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Role of University-Industry Linkages and Its Impact on Innovation: Evidence from Pakistan

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Abstract: *This paper analyses the barriers to University-Industry linkages in Pakistan and the significance of these linkages towards innovation outcomes of the firms. We used primary data collected by a questionnaire survey named "innovation survey 2013- 2014" from 200 firms (manufacturing/services) of Pakistan. Inspiration of the study has been taken from the theoretical grounds of the national innovation system and its major innovation players, i.e. universities, firms, govt. And research institutions. Two out of four institutions have been studied in this research work, i.e., universities and industries, to address the first research objective examining the significance of University-Industry linkages towards innovation. The second research objective focuses upon the barriers to University-Industry Linkages and their impact on creating these linkages. Another contribution to the innovation literature has been made by studying the barriers towards this collaboration is a major focus of our analyses. Research methodology is based upon the Probit regression function to study the effect of barriers to U-I linkages on the university-industry relationship and the role of these linkages for a firm's innovative performance. Our findings conclude that top manager reluctance is the most significant barrier towards the U-I linkages. Moreover, our analysis reveals that firms, which are engaged in collaborative arrangements with academia, are more innovative.*

Key Words: Innovation; Absorptive Capacity; University-industry Linkages; Innovation Players

JEL Classification Codes: O1, O2, O4

Introduction

Linkages between University & Industry are vital for economic development. These linkages, if they strongly exist, offer a stimulated spread of two-way communication for improved activities both in academia and industry (Rogers, 2006). Somewhat these linkages are relatively stronger in developed countries than in the least developed countries (Liventhal, 1990). Developed countries indicate that radical innovation[1] is often found lacking in less developed economies of the world as the latter mostly rely on "Imitation" of the successful products or processes around the globe. First-world countries contribute towards "Economic Development" by innovation, whereas third-world countries do the same by imitation with significant differences in the levels of economic progress (Fagerberg & Verspagen, 2010).

Innovation is central to "Industrial and Economic Development" for any country by the contributions of major innovation actors, including Governments, Educational Institutes, Research Institutes, and Industries (Izmir, 2007). Collaboration between the two is vital to economic progress as "University-Industry activities" bring them closer to unanimity, creating a synergy effect. Independent research by industries is sourced either by their internal R & D departments or by taking the services of specialized research institutions or governments.

Economic change is an outcome of innovation (Schumpeter, 1982). Schumpeter's view on innovation states that a critical dimension towards economic growth is innovation. Innovation, market power, and entrepreneurial activities are the pillars of economic modifications (Metcalfe, 1995). As an accepted notion that innovation and economic growth are interconnected, it is pertinent to find out the sources

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from where and how innovation actors (governments, Industries, Research Institutes, and Academic Institutes) build new concepts and imply them in their respective areas and their independent R & D departments (Liu, 2001). National Innovation System (NIS), Regional Innovation System (RIS), and Sectoral Innovation System (SIS) are the bodies in authority to ensure and control significant innovation activity for an overall economic benefit towards the country, region, and sector, respectively (Levinthal, 1990).

At the macro level, National Innovation System (NIS) focuses on a more extensive view of innovation activity by stating its formation as a process of interaction between the Knowledge Innovation Process (KIP) and the embedded innovation environment (Guan, 2012). The process is represented by framework conditions and infrastructure related to government interventions, and it reflects that NIS is a combined form of RIS and SIS, i.e., sectors fuse together in different regions while regions mingle up to form a national level arrangement (Chung, 2002). Among all, universities and industries are two key major interrelated innovation players of any country, providing a two-way relationship to the creation and consumption of new products/processes (Nelson, 1993). The importance of U-I linkages has been addressed frequently by many researchers (Etzkowitz 2000; David, 1994; Bishop K D'Este P, 2009). These U-I linkages are also considered as a catalyst between academic sectors, policymakers, and business investors.

The main objective of the study is to explore the U-I linkages and to study the innovation phenomenon in Pakistan. Morespecifically, the research objectives are to elaborate and explore the factors causing hindrances to U-I linkages, to identify the importance of U-I linkages and their impact on product innovation, to suggest more ways towards economic development by strengthening U-I linkages.

The research question is what is the impact of U-I barriers on U-I linkages? And to identify the significance of U-I linkages for a firm's innovation. In the paper, Section two highlights the theoretical framework focusing mainly on three important and relevant theories; the theory of the National Innovation System, the theory of absorptive capacity, and the theory of innovation diffusion.

Section three constitutes model specifications, data, and summary statistics. The detailed analyses of the data are described in Section four. Section five comprises the conclusion of the study.

Theoretical Framework: National Innovation System (NIS)

National Innovation System (NIS) is a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies (Freeman, 1995). It is a set of institutions whose interactions determine the innovative performance of national firms (Rosenberg, 1993). This conceptual framework has its roots back in the idea of the "Common Research Program" some four decades ago (Beng-Ake Lundvall, 2002), which gives a base to the National Innovation System.

