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Does Innovation Benefit Exporters in Pakistan more than Non-Exporters? An Analysis of Firms from the Textile, Light Engineering and Automotive Sectors

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Abstract

Innovation is an essential catalyst for growth and competitiveness in the global economy. Yet, its specific impacts on firm performance remain inadequately explored, particularly across different sectors in the context of developing countries. This paper examines the effects of innovation on the performance of exporting and non-exporting firms within Pakistan's textile, light engineering, and automobile industries. Utilizing a modified version of the Crépon, Duguet, and Mairessec (1998) innovation model, we investigate the impact of various innovations on firm performance and explore how adopting complementary innovations influences outcomes. Our initial results imply that non-exporting firms benefit more from individual types of innovations and their respective combinations of innovations purely driven by younger firms. However, we get more nuanced results when we divide firms by sector. In the textile sector, dominated by exporters, innovation positively impacts firm outcomes through product and technological advancements, with the benefits focused on more extensive and established firms.

Conversely, in the light engineering sector, individual innovation adoption favors exporters, while adopting complementary innovations benefits non-exporters, especially young firms. In the automotive industry, innovation impacts exporters and non-exporters differently and favors older firms. These results add to our understanding of the innovation-performance nexus in Pakistan's industrial landscape and can provide practical insights for policymakers, industry stakeholders, and academics.

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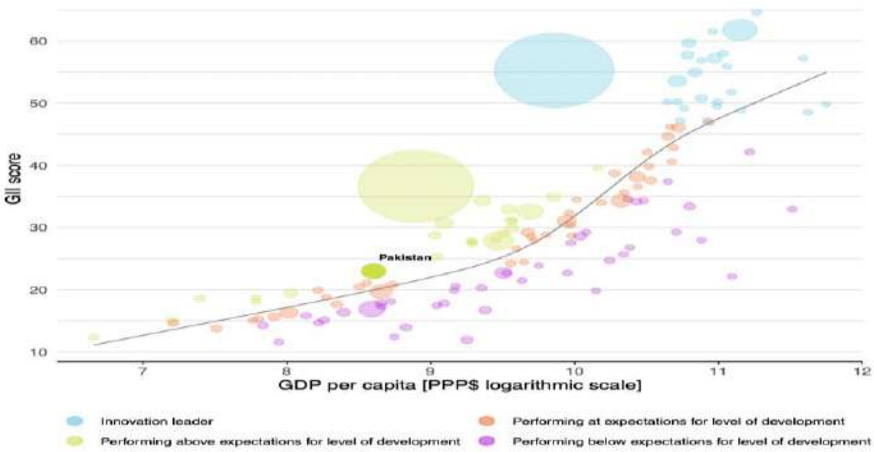
Introduction

Innovation is a critical driver of competitive advantage, productivity growth, and economic resilience in the globalized economy. This holds true both at the macroeconomic and firm levels. As firms face intensifying pressures to adapt and remain competitive, innovation emerges as a catalyst for internal efficiencies and a key component for sustaining international competitiveness. By fostering productivity improvements, enhancing competitiveness, and enabling firms to penetrate global markets, innovation is essential for driving economic progress. The economic literature extensively explores the relationship between innovation and firm performance. Schumpeter (1942) highlighted the role of innovation in economic dynamism, allowing firms to create monopolistic advantages and improve performance. While innovation is crucial for both developed and developing countries, it holds particular significance for developing countries like Pakistan, where firms often operate under resource constraints and dynamic market conditions.

Figure 1.1 below shows a strong positive correlation between the Global Innovation Index (GII) score and its GDP per capita. The trend line represents the expected innovation performance levels based on a country's GDP per capita. Countries above the trend line outperform their expected innovation levels, while those below underperform.

Figure 1.1: Relationship between GDP per capita and innovation performance (GII score) across Countries



Source: Global Innovation Index, 2022- ranks approx. 132 countries based upon 80 indicators are released annually by the World Intellectual Property Organization (WIPO)

Pakistan is heavily reliant on traditional manufacturing sectors like textiles, light engineering, and automotive, lags in innovation. According to the Global Innovation Index 2021, Pakistan ranks 107th (118th in innovation inputs and 88th in innovation output), significantly lower than its peers in the lower middle-income group. Innovation can enable Pakistani firms to enhance performance, particularly in export markets. Both exporters and non-exporters can benefit from innovation. However, the specific ways in which these benefits manifest, especially when innovations are adopted in combination, remain underexplored in the context of Pakistan's industrial landscape.

Recent literature has delved deeper into the benefits of innovation, differentiating between various types such as product, process, technological, marketing, and business model innovations. Each type contributes differently to firm performance, impacting revenue growth, cost reduction, and market expansion. Another more intricate aspect is also attached to it: the nature and types of innovations. Moreover, the most suitable type of innovation for a specific country or industry may vary, highlighting the need for a tailored approach. Empirical studies, including those by by Griliches (1998), O'Mahony et al. (2010), Abazi-Alili et al. (2017), and Exposito & Sanchis-Liopis (2018), have shown that product and Technological Innovations, especially when paired with robust R&D efforts, can significantly enhance firm productivity and market reach, particularly for exporting firms operating in competitive international markets.

Complementary innovation, the simultaneous adoption of multiple types of innovation simultaneously, has garnered attention for its potential to create synergistic effects. For instance, combining process and business model innovations can streamline operations and reduce costs, while product and Technological Innovations can drive market expansion and product differentiation (Hervas-Oliver et al., 2014; George & Teimuraz, 2018). However, the effectiveness of complementary innovation can vary across different contexts. Resource limitations, market conditions, and sector-specific dynamics can shape the efficacy of combined innovation efforts. In emerging economies like Pakistan, where sectors vary widely in technological readiness and export intensity, understanding these contextual dynamics is essential for tailoring innovation strategies to maximize firm performance.

Relevance to Pakistan's Textile, Light Engineering, and Automotive Sectors

Pakistan's industrial landscape is diverse, with the textile, light engineering, and automotive sectors playing a significant role. The export-oriented textile sector has demonstrated a proclivity for Product Innovation to meet international standards and shifting consumer demands (Wadho & Chaudhry, 2018). However, the light engineering sector, characterized by both exporters and non-exporters, reveals a different trend where process innovation is central to enhancing operational efficiencies. The automotive industry, while potentially benefiting substantially from dual or complementary innovation, meanwhile, faces high adoption costs. These sector-specific dynamics suggest that the heterogeneity of innovation on firm performance, which may be potentially influenced by the factors such as export orientation.

While prior research underscores the importance of innovation in enhancing firm competitiveness, relatively few studies address how different types of innovation, and their combinations, impact exporters and non-exporters in developing countries. In Pakistan, there is limited evidence on the comparative benefits of innovation across firms of varying sizes, ages, and sectors, particularly regarding export activities. Additionally, the potential advantages of combining innovations, such as cost efficiency and product development, remain understudied in the Pakistani context, especially considering sector-specific constraints. This study aims to evaluate the impacts of five key types of innovation—product, process, technological, marketing, and business model—on critical performance indicators such as revenue growth, cost reductions, and price adjustments. By assessing whether complementary adoption yields additional benefits, this analysis also addresses whether dual innovations enhance firm outcomes beyond those achieved by singular innovation. Importantly, we have examined how these effects differ between exporting and non-exporting firms, reflecting sectoral heterogeneity across Pakistan's textile, light engineering, and automotive industries. This disaggregation allows us to account for potential sectoral variations in the impact of innovation on firm performance, providing insights into how industry-specific characteristics influence the effectiveness of innovation strategies in Pakistan's economy.

Literature Review

Innovation is widely acknowledged as a critical driver of economic growth, competitive advantage, and firm performance (Schumpeter, 1942). Schumpeter's emphasized the role of innovation in creating temporary monopolistic advantages that drive industrial progress and economic development. More recent research has explored this concept in greater detail, with firm-level analyses highlighting the importance of innovation and R&D in boosting productivity, efficiency, and profitability (Griliches, 1998; O'Mahony et al., 2010; Abazi-Alili et al., 2017; Exposito & Sanchis-Llopis, 2018). Griliches (1998) emphasized that innovation and R&D are highly correlated with productivity gains, particularly in high-tech sectors, where firms face constant pressure to improve products and processes. In addition to the traditional view of innovation, scholars have increasingly focused on distinguishing between different types of innovation, each impacting firms in unique ways. Hervas-Oliver et al. (2014) and George & Teimuraz (2018) argue that product, process, technological, marketing, and business model innovations have distinct impacts on firm performance. Product Innovation is crucial for differentiation in industries with evolving consumer needs, while process innovation is valuable for cost efficiency and streamlined production (Dosi, 1988). In Pakistan, Wadho and Chaudhry (2018) found that Product Innovation significantly enhanced performance in textile and apparel manufacturing sector, underscoring its importance in export-oriented industries.

The literature also discusses the potential benefits of combining multiple types of innovation, often referred to as complementary or dual adoption. This approach can leverage synergies between different types of innovations, such as pairing process and Business Model Innovation to streamline operations and improve value proposition, or combining product and Technological Innovations to enhance product differentiation and market competitiveness (Cassiman & Veugelers, 2006; Belderbos et al., 2006, Bouncken et al., 2016). However, adopting complementary innovations can be challenging, particularly for resource-constrained SMEs. The high costs and risks associated with implementing dual innovation strategies can be significant barriers (Exposito & Sanchis-Llopis, 2018).

Innovation in Developing Economies and the Role of Export Orientation

In developing economies, the impact of innovation on firm performance is influenced by various contextual factors, including resource limitations, institutional frameworks, and market structures. Innovation can be particularly transformative for export-oriented firms, which face higher competitive pressures to meet international standards and deliver innovative products (Freeman, 2002; Girma et al., 2004). These firms are more likely to adopt product and process innovations to gain a competitive edge in global markets. Studies on export-led economies like China and India demonstrate that product and process innovations significantly bolster firms' export performance, contributing to national economic growth (Aw et al., 2000; Fu, 2008; Chen & Tang, 2013). Conversely, non-exporting firms, operating primarily in domestic markets, may prioritize innovation types that drive cost efficiency, such as process and business model innovations. These innovations can enhance internal operations without necessitating significant R&D investment as product or Technological Innovations as suggested by Cohen and Levinthal (1990) and Lall (1992).

The influence of innovation on firm performance also varies across industrial sectors. Sector-specific studies prove that different types of innovation yield varying benefits depending on industry characteristics, technological intensity, and competitive structure (Pavitt, 1984; Malerba, 2002). In the manufacturing sector, particularly textiles, process and Product Innovations have significantly boosted productivity and competitiveness (Nadvi, 1999; Wadho & Chaudhry, 2018). Pakistan's export-oriented textile sector, for example, benefit from Product Innovation to meet global demand for high-quality and unique products. In contrast, industries like light engineering, characterized by technological advancement, often prioritizes process innovation for operational efficiency and cost control.

Automotive firms, particularly in developing economies, encounter distinct challenges in innovation due to high capital requirements and complex supply chains. Studies on automotive sectors in emerging markets demonstrate that technological and Marketing Innovations enhance firm competitiveness by improving product features and expanding market reach (Fujimoto, 2007; Iyer et al., 2009). However, the high costs of these innovations limit their adoption, particularly for smaller firms. Therefore, sectoral heterogeneity influences the impact of innovation on firm performance, underscoring the need for sector-specific innovation strategies.

