MEASURING RELATIVE INDUSTRIAL INNOVATION IN RELATION TO ESTABLISHMENT'S CO-LOCATION AND INFRASTRUCTURE ACCESSIBILITY, COMPARATIVE INDUSTRIAL PERFORMANCE OF PUNJAB

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ABSTRACT

Mixed economies in developing countries face challenges and opportunities both for their co-location. Co- location in developing countries is associated with dedicated infrastructural supply. The paper presents a logistic regression model to summarize the key predictors as contributors for innovation measures in firms. The data used in the study is taken from The World Banks' Universal Enterprise survey data conducted for many countries. Scope of the study is the comparison of innovative measures introduction and practices in all industries except agriculture sector in Punjab, a province with most economical significance. Analysis shows that marketing innovation and spending on R&D are the key indicators primarily affected by co-location as they have had higher odds ratio in the model analysis. Amongst infrastructure inequality electricity provision and use of electronic communication are important contributors to innovation practices in stakeholder's view from manufacturing and services industry of Punjab Province.

Key words: logistic regression, innovative, Investment in R&D.

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1. INTRODUCTION

Geographic concentration is one of the key components of economic activity as its source of possible innovation promotion and provides targeted focus on provision of infrastructure necessary for industries. Planned development in the form of clusters or organic development both can affect the productivity of industry as well as surrounding land use. This clustering also affects factors of production in cities, mainly distribution of infrastructure, and availability of raw material. These factors ultimately empower industries to be innovative in terms of introduction of new product/service, or adopt any marketing or logistic innovation or be more capable for investing in research and development. These are the levels and types of innovation supported by literature and covered in the survey of World Bank's Enterprise Survey used for this study.

The concentration of economic activity in few metropolitan areas and around it symbolizes the coexistence of development and underdevelopment within and between regions (Burki A. A, 2011). For sake of highlighting this difference, this study aims at presenting difference of innovation measures adopted and introduced by establishments in planned clusters, i.e. Export processing Zones (EPZ), or Industrial Estates (IEs). A number of theories explain that why geographical concentration of economic activity takes place, but the area of possible factors that drive internal economic geography of developing countries, how is innovation which itself is defined relatively takes after infrastructural inequality. Also, whether and if this inequality is socially desirable, or lead to any positive results? The scope of this paper however is to assess the factors contributing to the probability of establishments' "innovative" behavior. The study at this stage relies on inequality indicators used in world Banks' data for enterprises on national level. An elaboration of which will be presented in Methodology segment that follows. The context of inequality for sake of this study includes both access to space and utility services required for industrial operation.

1.1 Problem Statement

The field of new economic geography deals with the problems arising out of conflicting land use activities in terms of environmental sustainability, social compatibility and economic durability. Dominant land use studied in this regard is industrial and is associated with implications of its co-location. The social desirability for its co-location varies from country to country, so does methods of reaping benefits of mixed location. For sake of this study, the concepts of co-location and its converse as mixed location are both used in context of industrial activities.

It is important to define policy implications for co-location not only for better urban planning but also for better industrial growth and activity management. Pakistan adopted the pattern of EPZ around 1980's at Karachi and since then in last 30 years have been able to expand in and different provinces (GOP, n.d). The success and desirability of these zones however has been questionable by many policy analytics

1.2 Significance

Utilizing the nominal variables used in empirical analysis of the Enterprise survey data, this study attempts to understand the relation of innovation with

- Adequacy of relative measures taken to map relative innovation in industries as a result of co-location
- Comprehensive sample for Punjab province for conducting industrial innovation predictors analysis
- Policy recommendations for planning and managing future industrial activities in rapidly changing world.

2. LITERATURE REVIEW AND DEVELOPMENT OF RESEARCH QUESTION

Based on Roger's Innovation diffusion theory, Wonglimpiyarat & Yuberk summarize the principal concepts of innovation, extracted from literature, as establishment's problem definition, research (basic and applied), development, commercialization, adoption, diffusion, and consequences of adoption (Wonglimpiyarat & Yuberk, 2005) & (Rogers, 1995). Most widely accepted as the region with possibilities of informational and transactional incentives, industrial clusters are regarded as important source of innovation spread (Porter, 2000) (Khalil A. ARBI, 2017).

This paper includes variables from Enterprise survey data based on their importance extracted from literature. For this purpose, it includes systematic review of papers for covering predictor's models for suggesting industries' adoption of Level of Innovation. To fulfil this aim, the broader categories of independent set of variables such as industrial clustering or industrial co-location and Infrastructural provision & practices were studied from literature for their role in industries' adoption of innovation at different levels of production and distribution. Existing stats show that Pakistan's R&D spending as percentage of GDP has sequentially been declining from 0.44 to 0.29 during past decade as for a population of 210 Million people, and major youth population, there are only 60,000 active researchers out of which only half are full time employed (PCST, 2013). This shows lack of attention towards competitive industrial thinking.

