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NATURE & EFFECTS OF AGGLOMERATION ECONOMIES ON MANUFACTURING FIRMS IN PUNJAB

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ABSTARCT
This paper quantifies the nature and effects of agglomeration economies on manufacturing firms of Punjab, the largest province of Pakistan. Using firm level cross-section data, this research first explains the extent of agglomeration of manufacturing firms in Punjab by calculating the agglomeration indicators i.e., urbanization and localization. We used the firm's distance from urban center as a proxy for urbanization. We used spatial autocorrelation as a measure to show the localization of firms. We constructed the translog production function to measure the effects of urbanization and localization on firms' annual turnover. The overall impact of both agglomeration economies is positive on firms' turnover. However, the effect of urbanization economies is more prevalent than the effects of localization economies in Punjab. At two-digit sector level, thirteen out of twenty-three sectors showed positive effect of urbanization on firm's turnover. For localization, ten sectors showed positive on firm's turnover. The results are consistent with the literature and the existing status of manufacturing sector of Punjab.
Keywords: Agglomeration, urbanization, localization, spatial autocorrelation, manufacturing, Punjab.
JEL: *C21, L6, R12, R32*

INTRODUCTION

Industrial sector plays an important role in the growth of any country since it contributes into the growth of almost all other sectors economy. It provides foreign exchange reserves to the economy through exports, address the imports burden by domestic production, strengthen both agriculture and services sector thorough labor employment and serves domestic commerce and domestic consumption. The nature of manufacturing production depends on variety of factors. The provision of skilled labor, availability of raw materials, and prevalence of the state-of-the-art production technology and existence of infrastructure are some of the requirements for optimal production.

Given this pivotal nature of this sector, it is interesting to know about the concentration of industries in a particular area. There has been a variety of literature (Hendersen 2003, Duranton 2005, Nakamura 1985, Krugman 1991, Baldwin 2007) who suggests various reasons for concentration of manufacturing activities in specific region. This concentration of manufacturing activities in a particular area is called agglomeration. The literature suggests that firms tend to agglomerate to attain benefits of being close to center and to each other. There are two major types of agglomeration economies i.e., urbanization and the localization. Urbanization economies means firms try to locate near the city center to benefit from the urban economic activities. Localization economies means the firms benefit from the cluster of similar firms based on labor pooling, inputs sharing and knowledge spillover. Idea of localization economies was first present by Alfred Marshall in 1920 in his classical work.

Punjab is the largest province of Pakistan in terms of population and economic activities. It constitutes 110 million populations (52.95% of national population), out of which 36.7 million are residing in urban areas and 63.3 million are in rural areas (Government of Pakistan, 2018). The estimated share of the economy of this province was 54.2% in the national GDP in 2017-18(Pasha, 2018). Punjab contributed 62.3% in the agriculture sector of Pakistan. It contributes 39.8% and 55.7% in the industry and services sector respectively. Within the economy of Punjab, agriculture contributes

20.2%, Industry contributes 17.5% and services sector contributes 62.4%. In terms of total employment of Punjab, agriculture employs 40% of the labor force, manufacturing employs 17.7% and services employs 43.3%. Administratively, the province is divided into 36 districts (prefectures) and 142 sub-districts (tehsil). Total geographic area of the province is 17,512 thousand hectares.

Given the major economic indicators of Punjab, a further peek into the manufacturing sector reveals that it is highly agglomerated. There are 25,202 manufacturing sector units across Punjab. The district with highest number of manufacturing units is Faisalabad (6,695), followed by Gujranwala (3,494), Lahore (3,421) and Sialkot (2,904). Whereas the districts with minimum number of manufacturing units are Mianwali (63) and Pakpattan (59).

Table-I: Manufacturing Firms in Punjab

District	No. Of manufacturing firms	District	No. Of manufacturing firms
Faisalabad	6,695	Okara	212
Gujranwala	3,494	Hafizabad	211
Lahore	3,421	Vehari	185
Sialkot	2,904	Narowal	178
Sheikhupura	1,275	Rahim Yar Khan	159
Multan	927	Muzaffargarh	138
Gujrat	647	Chakwal	129
Kasur	619	Layyah	125
Sahiwal	503	Nankana Sahib	123
Rawalpindi	411	Chiniot	122
Mandi Bahauddin	300	Dera Ghazi Khan	105
Bahawalpur	289	Jhelum	96
Toba Tek Singh	288	Bhakar	90
Jhang	261	Attock	84
Khanewal	257	Khushab	68
Sargodha	254	Lodhran	65
Rajanpur	232	Mianwali	63
Bahawalnagar	213	Pakpattan	59