Complementary Innovations and Synergistic Effects

While specific types of innovation can improve firm performance, the literature increasingly emphasizes the potential of complementary or dual innovations to create synergistic effects (Cassiman & Veugelers, 2002; Leiponen & Helfat, 2010). Combining innovation types can enable firms to address multiple business dimensions simultaneously, creating added value and resilience in changing markets. For instance, integrating technology with Marketing Innovation can enhance product appeal and accelerate market adoption, whereas combining process with Business Model Innovationcan reduce costs and streamline value delivery (Bouncken et al., 2016). Cassiman and Veugelers (2006) highlight that firms in high-tech industries that engage in dual innovations achieve higher profitability and are more competitive than those that innovate in isolation. However, implementing complementary innovations can be challenging, especially in developing economies. The costs and risks associated with dual innovation are significant, particularly for smaller firms with limited financial and human resources (Freel, 2005). Resource constraints may force firms to prioritize specific innovations over others, limiting their ability to achieve the fully realize the benefits of complementary innovation (Rosenbusch et al., 2011). Additionally, firms in sectors with low technological readiness, may face difficulties integrating complementary innovations effectively, leading to diminished returns or negative synergies.

Despite the extensive literature on innovation, few studies have specifically examined how different types of innovation, and their combinations affect firm performance in Pakistan's textile, light engineering, and automotive sectors. Most research focuses on developed economies or fast-growing emerging markets, with limited attention to the nuanced impact of innovation in Pakistan, where firms operate under distinct institutional, financial, and market constraints. Additionally, while the benefits of complementary innovation are well-documented, more research is needed to understand how these benefits vary between exporting and non-exporting firms in developing countries. This study aims to address these gaps by analyzing the effects of individual and complementary innovations on the performance of exporters and non-exporters in Pakistan's major industrial sectors. By examining sector-specific dynamics, this study seeks to gain a deeper understanding of innovation's role in driving competitiveness within Pakistan's economy.

Data Collection and Research Design

The Lahore School of Economics collected the primary data used in this study through a structured survey administered to textile, light engineering, and automotive firms in Punjab and Sindh, two of Pakistan's most industrialized provinces. These provinces were selected due to their significant industrial contributions, housing many firms engaged in manufacturing and export activities. This approach enabled us to capture the heterogeneity within each sector and the distinctions between exporting and non-exporting firms. The survey was administered over four years (2018-2021), providing a time-based perspective on innovation adoption and its outcomes in the context of evolving market conditions and policy changes. The sample of firms was drawn from the Directory of Industries and the Census of Manufacturing Industries (CMI). Firms were selected based on sector affiliation, firm size, and export orientation, ensuring a representative sample across varying firm demographics.

Moreover, the survey was designed to capture information on various forms of innovation adopted by firms, including product, process, technological, marketing, and business model innovations. In addition to innovation adoption, the survey captured vital performance indicators (KPIs) related to firm outcomes, such as revenue growth, cost reductions, and product pricing adjustments. Firms were asked to report on the types of innovation they had implemented and their specific impacts on performance metrics. For instance, firms were queried on whether product or process innovation had contributed to revenue increases or reductions in operational costs.

To quantify the impact of innovation impact, we utilized a modified Crépon, Duguet, and Mairessec (CDM) model, commonly used to evaluate the effects of innovation on firm performance. The model is well-suited for studies where innovation decisions and performance outcomes may be endogenous. This modification allowed us to address selection bias by estimating a latent variable that captures predicted innovation effort among firms actively investing in innovation. Additionally, the model accommodates binary response variables for firm performance indicators, such as increases in revenues or reductions in production costs, providing a robust framework for analyzing the effects of innovation.

To ensure data accuracy, firms reporting significant performance changes were cross-verified through follow-up interviews. Additionally, the survey included control questions to minimize response biases and discrepancies. Data from firms with incomplete or inconsistent responses were excluded from the final analysis. This rigorous approach helped compile a reliable dataset that accurately reflects the impact of innovation on firm performance across Pakistan's diverse industrial landscape.

Empirical Strategy and Econometric Methodology

This study employed a modified version of the Crépon, Duguet, and Mairessec (CDM) model to assess the differential impact of various types of innovation—product, process, technological, marketing, and business model—on the performance of exporting and non-exporting firm indicators, focusing on revenue growth, cost reduction, and product price adjustments. The CDM model is suitable for addressing potential endogeneity and selection bias, allowing for a more accurate estimation of the impact of innovation.

The CDM Model Framework

The modified CDM model in this study involves a multi-stage approach that examines (a) the firms' decisions to innovate, (b) the intensity of innovation efforts, and (c) the impact of these efforts on firm performance outcomes. The model first estimates the probability of firms deciding to innovate, considering specific firm characteristics and sectoral attributes. This addresses the endogeneity concern, as firms that choose to innovate may already have different performance trajectories. Next, the model measures the innovation effort, conceptualized as a latent variable representing the extent of a firm's investment in innovation activities, influencing its performance. This stage helps distinguish the impact of the actual intensity from its mere presence. The final stage then models the impact of individually and combined innovation on firm performance indicators using binary response variables. These response variables capture whether firms have achieved specific outcomes, such as revenue growth or cost reduction, due to their innovation efforts.

Econometric Specifications

The core econometric specification for this analysis involves a binary response model applied to performance indicators, capturing outcomes as binary (e.g., increase in revenues due to innovation, reduction in costs due to innovation, and reduction in prices due to innovation). For each innovation type (product, process, technological, marketing, business model) and their combinations, the model estimates the marginal effects on performance outcomes for exporting and non-exporting firms. The following econometric specifications are used:

Probit Model for Innovation Adoption: We use a probit model to estimate the probability of innovation adoption. In the model, the dependent variable is a binary indicator of whether a firm has adopted any form of innovation, and the independent variables include firm characteristics (such as size, age, and sector) and market orientation (exporting vs. non-exporting).

$$P(I_i = 1) = \Phi(\alpha_0 + \alpha_1 \text{FirmSize}_i + \alpha_2 \text{FirmAge}_i + \alpha_3 \text{Sector}_i + \alpha_4 \text{Export}_i + \epsilon_i)$$

Where Φ is the cumulative distribution function of the standard normal distribution (for probit). *Firm size (FirmSize*), firm age (*FirmAge*), the industrial sector (*Sector*), and *whether the firm is an exporter (Export*), are firm-specific characteristics that influence the decision to innovate.

Linear Regression for Innovation Intensity: For firms that engage in innovation, the model estimates innovation intensity as a continuous latent variable representing the firm's effort in innovation. This latent variable is calculated based on observable inputs such as R&D expenditures, frequency of new product introductions, and the number of new processes adopted. Ordinary Least Squares (OLS) are applied where possible, while instrumental variable techniques address any remaining endogeneity concerns in innovation investment.

Binary Response Models for Performance Indicators: We use binary response models (such as probit or logit models) to assess the impact of innovation on performance. In these models, the dependent variables are revenue growth, cost reduction, and price adjustment. A binary indicator is used for each performance outcome, where 1 represents a positive outcome (e.g., revenue increase due to innovation) and 0 otherwise.

$$P(Yij=1)= \Phi(\gamma_0+\gamma_1\ ProductInnovationi+\gamma_2\ ProcessInnovationi+\gamma_3\ TechnologicalInnovationi+\gamma_4\ MarketingInnovationi+\gamma_5\ BusinessModelInnovationi+\ \gamma_5\ Exporti+\gamma_7\ Sectori+\eta_i)$$

Yij=1 indicates a positive performance outcome (e.g., revenue increase, price decrease, or cost) due to innovation type j. Each innovation type (*ProductInnovation, TechnologyInnovation, ProcessInnovation,* etc.) is a binary variable indicating whether or not I have adopted that type.

Moreover, to capture the synergistic effects of complementary innovations, this study introduces interaction terms between pairs of innovation types (e.g., product and process, technological and marketing). The model tests these dual adoption effects by including interaction variables and evaluating their statistical significance and effect sizes. Additionally, sectoral dummy variables are introduced to capture the industry-specific impact of innovation in the textile, light engineering, and automotive sectors. These dummy variables help control for unobserved sectoral characteristics that may influence innovation impact, allowing for a more nuanced understanding of how innovation outcomes differ across industries.

Addressing Sectoral and Export Heterogeneity

By including interaction terms, we account for heterogeneity in innovation effects between exporters and non-exporters across sectors. These interaction terms combine innovation types with export orientation and sectoral indicators. This enables the model to estimate differential impacts for exporting firms within each industry compared to non-exporting firms. These interactions reveal how innovation types and their combinations may yield distinct outcomes depending on a firm's market orientation and the sectoral context in which it operates.

Results and Discussion

Overall descriptive Statistics

The descriptive statistics in Table 1 provide an overview of the firms in Pakistan's textile, light engineering, and automotive sectors, detailing firm demographics, innovation adoption, and sectoral characteristics. The sample comprises 300 firms from the country's primary industrial provinces, Punjab and Sindh, which collectively house a significant portion of Pakistan's manufacturing and export-driven activities. The sample of 300 firms includes approximately 29% from textiles, 25.4% from automotive, and 43.8% from light engineering. Each sector reflects unique market dynamics; for instance, the textile sector is primarily export-oriented, while light engineering includes a mix of both exporters and non-exporters. Within this sample, 49.9% of firms are engaged in exporting, providing a balanced comparison between firms with international exposure and those focused solely on domestic markets. Firm age and size are essential characteristics influencing innovation practices and potential outcomes. In terms of age, around 35.1% of firms are classified as "young" (15 years or younger), whereas 64.8% are considered "older" (over 15 years). This age distribution may influence innovation decisions, as younger firms may be more open to experimentation while older firms may have established processes that affect their innovation strategies. Firm size also shows variation, with small firms (those with 50 or fewer employees) making up 38.13% of the sample, while larger firms (more than 50 employees) comprise 61.9%. Since size is closely linked to financial and operational capacity, more prominent firms generally allocate more resources toward innovation than smaller firms, which may focus on cost-effective innovations.

Innovation adoption is prevalent within the sample, though the extent and type vary across firms with approximately 64.9% of firms reported engaging in some form of innovation. Product Innovation is the most widely adopted type, with 47.2%

of firms introducing new or improved products. This type of innovation is prevalent in the textile sector, where product differentiation is crucial for competitiveness in export markets. Technological Innovation, adopted by 31.2% of firms, reflects investments in new technology to enhance operational capabilities. Process innovation, aimed at improving efficiency and reducing costs, is adopted by 8.4% of firms, while Marketing Innovation is also reported by 8.4% of the firms. Business Model Innovation is relatively rare, with only 4% of firms employing it, suggesting limited strategic restructuring efforts among firms in these sectors.

Sectoral differences in innovation patterns are also evident. In the export-oriented textile sector, product and Technological Innovations are prominent, driven by the need to meet international standards and adapt to global market demands. In the light engineering sector, firms focus on cost-saving process innovations that enhance efficiency. The automotive sector, facing higher capital requirements and technological barriers, displays moderate product and Technological Innovation, primarily driven by larger firms. These sector-specific dynamics highlight the influence of industry-specific factors on innovation decisions, with firms tailoring their innovation strategies to align with sectoral demands and resource availability.