2.1 Innovation and Co-Location

As a cluster participant, industrial establishments face multiple productive advantages of innovation participation. (Porter,2000) states that rather than a classification of sectors such as manufacturing or services, the cluster based classification is significant, as it involves sense of competition amongst industries and collective policies from government (Porter, 2000).

Evidence from global experience suggests that firms tend to locate in areas where there are "location economies," which are areas that minimize procurement costs (transport costs associated with the transportation of raw materials to the firm) and distribution costs. (Sanchez-Triana, et al., 2014) (GOP 2. a., 2018). The clusters development in the form of Industrial estates, and incentivized by clusters in the form of Export processing zones, such areas provide specialized labor, inter-industry spillovers, local transfers of knowledge, and access to export markets.

Planning such developments is a model approach, but the colonization of such developments needs evidence based policy measures. The statistical figure of major economic center of Punjab province reported that there are more than 30,000 industries in the residential area of Lahore showing an unplanned growth of industries, whereas the occupancy rate of industrial estates and nine SEZ's of Punjab is low. GOP reported, colonization rate of IE's

under PIEDMIC and beyond urban peripheries as less than 50% (GOP 2. a., 2018). Burki et.al also reports that from 2000–01 to 2005–06, industry concentration decreased dramatically by about 33 percent (Burki A. A, 2011).

The evidence found in literature for possible relation amongst co-location and innovation depends on firm's selection of work space based on proximity to either suppliers, customers or to potential of area due to natural endowments (Johansson & Forslund, 2006). Porter however explored extensively on theoretical relations of co-location with productivity and innovation with differentiation amongst developed and developing countries. While referring to technological and input based spillovers due to co-location, He elaborated that clusters are indeed set of locations whose whole is more than sum of its parts (Porter, 2000). The literature also acknowledge that formal and informal organizations along with cultural norms also play a role in developing organic clusters rather than planned cluster development (Such as IE's and SEZ's). The spillover aspects of innovation found in literature include development of pure public, quasi-public and some mutually beneficent but privately developed infrastructure necessary for industrial growth and functioning. Specifically they refer to mobility solutions, communication infrastructure and marketing competencies. Access to information is additional aspect found both positively and negatively contributing to innovation practices (Porter, 2000).

2.2 Innovation and Infrastructural Quality

The gap in regional development for infrastructure provision is increasing in terms of roads, water, electricity and sewage, the essentials to industrial development and growth (Yuen & Choi, 2012). Mixed economies are combination of localization economies and urbanization economies. Burki et.al refer localization economies as those with within-industry or intra-industry benefits accruing through knowledge-diffusion, buyer-supplier networks, subcontracting facilities and a class of skilled workers. Whereas, Urbanization economies refer to reaping across industry spillovers such as supply of other complementary services, e.g., financial institutions, marketing and advertising agencies, and other cheap infrastructure, etc (Burki A. A, 2011). Punjab having mixed economy type have immense potential for reaping benefits from both. It is therefore interesting to note that Innovation has been defined in various contexts, specially referring to capitalizing on type of economies as discussed above. The mutual sense of definitions extracted from literature for innovation is that it's an element which adds value to organizations, and it is regarded as driving factor for success and survival of organizations (Narvekar & Jain, 2006). The literature suggests that infrastructure is key to stimulate the industrial potential and associated value addition in the form of innovation (Burki A. A, 2011).

It is hypothesized that spatial inequality of infrastructure provision is outcome of imbalance between centripetal and centrifugal forces in a region. There are many factors which such as integrated planning with incentivized policies that tend one region to grow faster than others. Models suggest that these parameters would depend on model parameters. One of the integrated factor mentioned in literature is transport, IEs and SEZ's models are brilliant as to reap on outcomes such as improved labor mobility and reduced commuting cost (Sanchez-Triana, et al., 2014) along with other and infrastructure services. The intra-province migration rate in Punjab is one of the highest amongst other provinces of Pakistan and is reported to be 71% by GoP. This is reported to be an outcome of high urban-rural parity in infrastructure provision for industries as well. (Sanchez-Triana, et al., 2014) The infrastructure development itself can contribute to jobs creation if targeted with area specific needs for special facilities development such as that of Industrial estates and SEZ's. But common contributing infrastructure such as transport, electricity and tele-communication are vital catalysts. Figures show that the share of

Punjab's transport industry for employment is only 4.9 %, and that of major utility services such as electricity and telecommunication is 0.32 & 0.53 respectively (Punjab, 2019).