Pakistan Standard Industrial Classification (PSIC) has classified manufacturing industry according to the sectors at 2-digit, 3 digit and 4-digit levels keeping in view the International Standard Industrial Classifications (ISIC). There are 23 manufacturing related sectors at 2-digit level. A quick spatial review of the manufacturing sector in Punjab reveals that, manufacturing activity in Punjab is highly concentrated/clustered both in terms of districts and sectors. The spatial concentration of these industries is very skewed as 80% of these manufacturing units are concentrated in 8 districts only (as shown in table 1). Those 8 districts (Lahore, Gujranwala, Sheikhupura, Kasur, Sialkot, Gujrat, Faisalabad, Nankana Sahib) comprise of only 20% of the geographical area of Punjab. Similarly, manufacturing activity is concentrated in terms of sectors as well as only 6 out of 23 (at 2-digit PSIC) sectors dominate the total manufacturing units. Those six sectors constitute 69% of total manufacturing units. Two major examples of industrial agglomeration in Punjab are the agglomeration of textile industry (PSIC-14) in Faisalabad district and surgical industry (PSIC-32) in Sialkot district. District Gujranwala presents the agglomeration of different sectors in one place. Such skewed concentration of manufacturing intrigues many questions for research.

Objective of the study

There are two major objectives of this study.

First, this study tries to identify the nature and type of agglomeration in manufacturing sector of Punjab. This study will identify the extent of agglomeration economies (urbanization and localization) in the province.

Secondly, this study will explore the effect of agglomeration economies on the firm's performance in Punjab, both at overall and at sector level.

LITERATURE REVIEW

Literature provides a variety of explanation for industrial agglomeration. The oldest literature presents something seminal in economic geography is the idea developed by Alfred Marshal in 1920. In his book "The Principles of Economics", identified three sources of industrial agglomeration i.e., input sharing, labor pooling and knowledge spill overs. He presented the idea that the productivity of the firms can be increased due to agglomeration economies, such as.

> "When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from neighborhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously...Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skill which they require...The advantages of variety of employment are combined with those of localized industries in some of our manufacturing towns, and this is a chief cause of their continued economic growth." (1920, pp.271).

Thus, Marshall presented the idea of localized agglomeration of the industries explaining the concentration of same type of industries in a specific geography. In district Faisalabad, concentration of textile sector is a good example of such agglomeration.

On the contrary, many researchers have argued that the agglomeration of economic activities may be because of obtaining the benefits of environment and big cities. Hence, the city size or its diversity may also contribute towards increased productivity of the firms. The urbanization agglomeration describes the benefits accrued because of the presence of other economic activities such as services sector, diversified labor skill set, consumption, and population (Jacob, 1969). District Gujranwala presents such type of agglomeration where presence of allied and other industries along with population for consumption has led to agglomeration of variety of sectors. Krugman (1991) presented theory of "core" and "periphery" and provide economic rationale for regional divergence. Based on the geographic concentration of manufacturing activities, author argues that, in the presence of lower transportation costs and scale economics, manufacturing tends to concentrate in "core", other areas with remaining regions playing the role of "periphery" or agricultural suppliers to manufacturing "core". The concentration of manufacturing occurs near the areas where there is a large demand market since it minimizes the transportation costs, and the markets will be large where the manufacturing is concentrated. Thus, Krugman advocated in favor of both localization and urbanization of agglomeration.

Industrial clusters, through agglomeration, affect the industrial productivity. Tomoya & Smith (2013) explored this phenomenon using multi-stage estimation for Japan. The results of the study show that the larger firms are surrounded by cluster of smaller firms. The effect of agglomeration on productivity has also measured by using total factor productivity and translog specification for estimation and findings depict that productivity and agglomeration are positively related with each other but these effects are nonlinear and not uniform across firm size, industry lifecycle and products (Fernandes et al., 2017). The doubling the size of city may increase the productivity by roughly 3-8% has been concluded by Rosenthal-Strange (2004). Further, in France the agglomeration economies benefitted due to urbanization in short run but in long term agglomeration economies are more beneficial due to localization (Martin *et al*., 2011). Similarly, in US and Brazil the effect of agglomeration has estimated, and the results depict that localization economies have effect on productivity and research has found no evidence of urbanization (Henderson, 1986). Later, the same author in 2003 has used the firm level data of US finds the evidence of positive effect of localization economies on high-tech industries but not in machinery industries. However, the study does not find any evidence of presence of urbanization agglomeration for two industries.

According to Marshall, main sources of agglomeration economies are knowledge spillovers, input sharing and labor pooling, famously known as Marshallian externalities in the literature. Knowledge spillovers include the knowledge sharing by firms as Audretsch and Feldman (1996) showed that innovative industries are geographically concentrated. Jaffee *et al* (1993) calculated that an innovator is 5-10 times more likely to cite patent from the firm is the same metropolitan as compared to the firms from elsewhere in the country. Input sharing involves the local outsourcing by the firms. Yarn, textile, and garments sector in district Faisalabad provides such examples. The presence of yarn

factories and garments improve the scale economies and lower the transportation costs. Holmes (1999) measured the input intensity showing the benefits of input sharing. A third benefit of agglomeration is labor pooling. Krugman (1991) argues that labor pooling reduces the search cost, implying that the agglomeration offers the labors a kind of insurance. The labor pooling case has been exemplified by the Costa and Kahn (2003) that combines, both individuals have college degrees or higher education, will be more likely to locate in large metropolitan areas.

