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Competitive Pressure and Firm-Level Innovation: The Perspective of a Developing Economy

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ABSTRACT

The connection between firm-level innovation and competition has received scholarly attention for a long time before now. This paper attempts to shed light on this complex relationship from a novel perspective where a detailed firm-level dataset of private manufacturing Pakistani firms spanning from 2002 to 2015 is used. We test whether the non-linearity estimate of Aghion et al. (2005) is sustained by our firm-level data. A multivariate probit estimation technique indicates that higher competition leads to a more probability of innovation, but at a declining rate as competitor numbers increase. Moderate confirmation of an inverted-U relationship between competition and innovation is found, especially in process and organizational innovation. The findings have practical implications for policymakers in the area of market structure and firm-level innovation.

Keywords
Innovation; Competition; Firm Performance; Inverted-U Shaped; Developing Economy

JEL Classification
L1; L10; O31; O32

1 Introduction

Innovation and rivalry are the key driving forces of productivity growth both at the micro and macro level (Beneito et al., 2017). The connection between innovation and competition traces back to Schumpeter research (1934, 1942), and is a substantial theoretical and conceptual area that has drawn the attention of the researcher for decades. Owing to its significance for the policymaking process, researchers worked extensively on this area but a closer look at the literature reveals that the relationship is still not always crystal clear (Moen et al., 2018; Bessonova and Gonchar, 2019). The tie

between innovation and competition has a complex and strong idiosyncratic character that is hard to generalize across circumstances and firms (Mulkay, 2019; Tammi, 2020). With this in mind, the current study re-examines this relationship using a panel dataset of a developing economy and finds clear nonlinearities in the form of an inverted-U shape.

There exists a considerable body of literature on the relationship between innovation and competition, seminal contributions are made by Schumpeter (1942), Arrow (1962) and Aghion et al. (2005). According to Schumpeter (1942), the lack of competition has a beneficial effect on the firm's engagement in R&D activities. Due to the availability of more stable funds and facing less market uncertainty, monopolistic firms are more willing to perform innovative practices. Arrow (1962) provides a counter-argument and concludes that the competitive environment spurs R&D. He argues that the monopolist firm does not need to innovate due to the possibility to slack. This is also documented as the Arrow-Schumpeter debate in the literature. Besides, Aghion et al. (2005) maintain that the association between innovation and competition is neither a Schumpeterian or Arrow but an inverted-U shaped relationship.

Two different research directions can be identified from these discrepancies in literature; the first is opposing views of the Arrow-Schumpeter debate and the second is the integration of both to examine the dual impacts of rivalry (Negassi et al., 2019; Bonfatti and Pisano, 2020). A strand of literature (Tang, 2006; Vives, 2008; Darai et al., 2010; Castellacci, 2011) provides empirical evidence on the relevance of the Arrow-Schumpeter debate. Following (Scherer, 1967a), research in the second direction includes plenty of studies demonstrate that the dual impact of competition on innovation is characterized by non-linearity (Kamien and Schwartz, 1976; Scott, 1984; Boone, 2001; Aghion et al., 2005). These empirical validations, especially Aghion et al. (2005, 2018) studies, revitalized the attention of researchers towards innovation and competition interaction.

The central goal here is to re-examine how persistent is the association between firm-level innovation and competition. All previous studies on the interplay between innovation and competition are conducted with the perspective of western and other advanced Asian economies but there is no serious attempt has yet been made that provides a firm-level analysis of developing economies like Pakistan. Study in hand fill this research gap and contribute to the current literature in different ways. First of all, unlike the majority of the previous studies, it is based on the domestically focused firms which is an under-researched category. Secondly, more firm-level based research is

required for developing economies if we acknowledge that "*one size fits all*" industrial policy is not valid in diversified global markets. Thirdly, along with examining the linearity of the relationship this paper also considers the spatial aspects. The study revolves around a key research question; How business-level innovation of domestically focused firms of a developing economy affected by competition? This question is empirically examined with the multivariate probit model which is the best choice when we have more than one dependent variable and these variables are correlated with each other.

1.1 Objective of the study

The association between innovation and competition has remained a mystery in industrial economics. Thanks to the better data availability and motivation from novel theoretical models, the research agenda has added thrust in the last couple of years. The fundamental objective of this study is to find the answer to a research question: "Do the linkages between competition and innovation vary across industries in Pakistan?" In other words, as suggested by Aghion et a. (2005), is the relationship between innovation and market competition in Pakistan inverted-U shaped or not?