Integrated factors such as transport and procurement cost are regarded attached for industries to locate closely, if the costs are extremely high, the industry would be highly dispersed hence it would be harder to equip them with other basic necessities. (Burki A. A, 2011) (Sanchez-Triana, et al., 2014)

This serves as base concept to assess impact of industrial concentration in the form of IE or EPZ on Innovation adoption as associated with transportation linkages and other social amenities (LCCI, 2013). The infrastructural inequality affects different industries differently, some industries might severely affect by a kind of unavailability, relatively indifferent to other industries, such as water supply for services sector. Hence this study presents the impact on broader classifications of industry ignoring only agriculture sector, as explained in the sampling section. (World Bank, 2013)

Burki et al. explained that infrastructural inequality owes to many historical, socioeconomic and strategic concerns amongst various regions. One driving factor is also of population setting connected to political incentive associated with regions (Burki A. A, 2011).

In order to study the inter-industrial impact of location and infrastructural inequality on innovation, in the light of literature consulted, it is important to note that The ES survey data is comprehensive for covering industrial firm characteristics, land access, Firm's presence, infrastructural availability and practices of development infrastructure (World Bank, 2013) The following section states the derived questions for this study in the light of literature consulted.

2.3 Research Question/s

- Can status of an innovative industry (Yes/No) be rightly predicted by indicators of infrastructure provisions i.e., access to land, electricity, and website and email practice?
- If "innovative" industry status can be predicted correctly, which variables of land status are central to prediction of that status? Does the inclusion of a particular variable affects (increase or decrease) the probability of a specific outcome?
- How good is the model at classifying cases for which the outcome is not known? (In other words) how many "innovative" industries are classified correctly? And vice versa.

The null hypothesis are the equal probability for adoption of innovative measures. Whereas alternate hypothesis are not equal probability distribution of innovation adoption measure.

3. METHODOLOGY

The World Bank ES data questionnaire was used to record response from establishments. The ES survey is ongoing in series for different other countries even at present (World Bank, 2013). The total survey sample collected from Pakistan was of 1230, however for sake of this study Punjab's establishments were focused and when filtered using "Region of Establishment" as screener, the survey consisted of 668 Questionnaires. The sampling method as defined by the World Bank was stratified random sampling stratified based on Industry type, size of establishment and region (World Bank, 2013) [Size stratification was defined following the standardized definition for the rollout: small (5 to 19 employees), medium (20 to 99 employees), and large (more than 99 employees). For region stratification out of 5 administrative regions the sample was further screened for Punjab region only for sake of this study.; For Industrial stratification, World Bank used sample frame for Manufacturing establishments from the Pakistan Bureau of Statistics (PBS) whereas for Retail and Other Services establishments, World Bank used Nielsen Pakistan's sample frame through desk research]

Figure 1 Research Design

The World Bank also informed that the number of interviews per contacted establishments was 0.16. They stated this number as a result of explicit refusals and quality of the sample frame, as represented by the presence of ineligible units the number of rejections per contact was 0.12.

3.1 Instrument Validity

Regarding instrument for survey, two questionnaires differentiated in very few survey sections were designed by World Bank for distribution to “manufacturing” and “services or retail” establishments (World Bank, 2013). The variation of questionnaire was evident from index variable a0, identifying the firm as either manufacturing or retail/service. Few questions with prefixes showed some special regions e.g. SAR for south Asian Region. For purpose of this study one such variable contributing to significance of this study was “Location of the establishment” in a type of clustering provided

3.2 Description of Variables & Analysis Method

As Enterprise survey data mostly comprises categorical and ordinal data, the variables selected for research were dominantly categorical. We hypothesized that industrial establishment's tendency towards innovation depends on infrastructural needs and their location.

With limited availability of analysis availability when the independent variable/s are categorical, logistic regression model was applied for assessing and identifying the group membership for different industries as “innovative”.

In this regard, the assumptions of binary logistic regression were tried to meet. These include, ratio of cases to variables included in the analysis, goodness of fit test, and multicollinearity i.e. strong co-relation amongst predictor variables. These results for testing compliance with these assumptions are presented in detail later in this section.

4. RESULTS

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics for the establishments surveyed for the Punjab region.

