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DOES INNOVATION AFFECT INTENSIVE AND EXTENSIVE MARGINS OF EXPORTS? A FIRM-LEVEL ANALYSIS

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In the progressively globalized world, firms and nations are ceaselessly endeavoring for competitiveness in international market to increase their export earnings. This study is intended to investigate the effects of different types of innovation - product, process, management and marketing - on margins of exports by using data of manufacturing firms operating in four South Asian countries. The study is based on a simple theoretical model that successfully predicts the effects of innovation on extensive and intensive margins of exports and guides our empirical analyses. We use the probit, fractional response model, and control function approach for endogenous treatment as estimation strategies. The findings of the study uncover that different types of innovation have positive and significant effects on both extensive and intensive margins of exports. Our results are robust to alternative specifications and estimation techniques. These findings suggest that different innovative activities - product, process, management, and marketing innovation - provide a sustainable, competitive advantage for firms in international market.

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1. INTRODUCTION

A growing concern of many developed economies has been the persistent trade. International trade has been recognized as a key driver of growth and development[1]. The

[1] It bridges the idea gap in developing countries by transmitting productive ideas from developed north to developing south and also serve as vehicle for diffusion of technology (see, for example, Alvarez and Lucas, 2007; Alvarez et al., 2013). Moreover, trade openness is also positively associated with the living standard in developing countries (Frankel and Romer, 1999)

progressive pace of economic globalization makes export competitiveness as major consideration for performance of individual firms as well as for whole macroeconomic outlook. Growth miracles in newly industrialize economies of East Asia encouraged many developing countries to pursue outward looking export promotion policies. Currently, among the emerging economies, China is seen as a flagship of export-led development. Export encompasses different channels through which it contributes to growth and development. First, export earning provides foreign exchange for the imports of machinery and intermediate inputs which in turn increases productivity and expands overall production frontier. Second, economies of scale in the industrial manufacture products make it advantageous for firms to export goods along with production for domestic needs (Krugman, 1979). Expansion in size of markets for local firms provides stimulus for growth rate of income and employment which increases the living standard of people (Romer, 1990). Third, there is also diffusions of production related ideas from exporters to the domestic non-exporting firms leading to productivity gain in the whole economy (Alvarez et al., 2013; Luttmer, 2007; Lucas and Moll, 2014).

Despite these positive externalities of exports, South Asian countries are for behinds in export performance from their East Asian counterparts. The New-New trade theory (Melitz, 2003) based on firm heterogeneity in productivity predicts that only more productive firms enter into export market because of irreversible fixed investment for firms' entry in export market. The trade theory based on firm heterogeneity emphasizes on the competitiveness of firms as a policy objective as an alternative to the traditional market access approach for increasing exports in developing countries. However, Melitz (2003) takes firm productivity as draw from random distribution or exogenously assign to firm by luck. In contrast, the endogenous growth theory emphasizes on industrial innovation as a major source of productivity growth and firms' competitiveness in the international market (Romer, 1990; Aghion and Howitt, 1992). This strand of literature considers productivity as endogenous and allow firms to enhance their productivity through industrial innovation. This study is an attempt to uncover the effects of innovation on intensive and extensive margins of exports using the enterprise level data of selected South Asian countries. Although South Asia is the fastest growing region in the world with the project growth rate of 7.1 percent in 2019-20 (World Bank, 2019). Yet, exports growth is low and long run growth process is majorly derived by the domestic demand[2]. As a result, these countries are facing persistent trade deficit and balance of payment crises. Existing literature document that extensive and intensive margins play a major role in the sustainable exports' growth process (see for instance, Hummels and Klenow, 2005; Besedes and Prusa, 2011). Hence, this study explores the response of intensive and extensive margins of exports to the productivity enhancing and

[2] This scenario is reflected in World Bank (2019) that proclaims it as "export grew at the rate of 4.6 percent in 2017 and 9.7 percent in 2018 while import grew at the rate of 14.9 percent in 2017 and 15.6 percent in 2019 and strong domestic demand fueled by the consumption and investment boom amplifies the import growth in South Asian region".

cost-reducing innovation.

The innovation encompasses different channels through which it effects the intensive and extensive margin of exports. The product cycle models of trade (Vernon, 1966; Krugman, 1979; Dollar, 1986) predict that product innovation expand the range of goods that a country exports. Hence, product innovation is positively associated with the extensive margin of export. Similarly, endogenous growth model predict that innovation is the major source of productivity growth (Romer, 1990; Aghion and Howitt, 1992; Eaton and Kortum, 2001) and trade theory based on firms' heterogeneity (Melitz, 2003) predict that only more productive firms enter into exports market. Hence, innovation indirectly expands the extensive margin of exports through its amplification effect on productivity growth. Another strand of literature (Grossman and Helpman, 1991) emphasizes on the role of innovation in the quality of product and hence increases the value of exports - intensive margin. Similarly, some studies argue that cost reducing process innovation increases the export competitiveness of firms and increases domestic as well as foreign sale - intensive margin of exports (Basile, 2001; Becker and Egger, 2013).