Average Impact of Innovation Type & its Complementarities

The analysis reveals that firms adopting specific types of innovation outperform non-innovators across key performance metrics, including revenue growth, cost reduction, and pricing strategies. Product Innovation is a significant driver with firms introducing new or improved products reporting higher revenues. This allows firms to meet market demand better, expand their customer base, and achieve cost efficiencies in production. Technological Innovation plays a crucial role in helping firms reduce the prices of their final products. By implementing automation and advanced production techniques, firms lower input costs and enhance production efficiency, passing these savings on to customers. This benefits non-exporting firms facing intense domestic competition.

Moreover, younger firms, particularly those that are non-exporting benefit most from innovation. These firms are more flexible in adopting new technologies and strategies, enabling them to adapt quickly to market demands and establish competitive price points. In contrast, older firms with more established processes may see more limited immediate benefits from innovation. Moreover, firm size also affects the impact of innovation. Small firms that engage in Technological Innovation report higher revenues and reduced prices than non-innovating small firms. For non-exporting small firms, these price reductions improve their positioning in price-sensitive domestic markets, allowing them to reach a broader customer base and compete effectively against larger firms. More concisely, product and Technological Innovations have the most substantial positive impact on firm performance, particularly for younger, smaller, and non-exporting firms. These insights highlight the importance of aligning innovation strategies with firm characteristics to maximize performance outcomes.

Effect of Pairwise innovation adoption on the increase in Firm Revenue

Figure 1 illustrates the synergistic effects of adopting dual (pairwise) innovations on firm revenue, comparing the impacts of different innovation combinations. The results indicate that specific pairs of innovation types yield significantly higher revenue gains than others, highlighting the synergistic potential of complementary innovation strategies. The combination of Process Innovation and Business Model Innovation and the combination of Product Innovation and Technological Innovation demonstrate the strongest positive impact on revenue growth. The combination of Process Innovation and Business Model Innovation is particularly effective in driving revenue growth. This pairing enhances operational efficiency and strategic positioning, as process improvements streamline production or service delivery, while Business Model Innovation allows firms to restructure their value propositions. Combining these innovations enable firms to optimize costs and simultaneously create new revenue channels or improve existing ones, significantly boosting overall revenue.

Similarly, combining product and Technological Innovation has a robust positive effect on revenue. Product Innovation enables firms to introduce new or improved products to meet market demand, while Technological Innovation enhances production efficiency and quality. When adopted together, these innovations allow firms to differentiate their products in the market while benefiting from cost-effective and scalable production, leading to increased sales and higher revenue. This combination is especially advantageous in competitive sectors where product quality and differentiation are crucial for revenue growth. These complementary innovation strategies, particularly these two combinations, provide firms with a significant revenue advantage over single or isolated innovation efforts. These findings highlight the importance of adopting synergistic innovation approaches to enhance market position and maximize revenue potential.

The Impact of Pairwise Adoption of Innovation on Decreases in Output Prices

Figure 2 highlights how specific innovation combinations influence pricing strategies, cost competitiveness and reduce output prices. This illustrates the value of strategic innovation pairing in enhancing market competitiveness and driving cost efficiencies.

The combination of Product and Technological Innovation is particularly impactful in reducing output prices. Product Innovation enables firms to create or improve offerings tailored to market needs, while Technological Innovation enhances production efficiency, reduces costs, and supports scalable output. These innovations allow firms to introduce high-quality products at more competitive prices. By leveraging technological advancements, firms can optimize processes, minimize production costs, and increase economies of scale, offering more cost-effective products without compromising quality. This strategic pairing thus provides a solid basis for firms to capture market share through lower pricing strategies while maintaining profitability.

Additionally, combining Process innovation with Business Model Innovation can reduce output prices. Process Innovation improves production or operational efficiency, resulting in cost savings that can be passed on to customers. Business Model Innovation redefines value delivery, further optimizing cost structures and pricing strategies. This synergy enables firms to offer differentiated value at reduced prices, enhancing market competitiveness.

Figure 2 illustrates the potential of strategic innovation pairing to achieve cost leadership. By strategically adopting combinations like Product and Technological Innovation or Process and Business Model Innovation, firms can achieve substantial cost efficiencies, translating into lower output prices and a stronger market position. These findings emphasize the critical role of innovation synergies in creating competitive advantages and driving business success.

Impact of Different Types of Innovation on Firm Performance Across Age and Export Status

The analysis in Table 3 shows that the impact on firm performance varies based on firm age and export status. Younger non-exporting firms showed a negative effect on revenues (-0.318) and a slight negative impact on prices and cost effect. In contrast, younger exporting firms exhibited a strong negative effect on revenue (-1.502***) and price, suggesting that innovation efforts might be associated with cost increases or challenges in market adaptation for young exporters. For older firms, the effects were somewhat different: non-exporters showed a negative revenue effect (-0.588***), while the price and cost effects were relatively neutral or positive. Older exporting firms positively affected price, cost efficiency, and revenue performance, indicating more maturity in leveraging innovation for market gains.

The impact of Business Modeling Innovation varied based on firm age and market status. Young non-exporting firms showed a significant positive revenue impact (0.560***) but a negative effect on cost (-0.433***). Young exporting firms had mixed results, with negative impacts on prices and costs. Older non-exporting firms saw consistent negative effects on cost and price indicators, while older exporting firms did not experience significant benefits. These findings suggest that Business Model Innovation may require careful cost control, particularly for older non-exporting firms. Young exporting firms, however, may benefit from Product Innovation (28.886***), though with mixed results on cost and pricing.

On the other hand, non-exporting young firms displayed significant but smaller revenue increases. Older firms, both exporters and non-exporters, often experienced adverse revenue effects from Product Innovation. This suggests that the potentially high costs and market risks of developing new products may outweigh immediate revenue benefits for more mature companies. Exporting young firms benefited greatly from product differentiation, while older firms struggled to leverage new products profitably.

Additionally, young exporting firms experienced a significant negative impact on revenue and costs from process innovation (-3.379***). Non-exporting young firms also experienced a negative impact on costs and prices. Older firms exhibited a more muted response, with relatively minor changes across the board. This suggests that adopting new processes might present initial cost challenges for young firms, especially exporters. In contrast, older firms may have already optimized their operations or may not see immediate benefits. Technological Innovation had a positive impact, particularly for young exporting firms, leading to a significant increase in revenues (2.797***), indicating that new technologies provide substantial competitive advantages in international markets. Young non-exporting firms experienced modest revenue gains, while older non-exporting firms showed a positive impact on revenues (1.043*), but variable cost effects. Older exporting firms demonstrated mixed results, with negative price effects indicating challenges in managing costs or market competition.

Moreover, while engaging in Marketing Innovation, young firms experienced a notable increase in revenue, particularly exporters (6.529**). However, this was accompanied by a negative impact on cost-effectiveness. This suggests that marketing strategies can drive sales but may require careful cost management. For older firms, the impact of Marketing Innovation was minimal or negative, indicating limited benefits in terms of revenue, price, and cost indicators. This implies that younger firms may be more adaptable to new marketing strategies and can capitalize on new market segments, while older firms might struggle to achieve similar results.

Impact of Innovation Types on Performance across size, small and large Firms

The impact of innovation differed significantly between small and big firms. Small non-exporting firms faced a substantial negative impact on revenue (-0.948***) and prices, as given in Table 4, while cost changes were relatively minor. Small exporting firms exhibited more pronounced negative revenue effects (-2.450), though the results were not statistically significant, suggesting that innovation efforts may introduce initial inefficiencies or market challenges for these firms. Large firms, both exporters and non-exporters, experienced more muted effects, with some positive impacts on price and revenue. This disparity indicates that while large firms may have more resources and capacity to buffer innovation-related costs, small firms may face more significant challenges in reaping immediate benefits from general innovation adoption.

Business Model Innovation had mixed results for small and large firms. Small non-exporting firms saw a marginally positive revenue impact (0.151) but significant negative impact on costs (-0.294**), indicating potential challenges in controlling expenses during business model adjustments. Small exporting firms experienced neutral effects. Large non-exporting firms experienced a significant negative impact on both revenue and costs (-0.298***, -0.472***), suggesting potential inefficiencies or market incompatibility with new business models. Large exporting firms experienced relatively neutral effects, highlighting that size and market access can moderate the outcomes of business model transformations.

Moreover, Product Innovation yielded contrasting results between small and large firms. Small non-exporting firms experienced a significant negative cost impact (-3.426***), indicating high production or R&D costs related to new products, while revenue and price impacts were less pronounced. Small exporting firms showed no significant gains or losses, implying they may struggle to capitalize on new products in competitive markets. For large firms, Product Innovation outcomes were mixed, with some observing a substantial revenue gain (10.234 for exporters) but inconsistencies in cost and pricing effects. This suggests that while Product Innovation can offer revenue potential for large firms, it may lead to complexities that affect cost management.

Also, the effects of process innovation varied with firm size and market engagement. Small firms generally exhibited minor changes in revenue, price, and costs. Large non-exporting firms also experienced relatively moderate shifts with no substantial or statistically significant gains or losses. This suggests that process adjustments alone might not be transformative for either group without complementary strategies. The limited influence on performance indicates that process innovation may have a more long-term, incremental effect than immediate transformative results.

Furthermore, small firms, particularly exporters, benefited from Technological Innovation (1.783** and 1.957**), highlighting their ability to leverage technology for competitive advantage. Non-exporting small firms also saw positive but lesser impacts. Large non-exporting firms had a mixed response with moderate gains in revenue, while large exporting firms showed variable outcomes. These results suggest that small firms might achieve significant gains through Technological Innovation due to their flexibility and market responsiveness. In contrast, large firms might face more complex dynamics in fully harnessing technological advancements.

Lastly, Marketing Innovation had a robust positive revenue impact on small non-exporting firms (0.247***), demonstrating its potential to drive sales in local markets. For small exporting firms, the effects were minimal. Among large firms, non-exporting firms faced more substantial challenges with negative impacts on revenue and costs, suggesting that marketing strategies alone may be insufficient without a broader support structure. Large exporting firms experienced minor negative changes in prices and costs, indicating that market-specific marketing adjustments may be required to achieve positive results. The results highlight the importance of tailored marketing strategies for different firm sizes and market engagements.

Impact of Innovation Complementarities on the Performance of the Firms for Exporters & Non-exporters

The combination of business and market innovation yielded mixed effects for exporters and non-exporters. Exporters experienced marginal negative impacts on all performance indicators, with coefficients around -0.025 to -0.049, indicating minimal improvements or slight declines due to this innovation pairing, as shown in Table 5. In contrast, non-exporters saw positive and statistically significant effects on revenue (0.178*) and cost efficiency (0.145**), highlighting that aligning business strategies with market needs can improve performance for firms primarily focused on domestic markets.

The combination of Business and Product Innovation led to generally negative but insignificant effects for exporters, with a minor impact on performance indicators. Non-exporting firms displayed marginal results with a slight positive impact on revenue (0.051), though cost and pricing changes were negligible. This suggests that integrating business model adjustments with new products might not yield immediate, substantial gains for exporting firms. At the same time, non-exporting firms may see limited benefits in aligning business practices with Product Innovation.

