

Sustainability of Goals to Growth in Asian Pacific: The Role of Innovation and E-Government Services

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ABSTRACT

The Asia-Pacific region accounts for one-third of the global population and economic growth, while being at the forefront of the climate crisis. Therefore, this study examines the relationship between Sustainable Development Goals (SDGs), national innovation capacity (GII), e-government (EGov), and private sector (PSG) contribution across Asia-Pacific economies. Using panel data from 2007 to 2023, this study identifies a strong linear relationship between the composite SDG index and the private sector share in GDP. There is also a strong connection between the GII and PSG contributions. Mediation analysis demonstrates that GII partially mediates the link between SDG advances and the PSG share of GDP, while the quality of EGov services significantly moderates the relationship. Similarly, goal-level analysis revealed that SDGs 1, 5, 10, 14, 15, and 16 remain the primary factors advancing PSG economic contributions, whereas SDGs 3, 9, and 12 are significant contributors to innovation in the economy. These results are essential for considering sustainability and innovation as mutually constructive concepts and for developing relevant policies to promote inclusive growth.

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1. INTRODUCTION

The rapid rate at which the environment is being destroyed has emerged as one of the most pressing global concerns of the 21st century. The recent decade has witnessed a significant and exponential increase in the number and severity of climate-related and environmental abnormalities, including high-temperature events, sea level rise, and biodiversity loss. (Jangid & Bhardwaj, 2023; Rasheed & Rasheed, 2024). Significant research evidence blames these trends on industrial emissions of carbon dioxide and unsustainable production practices (Ekwurzel et al., 2017). This has now shifted, and concerns are rising across governments, businesses, and civil society about the need to update existing systems and practices rapidly. To address these concerns, the United Nations incorporated sustainable development as a global priority in 2015 through the Sustainable Development Goals (SDGs). The 17 SDGs outlined a broad global development agenda that incorporated economic prosperity, social inclusion, and environmental protection as components of one strategy (Ozili, 2021; United Nations, 2015). The base of 169 targets to be attained by 2030 that constituted the 17 SDGs has altered the entire developmental priorities by prioritizing equity, ecological governance, and resilience, long-term perspectives (Mensi & Udenigwe, 2021).

In this new world order, the private sector is gaining increasing prominence. The current discourse on development acknowledges that the success of the SDGs cannot be limited to the commitments made by governments through public policies; instead, a more dynamic input was needed from private firms, which can drive innovations, create jobs, and integrate sustainability into their corporate practices (Bahoo et al., 2023). The private sector, owing to its agility and extensive economic presence, is regarded as a key player in achieving inclusive growth and transforming industrial models into more sustainable patterns.

This role is even more significant in developing regions, where the relative contribution of the private sector to employment and value-added growth is significantly higher. The current study focused on the Asia-Pacific region which accounted for one-third of the global populace and economic growth, while being at the forefront of the climate crisis. The region was also observing an exponential rise in economic cooperation, such as the Central Asia Regional Economic Cooperation (CAREC) region, comprising eleven member countries. Therefore, the current study focused on exploring the private sector's contribution as a pillar that determined local economic activities among these nations. CAREC, which began in 2001, has managed to attract over \$51 billion in development financing to achieve connectivity and trade facilitation among its members. Nevertheless, even though these investments were significant, the levels of intra-regional trade were trim: in 2024, intra-regional trade among CAREC countries accounted for only 4.1 percent of their combined external trade, which improved to 7.4 percent without Chinese trade, demonstrating the struggle against intra-regional economic integration to date among Asian Pacific nations (Ahmed, 2025).

Against this background, the current investigation aimed to study the nexus of SDG-linked investments, e-government structure, technological innovation, and private sector performance as an essential field for attaining sustainable economic growth. Technology and process innovations were drivers that can increase the added value of investments in sustainability by improving resource efficiency, diversifying into new markets, and providing the private sector with the tools required to meet new environmental standards (Bahoo et al., 2023). This implied a synergistic relationship in which innovation not only acts as an intermediary between SDG investment and private sector growth but also opened new avenues for inclusive

and sustainable development. Similarly, the modernization of government services aids businesses in streamlining their regulatory and operational avenues. Hence, the framework of the study incorporated technological innovations and e-government services as mediating and moderating mechanisms leading to the optimization of sustainable goals for sustained economic growth.

This study investigated the effect of investment in SDGs and its sensitivity to private sector performance across select Asia-Pacific countries, with a particular focus on the mediating role of innovation and the moderating role of e-government services to address the following research questions (RQ).

RQ1: How does investment in Sustainable Development Goals shape private sector contribution to GDP?

RQ2: How does the degree of a nation's innovation capacity influence growth in the private sector?

RQ3: How do investments in Sustainable Development Goals influence the innovation capacity of an economy?

RQ4: Does the degree of innovation mediate the relationship between Sustainable Development Goals and Private Sector Growth?

RQ5: Does E-Government development moderate the relationship between Sustainable Development Goals and Private Sector Growth?

The model of this study provided theoretical reflections on the current state of the phenomenon by combining empirical observations with policy perspectives to generate findings that can inform the formulation of national policies and regional cooperation patterns. More generally, the research findings will be relevant to discussions on the mutually reinforcing development of the private sector's potential through targeted development financing and innovation policies. The remainder of the manuscript is divided into literature review, methodology, results, and conclusion sections.