Based on a priori theoretical predictions, many studies empirically investigate the effects of innovation on the firm level export performance. Most studies use R&D expenditure as proxy for innovation or indirect measure of innovation output (see, for instance, Kumar and Siddharthan, 1994; Basile 2001; Esteve-Pérez and Rodríguez, 2013; Di Cintio et al., 2017; Falk and de Lemos, 2019). However, some studies also use explicit information on innovation output and document positive effects of innovation on firm level export performance using survey data (Roper and Love 2002; Caldera, 2010; Cassiman and Golovko, 2011; Becker and Egger, 2013 Rodil et al., 2016; Elliott et al., 2019). Mostly, these studies are based on the data from the developed countries. Nevertheless, firms embedded in developing countries business environment also use advance innovation for competitiveness in international market (Amann and Figueiredo, 2012). Few studies find the evidence for the positive effects of innovation on firm's level export performance in developing countries. For instance, Özcelik and Taymaz (2004) on Turkey, Alvarez (2007) on Chile, and Cirera et al. (2015) on Brazil document positive effects of innovation on export performance. More recently, some studies investigate the determinants of the intensive and extensive margin of exports using firm level date of different developing countries. For instances, some studies document the productivity of firms (Regis, 2018), and financial factors (Berman and Hericourt, 2010; Egger and Kesina, 2014) as important determinants of extensive and intensive margins of export in developing and emerging economies. Similarly, Chen (2013) investigates impact of innovation on extensive and intensive margins of exports using number of patents granted by US as proxy for innovation in 105 countries. Findings of study document the positive impact of innovation on both intensive and extensive margins of exports. According to the best of our knowledge, there is hardly any study that investigates the effects of innovation on extensive and intensive of margins of exports using explicit information on innovation output collected through survey. Moreover,

there is also a gap in existing literature in context of South Asian developing countries. Hence, this consequent study investigates the effects of innovation on extensive and intensive of margins of exports by using the survey data of manufacturing firms operating in four South Asian economies[3].

The rest of studies is organized as follow. Section 2 provides the insights from the existing literature. Section 3 discuss the theoretical framework of study. In Section 4, we discuss the econometric framework. Section 5 provides the empirical findings and discussions, and Section 6 concludes.

2. LITERATURE REVIEW

The innovation has been playing imperative role in growth and development since the seminal work of Schumepeter (1934) which argues that 'new combinations' works as engine of economic growth and amplify firms' productivity. Schumepeter (1934) also gives the detail description of the concept as "new combinations encompass introduction of new product or new quality of a good, introduction of new method of production, opening of new market, adaptation of new source of intermediate inputs, and promotion of new organization of an industry." In similar vein, the Vernon (1966) argues that innovation play major role in trade and growth in developed countries. The product cycle model of Vernon (1966) predicts that developed north due advantages of skills and social infrastructure always innovate and exports the high value innovative product to developing south while in later stage due to cheaper labor, the developing south imitate these product at more cheaper cost. Many studies based on product cycle model predict the dynamic comparative advantage in innovation and high tech sophisticated products for developed south (Krugman, 1979; Kellman and Landua, 1984; Dollar, 1986; Audretch et al., 2017).

Another strand of literature emphasizes on the industrial innovation as key driver for productivity growth. Second generation endogenous growth theory base on Schumpeterian idea of creative destruction stress on innovation for self-sustain long run productivity growth. Aghion and Howitt (1992) argues that along with formal education, learning by doing, on job training, and industrial innovation contribute to the knowledge accumulation which in turn amplify productivity growth. Similarly, Grossman and Helpman (1991) argues that innovation play crucial role for the continuous improvement of the quality of products which stimulate self-sustaining growth. Many studies document the evidence of the primary role of innovation in productivity growth and cross country convergence (Hall and Jones, 1999; Hall, 2011). Similarly, the link between firm level total factor productivity and innovation is also well documented in

[3] We have selected four South Asian countries namely India, Pakistan, Bangladesh, and Sri Lanka where manufacturing sector is relatively vibrant as compared to others South Asian countries.

existing empirical literature. For instance, Lööf and Heshmati (2002), Van Leeuwen and Klomp (2006), Crespi and Pianta (2008), Koellinger (2008), Hall et al., (2009), Bogliacino and Pianta (2011) document the evidence for the positive effects of innovation on firm level total factor productivity.