The influence of agglomeration varies according to the nature or type of industries. Research shows that this impact is different for mature and new entrant industries. For mature industries, Henderson *et al* (1995) found that localization agglomeration more effect. Glaeser and Mare (2001) found that wages are higher in large cities which show the impact of urbanization economies. Physical proximity is an important aspect of agglomeration as Rosenthal and Strange (2003) estimated the influence of distance on effect of agglomeration using firm level micro data. Although the impact of distance varies across sectors, overall agglomeration economies attenuate with distance.

There are certain ways to measure the impact of urban agglomeration on industries. Mitra (1999) in his paper has discussed two methods. First the direct impact of agglomeration on manufacturing industries. The second method is to measure the impact of agglomeration on efficiency of the manufacturing industries. This study has used two industrial sectors of Indian industries i.e., electrical machinery and cotton textiles. It calculated whether both industries are agglomerated or not. Results show that the city population has an impact on cotton and textile. However, there is no empirical indication of any significant impact of city population/agglomeration on electrical machinery sector. The impact of agglomeration has been measured by using translog production function by Graham and Kim in 2008. First, this paper has constructed the translog inverse demand function. This paper has made an analytical framework for agglomeration of economies using the UK data of manufacturing and services sector. The translog specification shows that all nine industries show positive effect of agglomeration on the sectors. Secondly, the researchers have calculated the elasticities of different variables with respect to agglomeration.

The results show that these agglomeration elasticities are positive, and they have significant impact in terms of UK industries showing that with the increase in agglomeration there is rise in industrial concentration as well as there is rise in wage as well. The elasticity result is negative for construction sector, business services and public services. It is positive in manufacturing, distribution, transport, real-estate sectors. Later, the Graham (2009) has extended his work by incorporating urbanization and localization externalities in manufacturing and services sector in the firms of UK. The results of the study show that the localization effect is relatively less as compared to the urbanization effect. This effect is being calculated through elasticities for the different sectors. So, the elasticities of manufacturing industries for localization are less as compared to the elasticities of different manufacturing sectors for urbanization.

Duranton and Overman (2005) have tested the localization of industries in UK using the micro data and challenged the Ellison-Glaeser (EG) Index of concentration and provided their own measure of concentration. This distance-based measure is calculated through the Euclidean space between the industries and gauged the dispersion between the industries. They constructed this measure by keeping the five crucial elements which were previously absent in the Ellison-Glaeser Index. Those five elements are that the formula which we construct to measure the concentration should be comparable across the industries, the measure should control the uneven distribution of manufacturing, control the industrial concentration and there must not be any aggregate bias and that the measure should be statistically significant. Based on these assumptions, this research has constructed the formula the k function which is basically to quantify the geographic existence. The results of the study found that 52% of the industries exhibit the localization. And that localization since they have calculated the distance, the localization is between zero to 50km. The industries which are beyond 50 km, the impact of localization will be diminishing. In another paper, Duranton and Overman (2008) used the same data and methodology, but they focused on prevalence of localization in terms of various features on the manufacturing industries such as entrant versus exit firms, foreign versus domestic owned firms, large and small sized establishments, and vertically linked industries. The research found that the localization exists between foreign owned plants do not appear to locate differently from domestic plants. The results also show that large plants were clustered as compared to small plants and there is evidence of co-localization for vertically linked industries as well.

Another country specific research on the aspect of nature and causes of agglomeration has done by Baldwin and Okubo (2005). This study includes the manufacturing firms of Canada and breaks this assumption of homogenous firms and assumes that the firms are heterogeneous. According to researcher there are two types of firms that are productive and unproductive firms. The productive firms tend to agglomerate in the central area, the core of any industrial hub. The non-productive firms tend to locate away from the center. There are two factors for such type of agglomeration i.e. selection effect and sorting effect. Sorting effect is the phenomenon when the regional policies attract the firms into some main hub. Selection effect is the phenomenon when the firms are concentrated somewhere because of their higher regional productivity. Baldwin *et al* (2008) also tested the presence of all three Marshallian causes of agglomeration for labor productivity in Canada. The study concluded that there is positive effect of agglomeration on labor productivity in manufacturing sector. The labor sharing, input sharing and the knowledge spillover have a positive relation with the plant productivity. Further, Baldwin (2010) has extended the previous analysis onto the panel data of Canadian industries. The results showed that Marshallian externalities exists i.e., labor pooling, input sharing and knowledge spillover and among all sources, labor pooling is the most important source of agglomeration in manufacturing industries.