All innovation actors (government, university, industry, and research institutes) in the NIS framework are linked together viavisible flows like financial flows, human flows, regulation flows, and knowledge flows (spillovers), making it a dynamic system (Niosi, 2002). The developing nations are more "Technology Followers" as opposed to "Technology Leaders," their focus with respect to absorptive capacity is shifted from "innovation" towards "learning," both active and passive (Feinson, 2002). Science and technological innovation is interlinked due to the cyclical nature of their relationship with each other. (Albuquerque, 1999). Even for developing nations, NIS offers an input-output approach stressing the network of policies because research and innovationcannot make alone a valid contribution unless it is fused into comprehensive policies (King, 1975).

In NIS, the innovation performance of any country depends on how formal institutions interact with each other (Smith, 1995). These sectors perform various functions, including the creation of new knowledge, guiding the direction of the research process, supplying resources, i.e., capital and competence, facilitating the creation of positive external economies, and the formation of markets (Jacobson, 2000). A "nation-specific" activity list research, implementation, end-use, linkage, and education as the major functionsof NIS institutions (Liu, 2001).

While absorptive capacity is the ability of a firm to recognize, assimilate and apply external information for the purposeof innovation by Cohen & Levinthal (Levinthal, 1990). There are few factors distinct for firms' absorptive capacity because it doesnot only refer to acquisitions/assimilation of new information; however, it also includes its ability of exploiting that information forcommercial purposes. As argued by

Levinthal (1990), it depends upon the transfer of knowledge among subunits and subsequentknowledge sharing. University-industry linkages are an important bridge between transforming and sharing ideas for innovation. In developing countries, specifically taking the case of Pakistan, a proper alliance between the idea generator and idea seeker does not exist (Schofield, 2012).

The importance of the University-Industry linkages has been addressed frequently by many researchers Leydesdroff, (2000);David, (1994) and Bishop, (2009). In collaborative activity, organizations tend to join for a number of reasons, like interest in acquiring new sources of funding and ideas for future research, sometimes in order to publish papers (Schmoch, 1998). On the otherhand, a firm's interest to collaboration might constitute the idea of identifying potential employees from academia and accessing sources of knowledge leading to industrial applications. The study has also stressed that U-I collaborations result in positive outcomes for the entities involved. Many of the ways are considered suitable for U-I collaborations according to the congeniality of the objectives pursued like firms and universities can collaborate for mutual benefits by joint and contract R&D; mobility of human resource; networking; information diffusion via journals, reports, conferences, and the internet; training and consultancy; property rights; incubators; spinoffs. However, the selection of channels by universities tends more towards meetings and conferences (Freitas, 2008).

Barriers to U-I linkages

There always has been a lack in exploring the factors that create these hindrances towards the U-I linkages and factors that can alleviate the obstacles. According to Bruneel (2010), barriers can broadly be categorized in relation to "orientation" and "transaction." In the context of Pakistan, one of the barriers in U-I relationship can be "differences in the norms governing public-privateinstitutes". In academia, competition is based on product development, hence focusing on patents and "confidential information", while in the industry, the competition is based on patents and copyright, i.e., public information. Moreover, firms and universities may disagree with the topics being researched and their publishing, along with the divergent outcomes. The conflicts arising from U-I collaborations can be mitigated if modes of U-I interactions have been selected properly. Industrial firms and academic institutes can collaborate either by "institutional governance[1]" or by "personal contractual governance[2]" depending upon size, absorptive capacity[3], and openness to technology frontiers (Freitas, I. M. B., Dantas, E., & Iizuka, M. 2012). As a result of intense competition,firms and institutes are in search of innovation sources from the external world which are able to generate new ideas and develop improved competencies leading this partnership to access resources from government and shared R&D expenses (Perkmann, 2011).

The previous studies have explained that some of the factors are considered specific for developing countries and need to be pondered upon. In emerging countries like Pakistan, U-I collaborations have to face additional challenges, including market stability, knowledge absorption capacity, local education, capabilities, and cultural value systems, including a model named triple helix[4] (Etzkowitz & J, 2008). Along with the accelerating factors, there exist decelerating factors known as barriers for U-I collaborations, including) a) inherent differences in mission and objectives (different time horizon, confidentiality, and exclusivity,publication approach by universities whereas competitiveness and result protection by industries) b) organizational differences (level of funding, university cost structure, academic incentive and different focus of research for university and industry includingacademic prestige and problem-solving respectively) c) cultural differences (explorative nature of universities vs. applied nature of industries) (Tassey, 1989).

Developing countries include some specific barriers in the context of imitation, i.e., i) limitations related to the country of origin (legal requirements, money exchange variants, methods of payment, inflation, stability, governmental tension, breach of IP rights. ii) restrictions associated with information (comparative advantage, compatibility, modularity, trial opportunities, reputation of transferring country/organization in specific field and relative price to acquire and develop knowledge) iii) boundaries allied with receivingcountry (less capacity for making payments, lower rate for absorptive capacity, civil service and tiered decision-making process of receiving country/organization) (Harvey, 2002).

Research Gaps

i) As per my knowledge, no study on U-I

Linkages and innovation has been conducted in Pakistan empirically

ii) Previous studies reside mainly on developed nations

iii) Even developed nation's studies state that in Pakistan proper alliance between idea seeker and idea generator should exist (Schofield, 2012)

iv) Imitation by developing countries is itself innovation

[1]Institutional governance is a mode of formal relationship and agreements with institutions of higher education, generally facilitated by managerial systems like faculty departments.