Research in industrial economics provides important insights on the role of cost reducing innovation in export competitiveness of firms. Spencer and Brander (1983) argue that investment in process innovation increases the export competiveness and provides the sustainable competitive edge for firms operating in relatively open markets. Many empirical studies also document the positive effects of innovation on firms export performance using the firm level data of developed countries. For instances, Roper and Love (2002) document the evidence for positive effects of innovation on export performance using firm level data of UK and Germany. Caldera (2010) investigates the effect of innovation on propensity of export using firm level data of Spain. Overall results show that product innovation is more important for the entry into export market than cost reducing process innovation. Similar findings are documented by the Becker and Egger (2013) using firm level data of Germany. Basile (2001) investigate the impact of innovation inputs such R&D expenditure on firm export intensity using data of Italian manufacturing firms and document positive impact on export intensity. Similarly, Falk and de Lemos (2019) document complementary role of R&D expenditure and firm productivity in export performance of Australian manufacturing firms. Rodil et al. (2016) investigates the effect of different types of innovation on export performance of using firm level data of Galicia - north-west region of Spain - and findings support the key role of innovation in export performance. Cassiman, Golovko and Martínez-Ros (2010) find that product innovation amplifies productivity of firms and help firms to inter into export market. Similarly, Cassiman and Golovko (2011) test the hypothesis that product innovation indirectly contributes to export propensity by increasing the productivity of firms in Spain. Findings of the study support that innovation indirectly contribute to export propensity.

Amann and Cantwell (2012) argue that some firms in developing countries closer to the technological frontier and innovation play major role in their exports. Many studies empirically investigate the effects of innovation on export performance of developing countries. Alvarez (2007) investigates the impact of innovation on exports performance of Chile and document positive role of innovation on export performance. Similarly, Özcelik and Taymaz (2004) find the positive effects of R&D expenditure on Turkish manufacturing exports. Empirical findings of study support the hypothesis that R&D expenditure helps firms to enter into export market. Cirera et al. (2015) investigates the effects of innovation on extensive margin of export using firm level data of Brazil. Findings of the study support the claim that innovation contribute to the export diversifications by increasing entry of firms in export market. Chadha (2009) analyze the role of innovation in product cycle framework using firm level data of Indian manufacturing firms in pharmaceutical industry and finds evidence for the positive role of innovation on export performance. Ang et al. (2015) investigates the effect of

innovation on export competitiveness using the country level data of East Asian countries and document positive effects of innovation on export performance of selected countries.

More recently, some studies investigate the determinants of intensive and extensive margin of exports using firm level date of different developing countries. For instance, Berman and Hericourt (2010), and Egger and Kesina (2014) document the positive impact of availability of credit and financial soundness of firms on both intensive and extensive margin of export. Chen (2013) investigates the role of innovation on extensive and intensive margins of exports using industry level data of 105 developed and developing countries. Findings of study document the positive role of innovation in increasing both intensive and extensive margins of exports. Regis (2018) investigate the effects of firm productivity on intensive and extensive margins of export using firm level data of 104 developing and emerging economies. Overall results support the claim that firms' productivity amplify both intensive and extensive margin of exports. However, according to best of our knowledge, there is hardly any study that investigates the effect of innovation on intensive and extensive margins of exports using the firm level data of south Asian countries.

3. THEORITICAL FRAMEWORK

In order to investigate effects of innovation on intensive and extensive margins of exports, this study is based on theoretical underpinnings of trade model based on the firms' heterogeneity in productivity and performance. Melitz (2003) incorporates the firms' heterogeneity in model of trade with assumption of increasing return and monopolistic competitive market structure. Trade model based on firms' heterogeneity can successfully predict intensive and extensive margin of trade (Chaney, 2008)[4]. The model based on firms' heterogeneity predicts that reduction in trade cost or any productivity enhancing measure such as firms' innovation increases both extensive and intensive margin of exports.

