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National Innovation Systems and Corporate Intangible Investment as a Driver of Sustainable Development: A Cross-Country Study

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ABSTRACT

We investigate the impact of national innovation systems (NIS) on corporate intangible investment, which is a crucial factor in economic growth and sustainable development. Using a comprehensive international sample of 25,974 firms from 77 countries during 2011–2019, we find a positive impact of NIS on corporate intangible investment and corporate intangible value growth. Our results suggest that governments can stimulate growth in intangible assets at the firm level by fostering innovation at the national level. The impact persists in different components of NIS, including human capital and research, infrastructure, technology and creative outputs, and business and market sophistication. Further analysis suggests that the impact is more pronounced in small firms, firms with high growth, and firms depending more on intangibles. At the macro level, the effect of NIS seems to be largely stronger in developed countries, weakened under income inequality while being supported by a younger workforce and strong rule of law. Our findings have practical implications for policymakers regarding how national innovation forms corporate intangible asset growth and contributes to sustainable economic development.

1 | Introduction

National innovation system (NIS) refers to the elements and relationships in the process of producing and using new and economically useful knowledge (B.-A. Lundvall 2007). In other words, NIS is a set of interacting institutions that determine the effectiveness of national innovation activities and impact a country's economic, political, and social factors (Nelson 1993; Chung 2002; Mowery 2008; Lerner 2013). Since innovation promotes national growth through encouraging creativity in various technological and economic fields (Balzat and Hanusch 2004; Mrozewski and Kratzer 2017), Mazzucato (2018) points out that governments are paying increasing attention to innovation policies at the national level to systematically enhance innovation capacity, which is expectedly translated into higher corporate efficiency. The United Nations officially recognizes innovation as an important driver of sustainable development, as indicated in the Sustainable Development Goal 9: Industry, Innovation, and Infrastructure.[1]

This study focuses on how NIS drives a fundamental business activity, which is corporate investment in intangibles. As intangibles are linked to corporate innovation and technological progress, they are the new sources of value in most business sectors and are considered the drivers of economic resilience under uncertainty (Nakamura 2010; Rowe 2019; Li et al. 2020; Hoang and Tran 2022; Hoang et al. 2023). Innovation and investment in intangibles such as intellectual property, R&D, and

organizational know-how are vital because they drive the development of new solutions to economic, social, and environmental challenges, directly supporting sustainable growth and resilience. Recognizing this, the United Nations includes innovation as a key pillar in the Sustainable Development Goals—especially SDG 9—since fostering both innovation and intangible assets is essential for building inclusive, sustainable industries and advancing progress across all SDGs.

Departing from conventional tangible asset investments, recent studies in the literature suggest that firms are shifting their investments from tangibles to intangibles for value creation. Crouzet et al. (2022) show that in the United States, the ratio of public firms' intangible assets to tangible assets has increased dramatically from 0.75 in 1975 to ~1.03 in 2021. The majority of the variation in the ratio is documented at the end of the last century and is attributable to the information technology-driven productivity boom in the early 2000s (Corrado et al. 2022). We argue that a strong NIS can create an environment that encourages firms to invest more in intangible assets and generate more value than tangible assets investments. Countries that provide robust innovation support can catalyze corporate innovative activities by stimulating higher levels of corporate investment in R&D and other intangible assets (Tsai et al. 2019; Gan et al. 2024). While the role of NIS and intangible assets is separately discussed in the literature, there is no direct evidence of how the two important drivers of economic growth are related. Given that an effective NIS is crucial for fostering an environment conducive to corporate innovation and economic growth, it is a surprise that the impact of NIS on corporate intangible investment remains under-researched in the literature.

This paper aims to investigate the impact of NIS on corporate intangible investment. Using a comprehensive sample of firms from 77 countries during 2011–2019, we unveil a robust positive causal impact of NIS on firm intangible investment after addressing different issues in panel data and regression analysis, including measurement errors, omitted variable bias, reverse causality, and more. By leveraging the national innovation pillar scores from the Global Innovation Index Report series by the World Intellectual Property Organization, we quantify the impact of national innovation on corporate intangible investment and the changes in values of those investments. The empirical findings suggest the importance of NIS in value creation from intangible assets at the firm level. Further analysis suggests that the impact is weakened in countries with high degrees of inequality and older workforces while being stronger in countries with better governance. The findings emphasize the roles of a young workforce, maintaining equality in the economy and society, and strong governance at the country level.

This study contributes to the literature in three specific ways. First, it is the first study revealing empirical evidence of how NIS, the macro-level institutions related to innovation, influence firm-level investment in intangibles in a cross-country setting. A large portion of the current innovation literature focuses on the drivers of corporate innovation and how corporate innovation factors into corporate decision-making and performance (e.g., Gunday et al. 2011; Tian and Wang 2014; Ellis et al. 2020; Hao et al. 2022; Breuer et al. 2025). With regard to NISs, there is a concentration of research interest on national/regional innovation models and macroeconomic consequences (e.g., Chung 2002; B.-A. Lundvall 2007; Huang et al. 2023; Suominen et al. 2023), while studies on the impact of NISs are virtually missing. This study offers a fresh view on the impact of NIS and its pillars on corporate investment—a crucial decision that has implications for not only firms themselves but also the broader economy in general.

A study that is close to ours is Hou and Feng (2024), which demonstrates that innovation-supportive policies stimulate investment efficiency. However, Hou and Feng (2024) do not use a comprehensive measure of NISs but rely on a dummy variable representing city-years that are in the list of national innovative pilot cities. The use of this nominal variable cannot capture the variability in the development of the innovation system constructed within the city. Furthermore, the scope of this study is restricted to the Chinese cities, which share certain government innovation policies apart from the special mechanisms designated for innovation pilot cities. Another related study that employs the Global Innovation Index to examine corporate investment behaviors is Huynh et al. (2025); nonetheless, that study is fundamentally different from ours as it examines firms' investment efficiency in response to changes in the index, and the sample only consists of Vietnamese listed firms. Meanwhile, our study adds to the general picture by elaborating on the beneficial effect of NIS on investments in tangible assets in a cross-country setting.

Using the cross-country setting brings forth advantages over focusing on a single country context for several reasons. Since countries develop their NIS depending on their specific institutional, economic, and governance contexts, there should be potential variations in the impact of NISs conditional on various economic and social factors. By covering 77 countries across different stages of development, this study captures heterogeneity in innovation environments and how firms accommodate their investments in adaptation to their NISs. We unveil that corporate responses to NIS initiatives are generally positive and most significant for the pillar of knowledge and technology outputs, followed by business sophistication, then infrastructure, and human capital. The findings shed light on how macro-level institutions and innovation infrastructure stimulate the growth of intangible assets and intangible values in the economy. Furthermore, using a consistent empirical framework across countries helps uncover systemic patterns and structural determinants that would be invisible in country-specific studies, which then allows us to figure out the interplay between NISs, corporate investment, and other key macroeconomic indicators that shape this relationship in meaningful ways. This study, thereby, offers both theoretical and policy-relevant contributions that extend the applicability of innovation system research to a broader global context in this new era of sustainable development.

Second, we show that strong institutions related to innovation hinder intangible investment, thus providing a reference for policymakers when formulating national innovation strategies to facilitate economic growth. Our findings complement the existing findings and arguments in the literature, such as the discussion of the relationship between institutions and innovation

systems (Nelson and Nelson 2002), the impact of institutions on innovation at the firm level (Aliyev and Kafouros 2023; Chadee and Roxas 2013; Donges et al. 2023; Rodríguez-Pose and Zhang 2020), government level (Tolbert et al. 2008), and community level (Lynn et al. 1996). Our findings emphasize that not all pillars of NIS encourage growth in corporate intangibles, thus suggesting heterogeneous impacts of NIS on corporate policy and outcomes. These findings are particularly important in shaping understanding of how national innovation pillars help form future corporate resilience and competitive advantage for sustainable economic growth.