[2] Personal contractual governance means a straight contract-based arrangement with university researchers.

[3] Absorptive capacity is the capability of an organization to recognize, captivate and comprehend technical knowledge that lets new productions and processes flow to the firm.

[4] Triple helix model as an approach towards nationwide progress is specified for developing countries and focuses upon creating strong links between industry, universities, and government to accelerate the transition of developing counties towards a knowledge-based economy.

v) No study explores why U-I linkages don't exist; this study will also find it by studying barriers.

Problem Statement

i) This study will find the impact of U-I Linkages on firm's innovation

ii) It will explore the relationship among barriers to U-I linkages and its effect on U-I Linkages

iii) The study will examine the significance of U-I linkages for developing nations

Data & Model Specification

(a) Data Collection

In the study, primary research has been done by conducting a questionnaire survey on 198 Pakistani firms, which is adopted fromCommunity Innovation Survey (CIS). The survey constitutes three different parts enquiring about innovation and innovation activities, possible barriers to collaboration, and firm-specific variables (controls in our case). The survey questionnaire is based onfour targeted sections; the first part of the survey particularly investigates how many industrial and educational projects are jointlyin operation and how many researchers are working in collaboration with industry. The second section finds out the possible hurdles in effective collaboration among the said entities. The third segment of the survey questionnaire focuses on innovation-related datain aggregate. The last section comprises of control variables necessary to be added in the study. These controls are "age of the firm,size of the firm (No. of employees), nature of the firm (manufacturing/ services/ trading), local/foreign operations, education of theworkers and the CEO.

(b) Model Specification

The econometric analysis of the study comprises of two systematic approaches: a forward flow of study examining the impact of barriers on U-I linkages and exploring the significance of U-I linkages. This has been done first by applying Probit regression of COLL on barriers, in addition to the control variables: Table 4.1 (b) provides the descriptions and labels of the variables used in the study.

Table 1(b). Variables and their Descriptions

Variables	Description
COLL	Collaboration of industries with academia. It is a binary variable representing firms that "are" and "aren't" collaborating
TMR	Top management reluctance towards collaboration with academia. A binary variable represents the extent of unwillingness by firms.
CRA	Conflicting research areas among firms and academia. A continuous variable representing that to what Extent these areas are contrasting for both.
VO	Varied objectives among firms and academia. A continuous variable representing that to what extent Firms and academia have differing objectives.
	Innovation by firms. A binary variable asking respondents if they have innovated any new/improved

Variables	Description
INN*	product or not during 2013-14.
INACT**	Innovation activity. A binary variable representing that an organization is engaged in any sort of Innovation activity (brainstorming sessions, cross-functional work teams, job rotations, etc.) or not.
AGE	A continuous variable for firms representing the years since their establishment.
FOR	A Binary variable representing the firm's operations is foreign.
LOC	A Binary variable representing the firm's operations are local.
MANU	A binary variable representing the firm is a manufacturing firm
SERV	A binary variable representing the firm is a services firm
GOVTS	Government support. A binary variable represents whether firms ask for govt—support or not.
CEO	CEO's education. A binary variable is explaining if the CEO of any firm is local or foreign qualified.
TRUS	Lack of trust among firms and academia. A continuous variable

INN refers to introducing a new product or improving an existing product. It denotes the physical product.*
*INACT** refers to innovation activities including brainstorming sessions, cross-functional work teams, etc.; it denotes the activitiesin progress towards innovating a physical product i.e. innovation.*

Economic Models

The barrier to U-I linkages Equation (Selective set of Variables)

The model explaining barriers to U-I linkages is as follows:

$$COLL = \beta_0 + \beta_1(TMR) + \beta_2(GOVTS) + \beta_3(FOR) + \beta_4(LOC) + \beta_5(MANU) + \beta_6(SERV) + \varepsilon$$

$$+ \beta_7(FOR) + \beta_8(MANU) + \beta_9(SERV) + \varepsilon \quad \text{In}$$

Equation (4.1), COLL is the dependent variable representing U-I collaborations; TMR represents the explanatory variable as top management reluctance. The coefficients β0, β1, β2, β3, β4, β5, β6 are regression coefficients, and ε states the error term. The government support (GOVTS), operations of the firm, locally operational firms (LOC) and foreign operational firms (FOR), nature of the industry, manufacturing firms (MANU), and services firms (SERV) are taken as control variables.

The barrier to U-I linkages Equation (Complete set of Variables)

The model explaining barriers to U-I linkages, after including all barriers as independent variables, is as follows:

$$INACT = \beta_0 + \beta_1(COLL) + \beta_1(AGE) + \beta_2(CEO) + \beta_3(LOC) + \beta_4(FOR) +$$

$$\beta_5(MANU) + \beta_6(SERV) + \varepsilon$$

Equation (4.2.2) explores the impact of barriers on U-I linkages and, in this model, the impact of TMR (with other independent variables including varied objectives (VO), conflicting research areas (CRA), and lack of trust (TRUS) on COLL (dependent variable) has been analyzed. The same set of controls (GOVTS, LOC, FOR, MANU and SERV) have been used.