Model Setup

The consumers preferences in importing country are characterized by the CES utility functions over continuum of varieties (i) of a good (x)

$$U = [\int x(i)^{\rho} di]^{1/\rho}, \quad 0 < \rho < 1,$$

[4] In similar vein, Bernard et al. (2003) introduced firms' heterogeneity in Ricardian framework, but Melitz (2003) model has proved to be more tractable and successfully predict real world trade.

where $x(i)$ is quantity of variety(i) and optimal demand in importing country for variety(i) can be expressed as

$$x(i) = \frac{Ep(i)^{-\sigma}}{P}, \quad \sigma = \frac{1}{1-\rho} > 1, \tag{1}$$

where E is the aggregate market demand in importing country and exogenous for individual exporting firms and normally depends on aggregate income, σ is the elasticity of substitutions between varieties and P is price index in importing country which also reflect CES preferences

$$P = [\int p(i)^{1-\sigma} di]^{\frac{1}{1-\sigma}}, \ \sigma = \frac{1}{1-\rho} > 1.$$

Supply side in exporting country is characterized with production technology that use single factor of production that is labor with fixed production cost (f) while marginal cost of the firms depends on its productivity (ϕ)

$$l = f + \frac{x(\phi)}{\phi}. \tag{2}$$

The firm's profit maximization problem can be defined as

$$\{p(\phi)x(\phi) - wl\} \ \ s.t \ \ x(i) = Ep(i)^{-\sigma}.$$

We substitute the value of $l = f + \frac{x(\phi)}{\phi}$ in above expression

$$max_{x(\emptyset)}\{p(\phi)x(\phi) - w(f + x(\phi)/\phi\} \quad s.t \quad x(i) = Ep(i)^{-\sigma},$$

$$\left\{p(\phi)x(\emptyset) - \frac{w\tau Ep(i)^{-\sigma}}{\varphi} - f\right\} = 0.$$

First order conditions imply that $\mathrm{p}(\varphi) = \frac{\sigma}{\sigma-1}(\frac{w\tau}{\varphi})$.

By normalizing wage rate(w) equal to one

$$p(\varphi) = \left(\frac{\tau}{\rho\varphi}\right), \tag{3}$$

where τ is variable trade cost, and above expression show that due to the assumption of monopolistic competitive market structure each firm can pass it productivity premium to consumers by lowering its price which in turn increases firm's revenue due to elastic demand. Similarly, the revenue and profit of a firm can be calculated as

$r(\phi) = P(\phi)x(\phi) = \left(\frac{1}{\rho\phi}\right)(Ep(i)^{-\sigma}\ )$.

As price in importing country is characterized by CES preferences, above expression can be written as

$$r(\phi) = \left(\frac{\tau}{\rho\phi}\right)^{\frac{1}{1-\sigma}}(Ep(i)^{-\sigma}\ ). \quad (4)$$

Profit of firm can be expressed as $\pi(\phi) = r(\phi) - l(\phi)$.

By substituting vale of $r(\emptyset)$ from Equation (4) and l from Equation (2)

$\pi(\phi) = \frac{\tau^{1-\sigma}r(\phi)}{\sigma} - f$.

The presence of market entry fixed cost (f) which is sunk in nature implies that there is threshold level of productivity to enter into exports market or zero profit cut-off for export market. $\pi\left(\overset{*}{\phi}\right) = 0$ which implies that $\pi\left(\overset{*}{\phi}\right) = \sigma f$.

Hence, a firm can enter into export market only when its productivity (ϕ) is greater than threshold level of productivity ($\overset{*}{\phi}$): $\pi(\phi) \geq \pi\left(\overset{*}{\phi}\right)$ or $\phi \geq \overset{*}{\phi}$.

Innovation increases the firms' productivity and enables firms to enter into exports market. The key proposition of our theoretical model is "innovators are more likely to export than non-innovators", which implies that innovation is positively associated with extensive margin. Moreover, innovation also increases the quality and value of product, hence also amplify the intensive margin.

4. ECONOMETRIC FRAMEWORK

We investigate the effect of innovation on extensive margin and intensive margin of exports separately using the firm level data of South Asian economies.

4.1. Extensive Margin of Exports

Extensive margin of exports - probability of being exporter - is a discrete choice, hence probit model is most appropriate estimation strategy. In line with Berman and Hericourt (2010), and Egger and Kesina (2014), the extensive margin of exports or probability of exporting by firm j in country c can be express as

$$\dot{Ex\_mar_J} = \alpha + X_j\gamma + D_c + D_i + \varepsilon_j, \quad (5)$$

where $\dot{Ex\_mar_J}$ is extensive margin of firm j and X_j is the set of firm specific control variable and γ is the vector of unknown parameters to be estimated. D_c and D_i are respectively the country specific and industry specific dummies that capture unobserved heterogeneity. $\dot{Ex\_mar_J}$ is not directly observable and we express it as binary choice

$$Ex\_mar_j = \begin{cases} Export_d = 1 \quad if \quad \dot{Ex\_mar_j} \geq 0 \\ Export_d = 0 \quad if \quad \dot{Ex\_mar_j} < 0 \end{cases}.$$

Now we can incorporate role of innovation in Equation (5) as

$$P\left(Ex\_mar_j \middle| X_j, innov_j\right) = \Phi\left(X_j\gamma + innov_j\delta_j + D_c + D_i\right) + \mu_j, \tag{6}$$

where $innov_j$ is different type of innovation such product, process, management and marketing innovation and $\Phi(\cdot)$ is the cumulative standard normal distribution function.