The remaining manuscript is organized as follows. Section 2 deals with the review of previous works. Section 3 presents the data and variable construction. Section 4 belongs to the econometrical method. Section 5 provides empirical results. Section 6 concludes the paper with suitable policy recommendations.

2 Related literature

As is clear from the works of Karl Marx and Adam Smith, and is nowadays part of the universal consensus among economists, that innovation plays a key role in enlightening the dynamic properties of the economic system, industries, and firms (Mulkay, 2019; Tammi, 2020). Joseph Schumpeter (1934), an economist from the Austrian School, further elaborated this mechanism who provides innovation a special room in his renowned monograph *The Theory of Economic Development.* He is recognized as the most radical economist of the 20th century who emphasized entrepreneurship, science, and technology in explaining the economic growth heterogeneity among economies both at the macro and micro levels. According to him, innovation can be divided into five different categories: new forms of organization, new markets, new production methods, new products, and new sources of supply. He endogenized the innovation role in his work and postulate that the dynamic efficiency of industries and firms is based on the concept of "*Creative Destruction*" which means something new kills an old thing.

The empirical literature on innovation and competition appears to point in several directions and has caused debates among scholars. Although the earlier research of Schumpeter (1934) proposes that new and small firms are key sources of innovation but his later work *Capitalism, Socialism, and Democracy* (1942) transformed the attention and emphasis on the competitive advantage of large-sized firms over smaller ones. He quotes that the larger sized firms have economies of scale in R&D, risk spread, access to finance, and management capabilities which provide a comparative lead to enhance product development and exploit new technologies. There is a bulk of studies available claiming that advancement and change are necessary for firm growth in modern competitive markets. To understand the theoretical foundation underpinning research and development, it is critical to grasp innovation in the context of market competition.

Arrow and Schumpeter have been depicted as rivals in the literature and the complementarities between both have largely been ignored by the researchers till the 2000s. Some prominent studies in favor of Schumpeter's negative relation between innovation and competition are (Horowitz and Clemens, 1962; Dixit and Stiglitz, 1977; Nelson and Winter, 1982; Romer, 1990; Hashmi and Van Biesebroeck, 2010). In contrast, Arrow's contribution of a positive association between competition and innovation is empirically supported by (Gilbert and Newbery, 1982; Reinganum, 1983; Geroski, 1995; Nickell, 1996; Blundell et al., 1999). But with the publication of Aghion et al. (2005) the empirical literature on the interplay between innovation and competition gets a new direction. They developed an insightful model of competition that describes that there is a U-shaped association exists between both variables and claims that the relationship is a mixture of Arrow and Schumpeter rather than one-directional. In other words, innovation takes place when the firm faces more competition, or in a market that has too little or do not have too much competition.

The non-linear association between innovation and competition was first spotted by Scherer (1967) and empirically tested by Kamien and Schwartz (1976). Aghion et al. (2005) re-estimate the shape of this relationship and find that the competition effect dominates at the low levels of competition leads to a positive association, whereas the Schumpeterian effect dominates at a high level of competition leads to a negative effect. Generally, this provides us an inverted U-shaped relationship. For simplicity, they divided industries into two groups; the first is neck-and-neck where firms have the same technology and the second is leader-follower where the technological gap among firms is high. In order to improve their odds of getting ahead of their competitor firms invest in R&D practices. The firms need the profit to participate in innovation but also need competition to get motivation for investing (Mulkay, 2019).

According to Aghion et al. (2005), two opposite impacts on the firm-level innovation take place when the competition increases in the industry; 1) There is less incentive to innovate in a competitive environment as more competition leads to less profit, known as the Schumpeterian effect. 2) The second effect is recognized as the escape competition effect in which firms engage in R&D activities to escape competition from competitors. So we can say that competition and innovation are negatively associated due to the Schumpeterian effect and positively connected due to the escape competition effect. They conclude that the escape competition effect dominates the Schumpeterian effect in neck-and-neck industries while the Schumpeterian effect takes over the escape competition effect in leader-follower industries. When rivalry is too low or too high, the innovation level is low. When rivalry falls in between low and high, the innovation level is high (Tammi, 2020). If we combine these propositions we get an inverted-U relationship between innovation and competition. The steepness of the inverted-U relationship is affected by the degree to which industries are technologically homogenous. The literature provides empirical support to the inverted U-shaped relationship between innovation and competition via using different proxies for both variables (Sacco and Schmutzler, 2011; Felisberto, 2012; Hashmi, 2013; Bento, 2014). However, the findings of these studies are the same. In this study, we re-examine this relationship from the perspective of a developing country Pakistan.

