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Is Innovation in Pakistan Driven by Specialisation or Diversity?

ADEEL ALI, SYED FAIZAN IFTIKHAR, and SABIHUDDIN BUTT

Innovation is among the main drivers of industrial development leading to economic growth. However, the question triggers that what drives innovation? Is innovation driven by specialisation or diversification? The literature has supported both, the specialisation and diversification as driver of innovation. Therefore, the purpose of this paper is to explore the determinants of innovation in Pakistan with a special emphasis on specialisation and diversity. The analysis is based on the cross sectional data set of 784 firms across 13 different cities of Pakistan, i.e. Investment Climate Survey (ICS) 2007, compiled by the World Bank Enterprise Group. Our findings have showed the positive relation between innovation and diversity i.e. diversity is conducive to innovation. On the other hand, specialisation has a negative effect i.e. it hinders innovation in cities of Pakistan.

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1. INTRODUCTION

Cities account for a large share of GDP, where economies of scale, advantages of agglomeration, contribute to innovativeness. The locus of economic development is now firmly believed has been shifted. Moreover, in cities, industrial composition and diversity contributes to growth and in turn reduces the cost of innovation in the region where the economic activity concentrates and boosts growth. [Griffith, *et al*. (2006)] They reported positive correlation between productivity and innovation. Some scholars have argued that most innovations are made in cities [Jacobs (1969); Bairoch (1988)].

Innovation is among the main drivers of industrial development leading to economic growth. However, the question triggers that what drives innovation? Is innovation driven by specialisation or diversification? Glaeser, *et al*. (1992), Daniele and Mario (1994), Franco, *et al*. (1997), Mario and Valentina (1996), Andre (2006), Mancusia (2003), Ludovico and Wilson (1998), Anton (2014) and Altuzarra (2010) provides support for the specialisation—specialisation drives growth. Specialisation/ concentration promotes the knowledge spillover and thence innovation. On the contrary, Maryann and David (1999), Jacobs (1969), Sylvia, *et al*. (2013), Donald Fan (2012), Maria (2006), Alison, *et al*. (2011), Robert and Hopkins (1981) are of the view that diversity of economic activity is more conducive to innovation than specialisation.

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Existing literature provides mix evidence. The evidence varies by regions and the way innovation is defined. Innovation is itself complex to define. Authors have used different approaches to define innovation. Some have used product advancement as innovation while others have used more complex definition. For example, Maryann and David (1999) are of the view that innovation could be anything if it comes under the umbrella of any one of the four: product is entirely new in the market, a newly introduced product of the same product category, the product is modified/ improved according to the latest technology & lastly, the product design in modest.

Likewise, according to Zemplinerová and Hromádková (2012), the firm is innovative if they take any of the following activity; introduced new/ extensively improved product or services, introduced new/ extensively improved production method/ or supporting activities related to production like, logistic, distribution, IT, accounting, or any ongoing innovation activity. Suresh, *et al*. (2009) develops an extended model of innovation. Their model incorporates the role of both owner and firm characteristics, they used this to determine how product, process, marketing and organisational innovations should vary with firm size and competition. The definition given by Suresh, *et al.* (2009) is an extension of the definition provided by Maryann and David (1999) and Zemplinerová and Hromádková (2012).

However, the questionnaire remains what drives this innovation? Specifically; is specialisation more important for innovation process or diversification leads to innovation? As indicated earlier literature has provided mixed result. Glaeser, *et al*. (1992) after providing in-depth review of Marshall (1890), Arrow (1962) and Romer (1986) formulated a new model—The Marshall-Arrow-Romer model. This model formalises the insight that the concentration of an industry in a city promotes knowledge spillovers between firms and therefore would facilitate innovation in that city-industry observation. This type of concentration is also known as industry localisation [Loesch (1954)]. However, Jacobs (1969) argues that the most important source of knowledge spillovers is external to the industry in which the firm operates and that cities are the source of innovation because the diversity of these knowledge sources is greatest in cities. Thus, Jacobs develops a theory that emphasises that the variety of industries within a geographic region promotes knowledge externalities and ultimately innovative activity and economic growth.