Exporting firms benefitted significantly from the pairing process and business innovation, as evidenced by a strong positive effect on revenue (0.109***). Non-exporting firms saw a similar trend with a notable impact on revenue (0.194***) and cost efficiency (0.145*). This combination suggests that improvements in operational efficiency, coupled with strategic business adjustments, can drive performance gains for both market groups. Moreover, this innovation combination yielded mixed and largely negative outcomes for both exporting firms and non-exporting firms. Exporting firms experienced negative impacts on performance indicators, particularly in prices and revenue, with coefficients of -0.055 to -0.116. Non-exporters faced a more significant negative impact on revenues (-0.370***), with some negative pricing effects. These results indicate potential difficulties in aligning process improvements with market strategies, possibly due to mismatches between operational capabilities and market demands. Exporting firms showed mixed results from combining process and Technological Innovations, with some positive effects on cost efficiency (0.274*) and negative price impacts (-0.200**). Non-exporting firms , however, saw a notable positive impact on cost efficiency (0.561***), indicating that technological upgrades within production processes can substantially enhance operational efficiency for firms with limited market exposure.

Moreover, the combination of product and market innovation had mixed results for exporters and non-exporters. Exporting firms experienced a slightly positive impact on revenue but a statistically significant negative effect on prices (-0.324*), suggesting challenges in aligning product differentiation with market expectations. Non-exporters displayed minor positive effects on revenue (0.095*), but no significant cost improvements, indicating limited but targeted market gains. This combination resulted in mixed outcomes for exporters, with a negative impact on prices (-0.391**) but neutral effects on other indicators. Non-exporters experienced a slight positive impact on revenue (0.109), though cost efficiency was negatively affected (-0.174*). This suggests that while integrating product and process innovations can support revenue, it may come at the expense of cost control.

Exporting firms generally experienced negative impacts from the pairing of product and market innovation, though results were primarily insignificant. In contrast, non-exporters experienced a robust positive effect on revenue (0.372***) and prices (0.150***), suggesting that combining product development with technological enhancements can drive market gains, particularly for firms focused on domestic markets. Also, this combination yielded mixed results, with exporters facing a significant negative impact on pricing (-0.369***) but some positive effects on cost efficiency. Non-exporters saw moderate positive effects on revenue (0.114*) and cost efficiency (0.353***), indicating that technological advancements aligned with market strategies can boost domestic firm performance. The pairing of business and Technological Innovation negatively impacted exporters, particularly in pricing (-0.260***). Non-exporters faced a similarly negative impact on revenues (-0.202***), highlighting potential challenges in aligning broad business changes with new technologies for both market segments. The results suggest that while combining these innovations may introduce operational complexity, the benefits might not be immediately apparent without careful implementation strategies.

Sectoral Analysis: Types of Innovation and the Impact on Sector-wise Firms Performance

Innovation and Firms Performance in the Textile Sector

We report the results for the textile sector in Table 6. All 87 firms in the textile sector are exporters. This suggests that international market conditions primarily influence innovation and performance dynamics in this sector. A significant proportion (74.7%) of firms in the textile sector are established, with over 15 years of operation.

The remaining 25.3% are relatively younger. This distribution suggests that older firms may have more resources and experience to engage in innovation than newer firms. A majority (93.1%) of textile firms are significant, indicating that large firms dominate the sector and are likely better positioned to invest in and benefit from innovation activities.65.5% of textile firms report engaging in innovation, which reflects a relatively high level of innovation activity in the sector.

Out of all, 4.6% of firms have innovated in business models and process improvements, suggesting that these areas are not a primary focus, as shown in Table 6. Only 2.2% of firms have focused on Marketing Innovation, indicating that firms in the textile sector may not prioritize changes to marketing strategies. A significant 57.5% of firms have engaged in Product Innovation, the sector's most common form of innovation, highlighting its importance for competitive advantage. 31% of firms have undertaken Technological Innovations, suggesting a moderate focus on technological advancements to improve production and operations. The overall impact of innovation on revenue in the textile sector is not statistically significant (-0.358). However, it is not statistically significant (indicated by the p-value in brackets), suggesting that general innovation activities may not significantly impact revenue in the textile sector. There is also a slight negative impact on pricing (-0.024) and costs (-0.285), though again these effects not statistically significant. This indicates that innovation may not have a drastic impact on pricing or cost strategies in the textile sector.

Business Modeling Innovation had a negligible and insignificant impact of on revenue (-0.058) pricing (-0.013) and cost (-0.069) for textile exporters, suggesting that Business Modeling Innovation does not significantly influence these performance metrics. Product Innovation had a significantly positive impact on revenue (0.303***) and pricing (0.253***), suggesting that it can drive revenue growth and pricing power. However, the negative effect on cost (-0.280***) suggests it may lead to increased costs, potentially due to research, development, and production adjustments. process innovation had minimal impact on revenue, price and costs (-0.055 for revenue, -0.216 for price and -0.080 for costs), suggesting that improvements in production processes have a neutral or negligible impact on revenue and pricing strategies and that process innovation does not significantly reduce costs.

Technological Innovation significantly impacts revenue (18.666*), indicating that firms implementing new technologies see substantial revenue increases, possibly through increased efficiency or new product offerings. While the positive effect on pricing (6.018) is statistically insignificant, suggesting that Technological Innovation increases revenues, it may not necessarily result in higher prices. Technological Innovation has a significant positive effect on cost (21.439*), indicating that while it increases revenues, it may also come with higher costs, likely due to investment in new technologies. Marketing Innovation, however, shows negligible and insignificant impacts on revenue (-0.081), price (-0.005), and cost (-0.082), suggesting it has a limited effect on performance indicators for firms in the textile sector.

Innovation Complementarities and Firms' Performance in the Textile Sector

As reported in Table 7, the effects of complementary innovation combinations on firm performance in the textile sector varied, with some combinations showing positive results while others lead to negative impacts. The combination of business and market innovation (Business*Marketing Innovation) shows a small negative effect on revenue (-0.048), which is not statistically significant. However, it does result in a statistically significant negative effect on price (-0.029*), suggesting that aligning business strategies with market needs may reduce the ability to charge higher prices. The effect on cost is also negative (-0.062) but not statistically significant, indicating no major impact on operational costs from this combination. Business and Product Innovation (Business*Product Innovation) shows substantial negative effects on both revenue (-0.380) and cost (-0.442). While these results are not statistically significant for revenue, integrating business modeling with Product Innovation may not achieve the desired outcomes.

Additionally, the negative effect on price (-0.142) implies that this combination might lower pricing power and lead to cost increases due to inefficiencies. The combination of process and business innovation (Process*Business Modelling Innovation) stands out as one of the more successful pairings, with a statistically significant positive impact on revenue (0.092***) and cost (0.103***), suggesting that aligning process improvements with business strategy can enhance revenue and reduce costs. The price impact is negligible (-0.010), showing that the changes in business and process innovations do not significantly affect pricing strategies.

For process and market innovation (Process*Marketing Innovation)**,** the results show a positive but statistically insignificant effect on revenue (0.206), while the effect on cost (0.266) is also positive but not significant. The price effect is negative (-0.135) and statistically insignificant, indicating that although this combination shows some promise in reducing costs, it doesn't significantly impact revenues or pricing strategies. When process and Technological Innovation (Process*Technological Innovation**)** are combined, revenue has a positive effect (0.217) but is not statistically significant. The combination of process and Technological Innovation (Process*Technological Innovation) yields the most significant result. The significant negative effect on cost (-2.227**) suggests that technological improvements combined with process changes can lead to substantial cost savings. However, it may not have a strong impact on revenue. The combination of product and market innovation (Product*Marketing Innovation) results in negligible effects on revenue (0.003) and price (-0.115), both statistically insignificant. However, the significant negative effect on cost (-0.362) suggests that this pairing can lead to cost reductions, likely due to better alignment between products and market needs.

Product and process innovation (Product*Process Innovation) yields a positive but statistically insignificant effect on revenue (-0.110) and a negligible effect on price (-0.014). However, the significant positive effect on cost (0.800**) suggests that integrating product development with process innovation leads to higher operational costs, potentially due to investments in production or process improvements. The combination of product and Technological Innovation (Product*Technolgical Innovation**)** leads to significant negative impacts on both revenue (-2.869) and price (-1.912), with a smaller negative effect on cost (-1.223). These results suggest that combining product and Technological Innovations may result in reduced revenue, lower prices, and higher costs, indicating that this combination is unfavourable for performance in the textile sector.

The combination of technological and market innovation (Technological*Marketing Innovation) shows a negative effect on revenue (-0.429), a positive but insignificant effect on price (0.225) and cost (0.487). This suggests that while technological and market innovations may lead to higher costs and potentially higher prices, they fail to increase revenue significantly, making this pairing less effective. Finally, business and Technological Innovation (Business Modelling*Technological Innovation) leads to minor positive effects on revenue (0.129) and price (0.061), but these effects are not statistically significant. The cost effect (0.236) is also small and insignificant, indicating that while combining business and Technological Innovations may result in minor increases in revenue and price, the overall effect on performance is not substantial.

The analysis suggests that certain innovation pairings are more effective than others in the textile sector. The combination of process and business innovation appears to be particularly beneficial**,** leading to increased revenue and reduced costs, Conversely, other combinations like product and Technological Innovation or business and Product Innovation, show substantial negative impacts, particularly in revenue and pricing. This suggests that while innovation is crucial, it is important—especially for older and larger exporters—to carefully consider the specific combination of innovation types and their potential synergies.

Different Types of Innovation and Innovation Complementaries and Firms' Performance in the Light Engineering Sector

In the light engineering sector, the impact of innovation varies across different types of innovation and adoption strategies. Out of 131 firms in this sector, only 18.6% export their products abroad, indicating that the majority of firms operate within domestic markets. The sector comprises 41.2% young firms, and the remaining 58.8% are older. In terms of size, 58% of firms are small (with fewer than 50 workers), while 41.9% are large (with more than 50 workers). Regarding innovation, 63.4% of firms report engaging in some form of innovation, with 34.4% of firms adopting Technological Innovation, 47.3% pursuing Product Innovation, 7.6% engaging in process innovation, 9.92% pursuing Marketing Innovation, and a very small percentage (0.76%) adopting business modeling innovation.

The results show some significant negative effects of innovation on average, mainly driven by the adoption of process innovation and Marketing Innovation individually. For instance, firms adopting process innovation saw decreased revenues and a significant cost increase, suggesting that while process improvements may offer long-term operational benefits, they may not immediately translate into financial gains. Similarly, Marketing Innovation led to a decline in revenues and a notable cost increase, possibly due to the costs associated with implementing new marketing strategies that did not effectively boost sales. These results indicate that process and Marketing Innovation alone may not improve overall performance, especially regarding revenue generation and cost control. However, exporters in the light engineering sector could significantly reduce their prices when they adopted business modeling, process, and Marketing Innovation individually. This price reduction benefit was notably more substantial for younger firms, which suggests that younger firms may be more adaptable and better positioned to leverage these innovations to adjust their pricing strategies. The ability to lower prices might provide younger exporters with a competitive advantage, potentially helping them capture a larger share of the market.