To sum up the discussion, this paper is an attempt to verify that the non-linear relationship between innovation and competition exists in manufacturing firms of a developing country like Pakistan. A distinctive feature of this study is that it emphasizes an under-researched category the domestically focused firms. There is a plethora of literature available which postulating that the exporting firms are extra prospective to innovate but there is no serious attempt has yet been made on the domestically focused firms of a developing economy like Pakistan. To the best of our knowledge, this is the first-ever study of its nature which investigating these non-linearities and markets structure impacts on firm-level innovation in the case of Pakistan or any other south Asian country.

3 Data and variable construction

The Dataset of this research is constructed by merging three recent waves of firm-level data (Investment Climate Survey 2002-04, Enterprise Survey 2007-09, Enterprise Survey 2013-15) obtained from world bank microdata library. Following the commonly applied benchmarks of size, geographical location and sector, these surveys include a broad range of subjects associated with the business environment, for instance, performance measures, innovation and technology, competition, crime, infrastructure, corruption and access to finance. Due to the stratified random sampling technique, each firm has the same odds of being selected in these surveys. All population units were clustered in different homogenous groups and then firms are selected from each group by using a simple random sampling technique. Identical questionnaires were used in all three waves and we merged these datasets after excluding firms with extreme observations or having incomplete information which left us the sample of 718 manufacturing firms. A detailed description of the variables selected for this study is presented in the appendix section.

Table 1: Summary statistics

	N	Percent	Mean	Std.Dev
Product New to Firm	717	27	0.27	0.44
Process Innovation	717	20	0.20	0.40
Organization Innovation	717	13	0.13	0.33
Product New to Market	717	15	0.15	0.36
Number of Competitors (log)	717	---	1.19	0.90
Competitors Squared (log)	717	---	2.22	1.90
R&D Active	717	21	0.21	0.35
Total Employment (log)	717	---	1.99	0.57
Investment	717	22	0.22	0.41
Firm Age	717	---	21.27	14.10
Firm Age (log)	717	---	1.24	0.29
Domestic	717	95	0.95	0.22
Multi plant	717	10	0.10	0.30
Low-tech	717	65	0.65	0.48
Medium Tech	717	20	0.20	0.40
High Tech	717	15	0.15	0.35
Market Locality	717	59	0.59	0.49
City over 1M pop	717	60	0.60	0.49
City with 250K to 1M	717	22	0.22	0.42
City with 50K to 250K	717	14	0.14	0.35
City with less than 50K	717	4	0.03	0.17
Low Competition	717	35	0.35	0.48
Medium Competition	717	53	0.53	0.50
High Competition	717	13	0.12	0.32

Table source: Authors own calculations based on ES survey

Table 1 provides descriptive statistics of our sample. The highest percentage of occurrence among all types of innovations is 27%, belong to the products that are new to the firm. 15% of manufacturing firms allied to the high technology sector and 85% are concentrated in low and medium-level technology businesses. Similarly, 95% of sample firms are domestically owned and 90% are operating with single plant capacity. As far as spatial aspects are concerned, almost 60% of firms are situated in the capital or city with over one million population, while 18% of firms are located in smaller cities suggesting that the majority of the domestically focused firms have a tendency towards capital or big cities like Islamabad, Karachi, Lahore, Sialkot, and Faisalabad. Lastly but most importantly, 53% of domestically focused businesses fall in the medium level competition category and 35% belong to the low-level competition markets.

Table 2: Correlation coefficients among innovation activities

Variables	(1)	(2)	(3)	(4)	(5)
(1) R&D Active	1.000				
(2) New to Firm Product	0.233	1.000			
(3) Process Innovation	0.377	0.598	1.000		
(4) New to Market Product	0.292	0.705	0.652	1.000	
(5) Organizational Innovation	0.464	0.292	0.451	0.350	1.000

Table Source: Authors own calculations based on ES survey

To certify the integrity of our results, Table 2 highlights the correlation coefficients among five different types of innovation practices. Research and development (R&D) have the highest link with organizational innovation, signifying that the leading purpose of R&D is to promote organizational innovations. New to the firm product is significantly associated with products new to the markets, suggesting that the businesses introducing new products to the firms are also tend to engage in activities leading new products to the markets as well. Furthermore, the process innovation is highly correlated with product innovation new to the market.