Third, our findings complement existing literature by highlighting the significant variations in the impact of national innovation on corporate intangible investment across different country characteristics, suggesting the presence of additional macro-level mechanisms influencing this relationship. The findings emphasize the importance of equality, rule of law, and young labor forces in shaping the relationship between NIS and corporate intangible investment. This builds upon previous studies such as that by Corrado et al. (2009) which examine the role of intangible capital in economic growth across countries, and Haskel and Westlake (2017) and Roth (2022), who study the implications of the rise of intangible capital in modern economies. Our current study's focus on country-specific factors aligns with the study of Pece et al. (2015) on the impact of national innovation systems on economic growth. Additionally, it extends the work of Dakhli and De Clercq (2004), who investigate the relationship between human capital, social capital, and innovation at the country level. By identifying specific country characteristics that modulate the innovation-intangible investment link, this study provides valuable insights into the understanding of NIS's impact on corporate intangible and intangible investment outcomes.

The rest of the paper proceeds as follows. Section 2 reviews related literature and develops hypotheses for empirical analysis. Section 3 discusses the research methodology and data used in this study. Section 4 presents and discusses the empirical findings. Section 5 concludes our paper.

2 | Literature Review and Hypothesis Development

Under the Resource-based Theory, a firm's sustained competitive advantage stems from its ability to acquire, develop, and strategically deploy unique and inimitable resources—many of which are intangible, such as knowledge, organizational processes, R&D capabilities, and intellectual property (Freeman 1995; B. Å. Lundvall 2010). NISs play a crucial role in encouraging corporate investment in these intangible assets by shaping the institutional, educational, and infrastructural environment in which firms operate. To be specific, NISs enhance the availability and value of intangible resources at the national level through fostering coordinated policies, investments in education and research, and connections between businesses and other actors in the economy. This systemic support reduces the risks and costs associated with intangible investments and makes it more attractive for firms to develop and internalize these resources rather than rely solely on external acquisition.

Central to the Resource-based theory, the VRIN framework highlights the necessity of acquiring resources that are valuable (V), rare (R), not perfectly imitable (I), and non-substitutable (N) to sharpen firms' competitiveness (Barney 1991). Many of these resources are considered intangible and cannot be effectively developed in isolation, such as knowledge, R&D capabilities, and intellectual property. By offering institutional, educational, and infrastructural foundations conducive to corporate innovation, NISs can boost human capital, research infrastructure, and interorganizational collaborations, as well as alleviate innovation uncertainty that may otherwise jeopardize firms' intention to pursue the innovation path (Patel and Pavitt 1994; Cobben et al. 2023; Nguyen et al. 2024). These innovation-incentivizing features of NISs deliver a greater range of resources readily available for innovative firms, enabling them to create and internalize knowledge-based resources that satisfy the VRIN qualities, namely: (i) valuable contributions to increasing innovation capacities and productivity; (ii) rarity and inimitability, as the resources are developed based on contextual specificity and complex interdependencies between firms' functions and external collaborations; and (iii) being strategically formed through the complex interplay between institutional embeddedness and partnerships. Thus, firms embedded in well-developed NIS are better positioned to accumulate and leverage unique intangible assets that are difficult for competitors to imitate, directly supporting the RBT logic of resource-based advantage and innovation-driven performance (Barney 1991; B. Å. Lundvall 2010). It is also worth noting that the acquisition of intangible assets enables firms to develop and implement eco-friendly innovations with optimal allocations of resources, which subsequently translate into more sustainable business approaches (Xu et al. 2021; Ye et al. 2023). Furthermore, to ensure an efficient deployment of intangible assets, firms need to (i) enhance human capital, who directly handle the intellectual work, and (ii) focus on stakeholder engagement, especially academia and government, to facilitate the evolution of their intangibles and innovation activities (Wang and Yu 2023; Dwekat et al. 2025; Hsu et al. 2025). NISs, therefore, serve as an enabling infrastructure that nurtures and amplifies these intangible resources, guiding firms toward not only innovation but also sustainable development pathways.

The notion that technological advancement is the primary driver of economic development has been widely adopted nowadays, replacing the conventional view on the dominant contribution of accumulated capital to the growth of a nation (Solow 1956; Gerschenkron 1962). Since there is no free ride to technology pursuit, countries that spend trivial effort on upgrading their technological capacity are going to lag behind. This is not surprising that developing countries are struggling more with technological adoption given their limited resources and insufficient infrastructure, consequently widening the gap among nations (Watkins et al. 2015; Allard and Williams 2020).

An advanced NIS is characterized by abundant public funding, collaborative platforms between firms and universities, and incentives for innovation (Granstrand and Holgersson 2020). Thus, NIS development can encourage investments from innovative firms, which are more inclined to engage in intangible investments than non-innovative firms. Particularly, the increased investments in innovative firms can be observed in

the form of research and development (R&D) expenditures, patents, trademarks, software, and other intellectual properties (Freeman 1995; B. Å. Lundvall 2010; Montresor and Vezzani 2022). It is important to note that the term R&D is used with high frequency in intangible studies, given that corporate R&D expenditure is a highly attended topic and is a subset of intangible investments (Wyatt 2005).

Intuitively, NIS can promote intangible investments in several ways. First, the development of NIS can bring up a knowledge-rich business environment that shapes firms' interests in intangible investments to stay competitive (Robertson et al. 2023). To be specific, NIS promotes collaborations among universities, research institutions, and businesses, which in turn facilitate knowledge spillovers, an utterly pivotal driver of firms' intangible investments (Perkmann and Walsh 2007). Moreover, NIS development typically involves the formation of geographical innovation clusters, which further facilitates the cooperation among firms and other research actors that are located in proximity to each other (Delgado et al. 2014). Such relationships enable firms to conveniently obtain permission to implement their research outputs, making corporate innovation less costly and risk-prone.

Second, the ambition to develop a well-functioning NIS requires proactive actions from the government in terms of policymaking and incentives to assist firms in acquiring intangible assets. Howell (2017) employs the data from the US Department of Energy's SBIR grant program to demonstrate that an increase in R&D investment and patenting, resulting from the government's R&D subsidy schemes, is mostly visible in small and financially constrained firms. This approach, however, might be suboptimal if firms, especially SMEs, cannot efficiently handle the administrative burden and properly develop their internal capabilities (Coad et al. 2014; Kleine et al. 2022). To mitigate these downsides, the government can foster subsidized collaborative R&D efforts in which firms partner with other research institutions to enhance the outcome of R&D investments (Kleine et al. 2022). Besides R&D grants, tax credit is another prominent tool utilized by the government, which has shown its ability to boost corporate investments in intangible assets (Fullerton and Lyon 1988; von Brasch et al. 2021). Moreover, to make the prospect of firms' intellectual assets being stolen less of a concern, the development of NIS typically comes with intellectual property protection. The strength of intellectual property regulation not only determines intangible attention within the country but also affects R&D investment inflows from foreign businesses (Albino-Pimentel et al. 2022). The advocacy to financially support intangible asset investment and safeguard firms' rightful innovative properties, such as patents and trademarks, can be a motivation for firms to consider committing to intangible investments in the long term.

Third, it is humans who ensure the smoothness and synchronization of NIS with the current stage of economic development; hence, proper development of NIS must come with effective education and training programs to maintain a pool of skilled workforce that can readily hop into the innovation wave (Delgado et al. 2014). This macro human resource strategy is beneficial for firms as it widens the talent pool that firms can recruit from, thus enhancing their innovation capabilities and promising to influence firms' intangibles.