The impact of agglomeration economies on the manufacturing industries has been explored very profoundly by Nakamura (1985). The researcher employed the cross-section data of manufacturing industries for Japan and estimated the impact of agglomeration on the manufacturing industries. For agglomeration parameters, the researcher took the proxy variable of city population and city climate along with the standard factors of production. The research employed the translog production function to extensity analyze the behavior of the variables under consideration. The results showed that the agglomeration economies affect the output of the firms. However, urbanization economies effect is stronger than the localization economies effects. 19 out of 20 sectors showed that there is positive effect of agglomeration in terms of urbanization. And 9 out of 20 sectors show that there is positive effect of localization on the manufacturing sector. In his second paper, Nakamura (2012) extended the same analysis to a panel of manufacturing industries. He took a panel of 1985-2000 data of manufacturing industries in Japan. The research extended the previous work and tried to explore the impact of agglomeration on the Marshallian externalities. The research concluded that agglomeration affects all the Marshallian externalities. It implied that there exists the impact of agglomeration can be seen on the labor pooling, input sharing and the knowledge spillover in Japanese manufacturing sector. The results showed that doubling the size of industry scale leads to 4.5% increase in productivity, whereas, doubling the size of city population leads to a 3.4% increase in productivity.

THEORETICAL FRAMEWORK AND METHODOLOGY

The debate of urbanization and localization of agglomeration has generated enormous literature and methodologies to measure this impact. These methodologies differ according to the availability of the data with the researchers. Due to the not availability of the data, researchers have been using various proxies to measure the impact of urbanization and localization. For urbanization, the most widely used proxy is the population of the city and for localization the researcher has used the labor employed in the industry (Baldwin 2008, Tao, Nakamura 1985).

A second wave literature has employed more advanced data and methodologies. With the availability of data about the location of the industry and a little introduction of geography into economic analysis has changed the thinking and analytical domain of agglomeration. Recently the researchers are using location-based indicators to measure the agglomeration factors such as distance between industries and regions (Duranton 2008).

This research has employed the tools of spatial econometrics to understand the agglomeration phenomenon in Punjab. We have employed the geo-spatial point data on the industries of industries in Punjab. This data includes the location of the firms, output level, annual turnover, labor employed, land utilization, export status of the firms and the PSIC classification at 2-digit and 3-digit.

This research is carried forward in two stages. At first stage, we have constructed the variables for agglomeration indicators. The point data of firm location is used for this purpose. And in the stage, we have explored the impact of those agglomeration variables on the turnover of the firms.

Stage 1: Construction of Agglomeration Variables

Variable for Urbanization

The variables of urbanization and localization constructed based on the nature of agglomeration. Since under urbanization agglomeration, firms take advantage of various types of activities and diversity in area such as cities. As the city expands, more economic benefits can be accrued by the firms. Thus, any firm which lies within the boundary of urban area, may assumed to be benefiting from urban economy.

There are 36 major cities in Punjab, and these represent the district headquarters as well. This study has measured the distance of the firm from the city sprawl area. A city sprawl is defined as the spatial urban sprawl of the city. Hence, the distance of each firm is measured, in kilometers, from the nearest city. If the firm lies within this city sprawl, the variable distance will assume zero value. ArcGIS software calculate the distance once we input the point data of firm location and city sprawl. Once we have distance for each firm, dummy variable is created for urban distance representing whether a firm is located within city or outside city.

$$X_1 = \begin{bmatrix} 1 & firm\ located\ within\ city \\ 0 & firm\ located\ outside\ city \end{bmatrix}$$

Variable for Localization

Since the firms who are befitting from agglomeration localization are expected to be indicating the Marshallian externalities i.e., input sharing, labor pooling and knowledge sharing. We need to construct a variable which depict the association between the firms based on these characteristics. The literature of economic geography suggests that Moran's *I* test of spatial autocorrelation provide such information whether firms are spatially autocorrelated or not, based on some indicator.

Spatial Autocorrelation

Spatial econometrics is used because we are working with the firm level data which possess the information about the location of the firms and this location is an additional source of variation. Therefore, it is necessary to use quantitative tools that consider the characteristics unique to each of the observation as well as their location.

The spatial autocorrelation generally defined as it is the measurement of the spatial association between a given variable. "It measures the trend of the linear relationship between the variables and the degree of intensity of the spatial direction of a given variable with the same variable, but for a defined neighborhood". The first proposed statistical measurement for the spatial autocorrelation is the Moran's *I* statistics and it is the most widely used test of spatial autocorrelation. This test grounded on the measurement of covariance. However, this test only provides the idea of the intensity of the average spatial autocorrelation in each sample for a given variable. It measures relationship between the value of suggested variable and value of this suggested variable in its surrounding (Legros & Dube, 2014). This test is robust to detect the presence of spatial autocorrelation between the variables and it provides calculations like the correlation coefficient. Due to these reasons, it is most widely used statistics.