2. LITERATURE REVIEW

The SDGs are a global milestone which focuses on cultivating a sustainable economy and social and environmental change by 2030. The private sector has assumed more weight in the achievement of this agenda, as highlighted by the United Nations and international financial institutions, including the Asian Development Bank (ADB, 2021; Akash, 2023). More than 90 per cent of enterprises and more than fifty per cent of the total number of employees worldwide are employed by the private sector (World Bank, 2020b). In emerging economies, such as Asian Pacific countries, these engines of job creation and innovation are even more critical, as these economies rely on them to achieve sustainability at the community level.

Regardless of their potential, the private sector has been facing problems in its development as it encounters structural challenges, including regulatory pressures, financing deficiency, and technological lag. Investments in reaching the SDGs, such as education, health, infrastructure, clean energy, and digital access, also contributed both indirectly and directly to the development of the private sector in enabling

environments, decreasing inequality, and opening new markets (OECD, 2019). Therefore, the literature proposed that the correlation between SDG and public and private investment can be a powerful technique to enhance the quality and inclusiveness of economic growth (Schwab, 2019).

Nevertheless, the available literature has a significant knowledge gap regarding the causal processes by which SDG investments can enhance the performance of private sector competitiveness and contribute to nations' GDP. There is a dearth of research, particularly in uncovering the indirect nexus between these goals and GDP contribution through innovation and e-government services, which this study aimed to address.

2.1 SDG and Private Sector Growth

SDG-aligned investments can be identified as those that contribute to or promote one or more of the 17 SDGs, either directly or indirectly, through the development of infrastructure by the state sector, policy reform, or privately engaged investment in sustainable sectors. According to the literature, these types of investments are beneficial for the growth of private sector in numerous ways. Like SDG 9 (Industry, Innovation and Infrastructure) and SDG 8 (Decent Work and Economic Growth), paid specific attention to inclusive industrialization and productivity-driven growth, which can significantly enhance the productivity and contribution of private sector to the economy (UNIDO, 2020).

Investments in specific areas of a vision of digital infrastructure, green energy, vocational education, and healthcare (SDGs 3, 4, 7, and 13) have been shown to boost the work efficiency, health, and market access of small companies (ILO, 2024). Moreover, empirical evidence from South Asia and Africa has indicated a positive relationship between SDG-friendly investment in infrastructure and private sector formalization, competitiveness, and survival. (Ayyagari et al., 2011).

The Dynamic Capabilities Theory (DCT) provides the necessary theoretical foundation for inferring this relationship. The theory pioneered by Teece et al. (1997) advocated the need to sustain competitive advantage in changing economic conditions. Investments in sustainable development initiatives are expected to build a competitive and sustainable economic ecosystem, leading to elevated participation and growth of the private sector in the economy. However, the degree to which these investments are absorbed and transformed into productive gains or contribute to GDP by the private sector may differ due to multiple intervening variables. Therefore, the current study focused on studying the contextualized nature of this association across Asia-Pacific economies.

2.2 Diagrams Innovation and Private Sector Growth

The role of innovation in catalyzing industrial innovation has been extensively studied and established in the existing literature (Anderson et al., 2014). Innovation can be broadly defined as the development or adoption of new products, processes, or organizational practices and can be considered one of the most critical determinants of private enterprise success in the modern world (Joseph, 1942; OECD, 2019). Creative businesses have a high likelihood of expanding their operations, venturing into new markets, and adapting to evolving consumer demands. They are also more productive and stronger during financially unfavorable periods (Radas & Božić, 2009).

The current study held the view that innovation was also a factor and an outcome of sustainable growth in global economies. Central and South Asia often faced systemic impediments to innovation, which were attributed to insufficient investment in R&D, skill shortages, and a lack of connection with research centers. (WIPO, 2021). Innovation ecosystems, which combine aspects such as public support, education, and infrastructure with digital tools, were necessary to enable small firms to prosper.

Modern literature has focused on the link between SDGs and innovation. Where government or SDG-related investments facilitated the performance of the private sector and provided a rich innovation environment, they have a greater opportunity to enhance their value propositions and contributions to the economy. (Nambisan et al., 2017). Again, the DCT provided the necessary theoretical foundation to link the degree of innovation to economic performance across nations (Teece, 2023). The higher the degree of innovation in a society, the higher its ability to distinguish the economy from the global order. Thereby, providing pathways towards growth in the private sector. This preposition aligns innovation as a precondition for an independent factor determining the performance of the private sector and was therefore posited to be studied in the current framework.

