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Probability Models For Explaining Migration Process From Eastern Uttar Pradesh, India

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Abstract This paper aims to examine the pattern of male out-migration and explains the distribution of households according to number of male migrants aged fifteen and above. The suitability of proposed model is tested with primary data collected from remote and semi-urban areas of Varanasi, 2012. Findings highlight that the average number of clusters from the remote households is higher and the average number of individuals per clusters is lower in comparison to the semi-urban villages. The average number of migrants per household has increased with increasing size of households in the remote as well as in semi-urban villages. The average number of migrants per household is higher among upper caste followed by middle caste, Muslims and scheduled caste from the study area. Average number of migrants per household has increased over six times in the low economic status of the households. In the medium and high economic status of the households, average number of migrants per household is found to be around three and two times more respectively, over the last three decades. The increasing average number of migrants per household portray that an increasing propensity of adult male migration from the study area. Over 2.7 times increase in the average number of migrants per household may be primarily due to increasing man-land ratio in the absence of relative growth in employment opportunities. Thus, the existing imbalances in demand and supply of gainful employment opportunities in the region may be the key to continuously increasing the number of migrants per households from the region.

Keywords: Migrants, household, poison distribution, geometric distribution, remote, semi-urban.

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1. INTRODUCTION

A number of attempts have been made during the past few decades to explain the migration process through migration models [4], [7], [2], [5], [6], [16], [17], [1], [10], [12], [3], [22], [23]. However, most of these previous researchers have focussed on aggregate variation in movement in relation to various social, demographic and spatial characteristics. These authors have utilized mostly a macro approach by operating on highly aggregated data for countries, states and the nation as a whole. These studies of migration may not provide adequate explanation for tremendous regional and local heterogeneity in planning, especially in developing countries.

Micro-level research on both residential mobility and migration has played a decisive role to the development of a theory of migration [14], [3], [9]. Micro-level studies may be done on community, village, households or individual level itself depending upon the need and availability of data.

In the area under study, there are mainly two types of migrants. First, an adult male aged fifteen years and above, migrated alone to the place of destination leaving his wife and children at the place of origin. Such a person maintains close links with his household in the village, sends remittances and visits the household at regular intervals of time. Secondly, those migrated with wife and children. In fact, the characteristics of the two types of migrants are usually different, which in turn may lead to a rise in the level of socio-cultural activities of the households. In the former case, there is only male migration, while the later type consists of the females and/or children too, which are more likely to affect the socio-cultural characteristics of the households. Thus, it is more important to investigate the nature and pattern of number of migrants from the household in the study area.

In the recent years, increased attention has been paid to the proposition and derivation of probability models for the movements of human population at micro-level [21]. In this regards [16], have used the negative binomial distribution to study the pattern of rural out-migration at households level. The distribution is applied to the data on migrants (male aged fifteen years and above) from a household taken from the demographic survey of Varanasi (rural), 1969-70. The negative binomial distribution described the observed distributions. Sharma (1984) [19] has examined the suitability of this model applying it to another set of data from “Rural Development and Population Growth” - A sample survey, 1978 and concluded that it fits the data satisfactory well. However, the model is not suitable for the total number of migrants (including females and children) from a household. As described earlier, migrated female are more likely to affect the socio-cultural characteristics of households in comparison to other females of the household. It is important to study the pattern of total number of migrants from household.

In this connection, Sharma (1984) [20] has proposed a probability distribution for the total number of migrants from a household under the assumptions that

1. The number of male migrants aged fifteen years and above follows a negative binomial distribution
2. The distribution of living children to a couple is known
3. There is no female migration from a household

Under these assumptions, he derived a distribution for the total number of migrants from a household and examined its suitability. However, this model suffers from a limitation that the distribution of living children should be known.

Further, Singh (1985) [18] has proposed another probability distribution as a mixture of Negative binomial and Thomas distribution to describe the pattern of total number of migrants from a household under certain assumptions.

Johnson and Kots (1969) [8] have given the Polya-Aeppli distribution which is useful for the situation where events (which are to be counted) occur in clusters, the number of clusters follows a Poisson distribution and the number of individuals per cluster has a geometric distribution. They have applied this distribution to the number of quadrants per plant, to the ecological data. However, the situation in the migration process is similar to the above distribution to represent the pattern of migrants from a household.

