	−0.28	1.00	0.71	0.73	0.73	0.76	0.74	0.74	0.79	0.74	0.74	0.73	0.71
REGU1	−0.19	0.71	1.00	0.62	0.62	0.60	0.56	0.43	0.47	0.44	0.41	0.38	0.37
REGU2	−0.27	0.73	0.62	1.00	0.55	0.63	0.57	0.50	0.49	0.40	0.43	0.45	0.40
REGU3	−0.33	0.73	0.62	0.55	1.00	0.76	0.76	0.47	0.42	0.28	0.26	0.58	0.36
REGU4	−0.31	0.76	0.60	0.63	0.76	1.00	0.76	0.51	0.45	0.31	0.32	0.57	0.35
REGU5	−0.28	0.74	0.56	0.57	0.76	0.76	1.00	0.47	0.38	0.30	0.32	0.61	0.37
REGU6	−0.24	0.74	0.43	0.50	0.47	0.51	0.47	1.00	0.67	0.52	0.52	0.50	0.42
REGU7	−0.14	0.79	0.47	0.49	0.42	0.45	0.38	0.67	1.00	0.73	0.70	0.49	0.54
REGU8	−0.09	0.74	0.44	0.40	0.28	0.31	0.30	0.52	0.73	1.00	0.80	0.43	0.60
REGU9	−0.03	0.74	0.41	0.43	0.26	0.32	0.32	0.52	0.70	0.80	1.00	0.41	0.61
REGU10	−0.30	0.73	0.38	0.45	0.58	0.57	0.61	0.50	0.49	0.43	0.41	1.00	0.63
REGU11	−0.16	0.71	0.37	0.40	0.36	0.35	0.37	0.42	0.54	0.60	0.61	0.63	1.00

Table 4 shows the effect of government regulation on technology innovation. There are a total of 12 models of government regulation including 11 detailed regulations. In order to avoid multi-collinearity problems, the regulation variable is included only individually. Estimated results show that sales of all models are not statistically significant. Schumpeter (1934) has argued that the larger and the more monopolistic in market structure the corporations are the more innovative. It is called the 'Schumpeterian Hypothesis'. The result shows that the hypothesis does not hold. Sales squares variable in all models are not statistically significant. These two results show that there is no inverted U-shaped hypothesis between market size and technology innovation. This is the opposite to Scherer (1965a; 1965b)'s findings of an inverted U

shape relationship, but consistent with Kamien and Schwartz (1982) and Acs and Audretsch (1990; 1991). Both operating income to sales and IPO are not statistically significant in all cases.

Firm age is negatively significant at 5% significance level in all cases. This implies that younger firms are more innovative than older and large enterprises. The effect of CR3 on technology is negative and statistically significant at a 10% significance level in Models 1 and 3 while insignificant in other models. The negative effect of CR3 on technology means that the more competitive market the more innovative of firms.

The effect of total innovation expenditure intensity is positive and statistically significant at 5% in seven models out of 12 models. It is natural that innovation activities enhance innovation of output. The government support system has a strong positive effect and significant at 1% level in all 12 cases. The total (average) regulation has a negative effect on private sectors' innovation at 1% significance level. Among the 11 detailed regulations, 10 regulations excluding labor (employment/labor) standards and regulations (REGU9) negatively affects innovation. This suggests that the government

Table 4 Estimation of Regression

Variable	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
SALE	2.3E-07	3.8E-08	2.1E-07	3.5E-07	2.3E-07	2.6E-07	3.7E-07	1.3E-07	4.7E-08	1.1E-07	9.3E-08	1.6E-07
SALEQ	2.9E-13	3.7E-13	2.5E-13	2.4E-13	3.0E-13	2.5E-13	1.9E-13	3.1E-13	3.3E-13	3.0E-13	3.4E-13	2.5E-13
AGE	−0.009**	−0.008**	−0.008**	−0.009**	−0.008**	−0.01**	−0.009**	−0.008**	−0.008*	−0.008**	−0.01**	−0.009**
CR3	−0.005*	−0.004	−0.006*	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004	−0.004	−0.003	−0.004
TIEINT	1.531*	1.466*	1.507*	1.274	1.502*	1.263	1.539*	1.332*	1.231	1.168	0.968	1.311*
OPR	−0.136	−0.21 0	−0.19 0	−0.162	−0.167	−0.142	−0.147	−0.131	−0.168	−0.156	−0.13 0	−0.116
IPO	−0.005	0.019	0.032	−0.051	0.02	−0.007	0.012	0.019	0.038	0.046	0.078	0.051
SUPPORT	0.711***	0.637***	0.671***	0.669***	0.618***	0.617***	0.637***	0.651***	0.654***	0.607***	0.670***	0.668***
REGUAVE	−0.677***											
REGU1		−0.437***										
REGU2			−0.529***									
REGU3				−0.599***								
REGU4					−0.543***							
REGU5						−0.481***						
REGU6							−0.451***					
REGU7								−0.246***				
REGU8									−0.153***			
REGU9										−0.074		
REGU10											−0.675***	
REGU11												−0.259***

Note: *** (**, *) means 1% (5%, 10%) significant.

needs to loosen regulations to enhance innovation. The results of government support system and regulation show that government plays an active role in private sectors' innovation.