2.3 Diagrams SDGs and Innovation

The SDGs are innovation-driven in themselves, as they focus on innovating and transforming existing mechanisms and models primarily through technological transformations and advancements. Innovation is incorporated through clean energy technologies (SDG 7), digital education (SDG 4), and smart infrastructure (SDG 9) as a method of effecting sustainable development and a product of sustainable development. This opinion has been justified in the literature, where it was stated that technological and social innovation was the only way to progress with most of the SDGs (Aleixo et al., 2020). The link between SDs investments and innovation got its foundations from the triple helix model (Leydesdorff & Etzkowitz, 1996). The model discussed how knowledge, technology and innovation paved the way for economic growth. It posited that universities, industries, and government interaction accelerated innovation and its diffusion. The current model held that SDG-aligned investments (both public and private) can drive innovation systems through R&D subsidies, startup incubators, and green finance instruments. Innovation, in turn, boosts the outcome of investments in SDGs by amplifying productivity, facilitating scale, and diminishing environmental externalities (WEF, 2022). Thus, the SDGs served as both a positive driver and an enabler of innovation in the economy, and this is particularly relevant when it comes to private sector development.

2.4 Innovation as a Mediator Between SDGs and Private Sector Contributions to GDP

The current model posited that the relationship between innovation and the private sector was not straightforward and may be viewed through an intervening variable to examine the connection between SDGs and the private sector's role in GDP. The current model drove this association by relying on the DCT and the Innovation Diffusion Theory (IDT), which presented established mechanisms for conceptualizing and transferring innovation across systems (Rogers & Williams, 1983). The DCT upgraded the Resource-based View (RBV) and assumed that economic entities used internal and external resources to achieve competitive advantage, some of which included technology, knowledge, and infrastructure (Barney, 1991). SDG investments can similarly be perceived as inputs of resources that contributed to the improvement of the collective economies' innovation capacity. This collective innovation capability, in turn, enabled the private sector to enhance its economic performance.

Similarly, the IDT (Rogers & Williams, 1983) suggests that the process of innovation adoption is subject to environmental preparedness and the capacity of economic entities. The development efforts funded by the SDGs could improve the socio-technical infrastructure needed to catalyze the adoption of innovation among private sector organizations.

Therefore, innovation mediated the relationship between SDG investment and GDP. Therefore, it was proposed that mitigating and harnessing SDG-aligned investment and innovation could improve private sector operations in terms of output, value addition, and, eventually, contribute to higher rates of their contribution to GDP.

2.5 E-Government Services as a Moderator Between SDGs and Private Sector Contributions to GDP

Technological advancements are continuously transforming every aspect of human life around the globe (Rasheed et al., 2024). The role and impact of technological integration in everyday life have become even more persistent and prominent in the post-pandemic era (Tan et al., 2024). Attributing to this global trend, governments around the globe are opting for the provision of government services by using these advancements in technology. This integration of technology and government services is referred to as “E-Government.” The current investigation adopted the definition of e-government by Carter and Bélanger (2005) as “e-government services as the use of ICT to enable and improve the efficiency of government services provided to citizens, employees, businesses, and agencies”.

This study viewed the services offered by e-Government as a strategic facilitator in streamlining the addition of the contributions of the private sector to GDP. Similarly, the economic yields from investment across the United Nations SDGs become more effective in the presence of a strong e-government network. Using digital resources, e-government systems are expected to offer more efficient, transparent, and accessible services that directly influence the private sector to create a conducive environment that supports sustainable economic growth. E-government services are also expected to improve the efficiency of implementation by streamlining regulatory procedures and mitigating bureaucratic delays. This enhances the private sector’s ability to contribute efficiently. Hence, E-Government fulfils the conditions for the moderating role amongst relationship of SDGs and the private sector to enable sustainable economic growth.

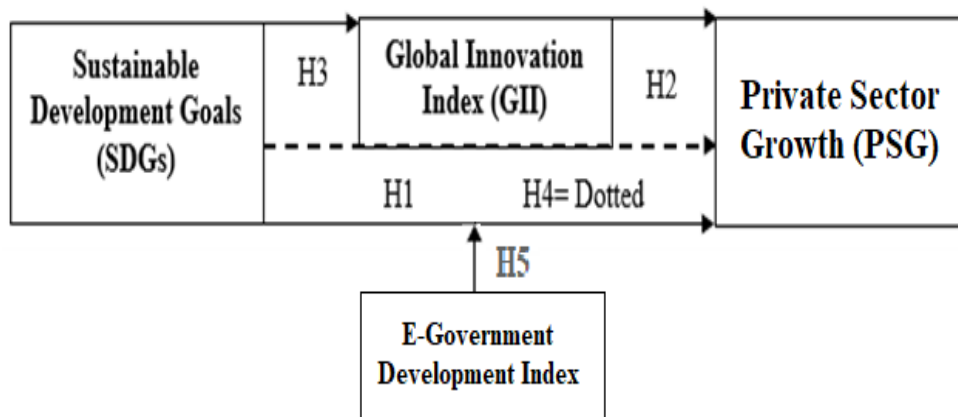


Fig. 1. Theoretical Framework

The feasibility of such a model can be supported by empirical research that has examined the mediated and moderated relationships between macroeconomic variables across various economies (Li & Umair, 2023; Lumpkin & Dess, 2001). However, such studies were rare in developing economies, such as those in the Asia-Pacific region; hence, this exploration offers significant value to the existing understanding of this avenue. The final proposed framework of the study is presented in figure 1, with the proposed hypotheses enlisted below.

H1: SDG Investments are a significant determinant of Private Sector contribution to GDP.

H2: Innovation in an economy is a significant determinant of Private Sector contribution to GDP.