4.2. Intensive Margin of Exports

The intensive margin of exports, ratio of exports to sale, of firm j is a fraction ($int\_mar_j \in [0,1]$), hence most appropriate estimation technique is fractional response model of Pake and Wooldridge (1996). To investigates the effects of innovation (innov) on intensive margin of exports, the fractional response model can express as

$$E\left(Int\_mar_j \middle| X_j, innov_j\right) = \Psi(X_j\gamma + innov_j\delta_j + D_c + D_i + \mu_j), \tag{7}$$

where Int_mar_j is intensive margin of exports measure as ratio of exports to sale, while X_j is firm specific control variables of firm *j*, $innov_j$ is innovation decision of firm *j*, $\Psi(\cdot)$ is the distribution function. The Equation (7) can be estimated through Quasi-Maximum Likelihood estimation technique.

4.3. Data and Variables

This study is based on the cross-sectional data of 9,749 manufacturing firms provided by the World Bank Enterprise Level Survey. After cleaning the data and dealing with missing observation on certain variables, it reduces to the 8,423 firms. We have selected four South Asian countries namely India, Pakistan, Bangladesh and Sri Lanka because manufacturing sector is relatively vibrant in these countries as compare to others South Asian countries. World Bank's Enterprise Survey used well-structure questionnaire with uniform design for 135 developing and transition economies. In order to ensure true representation of the sample, the surveys relied on the stratified random sampling technique to ensure that the sample is more representative of the population.

The data set is available for the year 2013 in the case of Pakistan and Bangladesh while in case of India and Sri Lanka the data set is available for 2014 and 2011 respectively. We assume that there are no structural and behavioral changes in four years across countries. This practice is consistent with existing literature (see, for instance, Krammer, Strange, and Lashitew, 2018; Barasa et al., 2017). The data availability of different countries in different years is limitation of our study. These limitations, however, provide an avenue for future research on the phenomena. Future research can investigate the issue separately for each country.

Our dependent variables are the extensive margin of export measure as probability of being an exporter and intensive margin of exports measure as ratio of export to total sale. We use the product, process, management and marketing innovation as our variable of interest. Our firm specific control variables include the size, age, and productivity of a firm. We also use the foreign ownership, skills workers, imported technology, use of ICT, and availability of credit as control variables. The detail description of variables of study is provided in Table A1 in Appendix.

5. EMPIRICAL FINDINGS AND DISCUSSIONS

The key objective of this research exercise is to investigate the effects of innovation on extensive and intensive margins of exports using firm level data of selected South Asian countries.

5.1. Extensive Margin of Exports

We estimate the extensive margin of exports by employing the Probit model with robust standard errors adjusted for heteroskedasticity. The Table 1 reports the estimated results for the extensive margin of exports.

First specification of empirical model in column (1) show that product innovation (Innov_1) is statistically significant with positive sign. This result authenticate the claim of product cycle model of trade that claim the major role of product innovation in extensive margin of exports. This result is also consistent with existing empirical literature. For instances, Caldera (2010) authenticates the primary role of product innovation in firms' participation in export markets. All the control variables such as age, size, productivity (prod), foreign ownership (F_own), ratio of skills workers to unskilled workers (skills_w), and access to credit are statistically significant with expected positive sign. Second specification of our empirical model in column (2) show that process innovation (innov_2) is statistically significant at 1 percent level of significance with positive sign. This results support the claim that process innovation (innov_2) increases the probability of firms to enter into exports market and make these firms competitive in international market. This result is also consistent with existing literature. Alvarez (2007), and Cirera et al.(2015) find similar results for Chile and Brazil,

respectively.

Table 1. Estimated Results of Probit Model(odd ratios) for Extensive Margin of Exports