Another remark is that NIS can be a supporter of small and medium firms (SMEs) which are considered constrained when it comes to innovation and investments. As the promotion of NIS introduces a greater range of innovation grants, public research access, and collaboration networks, SMEs may be able to find the missing resources for innovation activities in the incentive package offered by the government (Autio et al. 2014). This, in turn, stimulates firms' investments in intangible assets. This view, however, is controversial since large firms can be advantageous in capturing NIS's offered resources. That is, large firms typically (i) have greater capacity to utilize the resources to achieve desired innovation outcomes, (ii) possess richer experience in implementing innovation activities, and (iii) are more inadvertently favored in terms of regulation thanks to their strong resource base and private relationship. That said, it is not feasible to equally distribute the benefits among all beneficiaries; at least, open opportunities are available for SMEs to increase their intangible asset base.

Empirically, some prior studies suggest that the variations of corporate intangible investment are conditional on national-level innovation. Haskel and Westlake (2017) show that in innovative economies, firms tend to allocate more resources to intangibles to enhance their competitive advantages. The engagement with intangibles might also stem from the pressure generated by industry peers, given that NIS's innovation-supporting packages are not generally made exclusively for specific targets. It is also worth noting that the emergence of digital technologies and global supply chains necessitates investment in intellectual capital (Zambon et al. 2020). The investment in intangibles, particularly in knowledge-based assets as elaborated on in Corrado et al. (2009), can impact productivity and growth positively. Knott (2017) adds to the story by offering international evidence that by optimizing R&D expenditures and intangibles, firms can effectively convert intangible investments into revenue. While optimization is highly dependent on firms' infrastructure and management, NIS's innovation support scheme also plays a vital role in creating favorable conditions for innovation activities to grow. This notion is evident by significantly higher levels of R&D spending and investment in intellectual capital witnessed in countries where government support for innovation is strong. Earlier, Chen and Puttitanun (2005) tackle the intellectual property right protection perspective, which is typically integrated as part of NIS nowadays, and unveil a positive impact of intellectual property rights on corporate investment in patents, trademarks, and copyrights. With regard to regional innovation, Antonelli (2011) finds that firms operating in high-innovation clusters exhibit higher rates of investment in intangible assets, largely due to the strong linkages between national innovation policies and regional knowledge spillovers. Taking China's rise as a global R&D leader as a salient example, Boeing (2016) describes that China's national innovation policies, such as government subsidies for R&D and patent creation, have led to a substantial increase in corporate intangible investment.

The growing importance of intangible assets in driving firm-level performance and national economic competitiveness underscores the potential relationship between national innovation

and corporate investment in intangibles. National innovation systems provide a supportive environment for firms to pursue intangible investments through institutional support, public funding, and favorable regulatory frameworks (Freeman 1995; B. Å. Lundvall 2010; Rodríguez-Pose and Zhang 2020; Donges et al. 2023). Moreover, firms in countries with well-developed innovation ecosystems tend to allocate a greater proportion of their resources to intangibles, leading to enhanced firm performance and long-term growth (e.g., Haskel and Westlake 2017; Corrado et al. 2009). Thus, based on the theoretical and empirical insights from prior studies, we propose the following hypothesis:

Hypothesis 1. **(H1)**: *National innovation has a positive impact on corporate intangible investment.*

3 | Methodology and Data

3.1 | Empirical Model

To examine the impact of national innovation on corporate intangible investment, we use the following model:

$$INTANGINV_{i,t} = \alpha + \beta GII_{i,t-1} + \sum CONTROL_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where $INTANGINV_{i,t}$ is the measure of intangible investment of firm i during year t; $GII_{i,t-1}$ is the measure of national innovation of the country where firm i locates during year t-1; $\sum CONTROL_{i,t-1}$ is the vector of control variables; $\varepsilon_{i,t}$ is the residual term of the model. Industry-fixed, country-fixed, and year-fixed effects were added to the model to control for unobserved confounding factors at the industry level, country level, and time dimension. Based on the findings of previous studies in the literature (Arrighetti et al. 2014; Lim et al. 2020; Hoang and Tran 2022; Huynh et al. 2024), control variables include firm size (FIRMSIZE), profitability (PROFIT), financial leverage (LEVERAGE), cash reserves (CASH), revenue growth (GROWTH), existing tangible asset ratio (TANG), net working capital (NWC), country's GPD growth (GDPGR) and inflation (INFLATION). The variable descriptions tare in Table 1.

3.2 | Corporate Intangible Investment

Corporate intangible investment is measured using intangible assets' changes in book values (D.INTANGINV). For robustness, we use changes in corporate intangible value (Clausen and Hirth 2015) (D.INTANGVAL) as the alternative measured by (i) calculating the return on tangible assets (ROTA) by scaling EBITDA by net PPE value; (ii) adjusting ROTA for industry and business cycle by subtracting the industry-year median; and (iii) normalizing the results by its industry-year standard deviation to control for changes in variation. The measure reflects a firm's intangible value intensity over time, closely related to intangible investment.

3.3 | Proxies of National Innovation System

We use the country-level Global Innovation Index (GII) from the World Intellectual Property Organization (WIPO) as a proxy for NIS. The GII evaluates the innovation capabilities of 132 economies through seven pillars: Human capital and research, Infrastructure, Business sophistication, Knowledge and technology outputs, Creative outputs, Market sophistication, and Institutions. Each pillar is further broken down into sub-pillars and individual indicators, totaling around 80 metrics, all of which are normalized and aggregated to produce the final country scores and rankings. These indices and the aggregated index (TOTAL_GII) help policymakers and business leaders understand and benchmark innovation performance across countries, offering insights into the interplay between technological progress, economic development, institutions, and societal challenges.

3.4 | Data

The data used in this study are from different secondary sources. Firms' financial data are collected from the COMPUSTAT database. The GII data is available from the annual Global Innovation Index Reports from 2011 to 2023 for 132 countries. The report series are published by the World Intellectual Property Organization, a specialized agency of the United Nations dedicated to promoting innovation and protecting intellectual property worldwide since 1970. Macroeconomic and institution data are from the World Bank database. We exclude the COVID-19 period (2020–2021) and the period covering the Russo-Ukrainian war (2022 onward) to remove the impacts of those long events on the outcome of our analysis. After constructing the variables and removing missing values, our end sample consists of 149,168 firm-year observations of 25,974 companies from 77 countries. Continuous variables are winsorized at the 1st and the 99th percentiles to alleviate the impact of outliers. Table 1 reports the descriptive statistics of the variables. Appendix A presents the sample distribution by country.

We present the average values of corporate intangible investment rate by country and its 95% confidence interval in Figure 1. The two-way scatterplot in Figure 2 illustrates the linear association between corporate intangible investment and the country's GII score.

From Figure 1, we see that countries with the highest rates of corporate intangible investment include Malta (MLT), Sweden (SWE), Ireland (IRL), Israel (ISL), the United Kingdom (GBR), and Denmark (DNK). In contrast, countries with the lowest levels of corporate intangible investment are Lithuania (LTU), Bangladesh (BGD), Greece (GRC), Kuwait (KWT), Portugal (PRT), and Ukraine (UKR). From Figure 2, we can observe that there might be a linear association between corporate intangible investment and national innovation.

4 | Results and Discussion

4.1 | Baseline Findings

Table 2 reports the regression results of Model (1). We alternatively use the aggregated GII (TOTAL_GII) and the seven pillar indexes of GII as the variable of interest in the model to assess the impact of different dimensions of NIS.

In Column 1, TOTAL_GII's coefficient is positive and significant at the 1% significance level, suggesting a positive impact of

TABLE 1 | Variable description and descriptive statistics.