Table 1 Distribution of sample firms by type, size and age

Categories	No. of Establishments	Innovation Participant	Innovation Non-Participant
Type of Firm			
Manufacturing	600	207	393
Retail	24	8	16
Service (Non-Retail)	44	10	34
Firm Size			
Large	88	37	51
Medium	284	99	185
Small	296	89	207
Age of Firm			
01-10	5	3	8
11-20	113	42	155
21-30	147	69	216
31-40	67	55	122
41-50	41	24	65
51-60	14	14	28
61-70	4	11	15
71-80	4	1	5
81-90	0	1	1
Industry			
Basic & Fabricated metals	33	38	71
Chemicals	29	16	45
Electronics	12	8	20
Food	91	16	107
Hotel and restaurants	13	4	17
Leather	20	20	40
Machinery and precision equipment	23	25	48
Non-metallic mineral products	15	24	39
Paper	2	1	3
Plastics & rubber	10	15	25
Publishing, printing, and Recorded media	3	0	3
Recycling	19	5	24
Refined petroleum product	1	0	1
Textiles and garments	148	41	189
Tobacco	1	0	1
Transport machines	7	3	10
Wholesale	9	2	11
Wood & Furniture	7	7	14
Total	443	225	668

Table 2 presents the description of variables, their means, SD and hypothesized effect as also related in figure 1.

Table 2 Variables' Description and distribution statistics and hypothesized effects

Variables	Description	Mean	SD	Hypothesized Effect
Dependent Variables				
Innovation Introduction	=1 if firm has introduced in last few years, 0 otherwise	1.34	.473	
market Innovation		1.23	.421	
Product Innovation		1.28	.449	
Marketing Innovation		1.16	.371	
Logistic Innovation		1.14	.348	
Spending on R&D		1.14	.345	
Independent Variables				
Land Characteristics				
Location of Firm	1-3 EPZ, IE, None	2.50	.586	+
Land Access	Likert scale (1-4) Major – No Obstacle 1-3 (Both, Owned, Rented)	3.12	1.044	-
Ownership		2.09	.329	+
Infrastructure Practices				
Water sufficiency	1-2 (No, Yes)	1.97	.171	+
Email		1.44	.497	+
website practice	--	1.36	.481	+
Electricity accessibility hurdle	--	1.17	.585	-
Telecommunication	Likert Scale (1-4), Major to No obstacle	3.27	1.003	-

4.2 Model Specifications

The analysis model ran for testing hypothesized effects included logistic regression model due to nature of variables included in the study, as explained in section 3. The purpose of this model is to create a linear combo of IVs for the log of odds of being in one group. The groups refer to one of two from dichotomous Independent variables. The model comprises three main parts, statistics for overall model fit, classification table, and a summary of model variables (Mertler & Reinhart, 2001).

At first the group membership for being “Innovative” or not was tested with land indicators (Ownership), (Location), and “Land access as obstacle”. Later the test was run with Infrastructure variables, (Access to water, electricity, telecommunication and practice of Website and email). For all the times the test was performed, checking collinearity amongst selected IV's was first ensured and checked by performing simple multiple linear regression was performed as shown in table 3.

Table 3 Result of Collinearity check for Independent variables

Model	Collinearity Statistics		
		Tolerance	VIF
1	Location1	.968	1.033
	Ownership1	.947	1.056
	LandAccess1	.921	1.086
2	Telecom1	.936	1.069
	Elect1	.989	1.012
	waterinsufficiency1	.970	1.031
	emailPractise1	.470	2.129
	websitepractise1	.465	2.150
a Dependent Variable: introInn			

Tolerance values in Table 1 for all three IVs are above 0.1 showing that multicollinearity is not a problem.

After this screening, Binary Logistic regression was performed. The summary of results is presented in table 4 below.

Table 4 Summary results of Binary Logistic model with forward Logistic Regression (LR)

Dependent Variable	Step Summary		Model Summary	Classification table
	Chi-sq	sig	-2Log likelihood	Overall Percentage
Introduction of innovation	110.074	0.000	743.507	71%
Innovation to Market	89.80	0.00	631.540	76.9%
Product Innovation	121.1	0.00	671.2	72%
Marketing Innovation	54.197	0.00	543.41	84.3%
Logistics Innovation	47.390	0.00	495.3	85.8 %
Spending on R&D	82.93	0.00	452.5	85.9%