The Innovation Activity Equation

The model explaining the impact of U-I linkages on innovation activity is as follows.

$$COLL = \beta_0 + \beta_1(TMR) + \beta_2(VO) + \beta_3(CRA) + \beta_4(TRUS) + \beta_5(GOVTS) + \beta_6(LOC)$$

In Equation (4.3.3), INACT represents innovation activity as a dependent variable; COLL is the collaboration (independent variable). Firm's age (AGE), CEO's education (CEO), operations of the firm; locally operational firms (LOC) and foreign.

Operational firms (FOR) and nature of the industry; manufacturing firms (MANU) and services firms (SERV) are taken as controls. ε is the error term. The firm's age has been controlled as it is generally considered that old and established firms have more innovative skills as compared to newly established firms. Similarly, the qualification and experience of CEOs also matter a lot. Toevaluate the impact of all these variables, equation (4.3) has been designed. In this Probit regression function, the study explores the effect of U-I linkages on innovation activity.

The Innovation Equation

The model explaining the impact of U-I linkages on innovation is as follows.

$$INN = \beta_0 + (COLL) + \beta_1(AGE) + \beta_2(CEO) + \beta_3(FOR) + \beta_4(LOC) + \beta_5(MANU) +$$

$$\beta_6(SERV) + \varepsilon$$

In Equation (4.2.4), INN represents innovation by

firms (dependent variable), COLL is the collaboration (independent variable), measuring the extent of U-I linkages among major innovation players; the coefficients β_0, β_1, β_2, β_3, β_4, β_5, β_6 are regression coefficients. In this equation same set of control variables is used as in Equation (4.3). ε describes the error term. Both equations (4.3) and (4.4) independently explore the impact of collaboration (U-I linkages) first on innovation activity and then on innovation in industrial firms. In this study, control variables have been added for analyzing the impact of variables other than independent variables. In this study, firm's age (AGE), CEO's education (CEO), locally operational firms (LOC), foreign operational firms (FOR), manufacturing firms (MANU), and services firms (SERV) has been controlled. Their impact strongly influences the dependentvariable, so it couldn't be overlooked. Table (4.2) explains summary statistics for all the binary and continuous variables used in subsequent econometric analyses.

Data and Descriptive Statistics

Table 2. Summary Statistics of Continuous Variables Summary Statistics for Continuous and Binary Variables of our Econometric Analysis is as Follows

Variables	Mean	Std. dev.	Min	Max
Conflicting research areas	3.005882	0.7653522	1	5
Varied Objectives	3.315789	0.897537	1	5
Lack of Trust	3.480000	0.9274858	1	5

Source: Author's own survey (2013-2014)
Scale 1. Strongly disagree 2. Disagree 3—neutral 4. Agree 5. Strongly agree

In Table 2, continuous variables are taken on Likert's scale. The conflicting research areas (CRA), varied objectives (VO), and lack of trust among innovation players of the country (TRUS) are continuous variables used in subsequent econometric analysis. Their mean value and the standard deviation is given in Table (4.2.1). The mean value explains the respondents' average towards specific statement. Mean value of binary variables including collaboration (COLL), top management reluctance (TMR), innovation (INN), operations of the firm; locally operational firms (LOC) and foreign operational firms (FOR), nature of the industry; manufacturing firms (MANU) and services firms (SERV), innovation activity (INACT), government support (GOVTS), CEO's education (CEO) represents the percentages (%) of occurrence and non-occurrence of the defined variable.

Table 3. Summary Statistics of Binary Variables

Variables	Mean	Std. dev.	Min	Max
Collaboration	0.3513514	0.478688	0	1
Top management reluctance	0.3833333	0.487554	0	1
Innovation	0.7500000	0.434194	0	1
Local operations	0.3169399	0.466560	0	1
Foreign Operations	0.0655738	0.2482147	0	1
Manufacturing Firms	0.5136612	0.5011846	0	1
Services Firms	0.4262295	0.4958847	0	1
Innovation activity	0.7457627	0.436666	0	1
Government support	0.1348315	0.342506	0	1
CEO education	0.5892857	0.493434	0	1

Source: Author's own survey (2013-2014)
Scale 1. Strongly disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly agree

Table 4. Analysis of Barriers on University-Industry Linkages (Standard Errors are in Parenthesis)

Dependent Variable		
Independent Variables	**COLL**	
Intercept	-0.239**(0.120)	-0.604 (0.404)
TMR	-0.493*(0.205)	-0.411*** (0.221)

Dependent Variable		
Independent Variables	**COLL**	
LOC		-0.504** (0.242)
FOR		1.387* (0.457)
GOVTS		0.335 (0.330)
MANU		0.240 (0.447)
SERV		0.479 (0.456)
obs.	180	171
$R^2(5)$	0.025	0.109
LR Chi^2	5.89**	23.77*