H3: SDG Investments are a significant determinant of level of Innovation in an economy.

H4: The association between SGD investments and Private sector contribution to GDP is mediated by the level of innovation in an economy.

H5: The association between SGD investments and Private sector contribution to GDP is moderated by the level of e-government integration.

3. METHODOLOGY

The model of the current study was based on an underlying assumption that aligned with a quantitative, deductive approach to achieve the study's objective. This section elaborates on the data used in the study, the operationalization of variables, and the inferential methods employed to generate the study's empirical findings.

3.1 Data and Sample

The sample of the current study focused on Asian Pacific nations but given the fact that even nations in a region diverged in economic cooperation and dynamics. The behaviour of economically connected nations was expected to vary significantly from that of alienated economies. Therefore, the current study focused on developing countries in the region by considering countries that were part of the Belt and Road

Initiative (BRI) and Central Asia Regional Economic Cooperation (CAREC). The CAREC Institute was co-owned and managed by eleven member countries: Afghanistan, Azerbaijan, the People's Republic of China, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, Tajikistan, Turkmenistan, and Uzbekistan. This economically integrated sample enabled the analysis to control the impact of any political divergence across the sample. The final sample consisted of secondary indicators from eleven nations from 2007 to 2023. This sample was selected based on the availability of data for the indicators included in the study.

3.2 Variables and Measurement

This section focuses on the endogenous and exogenous variables incorporated into the study, where private sector growth was the main variable of interest. At the same time, economic innovation and sustainable investment goals were the dependent variables of the model.

Private Sector Growth (PSG)

The current study adopted a well-established World Bank indicator as a proxy for private sector growth. The proxy represented the percentage share of private sector merchandise trade in the economy's GDP (Margulescu & Margulescu, 2017).

E-Government (EGov)

The measure used to assess the level of e-government services was the UN E-Government Development Index. The proxy measured e-government services across three dimensions: degree of e-services, connectivity channels, and capacity of the population (Younus et al., 2024).

Innovation (GII)

To capture innovation trends across the sampled economies, this study used the Global Innovation Index (GII) as a proxy. The World Intellectual Property Organization (WIPO) generated an annual index for each economy, which was widely used as a barometer for innovation in existing literature. (Oturakci, 2023).

Sustainable Development Goals (SDG)

The SDGs were measured using 248 different indicators to provide a comprehensive evaluation of the progress made (United Nations, 2015). Based on the United Nations list of indicators for each of the 17 goals, a sustainable development index was adopted from the study of Sadiq et al. (2024), and indicators were selected based on data availability (Table 1 in the appendix).

Subsequently, the arithmetic mean of the indicators was calculated to obtain the score for each SDG.

$$SDG_i = \sum_{i=1}^n \frac{x_i}{n}$$

Finally, this study followed Sadiq et al. (2024) to attain an overall index for each country in the sample. The overall mean of all goals was calculated for each year and country in the sample.

$$SDG_{index} = \frac{SDG_1 + SDG_2 + SDG_3 \dots \dots \dots SDG_{17}}{17}$$

3.3 Statistical Techniques

The current study employed a sequential flow of analysis; a traditional approach commonly used in modern financial literature. First, the models of simple baseline regression models were obtained, and subsequently fixed and random effect models were applied to establish the robustness of the findings. Overall, the study adopted and utilized Baron and Kenny's (1986) four-step regression model to test for mediation analysis and utilized the interaction term of independent and moderator variables for moderation analysis.

I. Direct Associations

$$PSG_{it} = \alpha + \beta_1 SDG_{it} + \sum \beta_n C_{it} + \varepsilon$$

$$PSG_{it} = \alpha + \beta_1 GII_{it} + \sum \beta_n C_{it} + \varepsilon$$

$$GII_{it} = \alpha + \beta_1 SDG_{it} + \sum \beta_n C_{it} + \varepsilon$$

II. Mediation Model

$$PSG_{it} = \alpha + \beta_1 SDG_{it} + \beta_2 GII_{it} + \sum \beta_n C_{it} + \varepsilon$$

III. Moderation Model

$$PSG_{it} = \alpha + \beta_1 SDG_{it} + \beta_2 (EGovXSDG)_{it} + \sum \beta_n C_{it} + \varepsilon$$

PSG= Private Sector contribution to the GDP, SDG=Sustainable Development Goals Index, GII=Global Innovation Index, (EGov X SDG) = Interaction term of e-government and sustainable development index, and C= control variables.

3.4 Control Variables

Following the norms of existing economic and financial literature (Kumar et al., 2024; Rasheed et al., 2021), this study also considered pertinent control variables in the model to control and account for their impact. The inclusion of control variables not only enhanced the reliability and validity of the findings but also ensured the robustness and generalizability of the inferential estimates in the distortion and complexities of real-world dynamics. The current study adopted control variables from a similar study by Sadiq et al. (2024) exploring SDGs. The selected control variables included gross domestic product (GDP), inflation (INF), foreign direct investment (FDI), and population (POP). The findings of the control variables were omitted from the results as overall these factors remained significant determinants of the models and their dynamics were already established in the existing literature (Kumar et al., 2024; Sadiq et al., 2024).

