CHAPTER 3

MEASUREMENT OF RANDOMNESS OF MANUFACTURING INDUSTRIES IN INDIA

As pointed out in the introductory chapter, one of the objectives of this study is to measure the factor orientations of various manufacturing industries in India. But before measuring the factor orientations of various industries, it is necessary to examine, whether the manufacturing industries in India are systematically located or they are footloose. Some investigations have concluded that, some of the manufacturing industries in India are footloose and their location pattern cannot be explained in terms of classical Weberian framework.¹ The present chapter attempts to critically examine one of these studies. After that a measure of randomness is developed and then an attempt is made to use this measure of randomness in exploring the fact that a significant proportion of manufacturing firms in India has located systematically and therefore is not footloose.

3.1 A Review of the Study of Footlooseness

M.L. Pandit in his study of Industrial Development in Punjab and Haryana, has tried to prove that most of the industries which had developed in this region over the years did not enjoy any apparent locational advantage. He points out that since these industries developed in this region without any locational advantage, therefore, they could be called 'footloose' and on this basis he has also questioned the validity of the conventional location theory in studying the spatial pattern of location of such industries. The study under review took twelve most important industries (namely, Hosiery, Sports goods, Rubber goods, Water pipe fittings, Hand tools, Bolts and nuts, Agricultural implements, Machine tools, sewing machine and parts, Bicycle and parts, Automobile parts and scientific instruments) of this region and tried to reach the conclusion that despite having no locational advantages in terms of market or material, these industries have dominated the industrial development of this region.

This study takes Alonso's definition of footlooseness as its base. According to this definition "Industries that have no strong locational preferences, and particularly industries that are not transport oriented are often called foot-loose, and there
is a good reason to believe that technical developments are making more industries foot-loose".\(^2\)

Pandit points out that an industry is transport oriented, when costs involved on the transfer of raw materials and finished products constitute a significant proportion of total cost. The manufacturers, in order to economise these costs locate their concerns in close proximity of the sources of material supplies and/or market areas. He points out that in case of foot-loose industries, transport costs constitute an insignificant proportion of the total cost. Naturally, the temptation of the industrialist to locate his plant in the proximity of material supplies and markets is weak. The manufacturers, therefore, enjoy a great deal of locational freedom. This freedom, as is the case of material and market oriented industries, is not restricted by the locations of raw material and market areas. He says that costs of production and distribution in case of foot-loose industries do not vary noticeably from location to location due to variations in transport cost component. Thus these industries enjoy a great degree of locational freedom.

Pandit's study further says that industries requiring a large variety of inputs and producing a variety of products also enjoy a great deal of locational freedom. In their case, distance from one source of input or market is compensated by proximity of the other. Such industries, the study says may also be referred to as footloose. In the words of Pandit "Perhaps, the term 'footloose' industry can be explained by referring to a hypothetical person with a perfectly flexible foot. A shoe of any size fits such a person. Naturally, the person enjoys much greater degree of freedom to choose his shoe than a person whose foot is size specific. His choice is restricted to the size of his foot. Foot-loose industry, to continue the parallel with a person who has a flexible foot size, is not, therefore constrained by the location of material and markets. It therefore, enjoys a great deal of locational freedom". ³

But later on in the study he modifies the definition of footloose industries a little, keeping in view the freight equalisation policy of govt. of India. Later on he points out, "As transport costs were borne by the government, the prices of basic industrial raw materials came to be more or less equalised throughout the country. Industries using mostly these materials, therefore, became foot-loose in respect of location of their

sources of material supplies. When an industrialist has not to pay for the transport of his raw materials, costs arising on this account do not influence his locational decisions. Naturally, in India the classification of industries into foot-loose and other categories cannot be undertaken on the basis of transport costs". 4

Thus in view of the above facts he delinks the operational definition of footloose industries from transport costs. His operational definition of footloose industries is "A foot-loose industry, for the purpose of the present study, was defined as one whose material inputs come from outside the region and the bulk of whose output is also sold outside the region". 5

After defining footloose industries Pandit, through various kinds of data substantiates his contention, that since the sources of raw material supplies and market outlets for the finished product of these industries are mainly located outside the region, therefore they are foot-loose.