Table 3: Different levels of competition

Organizational	Product (NTF)	Product (NTM)	Process	
Low Level Competition	39	43	44	48
Medium Level Competition	50	44	50	47
High Level Competition	11	13	6	

Note: NTF stands for new to firm, and NTM stands for new to market.

Table Source: Authors own calculations based on ES survey

As mentioned earlier, we divide competition level into three different categories where firms with 0 to 10 competitors fall in low-level competition, 11 to 99 belong to medium level competition and above 100 are considered as highly competitive firms. Table 3 indicates a summary of the percentage of firms introducing innovation in terms of different competition levels. In all types of innovations, the highest percentage of firms have their place in the medium level competition category. The table also provides compelling evidence in support of an inverted-U shaped relationship between competition and innovation because the high-level competition is associated with decreasing innovation levels.

4 Model and econometrical specification

4.1 Inverted U-shaped relationship

The association between firm-level innovation and competition has always remained a puzzle for researchers. But the investigation agenda has gained momentum during the last decade, thanks to the stimulation from new theoretical models and the availability of improved datasets. No general harmony has developed despite the seminal contributions by renowned scholars (Schumpeter, 1942; Arrow, 1962; Aghion et al., 2005; Crowley and Jordan, 2016; Chernyshev, 2016) and the prime question is still stand: is augmented competition level obstructive or conducive to the firm-level innovation? In order to find the empirical answer to this puzzle, a study in hand employs an innovation production function that helps to evaluate the impacts of competition level, company-specific factors and various innovation inputs on firm-level innovation performance. The production function stated below defines the linkages between several key explanatory variables and the probability of a firm to participate in innovation actions (following Mansury and Love, 2008; Doran et al., 2012; Crowley and Jordan, 2016). As far as econometrical methodology is concerned, a multivariate probit model is used for the estimation of innovation production function which is the best choice when we have more than one dependent variables and these variables are more likely to correlate (Galia and Legros, 2004; Gordon and McCann, 2005).

$$\text{Innov}_{ij} = \alpha_o + \alpha_1 C_{ij} + \alpha_2 R_{ij} + \alpha_3 O_{ij} + \varepsilon_i \qquad (1)$$

Innov_{ij} is a dummy variable that represents the firm *i* engagement in four types of innovation and *j* denotes the innovation type. C_i indicates the competition level reported by firm *i* in terms of a log of total competitors of the main product. In order to check the linearity of the relationship between competition and innovation, we use a log of the number of competitors along with the squared of this term. Furthermore, to examine the

Aghion et al. (2005) proposed inverted U-shaped relationship, a categorical variable is generated which defines the competition intensity in terms of different levels i.e low level (0-10), medium level (11-99), and high level (above 100) competitors.

The relationship between innovation and engagement in R&D events is assumed to be positive and documented as a stylized fact in the literature. R_i specifies the predicted value of R&D of firm *i* for innovation type *j* which we obtained after estimating a probit model defined as the R&D active binary variable as a function of different factors like firm size, product diversification, education level of the employees, and foreign competition. While O_i indicates a vector of remaining variables including technological segmentation of the firm[1], market locality, firm size, firm age, plant capacity, spatial aspect in terms of city location and investment propensities towards types of machinery and equipment.

In addition, we re-defined our basic model and further estimate two equations to empirically evaluate the inverted U-shaped connection. In the first reformation, we replace the number of competitors with a categorical variable which we defined in terms of low, medium, and high competition levels, and re-estimated the basic model. In the second reformation, we introduced an interactive term via multiplying competition level with the market locality to examine the impacts of competition level by primary market location, the technology sector, and urban scale. These analyses are based on the last three waves of rich panel datasets of Pakistani manufacturing firms (ICS 2002-04, ES 2007-09, ES 2013-15).