Further to this the specialisation variable reflects the degree to which a firm is specialised. A higher value of this measure indicates a greater degree of specialisation of the firm in that industry. Thus, a positive coefficient would indicate that increased specialisation within a city is conducive to greater innovative output and would support the Marshall-Arrow-Romer thesis. A negative coefficient would indicate that greater specialisation within a city hinder innovative output and would support Jacobs' theory that diversity of economic activity is more conducive to innovation than is specialisation.

In case of Pakistan, to the best of the knowledge there is no empirical evidence available to date. Therefore, the main purpose of the study is to empirically explore the argument whether innovation in Pakistan is driven by specialisation or diversification across the cities of Pakistan. The empirical analysis is based on the Investment Climate Survey (ICS) of 2007 provided by the World Bank. The study first developed a measure to represent innovation process in a firm, secondly it develops indices to measure the

extent of specialisation and diversification in a firm, finally the determinants of innovation are explored keeping emphasise on specialisation and diversification. The argument is tested by using logit model. Our results provide support for the diversification theory i.e. in case of Pakistan. Diversity is leading to innovation which successively leads to economic development.

The study is organised as follows. In Section 2, the study has discussed the history of innovation in the context of Pakistan. The detailed methodology and data used have been discussed in Section 3. Finally, the empirical results and conclusion are mentioned in last section.

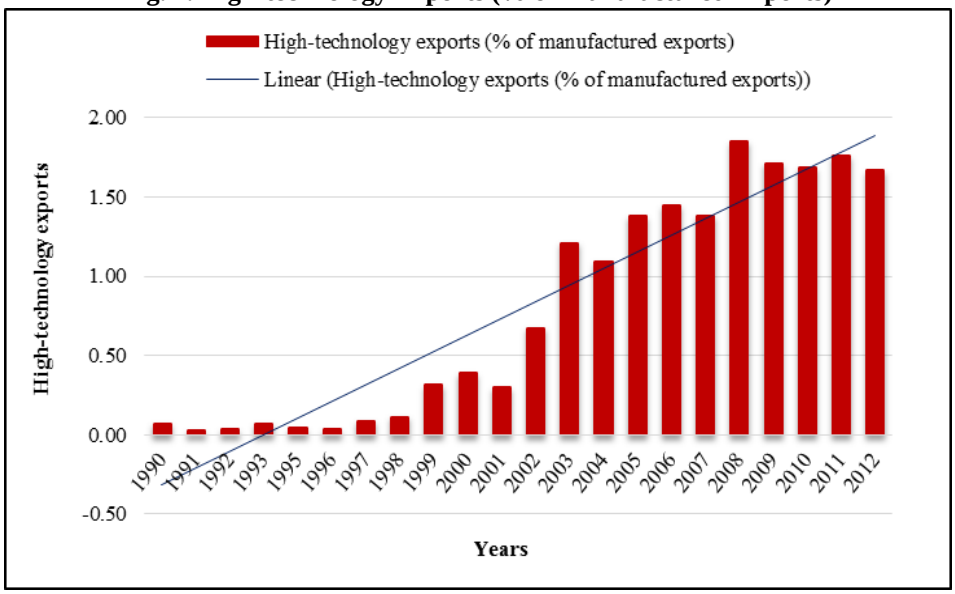
2. INNOVATION IN PAKISTAN

Data provides no specific variable that can be used to explain the process of innovation by firms in Pakistan. In order to understand the innovation process in Pakistan, we have used different proxies to explain innovation. These proxies help us in understanding the process of innovation in Pakistan over time. First proxy is high technology export. Kirsty (1986) analysed the causality between exports and innovation and concluded that high-tech exports explain innovation.

As portrayed in Figure 1, there is a very small share of high-technology goods in total manufacturing sector exports. In 90's decade, there is an approximately stagnant trend but since after there is a dramatic increase in high-technology exports. This indicates that in the last 15 years, there is a 15 folds' increase in high-technology exports.

Trademark is another indicator which illustrates the innovation trend. Trademark application is the registration of a distinct sign for a product or service to authorise owner or enterprise an exclusive right to use it. Sandro, *et al*. (2004) defined trademark as the complimentary variable of innovation.