The advantage of global spatial autocorrelation is real when the spatial observations (firms) are homogeneous, which is rarely a case. So, it is pertinent to consider whether there are local clusters of low and high values. In our case, where we try to find the local clusters of firms based on efficiency.
Local spatial autocorrelation allows us to identify the individual contribution to the global spatial autocorrelation. These measurements are used to study the significance of the spatial clusters around individual locations.
Local Moran's *I* indices is:

$$I_i = (y_i - \bar{y}) \sum_{j=1}^{N} W_{ij}(y_j - \bar{y}) \qquad \text{for } i \neq j$$

Where N represents the total number of observations, $\bar{y}$ is the arithmetic average of the values taken by the variable y over all the observations, and W_{ij} spatial weights matrix allowing us to link observation *i* with other observation *j*.

The significance test can be obtained by calculating the proportion *p* of the result of the permutations that provide the values of I_i that are greater than, less than, or equal to the observed value of I_i.

The Local Indicator of Spatial Autocorrelation (LISA) Moran's *I* test will be interpreted as if value of $p<0.10$ then it shows that given variable y_i is related with relatively high value of variable y_j in the neighborhood. An excessively high value of *p* means $p<0.90$ shows that y_i is related with relatively

low value of variable y_j in the neighborhood. Consequently, local Moran's *I* test classifies the significant zones of spatial clustering for the variable y. It is a cluster of dissimilar values (LISA<0) or the similar values (LISA>0). In this way, the study will construct the indicator of localization where firms were low-low and high-high spatially correlated. It is spontaneous to understand that, if the firms are spatially autocorrelated based on efficiency, they are benefiting from the localization of agglomeration.
Once, we have this information for each firm about their nature of spatial dependence, we construct the dummy variable for firms which are spatially dependent on other firms. Such that:

$$X_2 = \begin{bmatrix} 1 & firm\ spatially\ correlated\ with\ other\ firms \\ 0 & otherwise \end{bmatrix}$$

Stage 2: Impact of Agglomeration Economies
We have developed the measures of agglomeration factors i.e., localization and urbanization in the previous section. In this section, we will develop the production function to measure the impact of those agglomeration factors on the production process.

To understand the production process, there are few assumptions which are required to be made to fully capture nature of relationship between inputs and outputs. We assume that the manufacturing firms are competitive and have homogenous production function and the firms in the same industry/sector have identical production technologies. We further assume that the localization and urbanization are external factors for the manufacturing firms.
Assuming the separability between intermediate inputs (localization and urbanization) and the primary factors of land labor and capital and output, the production function of a typical firm *j* in the sector *i* is written as:

$$y_{ij} = g_j(X_i) f_j(L_{ij}, E_{ij}, Q_{ij}) \qquad (1A)$$

Where y_{ij} is the annual turnover of the firm, X_i is the information on the localization and urbanization of the firm, L_{ij} is the labor employed, E_{ij} is the land utilized by the firm, Q_{ij} is the output of the firm. The function $gi(X_i)$ is the firm specific function assumed to be independent of the production technology of the firm *j*.

The explicit form the $gi(A_i)$ must be specified to measure the agglomeration economies. We use two variables of agglomeration, as derived in previous section, for urbanization and localization of the firms.

In this study, following Nakamura (1985), the transcendental logarithmic (Translog) production function is used. The translog specification of the equation (1) is given as under:

$$lny = \alpha_0 + \sum_j \alpha_j lnX_j + \sum_j \alpha_j X_j$$

The translog full equation specification of the model becomes as flows:

$$lny_j = \alpha_0 + \alpha_1 X_{1j} + \alpha_2 X_{2j} + \alpha_l lnL_j + \alpha_e lnE + \alpha_q lnQ_j + \frac{1}{2}\alpha_{ll}(lnL)^2 + \frac{1}{2}\alpha_{ee}(lnE)^2 + \frac{1}{2}\alpha_{qq}(lnQ)^2 + \alpha_{le}(lnL)(lnE) + \alpha_{lq}(lnL)(lnQ) + \alpha_{qe}(lnQ)(lnE) \qquad (2A)$$

Where X_1 and X_2 are the agglomeration factors of urbanization and localization respectively. Equation (2) is the final translog specification to be estimated to assess the impact of agglomeration factors on turnover of the firms.

Data Description
Pakistan Bureau of Statistics (PBS) is the custodian of the classification of manufacturing industries in Pakistan. It is called Pakistan Standard Industrial Classification (PSIC) of all economic activities in which PBS has classified all economic activities according to the classification of International Standard Industrial Classification of All Economic Activities (ISIC) by United Nations. Currently, ISIC revision 4 is the latest version available according to which PSIC revision 4 is available from PBS[1].