Variable	Description	Mean	SD	P25	P50	P75
INTANGINV	Change in book value of intangible assets scaled by lagged total assets	0.0110	0.0737	−0.0014	0.0000	0.0020
D.INTANGVAL	The changes in the measure of intangible value as defined by Clausen and Hirth (2015)	−0.0181	0.6398	−0.1188	0.0000	0.0980
GOODWILL	The change in book value of goodwill scaled by lagged total assets	0.0417	0.0975	0.0000	0.0000	0.0228
TOTAL_GII	The natural logarithm of the country's aggregate Global Innovation Index	5.9649	0.2366	5.7607	6.0674	6.1545
HUCAP	The natural logarithm of the country's Global Innovation Index—Human Capital and Research Pillar	3.7839	0.3765	3.5410	3.8877	4.0639
INFRAS	The natural logarithm of the country's Global Innovation Index—Infrastructure Pillar	3.9513	0.2501	3.7842	4.0483	4.1604
BUSI_SOPHIS	The natural logarithm of the country's Global Innovation Index—Business Sophistication Pillar	3.7675	0.2770	3.5667	3.8480	4.0000
KNOW_TECH	The natural logarithm of the country's Global Innovation Index—Knowledge and Technology Outputs Pillar	3.6968	0.3197	3.4657	3.7424	3.9926
CREATIV	The natural logarithm of the country's Global Innovation Index—Creative Outputs Pillar	3.6770	0.2852	3.5145	3.7062	3.8691
MKT_SOPHIS	The natural logarithm of the country's Global Innovation Index—Market Sophistication Pillar	4.0711	0.1806	3.9416	4.0758	4.2017
INSTITUTIONS	The natural logarithm of the country's Global Innovation Index—Institutions Pillar	4.2436	0.2437	4.0218	4.3068	4.4819
FIRM_SIZE	The natural logarithm of total assets	7.8411	3.1622	5.6340	7.7756	9.9445
PROFIT	Return-on-total assets ratio	−0.0043	0.1760	−0.0069	0.0268	0.0636
LEVERAGE	Long-term debt on total assets ratio	0.1072	0.1463	0.0000	0.0461	0.1626
CASH	Cash and cash equivalents on total assets ratio	0.1331	0.1486	0.0303	0.0848	0.1793
GROWTH	Revenues growth during the year	0.1301	0.7882	−0.0612	0.0421	0.1590
TANGIBLE	The ratio of tangible assets on total assets	0.2897	0.2311	0.0930	0.2459	0.4385
NWC	The ratio of net working capital on total assets	0.1617	0.3167	0.0171	0.1633	0.3410
FIRM_R&D	R&D expenditure scaled by revenues during the year	0.1149	0.5856	0.0041	0.0188	0.0474
COUNTRY_R&D	R&D expenditure at the country level, percentage of GDP	1.9340	1.1728	0.7916	1.9979	3.1067
GINI	Gini coefficient, measure of income inequality in the country	0.3579	0.0470	0.3285	0.3540	0.3850
ROL	Rule of Law index	0.6904	0.8950	−0.1493	0.5536	1.5658
DEVELOPED	Dummy variable that equals one if the country is a developed country, zero otherwise. Country classification is from World Bank.	0.4201	0.4936	0.0000	0.0000	1.0000
MEDIAN_AGE	The median age in the workforce of the country.	36.1049	7.3124	28.9000	37.0000	41.5000

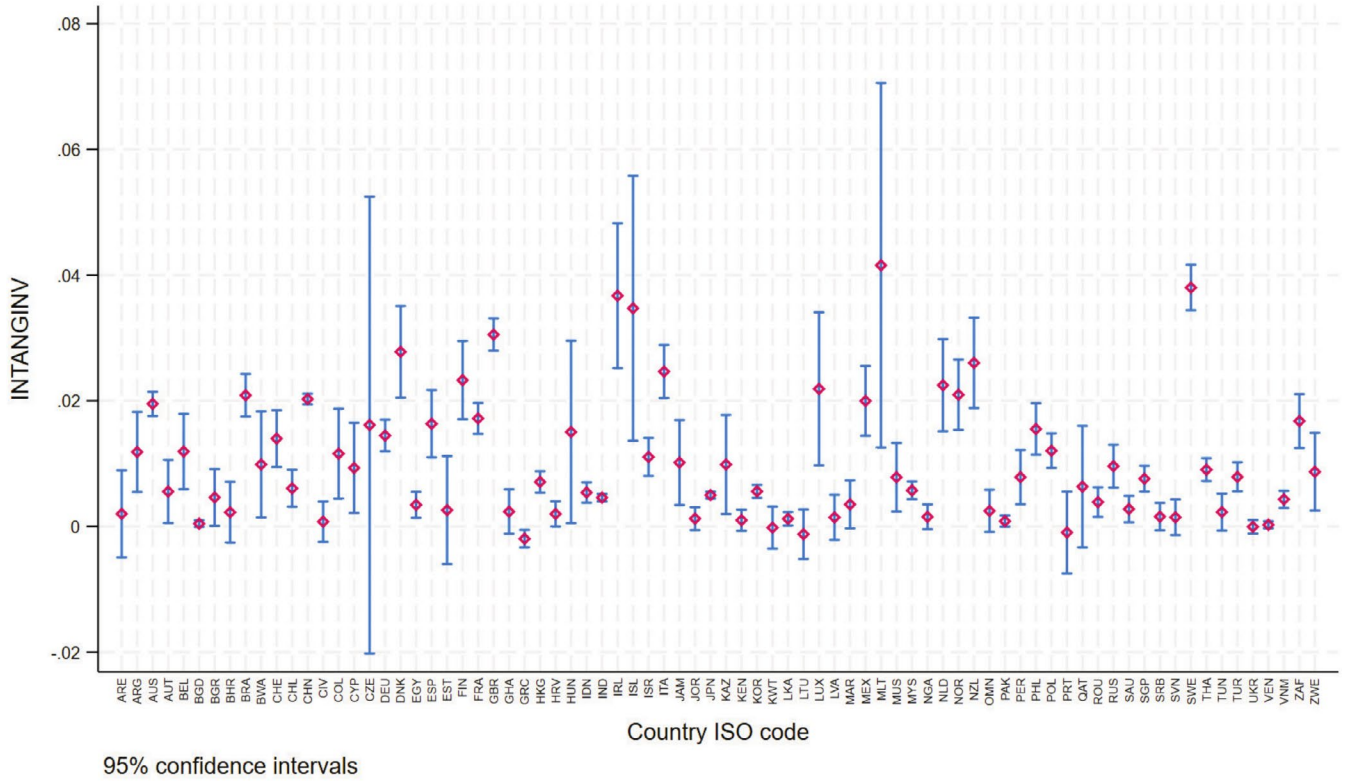

FIGURE 1 | Average rate of corporate intangible investment (INTANGINV) by country ISO code.