*Significance at 1%
** Significance at 5%
*** Significance at 10%

Table (4) represents the regression results for the impact of barriers on U-I linkages. The negative signs with the intercept and TMR define the indirect nature of the relationship between our explanatory variable i.e. Top management reluctance (TMR), and explained variable (COLL). The significant negative value of 0.411 shows that top management reluctance has been playing a major role in restricting university-industry linkages. The significant negative value of LOC is 0.504, reflecting that firms operatingonly in Pakistan do not engage in collaborations with academia and lack exposure to build and exploit benefits by maintaining university-industry linkages. The control variables i.e. operations of the firm; locally operational firms (LOC), and foreign operational firms (FOR), are found significant at critical values of 5% and 1%, respectively implying that both the controls (LOC and FOR) significantly affect the U-I linkages. The negative sign with the coefficient of LOC states that dealing only in local operations [5]With cross-section data, low R^2 is considered very high and Pseudo R^2 in probit case has no properties like OLS(Micheal Veall, 1994).

Will confine these firms to limited exposure. Whereas MANU, SERV, and GOVTS are the insignificant controls in this case, illustrating that U-I collaborations are independent of the industry sector and the government's role towards collaboration. The results in the model (see Table 5.1) explain that firms, irrespective of their manufacturing or services operations, are not affecting the possibility of university-industry linkages. The government's support is also found insignificant, explaining the fact that industry's innovation capabilities are self-governing. The R^2 (pseudo) values are 10.9%, and the overall fit for the model is 23.77% showing statistical fitness of the model to study the relationship of U-I linkages and barriers to U-I linkages.

Table 5 Analysis of Barriers on University-Industry Linkages

Table (5) represents an analysis of barriers on U-I linkages by taking the complete set of barriers. Both of the models represent similar results, pointing to TMR as a major hurdle in the way of effective collaboration. Similarly, top management reluctance values are equivalent to -0.637, that indicates its negative influence on U-I linkages with its significance at the critical value of 5%. Out of the complete set of barriers (including TMR, VO, CRA, and TRUS), only two variables have been observed valued at TMR equal to -0.637 and CRA values at 0.361. The positive sign with CRA shows that more conflicting the research areas will be, more collaboration will occur. The control variables, LOC and FOR are found significant and positive. Whereas GOVTS, MANU, and SERV are positive, however insignificant, implying an absence of reasonable influence on U-I linkages. The results are consistent in both the models (Table 5.1 & 5.2), depicting the robustness of control variables. The value of pseudo R- square equals 0.140 i.e. 14% explains that in the above-mentioned model (Table 5), the explanatory variable is explaining 14% variations independent variable. Whereas the overall fit for the model is 28.53% showing statistical fitness of the model to study the relationship of U-I linkages and barriers to U-I linkages in the presence of a defined set of control variables.

Table 7 Correlation Analysis among Independent Variables

In Table 7, correlation among top management

reluctance (TMR), conflicting research areas (CRA), varied objectives (VO), andlack of trust (TRUS) has been assessed. Correlation results explain that correlation values of independent variables are found significant, suggesting the impartiality of our econometric results.

Table 6. Analysis of Barriers on University-Industry Linkages (Standard Errors are in Parenthesis)

Dependent Variable		
Independent Variables	**COLL**	
Intercept	-1.04***(0.595)	-1.548***(0.797)
TMR	-0.678*(0.232)	-0.637** (0.257)
VO	-0.071 (0.121)	-0.102 (0.132)
CRA	0.307**(0.148)	0.361**(0.162)
TRUS	0.071 (0.115)	0.032 (0.127)
GOVTS		0.080 (0.357)
LOC		-0.535**(0.255)
FOR		1.402*(0.475)
MANU		0.538 (0.468)
SERV		0.762 (0.481)
Obs.	165	157
R^2	0.050	0.140
LR Chi^2	10.96**	28.53*

*Significance at 1%
** Significance at 5%
*** Significance at 10%

Table 7. Correlation Analysis among Independent Variables Correlation Results are as Follows

	TMR	CRA	VO	TRUS
TMR	1.0000			
CRA	0.2791*	1.0000		
VO	0.180**	0.236*	1.0000	
TRUS	0.225*	0.159**	0.227*	1.0000

Table 8. Multi Collinearity Analysis
Multicollinearity Results of Regression Analysis are Explained below

Variables	VIF	1/VIF
TMR	1.26	0.792
CRA	1.21	0.829
TRUS	1.23	0.815
VO	1.18	0.849
LOC	1.18	0.850
FOR	1.12	0.894
GOVTS	1.06	0.948
MANU	4.71	0.212
SERV	4.84	0.206

Variables	VIF	1/VIF
Mean VIF		
	1.98	

Table 8 specifically tests the collinearity of independent variables in regression analysis. The mean value of VIF at 1.98 is lessthan the critical value of 10, making our analysis unbiased.