4. RESULTS AND DISCUSSION

The findings of the baseline simple regression model are reported in this section. Table 2 presents the hypothesis-testing results for the study model. The findings indicated that the SDG Index was a significant determinant of the private sector's contribution to a nation's GDP. The findings of the percentage change in the SDG index resulted in ($\beta=0.1396$) at ($p<0.01$), making it a critical driver of private sector growth in the context of Asian Pacific countries. Hence, this fully supported the first hypothesis of the study.

Subsequent analysis of innovation against private sector growth and contribution to national GDP was also found to be significant ($\beta=00.39889$) at ($p<0.01$). Innovation was established as a key factor driving private sector productivity across the Asia-Pacific nations, validating the second hypothesis of the study.

Finally, to establish the mediation preconditions, an analysis between SGD and GII was conducted, and the results revealed a significant association with ($\beta=001.5043$) at ($p<0.01$). Hence, investing in development goals significantly stimulated innovation across Asia-Pacific economies, providing evidence to support the third hypothesis of this study.

Table 1. Hypothesis Testing

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Hypothesis 1				
C	-014.5729	12.3534	-01.1797	0.2396
SDG INDEX	001.1396	00.1905	05.9825	0.0000
Hypothesis 2				
C	036.42972	05.6517	06.4457	0.0000
GII	000.39889	00.0965	04.1308	0.0001
Hypothesis 3				
C	170.9396	23.7267	07.2045	0.0000
SDG INDEX	001.5043	00.3547	04.2410	0.0000
Hypothesis 4				
C	-100.7849	25.7866	-03.9084	0.0001
SDG INDEX	002.1888	00.3518	06.2218	0.0000
GII	000.2333	00.0763	03.0580	0.0026
Hypothesis 5				
C	043.7309	04.4731	09.7763	0.0000
SDGxEGov	000.4598	00.1269	03.6236	0.0004

This has led to the mediation analysis of innovation, and the results are reported in Hypothesis Four of the study, and it can be observed that both SDG and GII were significant and positive. These results negated the presence of complete mediation of innovation between SDGs and private sector development; however, following Preacher and Hayes (2004), a partial mediation was established. This established innovation as a multifaceted mechanism for private sector development. Hence, it was a significant consequence of the successful implementation of the SDGs, leading to the development of the private sector across Asian Pacific nations.

Similarly, to evaluate for moderation of e-government services amongst SDGs and private sectors economic contribution, an interaction term was created $SDG \times EGov$. The interaction term was then regressed against private sector contribution to the GDP. The findings indicated that there was a significant and positive moderating impact of e-government services. This established the degree of e-government services as a driver of private sector contribution towards GDP enabling effective translation of SDGs into economic gains. Figure 2 elaborates on the underlying moderation dynamics with an arbitrary interception of 3. Overall, it can be observed that EGov significantly strengthened the positive relationship between SDG and PSG. The figure uncovered that investment in SDGs significantly improves private sector contribution to the GDP even in the absence of e-government services, but this effect became significantly higher in presence of e-government services. The much steeper slope of the graph was testament to the fact that e-government services streamlined the pathways through which sustainable development investments translated into private sector productivity.

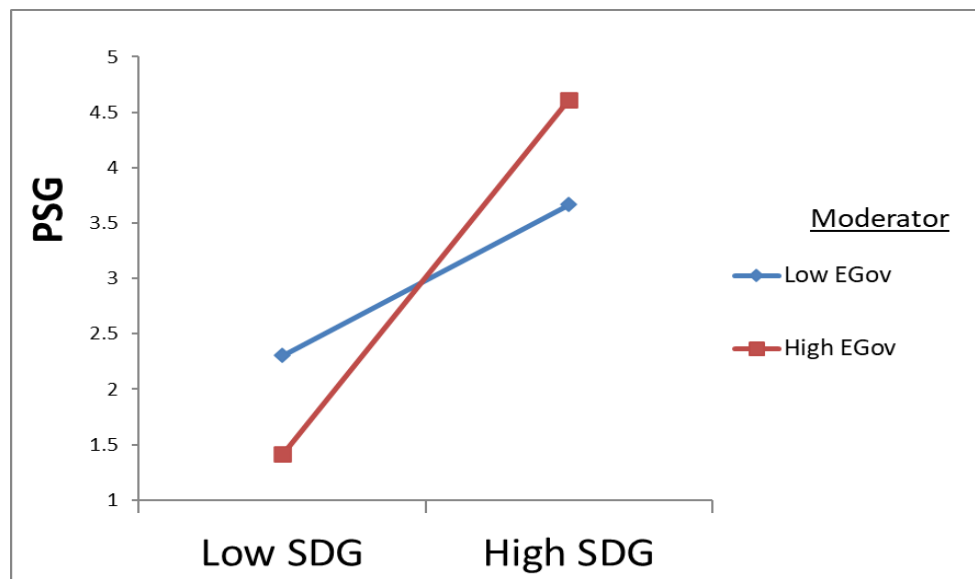


Fig. 2. Two-Way Interactions

To build a more profound and contextualized understanding of how each sustainable development goal contributes to driving private sector growth and innovation across economies, an indicator-wise analysis was conducted, and the results are reported in Table 3.