This study has used data on manufacturing industries of Punjab collected by The Urban Unit, Lahore in 2017. This data set includes the information about manufacturing firms' output level, employees, land use, annual turnover, PSIC classification of the firms, and geographic location. There is total 25,191 manufacturing firms identified in this census data in Punjab.

[1] Census of Manufacturing Industries (CMI) 2015-16, Pakistan Bureau of Statistics

Table 2: Manufacturing Firms in Punjab at 2-Digit

PSIC Code	Sectors	No. of Observations
10	Food Products	3,493
11	Beverages	79
12	Tobacco Products	8
13	Textile	6,747
14	Wearing Apparel	1,653
15	Leather and Related Products	943
16	Wood and Products	469
17	Paper and Paper products	531
18	Printing & reproduction of recorded media	334
19	Coke & Refined petroleum products	32
20	Chemical and Chemical products	473
21	Basic Pharmaceutical	268
22	Rubber and Plastic Products	991
23	Other Non-metallic mineral	2,750
24	Basic Metal	727
25	Fabricated Metal Products	1,612
26	Computer, Electronic and Optical Product	35
27	Electrical Equipment	634
28	Machinery and Equipment	770
29	Motor Vehicles and Trailers	337
30	Other Transport Equipment	173
31	Furniture	793
32	Other Manufacturing (surgical, sports, toys, jewelry)	1,339
	Total	25,191

ESTIMATION RESULTS

Nature of Industrial Agglomeration

Following the methodology developed in previous section, at first stage, we constructed the variables for agglomeration indicators of urbanization and localization. The dummy variable for urbanization has been constructed by measuring the location of the firm whether it was in city sprawl area or outside of city area. Table 2 shows the status of the firms' location.

Table 3: Urbanization Indicator

PSIC Code	Sector	Firms' Location		Total
		Outside City	Within City	
10	Food Products	2,491	1,002	3,493
11	Beverages	34	45	79
12	Tobacco Products	3	5	8
13	Textile	1,672	5,075	6,747
14	Wearing Apparel	291	1,362	1,653
15	Leather and Related Products	163	780	943
16	Wood and Products	345	124	469
17	Paper and Paper products	136	395	531
18	Printing & reproduction of recorded media	29	305	334
19	Coke & Refined petroleum products	22	10	32
20	Chemical and Chemical products	167	306	473

21	Basic Pharmaceutical	100	168	268
22	Rubber and Plastic Products	154	837	991
23	Other Non-metallic mineral	2,166	584	2,750
24	Basic Metal	149	578	727
25	Fabricated Metal Products	489	1,123	1,612
26	Computer, Electronic and Optical Product	4	31	35
27	Electrical Equipment	51	583	634
28	Machinery and Equipment	114	656	770
29	Motor Vehicles and Trailers	75	262	337
30	Other Transport Equipment	24	149	173
31	Furniture	321	472	793
32	Other Manufacturing (surgical, sports)	384	955	1,339
	Total	9,384	15,807	25,191

Based on the above table, a dummy variable is constructed for urbanization indicator. We performed the Local Moran's I (LISA) on number of employees to find the spatial autocorrelation among the firms based on labor pooling. Table 3 shows the number of firms in each sector which are spatially correlated and spatially uncorrelated.

Table 4: Spatially Autocorrelated Firms

PSIC Code	**Sector**	**Spatially uncorrelated firms**	**Spatially correlated firms**	**Total**
10	Food Products	3,446	47	3,493
11	Beverages	73	6	79
12	Tobacco Products	3	5	8
13	Textile	6,543	204	6,747
14	Wearing Apparel	1,595	58	1,653
15	Leather and Related Products	922	21	943
16	Wood and Products	468	1	469
17	Paper and Paper products	522	9	531
18	Printing & reproduction of recorded media	325	9	334
19	Coke & Refined petroleum products	31	1	32
20	Chemical and Chemical products	459	14	473
21	Basic Pharmaceutical	254	14	268
22	Rubber and Plastic Products	969	22	991
23	Other Non-metallic mineral	2,720	30	2,750
24	Basic Metal	717	10	727
25	Fabricated Metal Products	1,574	38	1,612
26	Computer, Electronic and Optical Product	33	2	35
27	Electrical Equipment	608	26	634
28	Machinery and Equipment	768	2	770
29	Motor Vehicles and Trailers	326	11	337
30	Other Transport Equipment	163	10	173
31	Furniture	769	24	793
32	Other Manufacturing (surgical, sports)	1,317	22	1,339
	Total	24,605	586	25,191

Based on the results of Moran's I test, we constructed the indicator of localization. Firms which are spatially correlated are assumed to be benefitting from each other. Thus, those firms are

agglomerated based on localization, i.e., firms are benefitting from the agglomeration of other firms in the same vicinity.