Table 9. Analysis of University-Industry Linkages on Innovation Activity
(Standard errors are in parenthesis)

Dependent Variable		
Independent Variables	**CONTACT**	
Intercept	0.438*(0.121)	-1.722*(0.585)
COLL	0.772*(0.242)	0.742* (0.286)
AGE		0.009**(0.004)
CEO		0.049 (0.245)
LOC		-0.452***(0.272)
FOR		1.449*(0.461)
MANU		0.432 (0.491)
SERV		0.797 (0.500)
Obs.	177	153
R^2	0.055	0.164
$LRChi^2$	11.05*	32.54*

*Significance at 1%
** Significance at 5%
*** Significance at 10%

Table (9) shows the analysis of U-I linkages on innovation activity of the firm. Findings reveal that collaboration positively impacts the extent of innovation activities in the firms. This means that collaborating firms engage themselves in innovation-related activities. In this model, a firm's age in a particular industrial sector is found significantly relevant for innovation-related activities. The positive coefficient of AGE equals 0.009 having significance at 5% is evident of the statement above. Interestingly, the CEO's education is having no significance in this analysis towards U-I linkages. The control variable of operations of the firms, locally operational firms (LOC) and foreign operational firms (FOR) both are again found significant for innovation activities resulting from U-I collaborations. The value of pseudo R-square equals to 0.164, i.e., 16.4% explains that in the above-mentioned model (Table 9), explanatory variable is explaining 16.4% variations independent variable. Whereas the overall fit for the model is 32.54% showing statistical fitness of the model to study the relationship of U-I linkages and barriers to U-I linkages in the presence of a defined set of control variables.

Table 10 Analysis of University-Industry Linkages on Innovation

Table (10) corroborates the impact of collaboration on innovation itself. The results are stimulating for the fact that innovation and collaboration are found insignificant. The reasoning may lie in the argument that when firms innovate something new or improve an existing product, they do not initiate any

linkages with academia. Their concern mainly remains on innovation itself. The variable, foreign operational firms (FOR), is positive and significant here, explaining the phenomenon of exposure differences. Firms having foreign operations are more into collaboration arrangements hence considered more innovative due to the synergy effects and brainstorming by both innovation players (universities & industries). The value of 1.467 for the variable of FOR shows that firms which are not confined to national operations only are more inclined towards building and maintaining U-I partnerships. On the

other hand, the negative value for the variable of LOC equals -0.508 depicts the contrasting relation between innovation and U-I collaborations.

The control variable of CEOs education (CEO) was found to have an insignificant value consistent with the previous resultsshowing irrelevance of executive's education with his/her propensity towards creating U-I linkages. As far as the age of a firm is concerned, results are again robust, giving a significant coefficient for the variable AGE. Significance is found at the critical level of 5%, showing a reasonable influence of age of the firm on innovation and collaboration. The R^2 (pseudo) value at 0.126 is considered acceptable with cross-sectional data. The value of pseudo R-square equals to 0.126 i.e. 12.6%, explains that in the above-mentioned model (Table 5.6) explanatory variable is explaining 12.6% variations independent variable. Whereas the overall fit for the model is 25.54% showing statistical fitness of the model for examining the relationship of U-I linkages and barriers to U-I linkages in the presence of a defined set of control variables.

Table 10. Analysis of University-Industry Linkages on Innovation

(Standard Errors are in Parenthesis)

Dependent Variable		
Independent Variables	**INN**	
Intercept	0.572* (0.121)	-1.210**(0.558)
COLL	0.314 (0.218)	0.328 (0.269)
AGE		0.008**(0.004)
CEO		-0.135 (0.242)
LOC		-0.508**(0.258)
FOR		1.467*(0.467)
MANU		0.328 (0.492)
SERV		0.697 (0.501)
Obs.	184	157
R^2	0.010	0.126
$LRChi^2$	2.11***	25.54*

*Significance at 1%
** Significance at 5%
*** Significance at 10%

Results and Discussion

Innovation and its relationship with U-I linkages have been of vital importance since the industrial revolution. The innovation actors, including universities, industries, government, and research institutes, come into contact to contribute to the National Innovation System (NIS) for the accumulated growth of the economy. The study contributes in two different aspects; firstly, understanding the barriers towards the U-I linkages and secondly, the significance of U-I linkages for facilitating the innovation.

Based on the primary survey named "Innovation Survey 2013-2014", the study explores data from one hundred and ninety-eight (198) firms throughout Pakistan, covering a wide range of industries (manufacturing/services). The respondents were asked to respond on various facets of innovation and related activities, including barriers of innovation in the context of developingcountries and the significance of U-I linkages. The Probit regression function has been applied due to the binary nature of our dependent variables. The actual success of the collaboration agreement depends upon understanding the nature of the partnership, its effectiveness, and potential barriers (Schofield, 2012). Out of all the CSFs, some of the factors act as catalysts and accelerate the process of university-industry collaboration. These factors include technology maturity, readiness for application, well-defined objectives and scope of the project, technical risks, and technical feasibility to implement results (Pertuze, 2010).

The outcomes of the analysis reveal that in Pakistan, the top management of industrial firms is reluctant to build connections with academia. Finding the reasons for not having a culture of collaborative arrangements among institutions of the country like

Pakistan, we found highly relatable outcomes. Adding to this, our empirical analysis also highlights the significance of U-I linkages in Pakistan. The objective of exploring this area is to find out the rationale behind collaborating with academia. Positive outcomes obtained verify that properly created and maintained U-I linkages are of vital importance for a country like Pakistan.