5 Empirical findings

5.1 Inverted U-shaped relationship

Using a rich panel dataset, we estimate a multivariate probit model for Pakistani manufacturing firms, and the results for each type of innovation outcome are presented in table 4. All types of innovations are positively influenced by competition level except organizational innovation. But squared competition level term has significantly negative sign advocates that the market competition has decreasing returns. These outcomes are consistent with a strand of the empirical literature (Tingvall and Poldahl, 2006; Peneder, 2012; Bos et al., 2013; Correa and Ornaghi, 2014; Halpern and Muraközy, 2015; Negassi et al., 2019) where competition level has a positive impact on innovation, however, with additional market contestants this association is non-linear in nature and the probability of introducing new product and/or process grows at a diminishing rate.

[1]For more details: https://ec.europa.eu/eurostat

Understanding this relationship can better equip the policymakers to device fruitful interventions, for instance, it suggests that the propensity to invest in innovation practices by additional entrants decreases with market growth.

Table 4: Determinants of firm-level innovation (Multivariate Probit Model Estimation)

	Innovation Type			
	Product (New to Firm)	**Product (New to Market)**	**Process**	**Organization**
Competition Level	1.540***	0.595**	1.427***	0.354
	(0.318)	(0.323)	(0.327)	(0.362)
Squared competition level	-0.701***	-0.320**	-0.699***	-0.242
	(0.146)	(0.150)	(0.152)	(0.169)
Domestic	0.129	0.033	-0.046	-0.436
	(0.277)	(0.279)	(0.284)	(0.298)
Firm Age	0.759***	0.247	0.753***	-0.002
	(0.200)	(0.214)	(0.211)	(0.244)
Investment	-0.262*	-0.155	-0.093	0.282**
	(0.143)	(0.146)	(0.147)	(0.149)
Firm Size	0.395***	0.475***	0.396***	0.226*
	(0.107)	(0.116)	(0.115)	(0.125)
R&D Active	0.472***	0.707***	0.986***	1.331***
	(0.157)	(0.153)	(0.161)	(0.162)
Multi-plant	-0.275	-0.180	-0.501**	-0.545**
	(0.189)	(0.205)	(0.226)	(0.288)
Low Tech×	-0.369**	-0.253	-0.314*	0.042
	(0.165)	(0.163)	(0.172)	(0.193)
Low to Medium Tech×	0.024	0.238	0.260	-0.293
	(0.202)	(0.214)	(0.208)	(0.260)
Market Locality	0.222**	0.373**	0.51***	0.005
	(0.115)	(0.125)	(0.124)	(0.139)
City with pop over 1 million″	-0.427	0.212	-0.016	-0.121
	(0.291)	(0.318)	(0.300)	(0.345)
City Over 250 to 1 million″	-1.478***	-0.631**	-0.670**	-0.434
	(0.327)	(0.355)	(0.326)	(0.383)
City with 50,000 to 2,50000″	-1.103***	-0.418	-1.069**	-0.018
	(0.327)	(0.362)	(0.366)	(0.375)
Constant	-2.03*	-2.59*	-2.79*	-1.30**
	(0.549)	(0.564)	(0.578)	(0.610)
Wald chi-square (p-value)	387.9 (0.00)			
Log likelihood	-1010.99			
No of Observations	717			

Note: *** Significant at 1%, ** at 5%, * at 10% level. The parentheses contain standard errors. × High Tech is the reference category. ″ City with a population of less than 50000 is the reference category.

Table Source: Authors own calculations based on ES survey

Table 4 further test the baseline hypothesis and shows that the firms active in terms of research and development activities are more likely to be innovative (Crepon et al., 1998; Revilla and Fernandez 2012; Doloreux et al., 2015; Younas and Rehman, 2020). Schumpeter (1942) claims that the size of the firm plays a key role in firm-level innovation is also confirmed by this study. Domestically owned businesses do not influence any type of innovation whereas market locality exerts positive impacts on products and process innovation. In addition, we find no evidence of multi-plant firms' connection with the possibility of product innovation, although the negative impact on the process and organizational innovation signifying that these types of firms are facing some coordination conflict challenge. Literature suggests that the agglomeration effects of large cities, localization, urbanization externalities and other spatial aspects of clustering have a strong association with firm-level innovation. The study in hand finds that the firm located in cities with a population of less than 1 million negatively affect the product and process innovation outcomes. As far as technological segmentation of the firms is concerned, low tech firms lower down the introduction of new products to the firm and process innovation.