Impact of Agglomeration

To understand the impact of agglomeration on annual turnover of the firms, we regress the equation (2A) constructed in previous section. Table 4 shows the parameter estimated, where α_1 and α_2 represent the agglomeration economies of urbanization and localization respectively. The overall regression analysis shows that both urbanization and localization impact positively annual turnover of the firms, showing the firms are benefiting from both city diversity and the clustering of firms. However, given the values of the parameters, it can be deducted that the impact of urbanization is greater than the impact of localization in Punjab. These results are consistent with the existing status of manufacturing sector development in the province.

When we regress separate regression equation for two-digit level sectors, the results are different. We found that out of 23 sectors, 13 showed positive impact of urbanization on annual turnover of the firms. These sectors are food products, textile, wearing apparel, wood and wood products, chemical and chemical products, other manufacturing (surgical, sports), printing & recorded media, basic pharmaceuticals, other non-metallic minerals, electrical equipment, furniture, fabricated metal products and motors and trailer.

The impact of localization economies is observed positive in 10 sectors, i.e., textile, leather and products wood and wood products paper and paper products, chemical and chemical products basic pharmaceuticals, electrical equipment, machinery and equipment and other manufacturing (surgical, sports and toys).

Table 5: Estimates of Translog Parameter in 2-Digit Codes Sectors

PSIC Code	α_0	α_1	α_2	α_L	α_q	α_{LL}	α_{qq}	α_{Lq}	R^2
10	-0.97 (-3.89)	0.177 (3.39)*	0.374 (2.05)*	0.609 (6.54)*	0.067 (-1.33)	.021 (1.03)	0.004 (-0.76)	-0.008 (-0.92)	0.450
11	1.899 (-1.79)	0.051 (-0.19)	-0.094 (-0.17)	1.469 (2.87)*	-0.503 (-1.81)**	0.098 (-0.65)	0.056 (-1.48)	-0.074 (-1.56)	0.5053
12	no regression due to small sample size								
13	-1.011 (-8.11)	-0.135 (-6.46)*	0.228 (4.25)*	0.609 (11.48)*	0.085 (3.56)*	0.002 (-0.14)	0 (-0.13)	0.018 (3.72)*	0.5423
14	-1.449 (-4.22)	0.313 (0.000)*	0.0024 (-0.02)	0.449 (3.62)*	0.237 (2.9)*	-0.132 (-4.13)*	-0.0264 (-2.71)*	0.035 (2.33)*	0.4709
15	-0.921 (-1.73)	-0.036 (-0.55)	0.948 (5.83)*	0.783 (4.45)*	0 0	0.0185 -0.47	0.0156 -1.21	-0.009 (-0.52)	0.5478
16	-0.151 (-0.54)	0.281 (5.21)*	-4.915 (-4.02)*	0.739 (6.35)*	-0.168 (-2.57)*	-0.0045 (-0.12)	0.023 (2.86)*	0.007 -0.59	0.7348
17	-0.619 (-1.52)	0.096 -1.02	0.551 (1.86)**	0.7 (3.35)*	-0.0218 (-0.29)	0.0203 -0.31	0.0075 -0.94	-0.004 (-0.21)	0.4526
18	-0.519 (-1.11)	0.436 (2.66)*	0.258 -0.91	0.69 (2.49)*	-0.0592 (-0.66)	-0.007 (-0.08)	0.006 -0.69	0.009 -0.37	0.5104
19	-7.024 (-1.73)	-0.479 (-0.71)	-1.134 (-0.78)	-3.049 (-1.68)**	0.9404 (-1.34)	-0.747 (-1.69)**	-0.0415 (-0.56)	0.306 (2.22)*	.4867
20	1.223 -2.41	0.588 (5.46)*	1.119 (3.81)*	1.683 (7.42)*	-0.403 (-3.87)*	0.226 (3.69)**	0.041 (3.37)*	-0.106 (-5.03)*	0.4119