When examining the dynamics of complementary innovation adoption, certain strategic pairings emerged as particularly effective in price reduction strategies. Specifically, combinations such as process and Technological Innovation, product and Technological Innovation, and technological and Marketing Innovation demonstrated significant potential. Across these multifaceted innovation approaches, prices consistently declined, illustrating how strategic technological advancements with other forms of innovation can systematically drive down operational costs and enhance market competitiveness. For instance, the synergistic integration of process and Technological Innovation can substantially optimize operational efficiency, enabling firms to streamline cost structures and subsequently offer more competitive pricing to consumers. Notably—in contrast to their export-oriented counterparts—appeared to generate the most significant positive effects from dual innovation adoption. This suggests that domestically focused non-exporting firms, may possess greater agility in implementing innovative strategies, potentially due to less complex market dynamics, that facilitate more targeted and precise organizational improvements. Conversely, exporters confronting intricate international market landscapes might encounter more nuanced challenges when attempting to integrate multiple innovation streams, thereby potentially constraining the immediate realization of innovation pairings benefits.

This shows that while standalone innovations such as process and Marketing Innovations often resulted in unfavorable outcomes, certain combinations of innovations—especially those involving technology—proved advantageous, particularly in reducing prices. Exporters, particularly younger firms, could benefit significantly from adopting specific innovations like business modeling and process innovation to improve their pricing strategies. Additionally, complementary innovation pairings such as product and Technological Innovation, hold considerable potential for improving price competitiveness. However, non-exporters may derive even greater advantages from these strategies, likely due to the less complex dynamics of domestic markets, which allow for more focused and effective implementation of innovation pairings.

Different Types of Innovation and Innovation Complementaries and Firms' Performance in the Automotive Sector

Among the 76 firms surveyed, 35% in the automobile sector export their final products internationally, while the remaining firms focus on domestic markets. The sector comprises 36.84% young firms, with the remaining 63.2% being older firms. In terms of size, 38.2% of firms are small (with fewer than 50 workers), while 61.8% are significant (with more than 50 workers). In terms of innovation practices, a substantial 67.11% of firms report engagement in some form of innovation. Specifically, 9.2% have adopted business modeling innovation, 13.2% engaging in Marketing Innovation, 14.5% pursuing process innovation, 34.2% adopting Product Innovation, and 27.63% have opted for Technological Innovation approaches.

The results show that innovation synergies—the strategic combination of diverse innovation types— tend to yield more substantial benefits for non-exporting firms. Notably, certain pairings demonstrated efficacy, such as business modeling with Marketing Innovation, process innovation coupled with business modeling innovation, process with Technological Innovation, product with Technological Innovation, and marketing with Technological Innovation were particularly advantageous for non-exporting firms. This pattern suggests that non-exporters, typically more attuned to local market dynamics, may be better positioned to leverage multifaceted innovation approaches. By aligning innovations across various operational dimensions, these firms appear to enhance their overall performance and competitive standing more effectively than their export-oriented counterparts.

On average, the results indicate that innovation outcomes are predominantly driven by Product Innovation, which significantly increases revenues, and Marketing Innovation, which not only increases revenues but also considerably reduces prices. This underscores the dual role of product in driving revenue growth and Marketing Innovation in fostering competitiveness by increasing sales and enabling firms to lower their prices effectively. Notably, older firms that adopted Marketing Innovation experienced significantly increased revenues and reduced prices, suggesting that older firms are particularly well-positioned to benefit from Marketing Innovations. Their established reputation may enable them to implement strategies that attract a broader audience while lowering prices effectively to remain competitive.

Both, small and large firms, that adopted Product Innovation experienced significant revenue increases. However, the magnitude of this effect was substantially more significant for larger firms, with revenue growth being at least tenfold greater than that observed in small firms. Similarly, firms that adopted Technological Innovation experienced considerable revenue increases coupled with cost reductions. This underscores the efficacy of technological advancements in bolstering the financial performance of automobile firms, especially in terms of cost efficiency. Interestingly, large firms that adopted Marketing Innovation were able to reduce the price of their final products significantly. This points to the fact that larger firms can implement broad marketing strategies that not only boost revenue but also enable price reductions, thereby enhancing their competitive position in the market. Conversely, non-exporters experienced more adverse effects from adopting Product Innovation, including significantly reduced revenues and increased costs. This pattern suggests that for non-exporters, Product Innovations may not always be aligned with market demands, leading to operational inefficiencies and financial setbacks when these innovations are not meticulously managed and tailored to market needs.

The adoption of complementary innovation strategies yielded significant positive outcomes. Specifically, combinations such as business modeling with marketing and process innovation with Business Modeling Innovation resulted in higher revenues and reduced costs. Additionally, synergies like process and Technological Innovation, product and Technological Innovation, and marketing and Technological Innovation significantly reduced costs for the firms that adopted them. These results highlight that combining different types of innovation can amplify the benefits, particularly in reducing costs and enhancing revenue, with certain combinations offering more efficient pathways to improved performance. These results show that the key drivers of innovation success in the automobile sector are product and marketing, which lead to significant revenue growth. However, the impact of these innovations is more pronounced for more extensive, older firms. Non-exporters in the sector face challenges with Product Innovation, which can result in reduced revenues and increased costs. However, firms that adopted complementary innovation strategies—such as combining business modeling with Marketing Innovation or product with Technological Innovation —

showed more promising results in reducing costs and boosting revenues. These insights suggest that firms in the automobile sector should adopt a holistic approach to innovation, strategically combining multiple types of innovations work together to enhance operational efficiency and market competitiveness.

Conclusion

In conclusion, our analysis reveals a nuanced understanding of how various innovation types and their combinations impact firms across different sectors. While the average results across sectors suggest some common trends, they often fail to capture the underlying heterogeneity of the effects, highlighting the importance of considering firm-specific characteristics, sectoral dynamics, and innovation synergies. In the textile sector, the effects of innovation differ significantly between larger, older firms and smaller, younger ones. Product Innovation, in isolation, primarily benefits larger and more established firms, enhancing their ability to generate revenue. Conversely, Technological Innovation predominantly supports larger firms, helping them improve operational efficiency and productivity. However, there is an apparent synergistic effect when innovation types are combined, mainly process innovation with business modeling innovation. This combination results in increased revenues and reduced costs, demonstrating that firms—especially larger ones—can achieve better performance by aligning different types of innovation. This synergy underscores the importance of integrating various innovation strategies to achieve optimal outcomes, particularly in the textile sector, where the impact of individual innovations can be limited without a complementary strategy.

In the light engineering sector, our findings underscore the critical role that export status plays in shaping the benefits derived from innovation. Younger, non-exporting firms benefit significantly from adopting business modeling, process innovation, and Marketing Innovation. These firms effectively leverage innovation to enhance operational efficiency and drive revenue growth, with benefits particularly pronounced for non-exporters. Moreover, the strategic combination of process and Technological Innovation, product and Marketing Innovation, as well as product and Technological Innovation, significantly bolsters their performance by reducing costs. These combinations illustrate how strategic innovation adoption can empower non-exporting firms to compete effectively, particularly when aligned with market demands. In contrast, for exporters in this sector, the impact of innovation are more heterogenous, with specific innovations facilitating efficiencies or boosting revenue depending on the firm's age and size.

The automobile sector presents a compelling case study: product and Marketing Innovation are vital for driving revenue growth. However, the magnitude of these effects differs by firm size. Larger firms derive greater benefits from Marketing Innovation, which enables them to reduce product prices and expand their market share. In contrast, Technological Innovation delivers more significant cost reductions for smaller firms, which may lack the same resources or market power of their larger counterparts. This sector also illustrates the importance of innovation combinations. Notably, combining process and Technological Innovation and marketing with Technological Innovation has proven particularly beneficial for non-exporters. This further emphasizes the necessity for targeted innovation strategies that address the unique needs of non-exporting firms.

Our results suggest that specific innovation synergies have particularly positive effects across sectors. For instance, combinations like process innovation with Technological Innovation and Product Innovation with Technological Innovation consistently led to cost reductions across industries, especially for non-exporting firms. These synergies enable firms to streamline operations, minimize inefficiencies, and improve their competitive position in the market. Similarly, **Marketing Innovation**, when paired with other types of innovation, helped firms lower their prices and strengthen their market positioning. However, its benefits were more pronounced for larger firms in specific sectors. Overall, our findings underscore the critical importance of understanding the sector-specific dynamics of innovation adoption. While the average results may provide valuable insights into general trends, they often mask the variation in impacts that different types of innovation have on firms of different sizes, ages, and export statuses. In particular, the complementary nature of various innovation strategies is essential to understanding how firms can optimize their performance through innovation. Policymakers and business leaders must recognize that innovation is not a one-size-fits-all solution. Firms must adopt strategies tailored to their specific characteristics and market contexts to truly benefit from innovation.

Thus, our analysis stresses the importance of a differentiated approach to innovation management, where firms consider the type of innovation they adopt and how different innovations can work together to drive long-term growth and competitiveness. The impact of innovation, whether positive or negative, depends on the sector, the firm's position within the sector (exporter vs. non-exporter), and the firm's size and age. Therefore, for businesses looking to remain competitive, adopting a holistic and context-specific approach to innovation will be vital to maximizing the benefits and minimizing the risks associated with innovation adoption.

Appendix

Figure 1: Examining the Impact of Pair-wise Adoption of Innovation on Increase in Firm Revenue

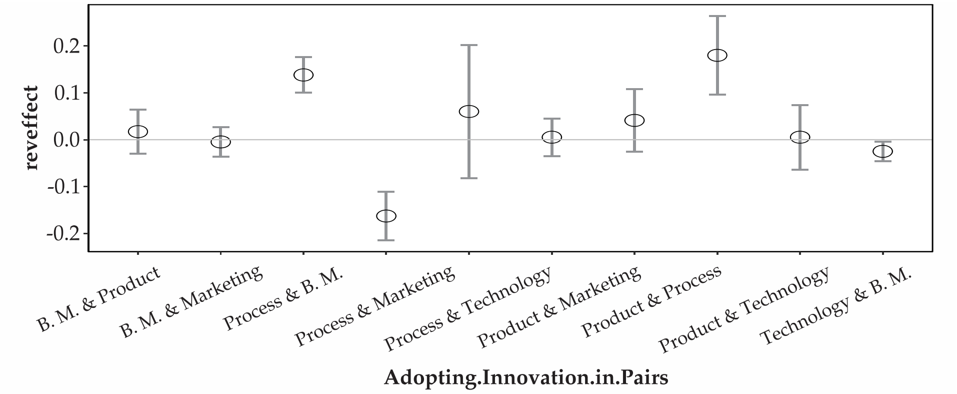


Figure 2: Examining the Impact of Pairwise Adoption of Innovation on Decreases in Output Prices

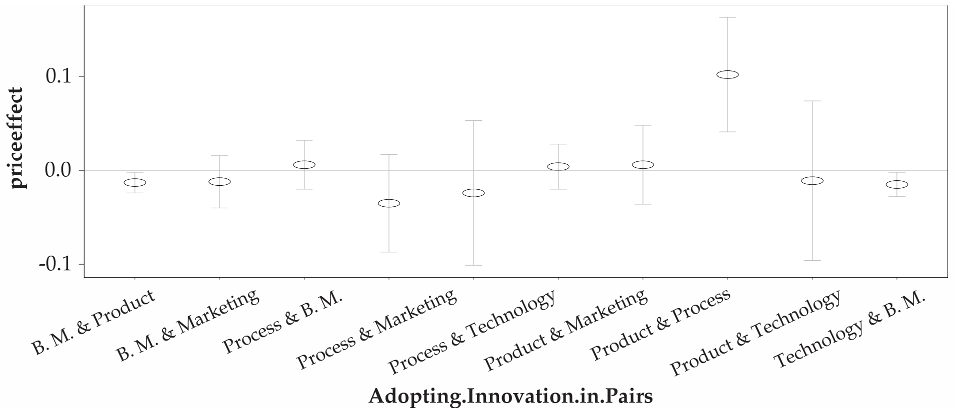


Figure 3: Examining the Impact of Pairwise Adoption of Innovation on Decreases in Firm's Costs