Table 5: Firm-level Innovation at different competition levels (Multivariate Probit Model)

	Innovation Type			
	Product (New to Firm)	**Product (New to Market)**	**Process**	**Organization**
Low Level Competition®	0.1903***	0.237***	0.244***	0.264***
	(0.123)	(0.133)	(0.128)	(0.147)
High Level Competition®	0.147	0.161	-0.610**	-0.656**
	(0.203)	(0.235)	(0.259)	(0.310)
Constant	-2.13*	-2.90*	-3.03*	-1.52**
	(0.545)	(0.573)	(0.587)	(0.629)
Wald chi-square (p-value)	296.9 (0.00)			
Log likelihood	-824.45			
No of Observations	717			

Note: We report only the coefficients of the replaced variable here as remaining all variable coefficients and their significance is the same as table 4. *** Significant at 1%, ** at 5%, * at 10% level. ® Medium level competition is the reference category. The parentheses contain standard errors.

Table Source: Authors own calculations based on ES survey

To ensure the reliability of our results about the U-shape relationship, a new categorical variable is created which divides the level of competition into three different categories including low level (0-10 competitors), medium level (11-99 competitors)

and high-level competition (above 100 competitors). We replaced the number of competitor variables with a series of competition dummies and re-estimate our base equation after controlling all other variables. The basic idea behind this variable replacement is to test whether the relationship between innovation and competition is inverted U-shaped or not. The simple guideline here is that relative to the reference category of medium level competition the coefficients of low and high-level competition should be significant. Table 5 provides the multivariate probit estimation results of this model.

Manufacturing firms are expected to introduce new products, processes, or organizational innovation at a low level of competition. However, high-level competition is connected with a lower likelihood of process and organizational innovation. So we can conclude that there is some indication of an inverted-U relationship between innovation and competition is found especially in process innovation and organizational innovation. After combining equation 1 and equation 2 results we can say that the firms are more prospective to innovate at a lower level but this continues until the market grows up to a "tipping point as mentioned by Aghion et al., (2005)" and after that, the probability to invest in R&D by the new entrants grows at a diminishing rate. Additionally, we re-estimate our main model to examine the impacts of competition level by the technology sector and find results differ by the neck-and-neck phenomenon proposed by Aghion et al. (2005). One justification for these diverging results is the nature of our dataset as almost every Pakistani firm belongs to either the low tech or the medium-tech sector.

Table 6: Multivariate probit model estimation for local market competition

	Type of Innovation			
	Product (New to Firm)	**Product (New to Market)**	**Process**	**Organization**
Competition in Local Markets	0.084	0.055	0.158**	-0.079
	(0.062)	(0.068)	(0.065)	(0.081)
Constant	-1.871*	-2.386*	-2.426*	-1.346**
	(0.527)	(0.548)	(0.545)	(0.590)
Wald chi-square (p-value)	274.5 (0.00)			
Log likelihood	-842.83			
No of Observations	718			

Note: We report only the coefficients of the replaced variable here as remaining all variable coefficients and their significance is the same as table 4. *** Significant at 1%, ** at 5%, * at 10% level. The parentheses contain standard errors.

Table Source: Authors own calculations based on ES survey

We further extend the analysis to check how competition in local markets affects different types of innovation outcomes. For this purpose, we introduce an interactive term by combining the market locality variable with several competitors and re-estimate equation 1. Multivariate probit model estimation results for the local market competition is presented in table 6 highlights that the competition in the local market has a positive influence on process innovation.

6 Conclusions and Policy Implication

There is no universal consensus on how firm-level innovation gets affected by market competition as different papers come to diverging outcomes. This study seeks to contribute to the existing literature on firm-level innovation by re-examining the relationship between competition and innovation in the Pakistani manufacturing firms, from a novel perspective of domestically focused businesses in a developing country. It is an attempt to answering the research question; How business-level innovation of domestically focused firms of a developing economy affected by competition? Our results, moderately consistent with Aghion et al. (2005) and others, specify an inverted-U shaped relation between innovation and competition in the Pakistani manufacturing firms. To ensure the reliability of our results about the U-shape relationship, a new categorical variable is created which divides the level of competition into three different categories including low, medium and high-level competition. The multivariate probit estimation results of this model suggest that the firms are more likely to introduce new products, processes, or organizational innovation at a low level of competition. However, high-level competition is associated with a lower probability of process and organizational innovation. So we can conclude that there is some clear evidence of an inverted U-shaped relationship between competition and innovation is found especially in process innovation and organizational innovation. We further extend our analysis to check how competition in local Pakistani markets affects different types of innovation outcomes and concludes that it has a positive influence on process innovation only. These findings are robust to different model specifications using different sample periods, instruments and inclusion/exclusion of control variables. The overall empirical analysis points to a need to reconsider the regulatory changes by the government as the competition encouraging strategies in Pakistan would tend to inverse decay in firm-level innovations. Understanding this relationship can better equip the policymakers to device fruitful interventions like it suggests that the propensity to invest in innovation practices by additional entrants decreases with market growth. Due to the inverted-U shaped