21	-1.702 (-2.92)	0.218 -1.55	-0.162 (-0.5)	0.429 -1.55	0.292 (2.47)*	-0.062 (-0.65)	-0.022 (-1.68)**	0.0141 -0.58	0.35 57
22	-0.401 (-1.61)	0.1345 (1.79)**	0.307 (1.66)**	0.468 (3.66)*	-0.077 (-1.47)	-0.1223 (-3.61)*	0.0173 (2.92)*	0.008 -0.62	0.41 99
23	-0.945 (-5.25)	0.481 (11.1)*	0.203 (-1.36)	0.9679 (11.35)*	0.0531 (2.18)*	0.0127 -0.64	-0.007 (-3.73)*	0.0082 -1.2	0.71 72
24	-0.408 (-1.58)	0.0357 (-0.29)	-0.5778 (-1.42)	0.1414 -0.86	0.218 (3.47)*	-0.168 (-2.42)*	-0.0359 (-4.13)*	0.0288 (1.64)**	0.17 62
25	-0.177 (-1.89)	0.168 (4.62)*	0.123 -1.09	0.834 (12.24)*	-0.091 (-3.66)*	-0.0604 (-2.25)*	0.0147 (4.21)*	-0.0149 (-1.89)*	0.54 77
26	2.647 -2.26	-0.819 (-1.05)	-0.258 (-0.25)	2.239 (-2.26)	-0.215 (-1.32)	0.613 (1.68) **	-0.005 (-0.19)	-0.143 (-1.54)	0.37 89
27	0.653 (-2.63)	-0.356 (-2.73)*	0.499 (2.84)*	1.229 (7.98)*	-0.207 (-3.58)*	0.147 (2.17) *	0.0295 (3.8)*	-0.062 (-3.4)*	0.39 42
28	-0.221 (-2.05)	-0.002 (-0.03)	1.208 (2.17)*	0.592 (8.6)*	0.0097 (-0.29)	-0.0918 (-4.13)*	0.0002 (-0.04)	0.0009 -0.08	0.41 33
29	-0.662 (-2.59)	0.206 (1.65)*	0.379 (-1.3)	0.506 (2.25)*	0.106 (-1.59)	0.015 (-0.13)	-0.008 (-0.87)	0.0292 -1.23	0.34
30	0.599 (-0.91)	0.0104 (-0.05)	-0.149 (-0.43)	0.0721 (-0.22)	-0.143 (-0.9)	-0.291 (-3.02)*	0.023 (-1.12)	0.0629 (1.66)**	0.39 49
31	-0.709 (-9.48)	0.208 (4.33)*	0.0349 (-0.25)	0.8 (12.34)*	0.1069 (3.15)*	0.0132 (-0.4)	-0.015 (-2.15)*	-0.012 (-0.9)	0.55 46
32	-0.676 (-2.38)	0.223 (4.18)*	0.887 (4.74)*	0.609 (5.55)*	-0.077 (-1.2)	-0.0741 (-2.69)*	0.0231 (3.13)*	-0.0067 (-0.58)	0.58 1
Over all	-.950 (-25.95)	.211* (14.84)	.296 (7.25)*	.401 (20.82)*	.134 (16.66)*	-.082 (-14.16)*	-.015 (-15.03)*	.039 (20.48)*	0.58 4

*Shows significant values at 5%, **shows significance at 10%, Values in parenthesis show t-values

The following table shows the summary of sectors which show positive impact of agglomeration economies. Given the overall economic development of the province, the below table summarize the agglomeration effect which are close to reality. Pakistan in general and the province of Punjab in particular, have more labor-intensive industries as compared to capital intensive. Since industries in Punjab are not from advance sectors (high-tech industries), the localization effect is less in manufacturing firms as compared to urbanization effect as literature suggests that localization effect strengthens when sectors specialize.

Table 6: Summary of Effects of Agglomeration Economies

2-Digit Sectors	Positive Effects of Agglomeration Economies	
	Urbanization	Localization
PSIC-10: Food Products	✓	
PSIC-13: Textile	✓	✓
PSIC-14: Wearing Apparel	✓	
PSIC-15: Leather and Related Products		✓
PSIC-16: Wood and Wood Products	✓	✓
PSIC-17: Paper and Paper products		✓
PSIC-18: Printing & Reproduction of Recorded Media	✓	
PSIC-20: Chemical and Chemical Products	✓	✓
PSIC-22: Basic Pharmaceutical	✓	✓
PSIC-23: Other Non-metallic Minerals	✓	
PSIC-25: Fabricated Metal Products	✓	
PSIC-27 Electrical Equipment	✓	✓
PSIC-28 Machinery and Equipment		✓
PSIC-29: Motor Vehicles and Trailers	✓	
PSIC-31: Furniture	✓	
PSIC-32: Other Manufacturing (surgical, sports, toys)	✓	✓

CONCLUSION

This research tried to understand the nature of industrial agglomeration in Punjab and its effect on performance of the manufacturing firms. Agglomeration economies are defined as the concentration of manufacturing firms in an area/geography. Literature suggest that two types of agglomeration are observed in manufacturing sector i.e., urbanization and localization. Urbanization economies means the firms are benefiting from the city center and the localization means the firms are benefiting from the clusters of the similar firms based on labor pooling, input sharing and knowledge spillovers.

This research used the firm level data to understand the phenomenon of urbanization and localization economies. We constructed the variable of urbanization based on distance of the firm from urban center. The variable for localization was constructed with the help of spatial autocorrelation of the firms. The effect of localization and urbanization on the annual turnover of firm is measured with the help of translog specification of the production function. The overall impact of the urbanization and localization is positive on turnover of the firms. However, the effect of urbanization is stronger than the location in Punjab. At sector level, the analysis showed that out of 23 manufacturing sectors, 13 showed the positive effect of urbanization on firm's annual turnover and 10 sectors showed the positive effect of localization in Punjab. The results are consistent not only with the literature of the subject matter but also conform to the manufacturing sector's performance in Punjab.

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