Table 5 illustrates marginal effects of the estimation results and shows the relative size of the variables. It indicates that the age is −0.003~0.004, CR3 is −0.002, total innovation expenditure intensity is 0.681~0.805, government support system is 0.442~0.530, REGU1 (competition restrictions by monopoly related regulations) −0.211, REGU2 (price limit) −0.260, REGU3 (private sectors' entry restrictions to public goods/services) −0.286, REGU4 (regulations on SMEs eligible industries) −0.264, REGU5 (financial market regulations and the separation of banking and commerce) −0.240, REGU6 (regulations on environments) −0.216, REGU7 (regulations on industrial safety and health) −0.117, REGU8 (regulations on consumer safety and hygiene) −0.074, REGU10 (regulations on start-up eligibilities) −0.332, and REGU11 (protection of intellectual property) −0.124. From these, it can be seen that the regulations that have the negative greatest influence among the detailed 11 regulations are REGU10, REGU3,

Table 5 Estimation Results–Marginal Effects

Variable	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
SALE	1.2E-07	1.9E-08	1.1E-07	1.9E-07	1.2E-07	1.4E-07	2.0E-07	6.9E-08	2.4E-08	5.6E-08	4.7E-08	8.2E-08
SALEQ	1.8E-13	2.5E-13	1.5E-13	1.5E-13	2.0E-13	1.6E-13	1.1E-13	2.0E-13	2.2E-13	1.9E-13	2.3E-13	1.6E-13
AGE	−0.004**	−0.003**	−0.004**	−0.004**	−0.004**	−0.004**	−0.004**	−0.003**	−0.003*	−0.003**	−0.004**	−0.004**
CR3	−0.002*	−0.002	−0.002*	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002	−0.002
TIEINT	0.801*	0.765*	0.788*	0.661	0.785*	0.656	0.805*	0.693*	0.638	0.605	0.498	0.681*
OPR	−0.068	−0.104	−0.094	−0.08	−0.083	−0.07	−0.073	−0.065	−0.083	−0.077	−0.065	−0.058
IPO	−0.003	0.010	0.016	−0.025	0.01 0	−0.004	0.006	0.01 0	0.019	0.023	0.039	0.026
SUPPORT	0.530***	0.461***	0.492***	0.490***	0.443***	0.442***	0.460***	0.473***	0.476***	0.433***	0.491***	0.489***
REGUAVE	−0.315***											
REGU1		−0.211***										
REGU2			−0.260***									
REGU3				−0.286***								
REGU4					−0.264***							
REGU5						−0.240***						
REGU6							−0.216***					
REGU7								−0.117***				
REGU8									−0.074***			
REGU9										−0.037		
REGU10											−0.332***	
REGU11												−0.124***

Note: *** (**, *) means 1% (5%, 10%) significant.

REGU4, and REGU2. A possible reason for insignificant REGU9 (labor standards and regulations) is that firms are already compliant with these standards to the point that they no longer present a barrier.

4. CONCLUSION AND POLICY IMPLICATIONS

Korea, like many advanced economies, faces significant challenges, including demographic shifts, slowing productivity growth, and the need to sustain innovation-driven development. This study contributes to literature by disaggregating regulatory types and providing empirical evidence on which categories most hinder innovation.

The empirical results reveal several critical insights. The relationship between market size (sales) and technological innovation does not support the inverted U-shaped hypothesis, as sales and their squared terms were not statistically significant across all cases. Similarly, sales-to-operating income and IPO status were also insignificant predictors. Firm age negatively correlates with innovation, suggesting that younger firms are more innovative. This underscores the importance of policies targeting SMEs and venture firms. Market competitiveness, measured by the CR3, is negatively associated with innovation in certain models, indicating that increased competition in some markets may stifle technological advancements.

Government support systems positively influence innovation, whereas 11 out of 12 regulatory categories examined have adverse effects. Among the regulatory categories, the most detrimental to innovation include restrictions on start-up eligibility, private sector entry into public goods and services, industry eligibility for SMEs, and price controls. These findings suggest that revising or deregulating these specific areas could yield substantial benefits.

The results have significant implications for policymakers. Rather than pursuing wholesale deregulation, which may lead to unintended consequences, policymakers should focus on the regulations identified as most harmful to innovation. Given the higher innovation potential of younger and smaller firms, policies that reduce barriers to entry and foster a competitive, yet supportive ecosystem are crucial. Revising regulations that limit certain industries to SMEs or impose price controls may enable firms to compete on quality and innovation rather than being constrained by regulatory mandates.

This study has some limitations that suggest avenues for future research. The use of binary variables to measure innovation, based on the OECD Oslo Manual framework, oversimplifies the complexity of innovation processes and outcomes. The potential endogeneity between regulations and innovation remains a challenge. Future research

could employ causality tests,[7] panel data approaches, or difference-in-differences methods to strengthen causal inferences. The Probit model results might vary with alternative specifications, such as Logit models, linear probability models, or subsamples stratified by sector, firm size, or export orientation. Advanced diagnostic tests could further validate these findings. While this study focuses on Korea, comparative analyses across OECD economies could reveal whether similar regulatory patterns exist in other contexts. Future research could investigate the interplay between regulatory interventions and other factors, such as industry characteristics and firm-level attributes. Examining the time-lagged effects of regulations on innovation could provide a deeper understanding of their long-term impacts.

[7] Hahn and Park (2011) performed causality test between innovation and export.

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