The findings against the private sector's share in GDP indicated that SDG 1 (no poverty), SDG 5 (gender equality), SDG 10 (reduced inequalities), SDG 14 (life below water), SDG 15 (life on land), and SDG 16 (peace, justice, and strong institutions) were significant drivers across developing nations, such as the CAREC countries in the Asia Pacific. Meanwhile, findings on economic innovation revealed that SDG 3 (good health and well-being), SDG 9 (industry, innovation, and infrastructure), SDG 10 (reduced inequalities), and SDG 12 (responsible consumption and production) were primary drivers of innovation.

Table 3: Sub-analysis of SGDs

Variable	PSG			GII		
	B	t-stat.	Prob.	β	t-stat.	Prob.
C	191.4450	1.4964	0.1408	-274.7025	-1.8072	0.0767
GOAL1	000.5384	1.9794	0.0493	000.3619	1.1197	0.2682
GOAL2	-001.0622	-1.6420	0.1069	001.1335	1.4749	0.1465
GOAL3	-000.3533	-0.6049	0.5480	002.9297	4.2213	0.0001
GOAL4	000.3336	1.4437	0.1551	000.0821	0.2989	0.7663
GOAL5	000.6474	2.0307	0.0476	000.6083	1.6061	0.1146
GOAL6	001.0547	1.4489	0.1536	000.0849	0.0981	0.9222
GOAL7	-000.6220	-0.8045	0.4249	001.1784	1.2827	0.2055
GOAL8	-000.2046	-0.3841	0.7026	000.8466	1.3373	0.1872
GOAL9	-000.0007	-0.0033	0.9974	000.7864	2.9868	0.0044
GOAL10	000.5609	2.5137	0.0152	000.4670	1.7617	0.0842
GOAL11	-000.0409	-0.0985	0.9219	-000.2216	-0.4496	0.6550
GOAL12	-000.0305	-0.0222	0.9824	003.7261	2.2821	0.0268
GOAL13	-001.7400	-1.5379	0.1304	-000.2561	-0.1905	0.8497
GOAL14	000.5075	2.6819	0.0099	000.1102	0.4903	0.6261
GOAL15	001.6805	1.9016	0.0630	000.6193	0.5898	0.5580
GOAL16	001.4573	3.0039	0.0042	000.1805	0.3131	0.7555
GOAL17	002.2591	5.1245	0.0000	-000.2937	-0.5608	0.5774

Note: Bold values are significant @ $p < 0.1$

4.1 Robustness Analysis

This section focuses on establishing the reliability, validity, and generalizability of the initial findings of the baseline regression model. Results were evaluated for the presence of issues like autocorrelation, multicollinearity, heteroskedasticity, and serial correlation through statistical measures like Durbin Watson (DW) with a value of 1.74, a Variance Inflation Factor (VIF) value of less than 5, and the Breusch-Pagan (BP) test. Furthermore, the robustness of the findings was established through the application of fixed and random effect models, and the results are reported in Table 4.

The findings of both the fixed and random effects models established the validity of the initial findings. It can be observed that the SDGs, E-Gov, and the GII remained significant and positive determinants of private sector contributions to GDP.

Finally, the Hausman test was applied to check the suitability of the fixed or random effect model. The test findings established the fixed effect model as the superior model compared to the random-effect model. Hence, based on the fixed effect outcomes, it can be inferred that SDG and GII drove private sector development by ($\beta=00.5055$) and ($\beta=00.0840$), respectively ($p<0.01$).

Table 4. Robustness Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Fixed Effect Model				
C	239.8126	37.7035	6.3605	0.0000
GII	000.2638	00.0840	3.1424	0.0020
SDG_INDEX	002.3927	00.5055	4.7332	0.0000
E-Gov	046.6306	17.5201	2.6615	0.0087
Random Effect Model				
C	199.9591	36.3852	5.4956	0.0000
GII	000.2012	00.0808	2.4885	0.0139
SDG_INDEX	001.8614	00.4786	3.8889	0.0002
E-Gov	030.0759	16.8018	1.7900	0.0755
Hausman Test		Chi-Square	df	Prob.
Cross-section random		10.671213	2	0.0048

This study examined the impact of sustainable development and innovation on the contribution of the private sector to GDP across Asian economies. The results provided unique insights that add to and build upon the existing knowledge base.

First, the strong and positive impact of the SDG Index on the contribution of the private sector to GDP confirmed earlier findings that referred to the macroeconomic advantages of sustainable development projects. Sachs et al. (2022) provided such an argument, as the achievement of the SDGs will drive economic growth through the creation of inclusive institutions, infrastructure, and social cohesion. In the same line of thought, Yu and Huang (2021) highlighted the fact that the improvement in terms of poverty level (SDG 1) and gender equality (SDG 5) drove entrepreneurial activity and thus, strengthened the private sector.

Second, innovation had a notable direct association with the contribution of the private sector, indicating that innovation promoted firm productivity and competitiveness (Ayyagari et al., 2011). By demonstrating that a higher GII was accompanied by higher rates of private sector contribution to GDP, the present study contributed evidence concerning the Asian region to international discussions that ecosystem innovation was an inevitable component of private sector-led development (World Bank, 2020a).