	Dependent Variable: Extensive Margin of Exports (Export Propensity)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
size	0.366***	0.362***	0.366***	0.366***	0.304***	0.301***	0.302***	0.302***
	(0.0154)	(0.0152)	(0.0151)	(0.0151)	(0.0167)	(0.0167)	(0.0167)	(0.0167)
age	0.126***	0.120***	0.128***	0.125***	0.125***	0.123***	0.130***	0.127***
	(0.0260)	(0.0259)	(0.0260)	(0.0259)	(0.0262)	(0.0261)	(0.0262)	(0.0261)
prod	0.069***	0.067***	0.068***	0.068***	0.040*	0.039*	0.040*	0.040*
	(0.0161)	(0.0159)	(0.0161)	(0.0161)	(0.0160)	(0.0159)	(0.0160)	(0.0160)
F-own	0.867***	0.830**	0.844**	0.837**	0.884**	0.860**	0.864**	0.864**
	(0.263)	(0.264)	(0.266)	(0.264)	(0.270)	(0.270)	(0.272)	(0.271)
skills_w	0.204**	0.171*	0.163*	0.177*	0.204**	0.174*	0.163*	0.179*
	(0.0744)	(0.0746)	(0.0756)	(0.0755)	(0.0760)	(0.0762)	(0.0773)	(0.0771)
credit	0.527***	0.510***	0.496***	0.514***	0.515***	0.495***	0.480***	0.498***
	(0.0581)	(0.0586)	(0.0587)	(0.0585)	(0.0586)	(0.0591)	(0.0592)	(0.0591)
im_tech					0.0613*	0.0580*	0.0658*	0.0752*
					(0.0325)	(0.0363)	(0.0263)	(0.0421)
ICT					0.467***	0.450***	0.453***	0.456***
					(0.0455)	(0.0449)	(0.0450)	(0.0449)
innov_1	0.0686**				0.0544**			
	(0.0264)				(0.0215)			
innov_2		0.166***				0.113**		
		(0.0392)				(0.0396)		
innov_3			0.177***				0.140***	
			(0.0398)				(0.0404)	
innov_4				0.129***				0.0843**
				(0.0396)				(0.0401)
con	-3.761***	-3.847***	-3.896***	-3.882***	-3.485***	-3.459***	-3.492***	-3.479***
	(0.265)	(0.249)	(0.251)	(0.251)	(0.261)	(0.249)	(0.250)	(0.250)
N	8423	8423	8423	8423	8423	8423	8423	8423
R^2	0.215	0.213	0.221	0.217	0.235	0.237	0.243	0.229
CFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
IFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01. Coefficient are odd ratios except constant.

All control variables are statistically significant at 1 and 5 percent level of significance except the skills workers (skills_w) that is statistically significant at 10 percent level. The third specification of empirical model in column (3) show that management innovation (innov_3) is statistically significant at 1 percent level of significance with positive sign. This result corroborate the hypothesis that management innovation (innov_3) help firm to enter into export market. All control variables such as size, age, productivity (prod), foreign ownership (F_own), credit are statistically significant at one percent level of significance. However, ratio of skills worker to unskilled worker is statistically significant at 10 percent level. The results in fourth specification of estimated model in column (4) show that marketing innovation (innov_4) also enters in model with statically significant positive sign. All control variables are statically significant with expected positive sign. The empirical specifications in column (5) to column (8) added imported technology (im_tech) and use of ICT by firms in existing control variables. All types of innovation such as product innovation (innov_1), process (innov_2), management (innov_3) and marketing innovation (innov_4) are statistically significant in theses alternative specifications. The additional control variables imported technology (im_tech), and use of ICT statistically significant with positive signs. In all specifications, we include the country and industry dummies to capture the unobserved heterogeneity across countries and industries.

There is possibility of potential endogeneity due to the fact that export can cause innovation through learning effect or there might be a possibility of self-selection of more productive firms in innovation and exporting. Hence to avoid any potential endogeneity threat and robustness of our empirical analyses, we use the endogenous treatment with control function approach devised specifically for binary outcomes. Wooldridge (2010) discusses the control function approach for endogenous treatment and generate excellent discussion on its application. The results of endogenous treatment with control function approach is reported in Table 2.

Table 2. Results of Endogenous Treatment with Control Function Approach for Binary Outcomes

	Outcome variable: Extensive margin of export (export propensity)			
	Treatments			
	(1) Product innovation	(2) Process innovation	(3) Organization innovation	(4) Marketing innovation
ATE	0.0827***	0.179***	0.242***	0.271***
	(0.0265)	(0.0500)	(0.0811)	(0.1055)
ATET	0.2094***	0.6511***	0.627***	0.5321**
	(0.0237)	(0.1150)	(0.2018)	(0.262)
N	8423	8423	8423	8423

The results in column (1) in Table 2 reflect that product innovation increases the probability of entering into exports market for firms that engage in product innovation and this is evident from both the average treatment effects (ATE) and average treatment effect on treated (ATET). Both average effect (ATE) and average treatment effect on treated (ATET) are statistically significant at 1 percent level. The results reported in column (2) show that average treatment effect (ATE) and average treatment effect on treated (ATET) both are statistically significant with expected positive sign. This result again support the claim that cost reducing process innovation increases the exports competitiveness of firm and increases the probability of firms to inter into export market. Similarly, results reported in column (3) and column (4) reveal that management and marketing innovation are important for internationalization of firms through export and both increase the probability of firms to inter into exports markets.