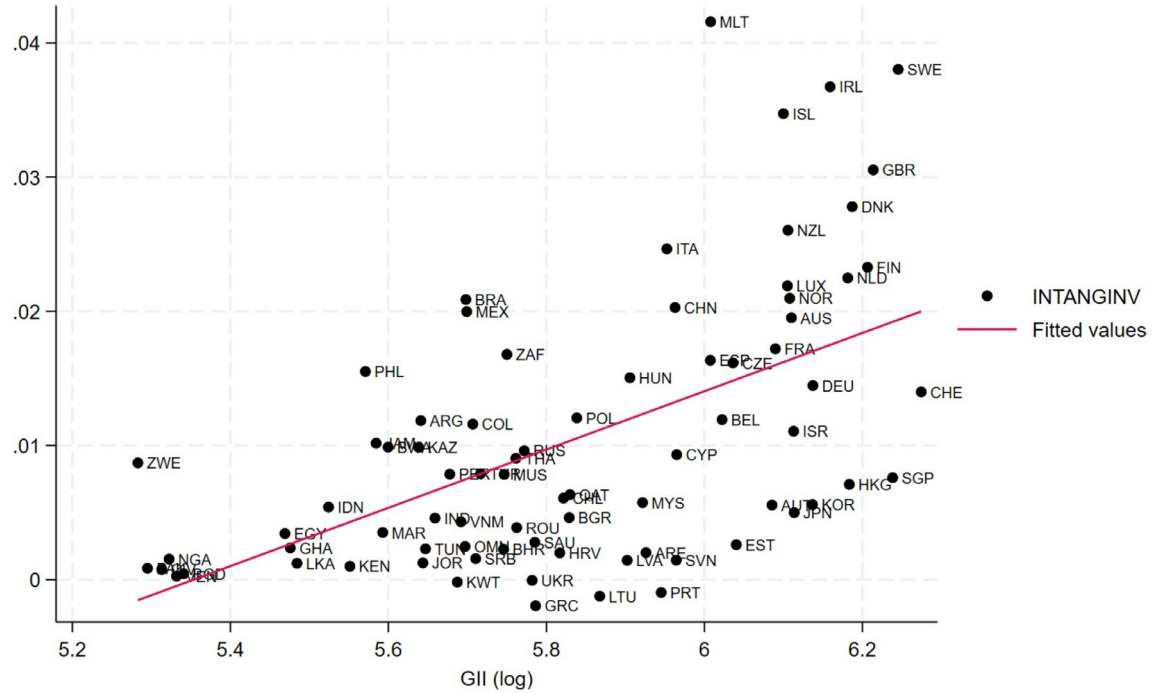

FIGURE 2 | Two-way scatter plots of corporate intangible investment rate and global innovation index (log) by country ISO code.

NIS on corporate intangible investment. By analyzing the economic significance of the impact, a 1% increase in the logged GII index leads to an increase of ~0.000094 units in corporate intangible investment. While this effect may appear small in absolute terms, it represents about 0.86% of the mean value of INTANGINV (i.e., mean of 0.011), highlighting a meaningful economic impact. This result suggests that improvements in a country's overall innovation environment can translate into tangible increases in firms' investments in intangible assets, reinforcing the importance of national innovation policy. This finding aligns with recent global trends, where investment in intangible assets such as data, software, and intellectual property

TABLE 2 | The impact of national innovation on intangible investment.

	Dependent variable: INTANGINV							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	TOTAL_GII as the explanatory variable	HUCAP as the explanatory variable	INFRAS as the explanatory variable	BUSI_SOPHIS as the explanatory variable	KNOW_TECH as the explanatory variable	CREATIV as the explanatory variable	MKT_SOPHIS as the explanatory variable	INSTITUTIONS as the explanatory variable
L.TOTAL_GII	0.0094***							
	(0.0011)							
L.HUCAP		0.0102***						
		(0.0006)						
L.INFRAS			0.0112***					
			(0.0011)					
L.BUSI_SOPHIS				0.0115***				
				(0.0009)				
LKNOW_TECH					0.0128***			
					(0.0008)			
L.CREATIV						0.0076***		
						(0.0009)		
L.MKT_SOPHIS							0.0027**	
							(0.0013)	
L.INSTITUTIONS								−0.0025**
								(0.0012)
L.FIRM_SIZE	−0.0008***	−0.0009***	−0.0009***	−0.0009***	−0.0010***	−0.0008***	−0.0009***	−0.0009***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
L.PROFIT	0.0190***	0.0194***	0.0193***	0.0188***	0.0184***	0.0187***	0.0186***	0.0182***
	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
L.LEVERAGE	0.0034**	0.0036**	0.0037**	0.0035**	0.0036**	0.0030*	0.0036**	0.0038**
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0016)

(Continues)

TABLE 2 | (Continued)

	Dependent variable: INTANGINV							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	TOTAL_GII as the explanatory variable	HUCAP as the explanatory variable	INFRAS as the explanatory variable	BUSI_SOPHIS as the explanatory variable	KNOW_TECH as the explanatory variable	CREATIV as the explanatory variable	MKT_SOPHIS as the explanatory variable	INSTITUTIONS as the explanatory variable
L.CASH	0.0336***	0.0331***	0.0331***	0.0321***	0.0315***	0.0343***	0.0348***	0.0352***
	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
L.GROWTH	0.0025***	0.0025***	0.0025***	0.0025***	0.0025***	0.0025***	0.0025***	0.0025***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
L.TANGIBLE	−0.0091***	−0.0087***	−0.0092***	−0.0088***	−0.0081***	−0.0090***	−0.0098***	−0.0101***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)	(0.0012)
L.NWC	−0.0037***	−0.0036***	−0.0036***	−0.0035***	−0.0031***	−0.0036***	−0.0038***	−0.0037***
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0011)
L.INFLATION	−0.0003***	0.0000	−0.0002**	−0.0001*	0.0001	−0.0005***	−0.0006***	−0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
L.GDPGR	0.0014***	0.0016***	0.0015***	0.0013***	0.0009***	0.0013***	0.0012***	0.0010***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	−0.0449***	−0.0292***	−0.0335***	−0.0321***	−0.0346***	−0.0172***	0.0018	0.0244***
	(0.0067)	(0.0025)	(0.0044)	(0.0034)	(0.0029)	(0.0034)	(0.0053)	(0.0053)
SE clustered by firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	149,168	149,168	149,168	149,168	149,168	149,168	149,168	149,168
Adjusted R-squared	0.0230	0.0239	0.0232	0.0235	0.0245	0.0231	0.0226	0.0226

Note: This table reports the regression results of Model (1) using different measures of GII pillars as the alternative variable-of-interest, including: the aggregated score (TOTAL_GII), Human capital and research (HUCAP), Infrastructure (INFRAS), Business sophistication (BUS_SOPHIS), Knowledge and technology outputs (KNOW_TECH), Creative outputs (CREATIV), Market sophistication (MKT_SOPHIS), and Institutions (INSTITUTIONS). Variable definitions are in Table 1. Standard errors are clustered by firm. ***, **, and * denote statistical significance of 1%, 5%, and 10%, respectively.

TABLE 3 | Sensitivity tests: Firm characteristics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	**D.INTANGVAL**	**INTANGINV**	**INTANGINV**	**INTANGINV**	**INTANGINV**	**INTANGINV**	**INTANGINV**	**INTANGINV**
L.TOTAL_GII	0.1451***	0.0313***	0.0096***	0.0105***	0.0100***	0.0088***	0.0185***	0.0096***
	(0.0553)	(0.0028)	(0.0011)	(0.0013)	(0.0012)	(0.0011)	(0.0020)	(0.0012)
L.TOTAL_GII×L.FIRM_SIZE		−0.0028***						
		(0.0003)						
L.TOTAL_GII×L.PROFIT			−0.0110					
			(0.0079)					
L.TOTAL_GII×L.LEVERAGE				−0.0106*				
				(0.0057)				
L.TOTAL_GII×L.CASH					−0.0071			
					(0.0081)			
L.TOTAL_GII×L.GROWTH						0.0043***		
						(0.0012)		
L.TOTAL_GII×L.TANGIBLE							−0.0272***	
							(0.0036)	
L.TOTAL_GII×L.NWC								−0.0016
								(0.0030)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE clustered by firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	144,787	149,168	149,168	149,168	149,168	149,168	149,168	149,168
Adjusted R-squared	0.0997	0.0237	0.0230	0.0230	0.0230	0.0232	0.0234	0.0230

Note: This table reports the regression results of robustness tests. Variable definitions are in Table 1. Standard errors are clustered by firm. ***, **, and * denote statistical significance of 1%, 5%, and 10%, respectively.

has surged and now constitutes a growing share of national GDP worldwide.