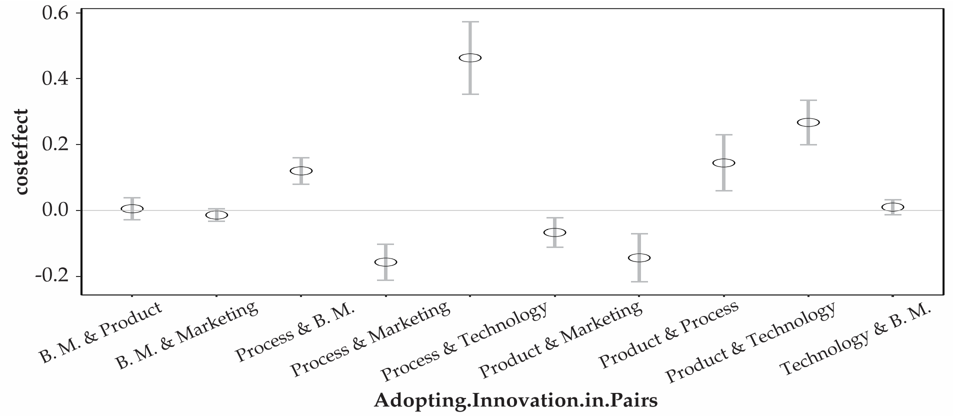


Table 1: Descriptive Statistics, by Sector

Types of Innovation	Observations	Mean	Std. dev	Min	Max
Textile Sector					
Dummy=1 if firms engage in anytype of Innovation	87	0.6551724	0.4780675	0	1
Dummy=1 if firms engage in Business Modelling innovation	87	0.045977	0.2106494	0	1
Dummy=1 if firms engage in Process Innovation	87	0.045977	0.2106494	0	1
Dummy=1 if firms engage in Product Innovation	87	0.5747126	0.4972525	0	1
Dummy=1 if Firms engage in Technological Innovation	87	0.3103448	0.4653167	0	1
Dummy=1 if Firms engage in Marketing Innovation	87	0.0229885	0.1507355	0	1
Lightengineering Sector					
Dummy=1 if firms engage in anytype of Innovation	131	0.6335878	0.4836736	0	1
Dummy=1 if firms engage in Business Modelling innovation	131	0.0076336	0.0873704	0	1
Dummy=1 if firms engage in Process Innovation	131	0.0763359	0.2665541	0	1
Dummy=1 if firms engage in Product Innovation	131	0.4732824	0.5012023	0	1
Dummy=1 if Firms engage in Technological Innovation	131	0.3435115	0.4767033	0	1
Dummy=1 if Firms engage in Marketing Innovation	131	0.0992366	0.3001272	0	1
Automobile Sector					
Dummy=1 if firms engage in anytype of Innovation	76	0.6710526	0.429527	0	1
Dummy=1 if firms engage in Business Modelling innovation	76	0.0921053	0.2910959	0	1
Dummy=1 if firms engage in Process Innovation	76	0.1447368	0.3541731	0	1
Dummy=1 if firms engage in Product Innovation	76	0.3421053	0.4775669	0	1
Dummy=1 if Firms engage in Technological Innovation	76	0.2763158	0.4501462	0	1
Dummy=1 if Firms engage in Marketing Innovation	76	0.1315789	0.3402785	0	1

Table 2: Measuring the Impact of the Type of Innovation on the Firm's Performance for Exporters & Non-exporters

Types of Innovation	Exporters			Non-exporter		
Any innovation	0.028	0.043	0.182	-0.287	-0.393**	-0.328
	[0.394]	[0.289]	[0.391]	[0.180]	[0.190]	[0.206]
Business Modelling Innovation	-0.032	0.006	-0.043	-0.083	-0.023	-0.106
	[0.052]	[0.039]	[0.062]	[0.074]	[0.054]	[0.103]
Product Innovation	0.071	0.414	-0.227	-0.052	-0.634**	-1.483***
	[0.489]	[0.376]	[0.588]	[0.493]	[0.307]	[0.516]
Process Innovation	-0.084	0.010	-0.013	-0.016	-0.051	-0.010
	[0.081]	[0.126]	[0.122]	[0.083]	[0.104]	[0.171]
Technological Innovation	-0.760***	-0.279	0.197	0.641	1.092**	0.796
	[0.271]	[0.211]	[0.325]	[0.501]	[0.521]	[0.496]
Marketing Innovation	-0.077	-0.009	-0.042	0.026	0.050	0.095
	[0.050]	[0.038]	[0.056]	[0.055]	[0.084]	[0.142]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 3: Measuring the Impact of Type of Innovation on a Firm's Performance for Exporters & Non-exporters by the age of the firm

	young firms						old firms					
	Revenues	**Prices**	**cost-effect**	**Revenues**	**price**	**cost**	**Revenues**	**price**	**cost**	**Revenues**	**Prices**	**Cost effect**
Types of Innovation	non-exporter			exporter			non-exporter			exporter		
Any innovation	-0.318	-1.502***	-0.368	-1.194	-0.530	-0.870	-0.588***	-0.224	-0.220	0.341	0.499	0.424
	[0.517]	[0.414]	[0.459]	[0.841]	[0.528]	[0.597]	[0.206]	[0.286]	[0.339]	[0.395]	[0.327]	[0.493]
Business Modelling Innovation	0.560***	-0.079	-0.433***	-0.236**	0.148	-0.282***	-0.063	-0.062	-0.302**	-0.040	-0.030	-0.074
	[0.093]	[0.107]	[0.119]	[0.100]	[0.167]	[0.103]	[0.068]	[0.069]	[0.131]	[0.062]	[0.044]	[0.056]
Product Innovation	6.111	28.886***	7.078	-45.825***	-1.842	-2.996	-1.856**	-1.692**	-2.920**	0.281	0.354	0.302
	[9.940]	[7.967]	[8.829]	[6.160]	[4.581]	[4.935]	[0.914]	[0.699]	[1.116]	[0.702]	[0.621]	[0.665]
Process Innovation	-0.875	-3.379***	-1.024	-0.101	0.383***	-0.145	0.053	0.088	-0.008	-0.124	-0.116	-0.031
	[1.186]	[0.902]	[1.082]	[0.083]	[0.033]	[0.108]	[0.103]	[0.097]	[0.201]	[0.134]	[0.128]	[0.149]
Technological innovation	0.625	2.797***	0.643	-4.357***	0.082	-0.319	1.043*	0.454	0.790	-0.607*	-0.293	0.350
	[0.975]	[0.789]	[0.876]	[0.681]	[0.661]	[0.598]	[0.597]	[0.786]	[0.814]	[0.312]	[0.246]	[0.386]
Marketing innovation	4.887	6.529**	-4.367	-0.106	0.066	-0.071	0.107	0.101	0.003	-0.085	-0.043	-0.090
	[3.087]	[3.080]	[2.713]	[0.096]	[0.106]	[0.092]	[0.111]	[0.092]	[0.207]	[0.061]	[0.039]	[0.074]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if *the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.*

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 4: Measuring the Impact of Type of Innovation on a Firm's Performance for Exporters & Non-exporters by the size of the firm

	Small firms						Big firms					
	Revenues	Price	Cost	Revenues	Price	Cost	Revenues	Price	Cost	Revenues	Price	Cost
Types of Innovation	non-exporter			exporter			non-exporter			exporter		
Any innovation	-0.948***	-0.991**	-0.259	-2.450	-0.570	0.003	0.219	-0.029	-0.532	0.918	0.331	-0.065
	[0.355]	[0.403]	[0.394]	[1.739]	[1.257]	[1.790]	[0.435]	[0.489]	[0.420]	[0.661]	[0.341]	[0.734]
Business Modelling Innovation	0.151	-0.168	-0.294**	-0.016	0.237	-0.088	-0.298***	-0.068	-0.472***	-0.018	-0.011	-0.044
	[0.108]	[0.155]	[0.123]	[0.190]	[0.147]	[0.138]	[0.062]	[0.072]	[0.073]	[0.060]	[0.031]	[0.063]
Product Innovation	-0.997	0.857	-3.426***	-1.031	-0.252	-0.067	-4.217	0.564	10.234	0.528	0.782	-0.377
	[1.186]	[1.181]	[1.146]	[0.827]	[0.494]	[0.698]	[8.364]	[9.411]	[8.070]	[0.839]	[0.650]	[0.569]
Process Innovation	0.123	-0.120	0.091	-0.013	0.212*	-0.094	0.423	-0.196	-1.550	-0.111	-0.179	0.085
	[0.087]	[0.107]	[0.146]	[0.160]	[0.118]	[0.116]	[1.009]	[1.119]	[0.940]	[0.170]	[0.132]	[0.117]
Technological innovation	1.783**	1.957**	0.391	-2.665	0.083	1.568	-0.387	0.072	1.066	-1.360	-0.023	0.112
	[0.696]	[0.785]	[0.761]	[2.378]	[3.471]	[4.153]	[0.831]	[0.942]	[0.796]	[1.341]	[0.511]	[1.537]
Marketing innovation	0.247***	-0.008	0.076	0.026	0.073	0.005	-2.298	-1.059	-0.439	-0.090*	-0.019	-0.044
	[0.065]	[0.093]	[0.143]	[0.130]	[0.170]	[0.136]	[1.527]	[1.722]	[1.943]	[0.052]	[0.034]	[0.062]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 5: Measuring the impact of Innovation Complementarities on the Firm's Performance for Exporters & Non-Exporters

Dependent Variables	Exporters			Non-exporter		
bus_market	-0.025	-0.049	-0.024	0.178*	0.029	0.145**
	[0.039]	[0.031]	[0.045]	[0.104]	[0.061]	[0.071]
bus_prod	-0.12	-0.144	-0.093	0.051	0.003	-0.008
	[0.148]	[0.120]	[0.178]	[0.049]	[0.037]	[0.064]
proc_bus	0.109***	-0.001	0.068	0.194***	0.026	0.145*
	[0.039]	[0.023]	[0.056]	[0.069]	[0.055]	[0.074]
process_market	-0.055	-0.108	-0.116	-0.370***	-0.150*	0.022
	[0.095]	[0.081]	[0.125]	[0.137]	[0.079]	[0.149]
process_tech	0.125	-0.200**	0.274*	-0.063	0.028	0.561***
	[0.112]	[0.081]	[0.160]	[0.195]	[0.100]	[0.183]
prod_market	0.013	-0.324*	-0.196	0.095*	0.006	-0.073
	[0.192]	[0.186]	[0.263]	[0.054]	[0.026]	[0.064]
prod_proc	0.021	-0.391**	-0.009	0.109	0.015	-0.174*
	[0.175]	[0.192]	[0.315]	[0.078]	[0.047]	[0.096]
prod_tech	-0.043	-0.422	0.124	0.372***	0.150***	0.092
	[0.717]	[0.541]	[0.833]	[0.107]	[0.048]	[0.119]
tech_market	-0.101	-0.369***	0.179	0.033	0.114*	0.353***
	[0.182]	[0.087]	[0.116]	[0.136]	[0.066]	[0.112]
bus_tech	-0.182	-0.260***	0.1	-0.202***	-0.028	-0.083
	[0.156]	[0.082]	[0.145]	[0.075]	[0.054]	[0.091]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The main independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as the firm's age, age squared, number of workers employed by the firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.
Robust standard errors in brackets are clustered at a firm level.
**** p<0.01, ** p<0.05, * p<0.1*