Table 5 Summary of Odds ratio for the variables included in the analysis

Dependent Variable	Exp (B) of variables in analysis								
	Ownership	Land Access as hurdle	Location	Telecomm as hurdle	Water Insufficiency	Email Practice	Website Practice	Electricity as hurdle	Constant
Introduction of innovation	1.113	0.765	1.2	0.757	3.221	2.711	1.941	0.013	1.113
Innovation to Market	1.12	0.811	0.922	0.635	1.39	3.129	1.169	3.194	0.023
Product Innovation	1.426	1.029	1.227	0.654	1.341	3.651	1.306	4.398	0.002
Marketing Innovation	0.948	0.996	1.357	0.882	1.627	2.705	1.123	3.69	0.001
Logistics Innovation	1.877	1.112	0.975	0.728	1.412	2.081	0.892	3.668	0.002
Spending on R&D	1.139	1.238	1.396	0.7	1.398	2.012	1.38	5.548	0.001

The odds ratio presented in table above show the increase or decrease (if $\text{Exp}(B)$ is <1) in odds of being classified as “innovative” industry, when the predictor variable increases by 1. The method of Binary logistic was “Forward LR”. Amongst Land indicators, Higher $\text{Exp}(B)$ values are observed for “ownership” predictor for affecting innovation variables. This is followed by the “location” of establishment variable showing higher values of odds ratio for being categorized as “Innovative”.

Amongst infrastructural inequality, electricity availability and practice of email for communication are significant contributors to industries' tendency to be more “Innovative”. It is interesting to note that from table 5, $\text{Exp}(B)$ values can be observed for different ordinal and nominal variables, for assessing which innovation indicator/s are best to record establishment's potential. As the study employs logistic regression, all these variables were recorded as binary, but the rows sum of table 5 can significantly show that “Spending on R&D” and “Product innovation” are important indicators for assessing establishment's innovation.

5. DISCUSSION AND CONCLUSION

Table 4 and 5 comprise the key indicators for logistic regression model which aimed at predicting the group membership of being “innovative” industry as defined by some categorical and few ordinal variables. All the DV's were binary, as they were either innovative at a level or not. The levels included in the analysis were innovation at market, product, logistic, marketing or spending to R&D. The purpose of model is to predict probability of membership based on the IVs, which varies from 0 to 1. Amongst variety of method options provided by the SPSS, We chose Forward LR method for running test, which uses likelihood ratio to exclude the variables with lower values of odds ratio or $\text{Exp}(B)$.

The three parts based out-put of the LR model is presented in table 4 and 5. The overall model fit, classification table and summary of model variables. Out of these outputs significant indicators have been presented as to build on or reject the hypothesized effects of these measures. Higher values of independent variables for $\text{Exp}(B) >1$ are evidently for innovation types in logistics and spending on R&D inferring them as good indicators for innovation mapping.

Additionally, the overall model fit for logistic regression is above 80% for indicators of marketing, logistics and R&D spending establishing their use as significant indicators when measured against infrastructural Inequality and co-Location.

POLICY RECOMMENDATIONS

- It is important to incentivize establishments for Investment in R&D for both process innovation and logistics. The industries in Punjab in respondent's view also consider this important measure of being categorized as “Innovative”.
- The processes significant for innovation are marketing and logistics rather than introduction of new products or making it computerized. This implies that as most of the participants of “Innovation” are from manufacturing, the common perception of innovation is novelty in marketing and logistics, rather than introduction of new product which might would be new to market as well.
- There is need to reconsider the planning of IE's and EPZ's as the study finds stakeholder's views not as aligned as planners of co-location. Provision of mutual amenities is one rationale for planning, but the world is moving to reaping trickling down technological transfer benefits from co-location. Hence, there is need to set priorities for colonization and planning of industrial zones.

- Not surprisingly, the electricity provision was regarded as major hurdle to be categorized as innovative, as industries suffer from frequent power cuts. It was interesting to note that establishments in even SEZ's and IE's were found complaining against these as hurdle for innovation. Policy makers need to incentivize greener and uninterrupted provision of energy for clustered industrial development.

PRACTICAL IMPLICATIONS FOR ASIAN BUSINESSES

Investors are highly encouraged to conduct an in-depth need analysis for product value to the assigned market, as shown by analysis of ES Data, the concept of innovation in developing countries of Asia is highly relative to use of technology and infrastructure associated with it.

Moreover availability of energy and its production is the most considerate factor despite very lucrative investment environment otherwise. Businesses need to asses real time need of enabling infrastructure with understanding of political nexus of the country.

Presence of legal instruments does not guarantee the ease of business doing in context of local culture and social setting. Hence understanding the culture is important in order to avoid impeding practices of law. Firm should partner with local professionals in order to grasp intricacies of business doing that can help in getting risk assessment in functional environment. Firms looking for spilt benefits from associated industries and support for provision of raw material, tend to locate in clustered industrial development. But policies of national government largely impact colonization rate of them. Hence a sharp analysis of real term progress on ground is important to identify the emerging markets.

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