5.2. Intensive Margin of Exports

The table 3 reports the results of fraction response model for intensive margin of exports. To avoid any possibility of hetroskedasticity, we use robust standard errors adjusted for hetroskedasticity.

The results in column (1) show that product innovation (innov_1) is statistically significant with positive sign. This result support the claim that product innovation increases the quality and value of product that increases the volume of export. This result is also consistent with the existing literature (Grossman and Helpman, 1991; Cassiman et al., 2010). All control variables such as size, productivity of firms (prod), ratio of skills workers to unskilled workers, availability of credit, foreign ownership (f_own) are statistically significant at 1 percent level of significance except age which is significant at 5 percent level of significance with positive sign. The results in column (2) show that process innovation (innov_2) is significant at 1 percent level of significance with positive sign. This results substantiate the claim that cost reducing process innovation improve firms' competitiveness in international market and increase the intensive margin of export. These results are consistent with existing literature. For instances, Elliott (2019) document positive effects of process innovation on the intensive margin of exports. All control variable are statistically significant at 1 percent level of significance except age of firm that is statistically insignificant. The column (3) and column (4) report the results of management innovation (innov_3), and marketing innovation (innov_4) which are statistically significant at 1 percent level of significance with expected positive sign. These results corroborates the claim that management and marketing innovation are more important for the export performance of developing countries. All the control variables are statically significant except age of firms which is statistically insignificant in both specifications. We also estimate the intensive margin of exports using some alternative specifications. The Table A2 in Appendix reports the results of intensive margin of exports with alternative specifications. We replace the skills workers (skills_w) with workers' education (w_edu) and includes some additional

control variables such as imported technology, and use of ICT by firms. The results reported in column (1) to column (4) in Table A2 show that product innovation (innov_1), process innovation (innov_2), management innovation (innov_3), and marketing innovation (innov_4) are statistically significant. The alternative control variable workers' education (w_edu) is statistically insignificant in all four specifications which reflect that skills are more important than simple year of education for increasing export share. The additional control variables such imported technology and firms use of ICT are statistically significant in all four specifications.

Table 3. Results of Fractional Response Model for Intensive Margin of Exports

	Dependent variable: Intensive Margin of Export (Export Intensity)			
	(1)	(2)	(3)	(4)
size	0.325***	0.343***	0.347***	0.345***
	(0.0160)	(0.0153)	(0.0152)	(0.0152)
age	0.0572**	0.0403	0.0496	0.0466
	(0.0285)	(0.0278)	(0.0278)	(0.0280)
prod	0.121***	0.108***	0.110***	0.111***
	(0.0166)	(0.0161)	(0.0161)	(0.0162)
skills_w	0.446***	0.458***	0.448***	0.452***
	(0.0873)	(0.0864)	(0.0865)	(0.0870)
credit	0.544***	0.477***	0.465***	0.481***
	(0.0638)	(0.0630)	(0.0631)	(0.0631)
f_own	0.971***	0.773**	0.814**	0.773**
	(0.272)	(0.258)	(0.256)	(0.258)
Innov_1	0.0422**			
	(0.0152)			
innov_2		0.220***		
		(0.0434)		
Innov_3			0.196***	
			(0.0430)	
Innov_4				0.215***
				(0.0431)
cons	-4.962***	-4.897***	-4.936***	-4.946***
	(0.264)	(0.256)	(0.258)	(0.258)
N	8423	8423	8423	8423
R^2	0.325	0.308	0.332	0.326
CFE	Yes	Yes	Yes	Yes
IFE	Yes	Yes	Yes	Yes

Notes: The robust standard error adjusted for heteroskedasticity in parenthesis. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Coefficients are the odds ratio except constant.

Table 4. Results of Endogenous Treatment with Control Function Approach for Fractional Outcomes

	Outcome variable: Intensive margin of export (export intensity)			
	Treatments			
	(1) Product innovation	(2) Process innovation	(3) Management innovation	(4) Marketing innovation
ATE	0.0572**	0.0459***	0.0277*	0.0327*
	(0.0265)	(0.0163)	(0.0141)	(0.0171)
ATET	0.1037***	0.1348***	0.133***	0.126***
	(0.0149)	(0.0092)	(0.0081)	(0.0098)
N	6681	6681	6928	6928

Notes: Robust standard errors in parenthesis. * p < 0.1, ** p < 0.05, *** p < 0.01.