Table 6: Measuring the Impact of Type of Innovation on The Textile Sector's Performance

	Textile Sector		
	Revenues	Price	Cost
Types of Innovation		exporter	
Any innovation	-0.358	-0.024	-0.285
	[0.551]	[0.500]	[0.539]
Business Modelling Innovation	-0.058	-0.013	-0.069
Product Innovation	0.303***	0.253***	-0.280***
	[0.059]	[0.083]	[0.065]
Process Innovation	-0.055	-0.216	-0.080
	[1.169]	[0.525]	[1.221]
Technological innovation	18.666*	6.018	21.439*
	[9.608]	[5.932]	[11.672]
Marketing innovation	-0.081	-0.005	-0.082
	[0.061]	[0.033]	[0.066]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The main independent variable is dummy=1 if the firm decides to

innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.
Robust standard errors in brackets are clustered at a firm level.
**** p<0.01, ** p<0.05, * p<0.1*

Table 7: Measuring the Impact of Complimentary Adoption of Innovation on the Textile Sector's Performance

	Textile Sector		
Complimentary Innovation	**Revenues**	**Price**	**Cost**
bus_market	-0.048	-0.029*	-0.062
	[0.054]	[0.015]	[0.059]
bus_prod	-0.380	-0.142	-0.442
	[0.355]	[0.134]	[0.391]
proc_bus	0.092***	-0.010	0.103***
	[0.031]	[0.013]	[0.037]
process_market	0.206	-0.135	0.266
	[0.337]	[0.230]	[0.500]
process_tech	0.217	0.011	-2.227**
	[0.800]	[0.311]	[1.074]
prod_market	0.003	-0.115	-0.362
	[0.280]	[0.136]	[0.309]
prod_proc	-0.110	-0.014	0.800**
	[0.263]	[0.126]	[0.370]
prod_tech	-2.869	-1.912	-1.223
	[3.565]	[2.033]	[4.044]
tech_market	-0.429	0.225	0.487
	[0.670]	[0.426]	[0.844]
bus_tech	0.129	0.061	0.236
	[0.645]	[0.375]	[0.742]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The main independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.
Robust standard errors in brackets are clustered at a firm level.
**** p<0.01, ** p<0.05, * p<0.1*

Table 8: Measuring the Impact of Type of Innovation on the Textile Sector's Performance by Age & Size

Types of Innovation	young			old			small			big		
	Revenues	Price	Cost	Revenues	Price	Cost	Revenues	Price	Cost	Revenues	Price	Cost
Any	-2.358***	-0.471	-1.920**	0.210	0.648	0.566	-1.098	-5.981	-1.098	0.305***	0.301***	-0.255***
innovation	[0.678]	[1.072]	[0.893]	[0.504]	[0.554]	[0.550]	[0.000]	[0.000]	[0.000]	[0.062]	[0.076]	[0.069]
Business	-0.316**	-0.079	-0.350**	-0.086**	-0.038*	-0.113***	-54.985	-174.953	3.946	-0.069	-0.011	-0.084
Modelling	[0.134]	[0.085]	[0.147]	[0.033]	[0.022]	[0.035]	[0.000]	[0.000]	[0.000]	[0.048]	[0.017]	[0.054]
Innovation												
Product	-0.452***	-0.049	0.106	0.296***	0.334***	-0.234***	-2.989	-7.148	1..808	0.306***	0.302***	-0.256***
Innovation	[0.141]	[0.121]	[0.163]	[0.071]	[0.092]	[0.067]	[3.010]	[8.052]	[2.058]	[0.062]	[0.076]	[0.069]
Process	-3.920	-0.045	-3.070	1.210	0.464	1.051	3.752	11.939	-0.269	0.833	-0.369	0.264
Innovation	[2.920]	[2.238]	[3.024]	[1.054]	[0.483]	[1.370]	[0.000]	[0.000]	[0.000]	[0.925]	[0.584]	[1.261]
Technological	15.711	3.251	1.987	13.133	5.287	21.462	74.343	236.546	-5.336	18.080*	4.474	21.099
innovation	[38.443]	[23.473]	[41.284]	[14.039]	[8.267]	[17.498]	[0.000]	[0.000]	[0.000]	[10.808]	[6.532]	[13.473]
Marketing	-0.048	-0.017	-0.004	-0.098	-0.023	-0.139	-0.178	-0.566	0.013	-0.105*	0.009	-0.087
innovation	[0.142]	[0.097]	[0.141]	[0.074]	[0.025]	[0.102]	[0.000]	[0.000]	[0.000]	[0.054]	[0.031]	[0.067]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The main independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as the firm's age, age squared, number of workers employed by the firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). District-fixed effects and sector-fixed effects for textile, surgical, light engineering, and automobile are controlled by the specifications. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.
Robust standard errors in brackets are clustered at a firm level.
**** p<0.01, ** p<0.05, * p<0.1*

Table 9: Measuring the Impact of the Type of Innovation on the Light Engineering Sector's Performance

	Light engineering Sector		
Types of Innovation	**Revenues**	**Price**	**Cost**
Any innovation	-0.215	-0.006	0.560
	[0.256]	[0.284]	[0.356]
Business Modelling Innovation	-0.036	0.099	-0.122
	[0.068]	[0.127]	[0.136]
Product Innovation	0.271	0.329	0.323
	[0.510]	[0.515]	[0.697]
Process Innovation	-0.101**	0.081	-0.242***
	[0.047]	[0.169]	[0.064]
Technological innovation	1.983	9.119	4.325
	[4.263]	[5.675]	[6.462]
Marketing innovation	-0.105**	0.072	-0.243***
	[0.048]	[0.173]	[0.064]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm *is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.*

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 10: Measuring the Impact of Type of Innovation on the Light Engineering Sector's Performance by Age & Size

Light Engineering												
VARIABLES	**small**			**big**			**young**			**old**		
	Revenues	**Price**	**Cost**	**Revenues**	**Price**	**Cost**	**Revenues**	**Price**	**Cost**	**Revenues**	**Price**	**Cost**
Any innovation	-3.484	-2.097***	1.6633**	1.84	-1.37	6.3	4.72	-1.235	11.42	-0.080	0.325	0.392
	[1,0.919]	[.408]	[6.620]	[1.014]	[8.9]	[14.326]	[8.670]	[11.15]	[8.698]	[0.329]	[0.364]	[0.417]
Business Modelling Innovation	-0.010	0.237	-0.220*	0.115	0.131	0.278	-0.103	0.430***	-0.134	-0.014	-0.032	-0.068
	[0.119]	[0.155]	[0.112]	[0.093]	[0.101]	[0.176]	[0.081]	[0.063]	[0.109]	[0.065]	[0.069]	[0.188]
Product Innovation	1.196	0.712	0.427	-0.354	-0.490	0.866	2.3509*	-4.066	10.125	0.165	-1.648	-0.139
	[1.440]	[1.294]	[1.482]	[0.545]	[0.748]	[0.893]	[1.924]	[23.813]	[14.311]	[0.997]	[1.012]	[1.174]
Process Innovation	-0.001	0.193	-0.213**	-3.686	-7.334**	-5.777	-0.080	0.370***	-0.116	-0.087	-0.104	-0.309***
	[0.108]	[0.135]	[0.093]	[2.374]	[3.060]	[5.613]	[0.070]	[0.054]	[0.090]	[0.068]	[0.078]	[0.112]
Technological innovation	0.827	12.382	-1.499	9.061	27.030*	20.422	-4.340	-19.564	-44.159***	4.336	9.289	11.472
	[6.710]	[8.050]	[10.026]	[10.768]	[13.722]	[15.329]	[16.951]	[24.271]	[12.920]	[5.261]	[6.433]	[8.157]
Marketing innovation	-0.003	0.188	-0.220**	0.035	-2.584	0.809	-0.092	0.372***	-0.128	-0.089	-0.109	-0.295***
	[0.110]	[0.143]	[0.096]	[2.113]	[3.322]	[4.318]	[0.072]	[0.054]	[0.093]	[0.067]	[0.075]	[0.112]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The main independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district-fixed effects for textile, surgical, light engineering, and automobile are controlled by the years 2018, 2019, 2020, and 2021 are also controlled.

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 11: Measuring the Impact of Type of Innovation on The Light Engineering Sector's Performance for Exporters & Non-exporters

	Light engineering Sector					
Types of Innovation	**exporter**			**Non-exporters**		
	Revenues	**Price**	**Cost**	**Revenues**	**Price**	**Cost**
Any innovation	-0.109	0.082	1.163	-0.197	0.029	0.286
	[0.688]	[0.695]	[0.756]	[0.358]	[0.389]	[0.493]
Business Modelling Innovation	-0.131	0.293**	-0.106	-0.096	-0.150*	-0.344***
	[0.089]	[0.106]	[0.196]	[0.063]	[0.086]	[0.108]
Product Innovation	0.593	0.084	-1.730	0.168	0.579	1.076
	[1.142]	[1.074]	[1.390]	[0.575]	[0.628]	[0.743]
Process Innovation	-0.126	0.315***	-0.214**	-0.040	-0.185**	-0.355***
	[0.080]	[0.070]	[0.096]	[0.067]	[0.089]	[0.103]
Technological innovation	-19.219	50.591	45.270	-0.975	5.103	3.942
	[23.318]	[34.291]	[44.788]	[4.924]	[6.137]	[8.052]
Marketing innovation	-0.137	0.321***	-0.209**	-0.057	-0.199**	-0.357***
	[0.085]	[0.075]	[0.101]	[0.064]	[0.088]	[0.102]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category): the specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.
Robust standard errors in brackets are clustered at a firm level.
**** p<0.01, ** p<0.05, * p<0.1*

Table 12: Measuring the Impact of Innovation Complementarities on the Light Engineering Sector's Performance

Light engineering Sector			
Complimentary innovation	**Revenues**	**Price**	**Cost**
bus_market	[0.101]	[0.211]	[0.151]
	0.110	-0.313	-0.424
bus_prod	-0.045	-0.027	-0.155
	[0.197]	[0.209]	[0.218]
proc_bus	1.301*	-0.125	2.628**
	[0.715]	[0.769]	[1.109]
process_market	0.781	-1.914	0.468
	[1.300]	[1.525]	[1.866]
process_tech	0.172	2.297***	0.449
	[0.257]	[0.320]	[0.408]
prod_market	0.047	-0.546***	0.111
	[0.109]	[0.202]	[0.172]
prod_proc	-0.031	-0.843***	-0.14
	[0.093]	[0.122]	[0.155]
prod_tech	1.029	7.640**	4.611
	[3.237]	[3.271]	[3.466]
tech_market	-0.035	1.466***	-0.231
	[0.293]	[0.550]	[0.458]
bus_tech	0.200	0.102	0.373
	[0.523]	[0.562]	[0.580]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). District-fixed effects and sector-fixed effects for textile, surgical, light engineering, and automobile are controlled in the specification. Time-fixed effects for years 2018, 2019, 202,0, and 2021 are also controlled.