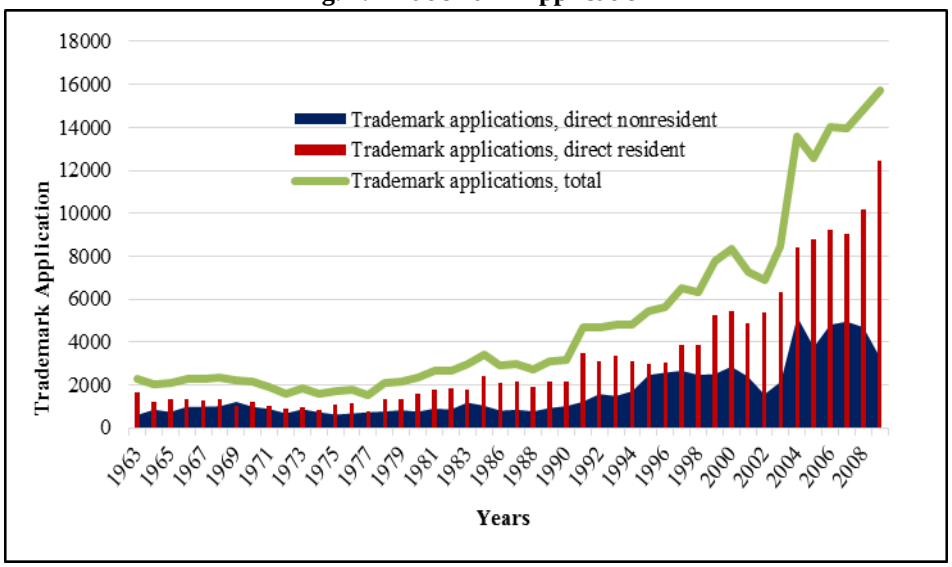
Fig. 1. High-technology Exports (% of Manufactured Exports)



Source: Authors Illustration (ICS, 2007).

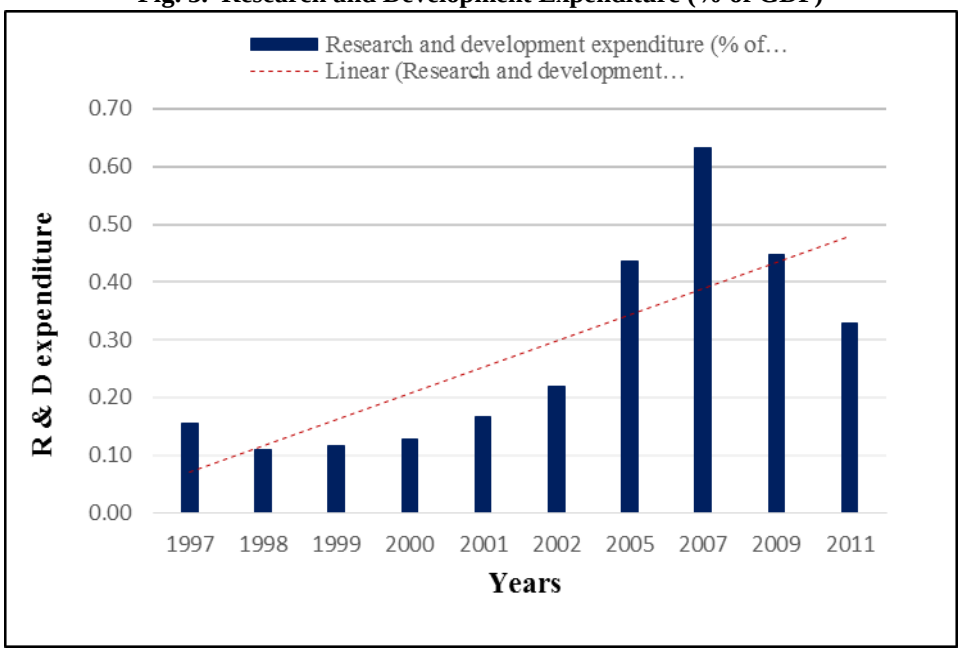
Figure 2 portrays the trademark application taken by both resident and non-resident firms over the period of 1963 to 1990. As depicted in the figure, on average, the application by resident firm is twice as of the non-resident. It can be analysed that trademark has a positive trend over the period. Though, from 1963 to 1990, a fluctuating trend can be observed, but since 1990 there is rigorous boost in trademark application.