There is possibility of endogeneity in our empirical model because of the fact that exports intensity can cause innovation through learning effect. To avoid any potential endogeneity and for robustness of our empirical analyses, we use endogenous treatment with control function approach devised for fractional outcomes.

The results reported in Table 4 from column (1) to column (4) show that regardless of type of innovation, innovative activity increases the exports intensity of firms. Both average treatment effect (ATE), and average treatment effect at treated (ATET) show that product innovation, process innovation, management innovation and marketing innovation positively contribute to the intensive margin of export.

6. CONCLUSION

The key objective of this study is to investigate the effects of innovation on the extensive and intensive margins of exports. Based on recent theoretical advancement in trade theory, this study develops a theoretical model that successfully link innovating activities of firms with extensive and intensive margins of export and guides our empirical analyses. This study uses firm level data of four South Asian economies for empirical analyses. Consistent with theoretical underpinnings, the results of the study reveal that innovation activities such as product innovation, process innovation, management innovation and marketing innovation increase firms' probability of exporting and also enhance the volume of export. The firm specific control variables such as age, size, productivity, skills workers, and availability of credit, foreign ownership, imported technology, and use of ICT positively explain both extensive and intensive margins of export.

These results have important implications for the selected South Asian countries. There is sluggish export growth process resulted in persistent deficit in balance of trade in selected countries. Existing literature document that the extensive and intensive margins play a major role in the sustainable export growth process. Hence, policy implication is obvious. As different types of innovations are important both for extensive and intensive margins of exports. The south Asian countries needs to take number of measures to actively guide enterprises to boost different types of innovations in order to ensure the sustainability of export growth.

APPENDIX

Table A1. Variables and Their Description

Variables	Description
Intensive Margin (In_M)	"Ratio of export sales to total annual sales."
Extensive Margin (Ex_ M)	"Dummy variable equal to one if firm export either directly or indirectly"
Firm Size (F_Size)	"Logarithm of number of full- time employees."
Productivity (prod)	"Logarithm of value added per permanent employee"
Age of firm	"Logarithm age of an establishment in years"
Access to Credit (credit)	"Percentage of working capital financed by banks and non-bank borrowing"
Foreign Ownership (F_Own)	"Percentage of firm is owned by private foreign individuals, companies or organization"
Workers skills(w_skills)	"Ratio of skilled production workers to unskilled production workers."
Product innovation(innov_1)	"Dummy variable equal to one if firm introduced significantly improve products"
Process innovation (innove_2)	"Dummy variable equal to one if firm introduced significantly improved process or methods of production"
Management innovation(innov_3)	"Dummy variable equal to one if firm introduced significantly improved management practices"
Marketing innovation (innov_4)	Dummy variable equal to one if firm introduced significant improved marketing methods"
Firm use of ICT(F_ICT)	"Dummy variable equal to one if firm using ICT"
Imported technology	"Dummy variable equal to one if firm use imported technology"

Table A2. The Results of Fractional Response Model for Intensive Margin of Exports

	(1)	(2)	(3)	(4)
size	0.241***	0.261***	0.262***	0.261***
	(0.0181)	(0.0175)	(0.0175)	(0.0175)
age	0.0544*	0.0392	0.0475*	0.0443**
	(0.0296)	(0.0290)	(0.0245)	(0.0214)
prod	0.0894***	0.0785***	0.0795***	0.0807***
	(0.0166)	(0.0161)	(0.0162)	(0.0162)
w-edu	0.0454	0.0459	0.0462	0.0507
	(0.0794)	(0.0766)	(0.0764)	(0.0764)
credit	0.556***	0.484***	0.470***	0.484***
	(0.0646)	(0.0638)	(0.0640)	(0.0642)
F_own	1.010***	0.790**	0.822**	0.787**
	(0.301)	(0.285)	(0.283)	(0.284)
ICT	0.688***	0.659***	0.666***	0.663***
	(0.0606)	(0.0590)	(0.0590)	(0.0590)
imp_tech	0.125**	0.180**	0.221***	0.274***
	(0.0621)	(0.0795)	(0.0591)	(0.0592)
innov_1	0.0721**			
	(0.0364)			
innov_2		0.183***		
		(0.0439)		
innov_3			0.183***	
			(0.0432)	
innov_4				0.193***
				(0.0434)
cons	-4.208***	-4.151***	-4.191***	-4.195***
	(0.253)	(0.244)	(0.246)	(0.246)
N	8423	8423	8423	8423
R^2	0.335	0.324	0.319	0.326
CFE	Yes	Yes	Yes	Yes
IFE	Yes	Yes	Yes	Yes

Notes: Robust standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Coefficients are the odds ratio except constant.

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