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 13: Measuring the impact of Innovation Complementarities on the Light Engineering Sector's Performance for Exporters & Non-exporters

	Light engineering Sector					
	Exporters			Non-exporter		
	Revenues	Price	Cost	Revenues	Price	Cost
bus_market	-1.516	-1.005	1.072	0.082	-0.496	-0.136
	[1.443]	[1.656]	[1.600]	[0.506]	[0.575]	[0.713]
bus_prod	0.154	0.028	0.419	-0.299	0.299	0.079
	[0.405]	[0.595]	[0.755]	[0.237]	[0.274]	[0.324]
proc_bus	1.267	1.163	4.686*	1.390	-1.731	2.818
	[1.733]	[1.925]	[2.689]	[1.172]	[1.195]	[1.728]
process_market	-0.839	-1.463	6.430*	1.001	-3.356	-4.641*
	[2.214]	[1.837]	[3.134]	[2.678]	[3.190]	[2.705]
process_tech	-15.470	-9.562	2.841	22.211	16.113	34.501**
	[12.050]	[12.527]	[33.360]	[14.173]	[17.077]	[15.781]
prod_market	11.926*	5.320	11.975	0.691	9.530***	3.094
	[6.077]	[8.141]	[7.603]	[2.966]	[2.229]	[2.551]
prod_proc				-8.861*	-5.407	-11.263
				[5.175]	[6.964]	[6.986]
prod_tech	8.476	-0.063	8.446	-0.352	11.898***	3.701
	[7.148]	[7.053]	[8.235]	[4.216]	[4.021]	[4.084]
tech_market	-32.122*	-13.510	-27.089	-1.197	-25.046***	-8.251
	[15.598]	[22.074]	[20.203]	[7.691]	[5.413]	[6.313]
bus_tech	-0.266	0.148	-1.096	0.864	-0.700	0.058
	[1.083]	[1.390]	[1.826]	[0.648]	[0.685]	[0.734]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as the rm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.

Robust standard errors in brackets are clustered at a firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 14: Measuring the Impact of Type of Innovation on The Automotive Sector's Performance

Automotive Sector			
	Revenue	**Price**	**Cost**
Any innovation	-0.058	0.024	-0.324
	[0.585]	[0.499]	[0.610]
Business Modelling Innovation	0.062	0.038	-0.140*
	[0.104]	[0.059]	[0.080]
Product Innovation	14.741***	-1.849	-4.526
	[5.527]	[2.506]	[4.375]
Process Innovation	-2.088*	-0.666	-0.539
	[1.222]	[1.101]	[1.292]
Technological innovation	42.948	-18.918	17.938
	[38.364]	[26.004]	[41.800]
Marketing innovation	0.817*	0.682**	-0.059
	[0.425]	[0.281]	[0.483]

Table 15: Measuring the Impact of Type of Innovation on The Automotive Sector's Performance by Age & Size

Automotive Industry												
	small			**big**			**Young**			**Old**		
	Revenues	**Price**	**Cost**	**Revenues**	**Price**	**Cost**	**Revenues**	**Price**	**Cost**	**Revenues**	**Price**	**Cost**
Any innovation	2.420***	1.113	2.200**	-0.053	-0.273	-1.155***	1.852	0.471	-1.752	-1.257*	-0.335	0.156
	[0.780]	[0.993]	[1.019]	[0.398]	[0.289]	[0.319]	[1.279]	[1.671]	[1.402]	[0.660]	[0.901]	[0.966]
Business Modelling Innovation	-2.887***	-0.847	-1.901*	0.102	0.077	-0.151	0.103	0.112	0.188	0.193	0.068	-0.157
	[0.773]	[0.929]	[0.996]	[0.126]	[0.084]	[0.102]	[0.211]	[0.203]	[0.274]	[0.137]	[0.086]	[0.121]
Product Innovation	2.788***	1.282	2.534**	20.515***	-2.231	-2.783	6.907	0.768	-0.619	13.654*	-0.388	-3.892
	[0.898]	[1.144]	[1.174]	[4.937]	[3.387]	[5.844]	[5.347]	[4.141]	[3.011]	[6.827]	[3.076]	[6.621]
Process Innovation	-13.945***	-2.774	-22.08***	-2.536*	-0.585	0.628	-8.926	-4.396	-20.281***	-4.189***	-1.126	0.435
	[4.570]	[4.500]	[1.658]	[1.426]	[1.198]	[1.403]	[5.322]	[4.238]	[2.908]	[1.092]	[1.510]	[1.699]
Technological innovation	160.778***	62.066	301.6***	44.468	-28.810	3.592	69.401	10.101	92.686	5.813	-80.205	74.480
	[55.845]	[59.880]	[16.712]	[37.535]	[32.947]	[45.872]	[48.235]	[30.249]	[70.888]	[53.175]	[51.717]	[64.588]
Marketing innovation	-22.333***	-7.736	-40.7***	0.710	0.708*	-0.022	-10.325	4.043	-12.195	0.837*	0.675**	-0.099
	[7.341]	[7.831]	[2.294]	[0.576]	[0.381]	[0.602]	[12.773]	[11.089]	[19.277]	[0.457]	[0.333]	[0.550]

Note: The three different dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation, and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category): the specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.
Robust standard errors in brackets are clustered at a firm level.
**** $p<0.01$, ** $p<0.05$, * $p<0.1$*

Table 16: Measuring the Impact of Type of Innovation on The Light Engineering Sector's Performance for Exporters & Non-exporters

	Automotive Sector					
VARIABLES	**exporter**			**Non-exporters**		
	Revenues	**Price**	**Cost**	**Revenues**	**Price**	**Cost**
Any innovation	-1.077	-2.586***	-0.361	-0.332	-0.116	-0.426
	[1.764]	[0.123]	[1.257]	[0.821]	[0.780]	[0.842]
Business Modelling Innovation	0.396*	0.144	-0.229	-0.190	-0.066	-0.151
	[0.207]	[0.318]	[0.297]	[0.169]	[0.068]	[0.140]
Product Innovation	41.215	24.657	31.197	-0.329**	-0.175	-0.451***
	[39.982]	[38.075]	[25.794]	[0.146]	[0.124]	[0.122]
Process Innovation	-3.841	-2.601	1.688	-1.455	0.135	-1.508
	[5.245]	[2.096]	[4.843]	[1.811]	[1.684]	[2.278]
Technological innovation	172.744	-263.765	-246.995	22.805	-49.810	60.662
	[947.275]	[346.318]	[549.010]	[51.747]	[41.408]	[52.515]
Marketing innovation	1.363	1.046*	-0.544	-1.065	0.281	-0.115
	[1.956]	[0.595]	[1.722]	[1.548]	[1.376]	[1.187]

Note: The three dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise characteristics such as the firm's age, age squared, number of workers employed by the firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category. District-fixed fixed effects and sector-fixed effects for textile, surgical, light engineering, and automobile are controlled by the specifications. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.

Robust standard errors in brackets are clustered at firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 17: Measuring the Impact of Innovation Complementarities on the Automotive Sector's Performance

	Automotive Sector		
	Revenues	**Price**	**Cost**
bus_market	0.232***	0.073	0.199**
	[0.066]	[0.063]	[0.075]
bus_prod	0.04	0.043	0.035
	[0.066]	[0.037]	[0.068]
proc_bus	0.246***	0.092	0.184**
	[0.058]	[0.056]	[0.073]
process_market	-0.068	0.092	0.016
	[0.138]	[0.073]	[0.097]
process_tech	0.137	0.114	0.480***
	[0.192]	[0.103]	[0.140]
prod_market	0.054	0.025	0.007
	[0.057]	[0.028]	[0.068]
prod_proc	0.031	0.017	-0.075
	[0.086]	[0.045]	[0.098]
prod_tech	0.088	0.130	0.284**
	[0.117]	[0.084]	[0.121]
tech_market	0.051	0.085	0.403***
	[0.129]	[0.075]	[0.115]
bus_tech	-0.270**	-0.027	-0.027
	[0.112]	[0.088]	[0.159]

Note: The three dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as the firm's age, age squared, number of workers employed by the firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). District-fixed effects and sector-fixed effects for textile, surgical, light engineering, and automobile are controlled by the specifications. Time fixed effects for years 2018, 2019, 20,20, and 2021 are also controlled.

Robust standard errors in brackets are clustered at firm level.

**** p<0.01, ** p<0.05, * p<0.1*

Table 18: Measuring the impact of Innovation Complementarities on the Light Engineering Sector's Performance for Exporters & Non-exporters

	Automotive Sector					
	Exporters			Non-exporters		
	Revenues	**Price**	**Cost**	**Revenues**	**Price**	**Cost**
bus_market	-0.001	-0.040	0.156	0.197	0.049	0.119
	[0.030]	[0.146]	[0.386]	[0.129]	[0.086]	[0.114]
bus_prod	-0.692	0.515	0.550	0.015	0.014	0.022
	[0.460]	[0.562]	[1.971]	[0.048]	[0.030]	[0.060]
proc_bus	0.261	-0.137	0.091	0.199*	0.055	0.134
	[0.254]	[0.213]	[0.690]	[0.102]	[0.083]	[0.113]
process_market	0.183	-0.087	0.522	-0.261**	0.060	0.082
	[0.853]	[0.329]	[0.713]	[0.122]	[0.070]	[0.112]
process_tech	2.256	1.863*	0.338	-0.262	0.094	0.479***
	[1.747]	[0.961]	[2.778]	[0.164]	[0.120]	[0.151]
prod_market	-3.122	-2.299**	-3.279	0.087	0.014	0.016
	[3.219]	[0.805]	[3.227]	[0.052]	[0.023]	[0.038]
prod_proc	4.200	-0.998	1.000	0.120	0.011	-0.031
	[9.199]	[5.144]	[7.786]	[0.078]	[0.051]	[0.067]
prod_tech	-5.060	-9.321	2.823	0.077	0.105	0.106
	[16.674]	[11.238]	[18.074]	[0.218]	[0.103]	[0.165]
tech_market	-1.766*	-1.080***	-1.098	-0.249	0.081	0.363***
	[0.937]	[0.374]	[1.344]	[0.169]	[0.080]	[0.123]
bus_tech	-0.548***	-0.116	-0.191	-0.356***	-0.041	-0.012
	[0.099]	[0.320]	[0.759]	[0.109]	[0.091]	[0.162]

Note: The three dependent variables of the specifications comprise dummy=1 if the firm's revenues increased due to innovation, dummy=1 if the firm's product price decreased due to innovation and dummy=1 if the firm's cost decreased due to innovation. The primary independent variable is dummy=1 if the firm decides to innovate. Other independent variables comprise the firm's characteristics such as firm's age, age squared, number of workers employed by firm, dummy=1 if the firm exports, dummy=1 if the firm has diversified products, dummy=1 if the firm makes the technology, dummy=1 if the firm buys the technology (keeping does not invest in technology), dummy=1 if the firm is publicly owned, dummy=1 if the firm is private limited, dummy=1 if the firm is family owned (keeping proprietorship as base category). The specifications control district and sector-fixed effects for textile, surgical, light engineering, and automobile. Time-fixed effects for years 2018, 2019, 2020, and 2021 are also controlled.

Robust standard errors in brackets are clustered at firm level.

**** p<0.01, ** p<0.05, * p<0.1*