relation, maximizing competition policy may lead to a reduction in firm-level innovation.

6.1 Generalization of Findings

To assess the generalization of our findings, it would be exciting to see if these patterns are applicable to other developing economies. The empirical results found in this study may not certainly hold for all developing economies because they display dissimilar innovation and industrial settings. Moreover, there is a geographical restriction as well as a restriction of organizational size, infrastructure and institutional environment. However, if the local business environment of any developing country is the same as Pakistan for example, Bangladesh, Nepal, Sri Lanka, etc. then we can generalize these findings to that particular economy. Also, the generalization can further be confirmed by using World Bank Enterprise Surveys for any specific country because the World Bank is using the same questionnaire and definition of the term "manufacturing" for all developing economies.

6.2 Study Limitations and Future Recommendations

With regard to empirical analysis, the major caveat to our findings is the limited availability of data. The findings of this study must be used with some caution as the analysis is limited to a binary nature of innovation variables. The binary structure of the dependent variables places some limitations on our understanding of the scope of the innovation. We do not know how many new products were introduced by each firm and have no information on the quality or complexity of these products. Therefore, complementarities in these dimensions cannot be ruled out. Another sample related important limitation is the lack of information to identify domestic and multinational subsidiaries to compare more appropriately the innovation performance of foreign subsidiaries.

Our results point to several further themes which also need to be studied in future research. Most importantly, it would be critical to identify what magnitude the research and development investments of micro organizations turn out to be profitable in terms of higher net revenues in the short, medium, and long-run in comparison to those micro organizations not making such investments. Upcoming research should also examine the question of whether those companies who are not entering the path of innovation are determining against it because they intentionally objective to evade the risks associated with this choice or because they face liquidity limitations. Likewise, we expect that the implications of our study are also held in environments outside of Pakistan. In order to assess the generalization of our findings, it would be exciting to

see if these patterns are applicable to other developing economies. This can be done as a replication of this study or other empirical literature on the same area with new datasets. This would not only help in the robustness checking of our findings but also assist to examine the amount of heterogeneity across developing economies with the perspective of firm-level innovation and competition interplay. We, therefore, look forward to upcoming research on this area.

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Appendix A

Table 7: Variables Description

Name	Definition
Competition Level	Number of competitors in the main market in which this establishment sold its main product (log)
Firm Age	Number of years since the beginning of the operation (log)
Firm Size	Total employment in the firm (log)
Domestic	=1 if the organization is owned by a majority of domestic people
NTF Innovation	=1 if the firm introduce new to the firm product
NTM Innovation	=1 if the firm introduce new to the market product
Process Innovation	=1 if the firm introduce any innovative methods of manufacturing products or offering services
Organization Innovation	=1 if the firm introduce any new or improved organizational activity
Active in R&D	=1 if the firm invested during the last fiscal year in the acquisition of; (a) external knowledge, (b) training, (c) machinery (d) external and internal R&D
City over 1M population	=1 if situated in capital or a city with over 1 mil. Population
A city with 250K to 1M	=1 if situated in a city with over 250000 but less than 1 million population
A city with 50K to 250K	=1 if situated in a city with over 50000 but less than 250000 population
A city with less than 50K	=1 if situated in a city with less than 50000 population
Investment	=1 if made any investment during the last fiscal year
Multi-plant	=1 if part of a larger establishment
Market Locality	=1 if the main market of the firm is local
Low Tech	=1 if belongs to the low technology industry
Medium Tech	=1 if belongs to the medium technology industry
High Tech	=1 if belongs to the high technology industry
Product Diversification	=1 if the firm has only one product i.e. if firm sales share is 100% for one product and zero otherwise
US and Europe	=1 if export to the US and Europe
South Asia	=1 if export to South Asian only