The highly significant value of top management reluctance (TMR) as a barrier to U-I linkages is a vital contribution to the literature of innovation and U-I linkages in developing countries like Pakistan. The reason behind this is the influential nature of higher management that hinders in enhancing the creativity of lower-level employees. As the directives are given by policymakersand subordinates are supposed to follow them without further criticism. Consequently, the top-down approach limits the scope of activities and lacks interaction among other institutes of the country. Thus, as a result. Overlapped operations and overutilization ofresources make the country to suffer.

Further, findings reveal that the significance of U-I linkages towards innovation-related activities and innovation itself also have interesting outcomes. Innovation activities depend upon collaborative arrangements implying that more collaboration with academia can bring more innovation-related activities in the industry. However, this effect has been found insignificant in the case of "innovation itself." The reason behind this could be that when firms innovate something new in developing countries like Pakistan, they have minimal concern for maintaining U-I linkages as innovation mostly is an imitation that does not require such formal alliances and collaborations with research institutions and academia. However, in the process of innovation activities, they take universities in the loop and prefer collaborations.

This paper certainly possesses a few limitations which can be mitigated by future research in the same field. Our researchis qualifying for a minimum sample of 200 firms; however, more accurate results might be found with increased sample size. Future research may be done by exploring motivating factors towards collaboration for both universities and industries. Output also suggests policymakers develop a strong system of linkages among all institutions of the country. A footstep from the "National Innovation System" (NIS) should be followed, which emphasizes systematic and defined partnerships among innovation players bringing more innovation and thereby more economic growth (Levinthal, 1990).

For the policy issues, we can relate the outcomes of this study with the reluctant behavioral approaches of seniormanagement in industry, which need to be regularized by establishing sophisticated state-level collaborative arrangements. The mor

e collaborative linkages will be, the better will be the execution of economic and business activities without overlapping of resourcesand ideas. Among all other variables, locally operated firms with limited exposure to the business and operational activity lack U-I linkages. For this, policy course of action cannot push all the firms to engage in foreign business activity, but they may be linked toother internationally exposed firms through the collaborations to get a macro-level facet, consequently enhancing productive interactions with the innovation players.

Our economic model and findings suggest that a developing country like Pakistan should have the shared and communicated research with the institutions like Government, Universities, and industries that will significantly enhance the economic growth of the country by efficient use of resources, enhanced capacities, and shared visions. However, the institutional concerns of all innovation players, as highlighted in Table 4.2.1, including lack of trust among parties, varied objectives, and initiallyhaving conflicted research areas, might be addressed by streamlining the collaborative arrangements, an area which might be studied and researched later on.

Government support for establishing these U-I linkages is an important factor in policy implementation. Nevertheless, our results reveal a non-significant effect but strong multicollinearity between government support and U-I linkages. It also makes sense because the government being the key player of National Innovation System, is the decisive source for NIS model,which is the base of this study, and NIS literature also highlights the same thing by stating that the norms of public-private partnerships vary, creating conflicts among the parties involved. Three out of four barriers mentioned in table 4.2.1 are also supported by the literature, including varied objectives of firms and parties, i.e., lack of trust for disclosing confidential informationlocal education of top management.

Pondering upon the reasons mentioned above, it is evident that few barriers are specific for the developing nations. Theirabsorptive capacity, culture value systems, market stability, and imitation rather

than innovation are the key factors needed to be catered to in policymaking and implementation. Knowledge spillovers and absorptive capacity is again a future dimension to explore. We may look for the NIS of developing nations to find out similarities and differences, respectively adding or hindering economicgrowth. These hindrances might be different in various sectors, which can be studied later on. We may also look for the type of linkages best suitable for different collaborative setups.

NIS, U-I linkages, and economic growth are complementary to each other. Developing nations are full of resources, platforms and intellects. Sophisticated collaborative setups, teams, and inter-organizational groups are needed to be developed for controlling/reducing the maximum barriers involved. Pakistan as a study component of NIS, is taking lead towards developing something new or improving something existing. By considering the suggestions of this study, policymakers may find a better way to figure out streamlined solutions for low or no economic growth.

The only matter of fact is that the National Innovation system is a key way out to develop and enhance any country's innovation activity. Innovation, either in radical form or in imitation, is vital for country's growth. It is argued above that growth capacity varies according to the absorption capacity of new ideas, technologies, and spillovers among the institutions of that state. Developing nations like Pakistan have no way out; these nations need to keep innovating and properly registering whatever is being created (patents, copyrights, trademarks, etc.) As far as Pakistan is concerned, we do not lack innovation activity, it is the formal institutional framework, which needs to be applied at the national level under which all innovation players of the state will be properlylinked to each other not only for their research activities but also for getting maximum efficiency within minimal resources. One of the biggest advantages of university-industry linkages is duplication of resources and ideas might be avoided. The whole nation willbe working as a team, knowing what the other party is doing or intended to do.