He has also tried to explore the locational determinants of these manufacturing industries located in Punjab and Haryana by contacting the first generation of entrepreneurs. On the basis of field survey, the study reveals "that the region enjoys a

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5 Ibid, p. 56.
decisive advantage in respect of specific skills for the selected foot-loose industries. Availability of these skills on a large scale and at very favourable terms has constituted a major factor of growth of these industries". 6

The study observes that influx of urban refugees from West Pakistan to this region, due to division of country at the time of independence, had helped a lot in development of these industries in this region. The people who migrated from West Punjab after partition were having long experience and skill in these kind of industries. According to this study, the influx of skilled labour having a very long experience of this kind of industrial production, the easy availability of capital due to rehabilitation programmes of government in this region and import substitution policy of government, had been the major factors for the location and development of selected industries in the region. Pandit has also referred to the fact that wage cost of skilled labour required for these industries in this region has always been lower as compared to other regions. On the other hand the productivity has been higher as compared to other regions. Most of the production of these selective industries have been through labour intensive techniques.

Pandit is in complete agreement with Klassen, that in Weberian analysis the optimum location is determined by the principle of minimum transportation costs. Other considerations such as the proximity of a market and its influence on the size of the firm and labour costs, are all treated as causing greater or smaller deviations from the optimum calculated from transportation costs. Thus in his study Pandit has taken account of material and market orientation and has not considered labour orientation and agglomeration orientation about which a lot has been mentioned in Weberian analysis.

It is felt here that this is one of the serious limitations of this study. This study has applied only a partial view of Weber's factors of location and on the basis of that, the conclusion has been drawn that these selective group of industries has developed in the region of Punjab and Haryana without any locational advantage and thus they may be called foot-loose. However while exploring the causes of location of these so called foot-loose industries in this region the study reveals that the skilled labour required for the production of these type of products were available in this region at a very low wage rate. The study under review, also concedes the fact that because of this, the entrepreneur of this region adopted a labour intensive technique and productivity of these labourers in
this region in these industries was much higher as compared to other regions of the country. Thus it is felt that this region certainly had a locational advantage of cheap skilled labour and thus the location of these industries in this region can easily be explained under Weberian framework, if labour orientation factor is taken into account.

This situation can also be explained by the comment of Dicken who says about increasing American investment in the third world "In Weberian terminology it would appear that these labour locations fall within the critical isodopane for specific types of production. Transport costs are more than offset not only by low wages but also by the fact that labour productivity is as high as, if not higher than, that in the United States".\(^7\)

Therefore, the present researcher feels that the development of these selective group of industries in the region of Punjab and Haryana is a typical case of labour orientation, under weberian framework and therefore these industries are not basically footloose. Thus this opinion of M.L. Pandit that "A study of industrial development of a region, where most industries do not enjoy any apparent locational advantage offers two significant clues. On the one hand, it questions the conventional theory of location and on the other generates a new

\(^7\) P. Dicken, op.cit., p. 141.
wave of industrial optimism in industrially backward and lagging regions\textsuperscript{8}, needs to be examined thoroughly, but this is beyond the scope of the present study.

3.2 \textbf{Measurement of Non-Randomness of Indian Manufacturing Industries}

The present investigation tries to define foot-looseness in a somewhat different manner. Foot-looseness has been defined here in terms of randomness and non-randomness. If a very large proportion of manufacturing Industries in India is foot-loose or free to locate in any of a large number of locations based upon primarily non-economic factors, then one might expect a greater degree of dispersion or randomness in location than if non-randomly distributed economic factors are important in determining the location of most firms. While randomness in location is not a perfect substitute for the degree to which industries are foot-loose, an investigation of randomness may nevertheless yield significant information in this regard. The methodology of measurement of randomness of industries used here, has been taken from Latham's study.\textsuperscript{9} But it has been used in the present study with some modification.

\textsuperscript{8} M.L. Pandit, \textit{op.cit.} p. 2.

\textsuperscript{9} W.R. Latham, \textit{op.cit.}, pp. 23-27.
The approach followed here defines randomness in location to mean that firms locate their plants among 367 regions, taken up in the study, randomly i.e. with equal probability. A test of randomness then consists of comparing the actual distribution of plants with a distribution that would be expected if the pattern was random by means of a Chi-square test. Several adjustments to this procedure as well as two possible interpretations of the random comparison distribution are described below.