The finding remains when we substitute TOTAL_GII with variables representing national innovation dimensions: Human capital and research, Infrastructure, Business sophistication, Knowledge and technology outputs, Creative outputs, and Market sophistication from Column 2 to Column 7, Table 2. These results are in line with our conjecture that with more resources readily available for innovative activities (in the form of infrastructure, talent pool, and financial-technical aids), firms are more confident in the innovation outcomes and are willing to engage in intangible investments. Moreover, the magnitude of corporate intangible investment is also accelerated following increases in the output end of innovation, namely the knowledge and technology outputs and creative outputs. This indicates that once the innovation productivity and absorptive capacity of a country are improved, firms are more inclined to focus on upgrading intangible assets to stay relevant in the market (Grimaldi et al. 2017). However, the effect changes to negative and significant when we test the impact of the political institution pillar of NIS (INSTITUTIONS), suggesting that too much political control on innovative activities may hinder intangible investment. More specifically, a strong institutionalized environment might create an institutional isomorphism phenomenon, where firms may prioritize legitimacy over innovation (DiMaggio and Powell 1983), thus forgoing innovation opportunities that may give rise to short-term uncertainty. Our findings show a significant positive impact of NIS on corporate intangible investment. Effective NIS promotes innovation, boosting intangible asset investments. However, excessive political control can hinder these investments, aligning with literature highlighting supportive innovation policies' critical role in economic growth and entrepreneurship.

Our baseline regression results relate to, but do not overlap with existing research on the relationship between national innovation systems (NIS) and corporate investment behavior. The findings align with and extend the findings of Furman et al. (2002), who established the importance of national innovative capacity in driving innovation outputs. The positive impact of NIS on corporate intangible investment supports B.-A. Lundvall's (2007) emphasis on the systemic nature of innovation and its influence on firm-level decisions. The results regarding different NIS dimensions support Fagerberg and Srholec's (2008) findings on the multifaceted nature of innovation systems. The negative effect of political institutions on intangible investment aligns with Acemoglu and Robinson's (2012) insights on the role of institutions in economic outcomes. Furthermore, our findings extend Corrado et al.'s (2009) work on intangible capital by exploring its determinants at the national level. Our analysis on corporate intangible investment as an outcome of NIS complements Castellacci and Natera's (2013) analysis of the co-evolution of innovation systems and economic performance.

4.2 | Sensitivity Tests

This section is devoted to checking the sensitivity of the baseline findings. We first revisit the baseline finding using an alternative proxy of intangible investment: INTANGVAL—the proxy of intangible assets value (Clausen and Hirth 2015) as the dependent variable. Furthermore, we test how the impact varies across different degrees of firm-level characteristics, that is, firm size, profitability, financial leverage, cash reserves, revenue growth, existing tangible asset ratio, and net working capital in Columns 2–8, respectively. Specifically, we alternatively include the interaction term between the explanatory variable (TOTAL_GII) and the firm-level control variables in the model; then re-estimate the model. Table 3 reports the regression results.

The coefficient of TOTAL_GII in Column 1, Table 3 (where INTANGVAL is the dependent variable) is positive and significant at the 1% significance level, which is consistent with the baseline results. This suggests that NIS exerts a positive impact on intangible investment and intangible value. Moreover, the coefficients of the interaction terms between TOTAL_GII and the firm-level controls are negative and significant in Columns 2, 4, and 7, implying that the positive impact of NIS on intangible investment is weakened with larger firms, firms that rely more on debt, and firms that have already pursued tangible-intensive investments. The negative and significant interaction between TOTAL_GII and firm size suggests that the positive effect of NIS on intangible investment is less pronounced as firms grow larger. This may reflect that larger firms already possess established innovation capabilities or achieve their economies of scale, making them less responsive to improvements in the national innovation environment compared to smaller, more agile firms. The negative interaction with leverage indicates that firms with higher debt ratios benefit less from national innovation systems in terms of intangible investment. High leverage may constrain managerial flexibility or risk appetite, limiting the ability to exploit new innovation opportunities fostered by NIS. Furthermore, the negative interaction with tangible-intensive investment implies that firms already heavily invested in physical assets are less able or willing to pivot toward intangible investments, even when national innovation conditions improve. This could be due to the higher degrees of irreversible investment and higher sunk costs of these firms, which prevent them from making new investments. On the other hand, the coefficient of the interaction term in Column 6 is positive and significant, suggesting the impact is more pronounced for high-growth firms. The results suggest that timing and firm lifecycle stage are critical for leveraging national innovation systems. Firms may need to proactively invest in intangibles when growth opportunities arise, capitalizing on favorable national innovation conditions. Overall, the findings in these analyses suggest the variation of the impact on corporate intangible investment across different firm characteristics.

Table 4 reports the estimation of alternative model specifications to see whether our finding changes with different model settings, including a reduced-form regression specification of Model (1) (Column 1), a regression excluding the fixed effects (Column 2), a regression with additional controls for firm-level and country-level R&D spending (Column 3), controlling for autocorrelation using the Newey-West and Prais-Winsten estimators (Columns 4 and 5). In addition, as national innovation has seven components, the noises in the components of GII may cause biases in explaining the variation in firm-level intangible investment. To address this issue, we use the Principal Component Analysis (PCA) to construct the first component

TABLE 4 | Sensitivity tests: Alternative model specifications.

	(1)	(2)	(3)	(4)	(5)	(6)
	Reduced-form model	Regression without fixed effects	Additional controls	Newey-West estimation	Paris-Winsten estimation	First component generated from PCA
VARIABLES	INTANGINV	INTANGINV	INTANGINV	INTANGINV	INTANGINV	INTANGINV
L.TOTAL_GII	0.0124***	0.0077***	0.0127***	0.0077***	0.0068***	
	(0.0002)	(0.0011)	(0.0039)	(0.0010)	(0.0010)	
L.FIRM_R&D			−0.0008			
			(0.0010)			
L.COUNTRY_R&D			0.0004			
			(0.0006)			
L.PCA1						0.0013**
						(0.0006)
Control variables	No	Yes	Yes	Yes	Yes	Yes
SE clustered by firm	Yes	Yes	Yes	No	No	Yes
Industry FE	No	No	Yes	No	No	Yes
Year FE	No	No	Yes	No	No	Yes
Observations	144,787	149,168	55,729	149,610	149,610	147,478
Adjusted *R*-squared	0.0001	0.0151	0.0268			0.1172

Note: This table reports the regression results of robustness tests. Variable definitions are in Table 1. Standard errors are clustered by firm. ***, **, and * denote statistical significance of 1%, 5%, and 10%, respectively.

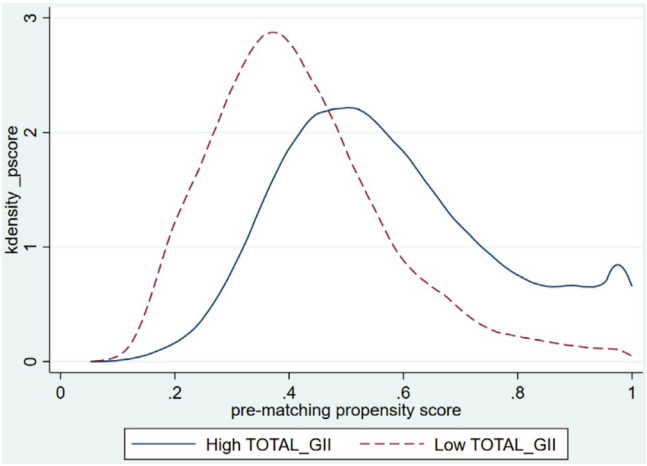

FIGURE 3 | Plots of pre-matching propensity scores.