Fig. 2. Trademark Application



Source: Authors Illustration (ICS, 2007).

Fig. 3. Research and Development Expenditure (% of GDP)



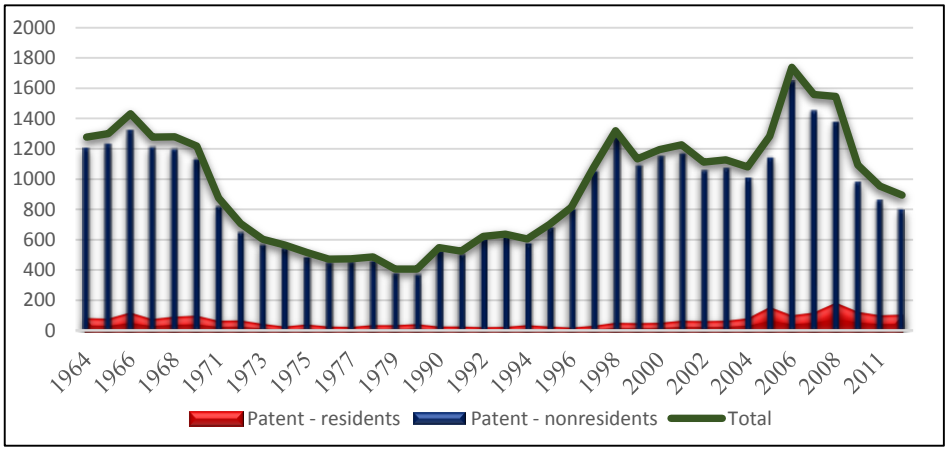
The early studies have taken Research and Development expenditure as a proxy of innovation. According to the studies, innovation is an outcome of research and development and to measure innovation in monetary terms, these studies have taken research and development expenditure as the innovation proxy.

To analysis the trend of R&D in Pakistan, the data on Research and Development Expenditure as a % of Gross Domestic Product (GDP) from 1997 to 2011 is used. The data is extracted from World Development Inidces. The data shows a fluctuating trend but the trend line indicates a positive trend forthe last 15 years.

Finally, patent appliciations as a proxy of innovation has been explored in the study. This proxy of innovation has an exlusive rights for an invention, i.e. a product or process that provides a new way of doing something or offers a new technical solution to a problem. Likewise, the recent literature, have used patent registered as innovation—[Feldman and Audretsch (1999)]. Which showed that R&D is an input to innovation while patents are output to innovation. Therefore, R&D as innovation indicator will over estimate the actual innovation. Hence in the context of Pakistan, the study has also explored the patent application as a proxy of innovation over the period of 1964 to 2012.

Figure 4 depicts fluctuations in patent application by resident and non-resident over the period 1964 to 2011. From the figure it can be inferred that first patent application increases initially then after 1966 it decreases over the 1980's decade. While through the 1990's and mid of the 2000's decade there was increasing trend and then gradually started decreasing.

Fig. 4. Patent Application (Resident/Non-Resident)



Source: Authors Illustration (ICS, 2007).

3. METHODOLOGY AND DATA SOURCES

Considering the research objectives, following equation is used to empirically test the hypothesis.

$$Innov_i = \beta_0 + \beta_1 Spe_i + \beta_2 SBD_i + \beta_3 Com_i + \beta_4 UB_i + \beta_5 FP_i + \beta_6 ED_i + \beta_7 TRA_i + \beta_8 ME_i + \mu_i \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

Where;

Innov = Reflects both Product and Process Innovation.
Spe = Skilled Workers over total workers.
SBD = whether the firm is science based or not.
Com = Competition, i.e. No. of competitors firm faces.
UB = Urban population over total population of the city in which that specific firm exists.
FP = Female participation in that firm.
ED = Average education level of typical production workers.
TRA = whether permanent or non-permanent employees are given formal training.
ME = Education level of top management.

Generally, definition of innovation can be split into four sub-components, defined in the Bogota and Oslo manuals as: (1) Product innovation: the introduction of a good or service that is new or substantially improved. (2) Process innovation: the introduction of a new or significantly improved production or delivery method. (3) Marketing innovation: the implementation of a new marketing method involving significant changes in product design or packaging, product promotion or pricing. (4) Organisational innovation: involves the creation or alteration of business practices, workplace organisation, or external relations.