Furthermore, the mediation and moderation analyses provided sophisticated insights. The partial mediating effect of innovation implied that although innovation was a significant avenue through which sustainable development was converted into private sector development, other simultaneous mechanisms, including better governance, human capital development, and market integration, were also critical. This indirect channel was partly a mediation process that was relevant to concepts and reflected research outcomes on multidimensional growth drivers (Rodrik, 2008). Finally, the role of e-government services significantly improved the translation of SDGs into private sector contributions to sustainable economic growth.

At the indicator level, the importance of SDGs 1, 5, 10, 14, 15, and 16 in terms of private sector contributions to GDP was consistent with the positions outlined by Hall et al. (2014), who argued that equitable, well-instituted environments promoted the growth of small businesses. Similarly, the fact that SDGs 3, 9, 10, and 12 had the most significant influence on innovation augured well with the presentations by UNIDO (2020), and Schot and Steinmueller (2018) that focused on the role of health systems, infrastructure, and responsible patterns of production to promote technological progress.

This study's findings provided strong empirical evidence that sustainable development and innovation played a significant role in improving the contribution of the private sector's GDP in Asia economies. The positive association of the SDG Index suggested that improving SDG was closely related to the growth of the private sector. The correlation was particularly relevant in the Asian context, as most Asian economies suffered from unequal development, institutional deficits, poverty, gender gap, and environmental issues. When it came to private enterprises, progress towards sustainable development fostered more stable and conducive conditions. Furthermore, the SDG Index strongly correlated with the private sector contribution, indicating that sustainable development contributed to laying the foundations for business activities. Economies' productive capacity increased due to advances in reducing poverty, improving gender equality, education, health, institutional quality, and infrastructure. Sustainable development worked not just as a social policy agenda. It was also a strategy for economic development as it enhanced human capital, increased the number of markets reached, and facilitated the expansion of the private sector.

The trend of private sector contribution to GDP was also positively correlated and had an impact on innovation. The result was consistent with the importance of innovation as a means of improving productivity, competitiveness, and firm growth. Nationally, economies that were more innovative were more likely to offer the necessary elements to support research, technology use, technology transfer, entrepreneurship, and value-added production. This finding was relevant for Asian economies as it pointed to a need to shift from the low-cost production paradigm to knowledge and innovation-based growth.

The mediation outcomes were more detailed explanations of the link between sustainable development and the contribution of the private sector. If the mediation was partial, then this implied that sustainable development strengthened the performance of the private sector partly through the mediation of innovation. Providing the right education, health, infrastructure, governance, and institutional capacity created conditions that were beneficial for innovation in the context of sustainable development. These conditions enabled companies to find ways of introducing modern technology, optimizing their production systems and access to higher value markets. The mediation effect was partial, and thus innovation was not the only way in which sustainable development impacted on the contribution of the private sector.

It was also observed that the moderation results further highlighted the significance of e-government services in bolstering the relationship between sustainable development and private sector contribution to GDP. E-government contributed to transparency, decreased administrative obstacles, decreased transaction costs, and increased access to public services. These enhancements enabled businesses to run more smoothly and predictably. The economic effects of sustainable development became more apparent in the performance of private sector when digital public services were strong.

The study contributes to this body of knowledge by demonstrating that sustainable development and innovation can go together to support the contribution of the private sector to GDP in Asian economies. Sustainable development, innovation, and digital governance should be linked as policies and treated together in the Asian economies. Governments are encouraged to enhance the implementation of SDGs and build innovation systems, digital public infrastructure, and quality of institutions and inclusive economic policies. Private sector productivity and its long-term contribution would improve if the government provided support for research and development, small and medium enterprises, digital services, women entrepreneurship, environment, and transparent governance. The findings indicated that high sustainable development, innovative capacity, and overall governance quality were also important for private sector-led growth in Asia.

5. CONCLUSION

This study aimed to explore the complex associations between SDGs investments, the Global Innovation Index (GII), degree of e-government (EGov), and the contribution of the private sector in the sampled Asia-Pacific economies. The findings of this analysis contribute to some vital conclusions.

The results indicated a strong and affirmative relationship between the composite SDG index and the contribution of the private sector to GDP; that is, the more successful a country is in achieving sustainability goals, the higher the private sector's contribution to GDP. The GII was found to be a critical factor, exhibiting a strong association with private sector value addition, thereby revealing the vital importance of innovation ecosystems in enhancing the dynamism of the private sector.

Additionally, the mediation and moderation tests showed that the GII partially mediated the connection between SDG progress and the share of GDP of the private sector. E-government services were also found to be positively enhanced among SDGs and private sector output to the economy. This indicated that although SDG-correlated investments directly affected the work of the private sector in the economy, there was also a share of influence which worked indirectly due to the reinforcement of national innovation capacity and e-government services. This pathway can build on the synergy between sustainability policies, the adoption of e-government, and innovation systems to enhance inclusive economic growth.