The first problem confronted here is that existing plants may not be the best measure of a firm's location decision. A very large plant may result from the decision to place a number of more basic units of productive capacity at a given location, possibly to take advantage of any economies of scale that might exist within the firm. Thus the large plant in a single region should receive more weightage than a small plant in another region when comparing with a hypothetical random distribution. Essentially, one is interested in the spatial distribution of capacity in an industry and not simply the number of plants.

If this is accepted, one is then confronted with the necessity of defining the basic unit for each industry. It may be assumed that the smallest level of operation observed in an industry among all geographic regions in which that industry is present at a non zero level, minimum $x_{i,j} = \text{MIN}_i$, is the level at
which a firm in that industry can operate economically in any single location. This level might be of sufficient magnitude to permit the firm to reap the benefits of a large part of any economies of scale within the firm and/or industry which are possible for firms in the industry.

If the total output of any industry, $\sum X_{ij}$, is divided by this smallest size, $\text{MIN}_i$, which might be thought of as the minimum 'efficient' level of output, the result is a number that can be interpreted as the maximum number of geographically separate economically feasible operations of which that industry is capable. The integer value of this number can be used as a proxy for the number of basic units or firm clusters, $n_i$, in the industry, $i$, which must be located in the $j$ regions.

Now, one must specify what a 'random' distribution of the $n_i$, clusters would be. It might be quite realistic to assume that firms locating their clusters 'randomly' would choose the various regions with other than equal probability. Randomness could mean that probability of a given firm locating in a given region was equal to the proportion of: (a) total population in that region, (b) industrial activity (Rupee value or employment) in that region or (c) total land area in that region. However, proportions of total population and industrial activity are undesirable measures because these magnitudes reflect the
presence of a given set of industries to the extent that people locate near jobs more than the converse. Proportion of land area is desirable because not only land area, but also the characteristics of the land are important locational consideration. It is both difficult and hazardous to subject the qualitative characteristics of land to a precise quantitative analysis. Thus for the above mentioned reasons it is assumed here that randomness means random selection among regions with equal probability of choosing each region. One difficulty which does remain unresolved here is that regions used in the study are defined on the basis of administrative boundaries.

Each of the $n_i$ clusters in each of the $i = 1, 2, \ldots, 66$ industries must locate in one of the 367 regions. If clusters decide among alternative regions with equal probability (randomly) then the probability of choosing any specific region is $p = 1/367$. In considering any single region, each cluster may be located there or not, and thus the probability that $C_{ij}$ of the $n_i$ clusters in industry $i$ are located in a specific region, $j$, has been obtained by Latham as the Binomial probability

$$B_i(C_{ij} = C_{ij} | n_i, p) = \frac{n_i!}{C_{ij}! (n_i - C_{ij})!} \frac{C_{ij}}{1-p} \frac{n_i - C_{ij}}{p}$$

or because $p$ is small, as the Poisson probability

$$P_i(C_{ij} = C_{ij} | n_i, p) = \frac{(n_i p)^{C_{ij}} e^{-n_i p}}{C_{ij}!}$$
where $B_i$ - represents Binomial probability of number
$P_i$ - represents Poisson probability of number
$C_{ij}$ - Number of clusters in a region
$n_i$ - number of basic units or firm cluster, in the industry, $i$, which must be located in the $j$ region.

The expected number of regions in which each possible number of clusters ($c_{ij} = 0, 1, \ldots, n_i$) appears has been found as $P_i \times 367$. The distribution of observed number of clusters has then been compared with the distribution of expected numbers by means of an appropriate statistical test, such as the Chi-square. The format for such a test is shown below:

<table>
<thead>
<tr>
<th>$C_{ij}$ Number of clusters in a region</th>
<th>$P_i(c_{ij} = C_{ij})$ Binomial or Poisson probability of number</th>
<th>$E_{ij} = (367)P_i(c_{ij} = C_{ij})$ Expected number of regions</th>
<th>$O_{ij}$ Observed number of regions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$P_i(c_{ij} = 0)$</td>
<td>$E_{i,0}$</td>
<td>$O_{i,0}$</td>
</tr>
<tr>
<td>1</td>
<td>$P_i(c_{ij} = 1)$</td>
<td>$E_{i,1}$</td>
<td>$O_{i,1}$</td>
</tr>
<tr>
<td>\ldots</td>
<td>\ldots</td>
<td>\ldots</td>
<td>\ldots</td>
</tr>
<tr>
<td>$n_i$</td>
<td>$P_i(c_{ij} = n_i)$</td>
<td>$E_{i,n_i}$</td>
<td>$O_{i,n_i}$</td>
</tr>
</tbody>
</table>

$$\chi_i^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

If $\chi_i^2 > \chi^2_{1,0.05}$, the hypothesis that clusters in industry are randomly located is rejected.
But due to large numbers involved and the cost of performing such a test many times, an alternative to the above test has been used by Latham. The expected number of clusters of industry located in each region has been assumed to be \((n_i)p\), where \(p = 1/367\). The distribution of expected numbers of clusters is compared with the observed numbers in each region by means of Chi-square test, similar to the one above, utilising data which can be presented as follows:

<table>
<thead>
<tr>
<th>Region number</th>
<th>(E_{i,j}) Expected number of clusters</th>
<th>(O_{i,j}) Observed number of clusters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(E_{1,1} = n_1p)</td>
<td>(O_{1,1})</td>
</tr>
<tr>
<td>2</td>
<td>(E_{1,2} = n_1p)</td>
<td>(O_{1,2})</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td>...</td>
</tr>
<tr>
<td>367</td>
<td>(E_{1,367} = n_1p)</td>
<td>(O_{1,367})</td>
</tr>
</tbody>
</table>

The Chi-square statistic is then calculated as above. More formally then, industry is not randomly located, if and only if,

\[
\chi_i^2 \geq \chi_{1,\alpha}^2
\]

Where \(\alpha\) is a pre selected level of significance (0.95 in this case); \(\chi_{1,\alpha}^2\) is the value of \(\chi^2\) which, if exceeded, permits one to conclude that the observed distribution is different from the one.
that would be expected if industrial location of plants was random over all locations; and where

\[ (O_{ij} - n_i/367)^2 \]

\[ \chi_i^2 = \sum_j \frac{(O_{ij} - n_i/367)^2}{n_i/367}, \quad n_i = \sum_j X_{ij}/MIN_i \]

\[ O_{ij} = X_{ij}/MIN_i \]

\[ MIN_i = \text{Minimum (} X_{ij} \text{)} \]

If clusters of firms in the various industries are not 'randomly' located, then one would expect that for large number of industries, the results of the above test would indicate that the distributions are different.

In the present study, however, instead of Binomial or Poisson distribution, multinomial distribution is used. The multinomial cell frequencies also tend to normal distribution if the number of observations is very large as in this case. Thus the contingency chi-square has been computed directly with rows representing industries (66) and columns representing locations, the 367 districts. Thus, the null hypothesis is that the row probabilities as well as column probabilities are equal. This means that each industry could be located in any of the 367 districts with equal probability and any district can have any of the 66 industries with equal probability. The
expected number of units of the ith industry in the jth district equals:

\[
\frac{n_in_j}{\sum_i \sum_j n_{ij}},
\]

Then the Chi-square has been calculated, by taking the expected frequencies as

\[
\frac{n_in_j}{\sum_i \sum_j n_{ij}},
\]

and the observed frequencies as

\[
\frac{X_{ij}}{\text{Min}_i} = O_{ij}
\]

Where \(n_i\) is the row total, \(n_j\) is the column total and \(n_{ij}\) the cell frequency in Cell \(ij\).

It is observed that values of \(\chi_i^2\) for all the 66 industries taken up in the study is higher than the critical value of \(\chi_i^2\) at 0.95 level of significance. Thus all the 66 industries used in this study were found to be non randomly located by the above measure. Examination of the individual industry distributions reveals the reason for this result. For most industries, there are a large number of regions in which the observed number of clusters \((O_{ij})\) is zero. In such cases, the value of \(\chi^2\) is

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increased by the value of the expected number of clusters for zero observation region. While this result is not very helpful and a better method of testing for randomness should be devised, the results show at least that there is not a strong degree of randomness in location of manufacturing industries in India.