Our study categorically enhances the worth of U-I linkages by empirically proving the factors and their output on innovation activity. The two-way relationship of U-I linkages towards innovation by adjusting maximum possible controlled variables can lead the country to the edge of being a developed nation agreeably with a different pace but on the same track of progress and development. With all the challenges and hurdles specifically related to Pakistan, collaborative arrangements, not immediately but gradually, will be acceptable by the state actors. This setup is the need of the hour as benefits are manifolds. Policymakers and researchers are repetitively stating this idea for the betterment of people, nations, and the world at large. We strongly recommend the results of our study to policymakers in Pakistan. This will be bringing institutions closer to each other by sharingand achieving each other's objectives, producing more efficient results, developing collective synergy and collective approaches, which will lead to building a team out of the whole country.

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Innovation Survey 2013-2014Questionnaire
For Researcher Use Only
Research Objectives

What is the Significance of University-Industry Linkages towards Innovation?

a. **Independent Variable:** University-Industry Linkages (to be measured by)
i) No. of projects together
ii) No. of academic researchers working with industry
iii) No. of students placed in industry
b. **Dependent Variable: Innovation** (to be measured by)
i) Sales
ii) Physical products/Processes
iii) Any other innovation output variables

2. **What are the Barriers to University-Industry Linkages and their Impact on Creating these Linkages?**

a. **Independent Variable:** R&D policies (Incentives, HEC policies, Promotion etc)
b. **Dependent Variable:** University-Industry Linkages (same as above)

Note: It is a purely quantitative research asking the respondents from Academia and Industry.

Regards:
Tahira Waryyam
MS Scholar/ Researcher

Innovation Survey(IS 2013-2014)
Survey Questionnaire

The following questionnaire gathers data regarding an organizations activities pursuing innovation or mediating through it during the year 2013-2014 inclusive.

Anything which is first-hand for an organization, be it a process, a tool, any marketing method, new product, or a new process opted by the company is categorized as innovation which might be firstly originated or used by some other enterprise

1. Section 1 refers to University-Industry Linkages
2. Section 2 refers to Product innovation
3. Section 3 refers to Barriers to University-Industry Linkages
4. Section 4 refers to Other Variables

Kindly Fill-up all Questions, except otherwise Instructed

Person we should contact if there are any queries regarding the form.Name: ___
Job Title: _____
Organization:_____
Phone:_____
Fax:_____
E-mail: _____

PS: Your honest and fair response will be a contribution towards this society, towards this nation

Regards:
Tahira Azam
MS Scholar/ Researcher

Enterprise' Basic Introduction

Name of the Enterprise_____ **Address:** _____
Postal Code:_____ **Main Activity** _____
Area of operations (Local, Regional, National, International.....

Section 1 University-Industry Linkages

1.1 Does your organization have any collaboration with academic institute? yes No
1.2 How many projects are being carried forward together?_____
1.3 How many researchers from academic sector are working with your enterprise?.....

Enterprise Willingly Place University Students on Working Positions?

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

What common ways does your enterprise use to collaborate with academia (joint seminars, Joint research, joint hiring,Joint projects, funding etc?**)** _____

Section 2
Barriers to University-Industry Linkages

2.1 Top Management is Reluctant to have any Collaboration with Academic sector? yes No

2.2 To what extent do you think that areas of research are conflicting and contrasting for both entities?

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

2.3 Varied innovation objectives (as few intend to publish new activity while others retaliate to exploit the opportunity)

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

2.4 Do you think Lack of trust among both entities becomes a hurdle?

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

2.5 Your opinion that absorptive capacity creates hurdles to be in joint research programs.

1. Strongly disagree

2. Disagree
3. Neutral
4. Agree
5. Strongly agree

Section 3 Innovation

3.1 During the fiscal year 2013-2014, did your enterprise introduce any new or improved product? yes No

3.2 Who developed these product innovations (Your enterprise itself, your enterprise together with other institutes etc.)during the fiscal year 2013-2014? _____

3.3 Were your products new to your enterprise or to your market? _____

3.4 Is your enterprise engaged in any sort of innovation activity during the fiscal year 2013-2014 for process or productinnovation? yes No

3.5 What are the innovation sources for your enterprise during the fiscal year 2013-2014? (Internal, market, institutional,others)? _____

3.7 Sale of innovative product as a percentage of total sales during the fiscal year 2013-2014 comes as? _____

3.7 Your enterprise use any method during the fiscal year 2013-2014 (Brainstorming sessions, cross functional work teams, job rotation, financial incentives for creative employees etc.) to stimulate new ideas or creativity among your staff.

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

Section 4 Other Variables

4.1 When your enterprise was established? _____

4.2 What is the size of your enterprise? (No. of employees in your enterprise) _____

4.3 Is this a public sector entity? yes No

4.4 Does your enterprise operate in local or foreign (or both) operations? _____

4.5 What is the percentage of foreign ownership? _____

4.6 In which industry does your enterprise fall? (Manufacturing/Services) _____

4.7 Do you find any support by the government for creating University-Industry Linkages? yes No

4.8 In which city is your firm located? _____

4.9 Does your organization have a formal R&D Department? yes No

4.10 Approximately how much your organization has spent on R&D during the fiscal year

2012-2013_____PKR

2013-2014_____PKR

4.11 Factory workers (engaged in production only) have their education level

1. Below Primary
2. Primary to Metric
3. Metric to Graduation
4. Graduation to Post Graduation
5. Above Post Graduation