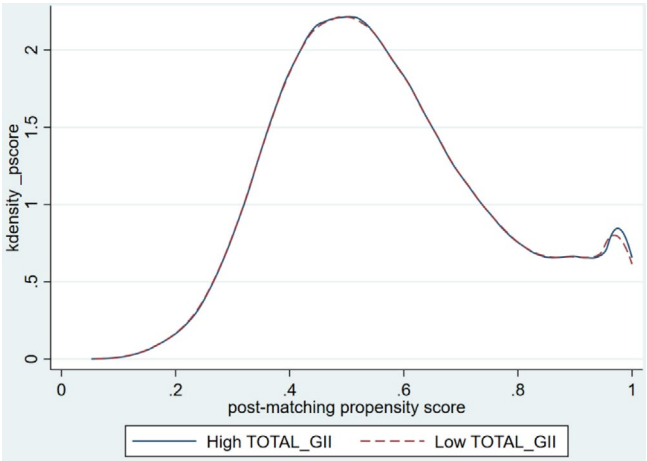

FIGURE 4 | Plots of post-matching propensity scores.

variable (PCA1) to ensure orthogonality, dimension reduction, and noise reduction in our analysis. Column 6, Panel B, presents the regression results of Model (1), with PCA1 as the substitute of TOTAL_GII. The result is in line with that of the baseline regression in Table 2; thus, reinforcing the robustness of the baseline findings.

To establish the causal inference of the newfound relationship, we employ various econometric approaches: (i) an IV/2SLS regression framework, (ii) the Lewbel's (2012) internal instrument approach, and (iii) regression using Propensity Score Matching (PSM) and Entropy Balancing (EB) weights alternatively to facilitate the "All else equal" assumption in hypothesis testing. For the IV/2SLS estimation, we follow the long-difference IV approach (Griliches and Hausman 1986; Hahn et al. 2007) to choose the fifth difference of TOTAL_GII (LD5) as the IV for regression. Additionally, the internal IV estimator (Lewbel 2012) exploits heteroscedasticity in the data to generate IVs, achieves identification without external instruments, and improves efficiency with smaller standard errors. It is important to note that for cross-country studies, it is challenging to find valid instrumental variables for cross-country studies. This is because instruments must meet strict requirements—they must be correlated with the explanatory variable but not directly affect the outcome, which is unlikely to guarantee given countries' diverse histories, institutions, and unobservable factors. Commonly used instruments in single-country setting may violate these conditions or be weak predictors, leading to unreliable results in cross-country studies. As a result, we rely on the internal IV methods discussed in Hahn et al. (2007) and Lewbel (2012) to support causal interpretation of the results. This method is proven to provide estimates that are plausibly similar to conventional instruments (Mishra and Smyth 2015).

To further support the causal interpretation of the empirical results, we employ the PSM and EB approaches to address selection bias and improve causal inference (Hainmueller 2012; Zhao and Percival 2017). The two methods help reduce selection bias by balancing observed covariates between treatment and control groups, making them more comparable. By improving covariate balance, these methods allow researchers to more credibly attribute differences in outcomes to the treatment rather than to pre-existing differences, thereby strengthening causal inference in observational studies. Figures 3 and 4 demonstrate the successful matching of the PSM procedure. Table 5 reports the estimation results of those methods. Overall, we find the results support our baseline findings about the causal impact of NIS on corporate intangible investment, hence mitigating the concern about reverse causality in our model.

4.3 | Cross-Sectional Analysis

In this section, we further test how the impact of NIS on intangible investment varies across country-level characteristics. High inequality, referring to a concentration of resources among top earners and large corporations, could potentially increase corporate intangible investments by these entities, as they have more capital to allocate to R&D and other innovation-related activities. However, the concentration of resources may also lead to a narrower focus on innovation, potentially limiting the breadth and diversity of national innovation outcomes. Governance effectiveness is another key factor influencing the relationship between national innovation and intangible investment since good governance provides a stable and predictable business environment crucial for national innovation and investment (Morrissey and Udomkerdmongkol 2012; Zhu et al. 2024). Furthermore, workforce age is an important demographic factor that fosters national growth (Frosch 2011). A younger workforce is typically associated with higher degrees of innovation at the firm level and vice versa (Ng and Feldman 2013; Derrien et al. 2023). Last but not least, we investigate whether the impact of national innovation systems on corporate intangible investment differs between developed and developing countries. This distinction is crucial, as these groups of countries often exhibit significant disparities in economic structures, innovation capacity, and institutional frameworks. By analyzing these variations, we aim to uncover how contextual factors shape the relationship between innovation systems and intangible investment across different stages of national development.

Based on the extant literature, we expect inequality, governance, and workforce age to play a moderating role in the impact of NIS on corporate intangible investment. We proxy inequality by the country's Gini index (GINI), proxy governance by

TABLE 5 | Endogeneity diagnostics.

	Standard IV/2SLS regression using long-difference instrument		Lewbel's (2012) internal instrument regression	Regression with propensity score weights	Regression with entropy balancing weights
	(1)	(2)	(3)	(4)	(5)
	First stage	Second stage			
VARIABLES	TOTAL_GII	INTANGINV	INTANGINV	INTANGINV	INTANGINV
L.TOTAL_GII		0.1083***	0.0230***	0.0074***	0.0058***
		(0.0208)	(0.0031)	(0.0011)	(0.0016)
Long-difference instrument (LD5)	0.0302***				
	(0.0006)				
Constant	6.1885***	−0.6539***	−0.1272***	0.0109***	0.0123***
	(0.0049)	(0.1284)	(0.0189)	(0.0019)	(0.0025)
Kleibergen-Paap rank LM statistic		2500.301***	1131.587***		
Kleibergen-Paap rank Wald F-statistic		2416.425***	192.737***		
Anderson-Rubin 95% confidence interval		[0.0724, 0.1456]			
Control variables		Yes	Yes	Yes	Yes
Industry FE		Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes
Observations		60,391	149,610	81,401	79,056
Adjusted *R*-squared		0.0474	0.0138	0.0203	0.0220

Note: This table reports the regression results of endogeneity treatment tests. Variable definitions are in Table 1. Standard errors are clustered by firm. ***, **, and * denote statistical significance of 1%, 5%, and 10%, respectively.

country's Rule of Law Index (ROL), the workforce's median age (MEDIAN_AGE), and an indicator variable that equals one if the country is a developed country and zero if it is a developing country (DEVELOPED) based on World Bank classification of developed countries. We alternatively add the interaction term of the variables with TOTAL_GII to the model and re-estimate it. The results are reported in Table 6.

Generally, the regression results align well with our expectations and show that inequality hinders the impact of NIS on intangible investment, while rule of law and a young workforce amplify the impact, thus stimulating more intangible investment. Specifically, in Column 1, the coefficient of the interaction term TOTAL_GII × GINI is −0.3645 (p-value < 0.01), while TOTAL_GII's coefficient is 0.1439 (p-value < 0.01). The mean value of GINI is 0.3579, meaning inequality weakens the positive impact of NIS by 90.66%, that is, (0.3654 × 0.3579)/0.1439 = 0.9066. This impact is economically significant, thus highlighting the necessity of dealing with inequality to enhance the effectiveness of NIS in shaping the sustainable growth of corporate intangible.

The coefficient of the interaction term TOTAL_GII × ROL in Column 2 is 0.0173 (p-value < 0.01), suggesting that rule of law plays a significant role in enhancing the positive impact of NIS on corporate intangible investment. In this regression, TOTAL_GII's coefficient is 0.0233 (p-value < 0.01), while ROL's mean value is 0.6904, implying that on average, rule of law improves the positive impact of NIS on corporate intangible investment by 51.26%, that is, (0.0173 × 0.6904)/0.0233 = 0.5126. This impact is statistically and economically significant.

The coefficient of the interaction term TOTAL_GII × MEDIAN_AGE in Column 3 is −0.0011 (p-value < 0.01), suggesting that a younger workforce plays a significant role in enhancing the positive impact of NIS on corporate intangible investment. In this regression, TOTAL_GII's coefficient is 0.0445 (p-value < 0.01), while the mean value of MEDIAN_AGE is 36.1049. Taken altogether, younger workforces, on average, improve the positive impact of NIS on corporate intangible investment by 89.25%, that is, (0.0011 × 36.1049)/0.0445 = 0.8925. Therefore, the impact of a younger workforce on how NIS shapes corporate investment in intangible assets

TABLE 6 | Further analysis.