Due to data constraint in Pakistan, the study has used product and process innovation as described in Bogota and Oslo manuals as an innovation proxy only. The data for product and process innovation is taken out from ICS 2007. The Product innovation means that the introduction of a good or service that is new or substantially improved. Secondly, the Process innovation which means that the introduction of a new or significantly improved production or delivery method. The product and process innovation are the dummy variable, i.e. if the firm is innovative by product or process then the respective variable will be equal to 1 else 0. Likewise, the innovation variable is the sum of both product and process innovation i.e. if the firm is innovative by product or process or both then the innovation variable is equal to 1 or 0.

Likewise, SPE in the equation represents specialisation. Here two proxies of specialisation have been used: (1) the ratio of total employees in a firm over total employment of that industry. (2) the ratio of skilled workers over total workers in a firm. The ratio ranges from 0 to 1. The higher the ratio, i.e. closes to 1, will represent that the firm is highly specialised and the lower value, i.e. closes to zero, will represent that firm is less specialised. Hence, a higher value of this variable indicates the greater degree of specialisation of the firms. Consequently, a positive sign of coefficient will indicate that specialisation is more beneficial for innovation and would support Marshall-Arrow-Romer model [Glaeser, *et al.* (1992)]. A negative sign will indicate that specialisation hinders innovation and would support Jacob's theory [Jacobs (1969)].

Similarly, SBD represents science-based diversity. The presence of science-based related firms are included in our analysis because science based firms are those who are currently using technology licensed with foreign-owned company. If the firm is using technology licensed from foreign owned company, then SBD will be equal to 1 else 0. The positive sign of science based firm would indicate that firms using foreign

technology are conducive to innovation and would support Jacob's theory [Glaeser, *et al*. (1992)]. On the contrary, the negative coefficient would indicate that greater presence of firms using foreign technology impedes innovation and support Marshall-Arrow-Romer Model [Glaeser, *et al*. (1992)].

COM represents competition in the analyses to show the impact of competition on innovation. In measuring the extent of competition, a variable ranging from 0 to 3 i.e. how many competitors did this establishment's main product/product line faces, has been used. If there is no competitor then will be equal to zero, or if the competitor(s) is 1, between 2–5 or more than 5, then the competition variable will be equal to 1, 2 or 3 respectively. The positive coefficient will indicate that competition is advantageous for innovation and if the coefficient is negative, it indicates that competition hampers innovation.

In addition to these three main variables effect on innovation, the study has also included some control variables in the regression as well. These controls include Female participation in the firm, average education level of employees, whether permanent or non-permanent employees are given formal training and Education level of top-level management. The variable FP represents the female participation in the firm. The variable is formed by the ratio of Female Production workers over total production workers. In the same way, ED characterised by the average education attainment of a typical production worker. The ED is a weighted variable, for example, if the year of education is between 0-3 years than ED would equal to 0.10. Similarly, if the years of education are in between 4-6, 7-12 or 13 years and above then ED would equal to 0.20, 0.50 or 1.0 respectively. Similarly, TRA represents the formal training to permanent and non-permanent workers. The variable again has been given weight of 0.5 each. For example, if a firm is providing formal training to any one, either permanent works or non-permanent workers then TRA would equal to 0.50. Similarly, if the firm is providing training to both, permanent and non-permanent workers, then TRA would equal to 1.0 for that specific firm.

The education level of top management has also been categorised in 8 different ways and each category is weighted accordingly by the degree in possession. The weights are mentioned in Appendix (Table 1A).

The analysis is based on the data set which is constructed from Investment Climate Survey (ICS) 2007, compiled by the World Bank Enterprise Group. The data is a based on cross section of 784 manufacturing firms which are located across 13 different cities of Pakistan. The descriptive analysis is provided in the annexure (Table 2A). Moreover, the correlation matrix has also been provided in annexure (Table 3A).

4. EMPIRICAL RESULTS AND CONCLUSION

The purpose of this paper was to penetrate the black box of geographic space by identifying the extent to which the organisation of economic activity is either concentrated, or alternatively consists of diverse but complementary economic activities, and how this composition influences innovative output.