At the goal-specific level, the discussion presented the process of achieving SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities), SDG 14 (Life Below Water), SDG 15 (Life on Land), and SDG 16 (Peace, Justice, and Strong Institutions) had a significant impact on promoting the contribution of the private sector to GDP. These objectives responded to the dimensions of social equity and environmental stewardship, which directly concerned market inclusivity and resource-related industries, where the private sector was frequently present. Similarly, the development of SDG 3 (Good Health and Well-being), SDG 9 (Industry, Innovation and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 12 (Responsible Consumption and Production) were found to promote the GII in significant correlations, which meant that investments in human resources, industrial infrastructure, and sustainable consumption patterns were major motives for the national performance of innovation.

Altogether, these results contributed to the current literature by empirically confirming the channels through which SDG advancement and innovation capacity collectively drove private sector-driven economic development in a multi-country, emerging economy scenario. For policymakers in Asia, the findings highlighted the need to integrate sustainability goals and innovation-based industrial policies to enhance the contribution of the private sector to development. This type of integrated solution can be used to accelerate the transition to more robust, inclusive, and sustainable economies. Future studies can further develop these lessons by examining industry-specific channels and considering firm-level microdata to gain a deeper understanding of the heterogeneity in private sector reactions to sustainability and innovation incentives.

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7. CONFLICT OF INTEREST STATEMENT

The authors agree that this research was conducted in the absence of any self-benefits, commercial or financial conflicts and declare the absence of conflicting interests with the funders.

8. AUTHORS' CONTRIBUTIONS

Omar Zuhier Abdul Karim Al Shar: Conceptualisation, methodology, formal analysis, investigation and writing-original draft; **Qingmei Tan:** Conceptualisation, writing-original draft, methodology, supervision and formal analysis; **Muhammad Haroon Rasheed:** Conceptualisation, formal analysis, and validation; writing-original draft, Software; **Muhammad Waqar Akhtar:** Conceptualisation, supervision, writing-review and editing, and validation; **Nordiana Mohd Nordin:** Conceptualisation, writing and reviewing-original draft, methodology, supervision, visualization and formal analysis

9. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the author(s) used AI assisted tools including Paperpal, Grammarly and QuillBot to ensure linguistic and grammatical accuracy. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

10. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

11. ETHICS STATEMENT

The authors declare that this research did not involve human or animal subjects.

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13. APPENDIX

A: List of SDG Indicators

Sr No	SDGs Goals	SDGs Indicator
1	“No Poverty”	“01-Poverty headcount ratio at \$2.15/day 02-Poverty headcount ratio at \$3.65/day”
2	“No Hunger”	“01-Prevalence of obesity, BMI $\geq$ 30 02-Human Trophic Level 03-Cereal produce 04-Sustainable Nitrogen Management Index”
3	“Good Health and well-being”	“01-Maternal mortality rate 02-Neonatal mortality rate 03-Mortality rate, under-5 04-Incidence of tuberculosis 05-New HIV infections 06-Age-standardized death rate due to cardiovascular disease, cancer, diabetes, or chronic respiratory disease in adults aged 30–70 years. 07-Age-standardized death rate attributable to household air pollution and ambient air pollution. 08-Traffic deaths 09-Life expectancy at birth 10-Adolescent fertility rate 11-Births attended by skilled health personnel 12-Surviving infants after 2 WHO-recommended vaccines”
4	“Quality education”	“01-Net primary enrolment rate 02-Lower secondary completion rate 03-Literacy rate”

5	“Gender Equality”	“01-Ratio of female-to-male mean years of education received. 02-Ratio of female-to-male labour force participation rate 03-Seats held by women in national parliament”
6	“Clean water and sanitation”	“01-Population using at least basic drinking water services. 02-Population using at least basic sanitation services 03-Freshwater withdrawal”
7	“Affordable and clean Energy”	“01-Population with access to electricity 02-Population with access to clean fuels and technology for cooking 03-CO ₂ emissions from fuel combustion per total electricity output 04-Renewable energy share in total final energy consumption”
8	“Decent Work and Economic Growth”	“01-Unemployment rate 02-Fundamental labour rights are effectively guaranteed 03-Fatal work-related accidents embodied in imports”
9	“Industry, Innovation & Infrastructure”	“01-Population using the internet. 02-Mobile broadband subscriptions 03-Logistics Performance Index 04-Articles published in academic journals”
10	“Reduced Inequalities”	“01-Gini Coefficient of Inequality”
11	“Sustainable Cities and Communities”	“01-Annual means concentration of particulate matter of less than 2.5 microns in diameter. 02-Access to improved water source, piped”
12	“Responsible Consumption & Production”	“01-Production-based air pollution 02-Air pollution associated with imports 03-Production-based nitrogen emissions 04-Nitrogen emissions associated with imports”
13	“Climate Action”	“01-CO ₂ emissions from fossil fuel combustion and cement production 02-GHG emissions embodied in imports”
14	“Life Below Water”	“01-Fish caught from overexploited or collapsed stocks. 02-Fish caught by trawling or dredging”
15	“Life on Land”	“01-Mean area that is protected in terrestrial sites important to biodiversity. 02-Red List Index of species survival”

16	“Peace, Justice, and Strong Institutions”	“01-Homicides 02-Corruption Perceptions Index 03-Press Freedom Index 04-Persons held in prison”
17	“Partnerships for the Goals”	“01-Government spending on health and education 02-Other countries: Government revenue excluding grants”



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