	(1)	(2)	(3)	(4)
VARIABLES	**INTANGINV**	**INTANGINV**	**INTANGINV**	**INTANGINV**
L.TOTAL_GII	0.1439***	0.0233***	0.0445***	0.0035***
	(0.0120)	(0.0015)	(0.0037)	(0.0011)
L.GINI	2.1718***			
	(0.1998)			
L.TOTAL_GII × L.GINI	−0.3645***			
	(0.0344)			
L.ROL		−0.1111***		
		(0.0081)		
L.TOTAL_GII × L. ROL		0.0173***		
		(0.0013)		
L.MEDIAN_AGE			0.0066***	
			(0.0007)	
L.TOTAL_GII × L.MEDIAN_AGE			−0.0011***	
			(0.0001)	
L.DEVELOPED				−0.2105***
				(0.0238)
L.TOTAL_GII × L.DEVELOPED				0.0343***
				(0.0039)
Control variables	Yes	Yes	Yes	Yes
SE clustered by firm	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	90,457	149,168	149,168	149,168
Adjusted *R*-squared	0.0302	0.0251	0.0253	0.0237

Note: This table reports the regression results of further analysis. Variable definitions are in Table 1. Standard errors are clustered by firm. ***, **, and * denote statistical significance of 1%, 5%, and 10%, respectively.

is economically and statistically significant. The finding is in line with previous studies indicating the role of a young workforce in economic development (Ng and Feldman 2013; Derrien et al. 2023).

In Column 4, the coefficient of the interaction term is 0.0343 (p-value < 0.01), implying that the impact of NIS on corporate intangible investment is more pronounced for developed countries. In the same regression, the coefficient of TOTAL_GII is 0.0035 (p-value < 0.01), and DEVELOPED is a dummy variable taking only two values of one or zero. Consequently, the impact of NIS on corporate intangible investment is on average more than 10 times stronger in developed countries compared to developing countries. This finding is intuitive as developed countries generally have better technological infrastructure, established institutions, human capital foundation, and have a strong focus on innovation (Intarakumnerd et al. 2002; Watkins et al. 2015).

The findings indicate the cross-sectional variations of the impact across different country settings and are supported by previous findings in the literature. For instance, it is in line with the findings of Roth (2022) on how rule of law exerts its impact on investment in intangible capital in the United States from 1996 to 2017, suggesting that the macro-level intangibles (i.e., rule of law, as defined by Basu and Waymire (2008)) play their parts in shaping corporate investment in intangibles; however, in a direct approach. In addition, Arocena and Sutz (2003) demonstrate a framework that inequality affects innovation and intellectual integration in general, where NIS serves as a solution.

5 | Conclusion

This study underscores the economic impact of NIS on corporate intangible investment, the driver of economic growth

in the contemporary era. We highlight the heterogeneity in the impacts of different categories of national innovation on intangible investment, implying the importance of building strong but flexible in-country institutions to facilitate sustainable economic growth at the firm level. The findings on the relationship between national innovation systems and corporate investment behavior provide a comprehensive picture of how macro-level factors influence firm-level investment and outcomes.

By identifying specific country characteristics that modulate the innovation-intangible investment link, this study provides valuable insights for policymakers and researchers seeking to understand and enhance national innovation ecosystems and their impact on corporate behavior. For policymakers, these results underscore the need for a systematic, context-sensitive approach to innovation policy. Governments can foster an innovative environment conducive to intangible asset growth, ultimately contributing to overall economic development and competitiveness in the global economy. We highlight the need for a systematic approach to innovation policy, recognizing that the effectiveness of NIS may vary depending on the specific context and characteristics of each country. This research thus provides a foundation for more targeted and effective strategies to stimulate intangible investment and drive economic growth in diverse national settings. Furthermore, building and maintaining effective NIS requires not only sustained public investment in research, education, and infrastructure, but also regulatory environments that foster collaboration, knowledge diffusion, and entrepreneurial activity in support of sustainable development goals. Targeted interventions, tailored to specific national and sectoral contexts, can amplify the positive spillovers from innovation, ensuring that the benefits of intangible investment are broadly shared and contribute to inclusive, long-term economic growth while addressing sustainable development challenges such as institutional, environmental, and social issues. Ultimately, this research lays the groundwork for more nuanced and effective strategies to strengthen innovation ecosystems, stimulate corporate intangible investment, and enhance national competitiveness in a manner that aligns with the principles of sustainable and resilient development in an increasingly dynamic global economy.

For future research, our findings highlight several important directions for future inquiry and methodological development within the NIS framework. First, the observed heterogeneity in the impact of different NIS components on firm-level intangible investment suggests the need for more granular, comparative analyses, both across countries and within sectors, to better understand how specific institutional arrangements, knowledge flows, and policy interventions shape innovation outcomes. Additionally, there is a need for further research into the mechanisms through which national policies and institutional configurations translate into firm capabilities and performance, especially in diverse and rapidly changing environments.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] See for more details: https://www.undp.org/publications/innovation-sustainable-development-goals.

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Appendix A

Sample Information

#	Country/territory	ISO code	Number of observations	#	Country/ territory	ISO code	Number of observations
1	United Arab Emirates	ARE	43	40	Kenya	KEN	212
2	Australia	AUS	7043	41	South Korea	KOR	8548
3	Austria	AUT	345	42	Kuwait	KWT	483
4	Belgium	BEL	567	43	Sri Lanka	LKA	1111
5	Bangladesh	BGD	843	44	Lithuania	LTU	177
6	Bulgaria	BGR	352	45	Luxembourg	LUX	162
7	Bahrain	BHR	88	46	Latvia	LVA	117
8	Brazil	BRA	1671	47	Morocco	MAR	317
9	Botswana	BWA	59	48	Mexico	MEX	599
10	Switzerland	CHE	1114	49	Malta	MLT	78
11	Chile	CHL	903	50	Mauritius	MUS	192
12	China	CHN	21,520	51	Malaysia	MYS	4709
13	Ivory Coast	CIV	113	52	Nigeria	NGA	556
14	Colombia	COL	244	53	Netherland	NLD	556
15	Cyprus	CYP	285	54	Norway	NOR	973
16	Czech Republic	CZE	8	55	New Zealand	NZL	704
17	Germany	DEU	3262	56	Oman	OMN	405
18	Denmark	DNK	676	57	Pakistan	PAK	1952
19	Egypt	EGY	818	58	Peru	PER	495
20	Spain	ESP	801	59	Philippines	PHL	914
21	Estonia	EST	102	60	Poland	POL	3309
22	Finland	FIN	792	61	Portuguese	PRT	266
23	France	FRA	3465	62	Qatar	QAT	133
24	The United Kingdom	GBR	6441	63	Romania	ROU	626
25	Ghana	GHA	44	64	Russia Federation	RUS	1258
26	Greece	GRC	1030	65	Saudi Arabia	SAU	755
27	Hong Kong, China	HKG	6752	66	Singapore	SGP	3108
28	Croatia	HRV	440	67	Serbia	SRB	131
29	Hungary	HUN	107	68	Slovenia	SVN	130
30	Indonesia	IDN	2361	69	Sweden	SWE	3129
31	India	IND	18,581	70	Thailand	THA	3012
32	Ireland	IRL	199	71	Tunisia	TUN	248
33	Iceland	ISL	85	72	Turkey	TUR	1846
34	Israel	ISR	1870	73	Ukraine	UKR	154
35	Italy	ITA	1506	74	Venezuela	VEN	14
36	Jamaica	JAM	127	75	Vietnam	VNM	1968
37	Jordan	JOR	650	76	South Africa	ZAF	1273
38	Japan	JPN	19,456	77	Zimbabwe	ZWE	124
39	Kazakhstan	KAZ	103				
Total					**149,610**		