Table 1 provides the estimates of Equation 1. The model is estimated using logit model. To explore the effects of innovation—both product and process innovation- on specialisation, science based diversification, competiveness, urban share of the specific firm, female participation, average education level of employees, dummy variable for employees' training and education level of top-level management.

Table 1

Result of Logistic Regression
Dependent Variable: Innovation

Variable	dy / dx	S.E.	Z
SPE	-0.092	0.0458	-2.00**
SBD	0.202	0.0829	2.44**
COM	-0.022	0.0063	-3.48***
UB	0.195	0.0450	4.34***
FP	0.231	0.0876	2.64***
ED	0.165	0.0603	2.73***
TRA	0.179	0.0786	2.28**
ME	0.124	0.0492	2.52**
Log Likelihood			-230.43464
Number of Observation			784
LR Chi2			174.98
Prob > Chi2			0.0000

Note: * denotes level of significance at 1 percent, ** denotes at 5 percent & *** denotes at 10 percent.

Our empirical findings depict that specialisation has negative and significant impact on innovation i.e. the concentration hampers innovation in the country. While, the science based diversify has a significantly positive impact on innovation which shows that diversity contributes towards the innovation. In other words, diversification is the positive driver of innovation in the case of Pakistan. Moreover, our study is consistent with the Jacob's theory i.e. a negative sign indicates that specialisation hinders innovation and the positive sign of science based firms are conducive to innovation [Jacobs (1969)]. Similarly, urban share, female participation, education level of employees, training and top management education has a positive impact on innovation. While competition in the case of Pakistan is an obstacle, i.e. the results show significantly negative impact of competition on innovation.

The objective of this study was to explore that whether innovation in Pakistan driven by specialisation or cience based diversity and to explore the determinants of innovative activity among cities of Pakistan using ICS 2007. The results show that in case of Pakistan, innovation is more driven by Science Based Diversify and specialisation hinders innovation. Therefore, innovation is driven by diversity and diversity successively leads to economic development. For the success, firms and industries must continually expenditure on R&D, technological change and innovation. There are clear policy implications of this debate in terms of policies directed towards innovation and technological change. Since in our study, the diversity thesis is correct, therefore a geographic region comprised of a diverse set of economic activities tend to yield greater output in terms of innovative activity. The key policy concerns would identify the commonalties and how to foster such diversity. Since, this research finding can provide significant and essential approach for stakeholders as well as policy makers to imitates the accomplishment of Asian economies.

APPENDICES

Table 1A

Level of Education	Weights
Less than secondary school	0.05
Secondary School	0.10
Higher Secondary School (Intermediate/A' levels)	0.20
Graduate degree (BA, BSC etc.)	0.35
Masters of Business Administration (MBA) from university in this country	0.50
Masters of Business Administration (MBA) from university in another country	0.65
Other post graduate degree (PhD, Masters) from university in this country	0.85
Other post graduate degree (PhD, Masters) from university in another country	1.0

Table 2A

Descriptive Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Innovation	784	0.140	0.348	0.0	1.0
Specialisation	784	0.618	0.212	0.0	1.3
Diversity	784	0.057	0.233	0.0	1.0
Competition	784	3.352	1.325	0.0	4.0
Urban Population Share	784	0.627	0.223	0.3	0.9
Female Participation	784	0.020	0.090	0.0	1.0
Average Education of Production worker	784	0.189	0.148	0.0	1.0
Employees Training	784	0.019	0.099	0.0	1.0
Manager Education	784	0.267	0.205	0.0	1.0

Source: Authors calculations, ICS (2007).

Table 3A

Correlation Matrix

	Innov	SPE	SBD	COM	UB	FP	ED	TRA	ME
Innov	1								
SPE	-0.1714	1							
SBD	0.3898	-0.1505	1						
COM	-0.1795	0.0584	-0.0656	1					
UB	0.2774	-0.0864	0.2223	-0.0233	1				
FP	0.1716	-0.0424	0.1213	0.0061	0.0707	1			
ED	0.3138	-0.1331	0.334	-0.1186	0.2229	0.0907	1		
TRA	0.2738	-0.1021	0.3118	-0.061	0.1561	0.0679	0.1842	1	
ME	0.3446	-0.2023	0.3863	-0.1738	0.2712	0.1459	0.4468	0.2256	1

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