The purpose of this paper is to analyse the changes in the pattern of male out-migration from Eastern Uttar Pradesh and the factors responsible for those changes

2. DATA SOURCE AND METHODS

This study is based on information collected from selected villages of Varanasi district and focus at the pattern of migration by adopting a modified definition of a household, which is often adopted for migration studies which are conducted at the places of origin. This study followed the definition adopted by Rural Development of Population Growth (RDPG) [13] survey, 1978 "*A household will be defined as a group of people who usually stay together and share a common kitchen, inclusive of persons usually living outside of the village but claiming to belong to the respective households.* The villages included in the RDPG survey of Varanasi district is classified in two groups based on the distance from Varanasi city, forming two strata. The villages located within the radius of 3 km from the Varanasi city formed the first stratum, known as semi urban villages; while those situated beyond

3 km from the city constituted the second stratum called remote villages. The researcher randomly selected three villages from the 8 and 6 villages included in the RDPG from the above two strata respectively. The sample included a total of 1300 households from 6 villages by complete enumeration. The data was collected in February-April, 2012 through personal interview method and migration record including questions on the present age, education, marital status, occupation, age at migration, year of migration, place of migration, reasons of migration, remittances, etc. for each migrated person of the households. To fulfil the objective of the study compound distribution of Poisson and Geometry distribution has been applied.

2.1 Model for Number of Male Migration Aged Fifteen Years and Above

2.1.1 Model A_1

In this section, based on certain assumptions, the distribution of number of male migrants aged fifteen and above has been presented. Let X denote number of male migrants aged fifteen and above from a household. We proposed the distribution of X under the following assumptions,

1. The migrants from a households move in clusters, the number of clusters Y, having a Poisson distribution

$$P(Y=j)=\frac{e^{-\theta}\theta^{j}}{j!},\theta>0 \tag{1}$$

$$j=0,1,2,3,.....$$

2. The number of individuals per cluster z, has the geometric distribution

$$P(Z=k)=q^{k-1}p \tag{2}$$

$$k=1,2,3,....$$

$$q=1-p$$

Under the above assumptions,

3. The probability of a household having no migration is

$$P(x=0)=e^{-\theta} \text{ for j=0} \tag{3}$$

since there is no clustering

Further, let us suppose that Z_1, Z_2, Z_3, ..., Z_j are j clusters originating from a household, then the probability of household having k migrants (k = 1,2,3, ...) will be equal to

$$P\left[X=k\right]=P\left[Z_1+Z_2+\ldots\ldots\ldots+Z_j=k \text{ and } Y\text{=j}\right]$$

Obviously,

$$\begin{aligned}P\left[X=1\right]&=P\left[Z_1=1 \text{ and } Y\text{=}1\right]\\&=P\left[Z_1=1\right]P\left[Y=1\right]\\&=pe^{-\theta}\end{aligned} \quad (4)$$

Similarly,

$$\begin{aligned}P\left[X=2\right]&=P\left[Z_1=2 \text{ and } Y\text{=}1\right]+P\left[Z_1=1,Z_2=1 \text{ and } Y\text{=}2\right]\\&=P\left[Z_1=1\right]P\left[Y=1\right]+P\left[Z_1=1\right]P\left[Z_2=1\right]P\left[Y=2\right]\\&=\text{q}\ \ \text{p}e^{-\theta}+\text{p}^2\,\frac{e^{-\theta}\theta^2}{2!}\\&=e^{-\theta}\theta p\left(q+\frac{1}{2}\theta p\right)\end{aligned} \quad (5)$$

$$\begin{aligned}P\left[X=3\right]&=P\left[\text{Z}_1\text{=3 and } Y\text{=}1\right]\\&+P\left[Z_1=2,\ \text{Z}_2\text{=1 and } Y\text{=}2\right]\\&+P\left[\text{Z}_1\text{=1, Z}_2\text{=2 and } Y\text{=}2\right]\\&+P\left[\text{Z}_1\text{=1, Z}_2\text{=1, Z}_3\text{=1 and } Y\text{=}3\right]\\&=P\left[Z_1=3\right]P\left[Y=1\right]+P\left[Z_1=2\right]P\left[Z_2=1\right]P\left[Y=2\right]\\&+P\left[Z_1=1\right]P\left[Z_2=2\right]P\left[Y=2\right]\\&+P\left[Z_1=1\right]P\left[Z_2=1\right]P\left[Z_3=1\right]P\left[Y=3\right]\\&=P\left[Z_1=3\right]P\left[Y=1\right]+2P\left[Z_1=2\right]P\left[Z_2=1\right]P\left[Y=2\right]\\&+P\left[Z_1=1\right]P\left[Z_2=1\right]P\left[Z_3=1\right]P\left[Y=3\right]\\&=q^2pe^{-\theta}\theta+2p^2q+\frac{e^{-\theta}\theta^2}{2!}+p^3\,\frac{e^{-\theta}\theta^3}{3!}\end{aligned} \quad (6)$$

$e^{-\theta}$ for j = 0

In general.

$$P[X=k]=e^{-\theta}q^{k}\sum_{j=1}^{k}\binom{k-1}{j-1}\left(\frac{\theta p}{q}\right)^{j}\Big/ j! \quad \text{for } k=1,2,3\ldots\ldots \tag{7}$$

1. Probability of households having one migrant (k = 1) from cluster one (j = 1)

$$p(k=1)=e^{-\theta}q\left(\frac{\theta p}{q}\right)^{1}$$
$$=pe^{-\theta}\theta$$

2. Probability of households having two migrant (k = 2) from cluster two (j = 1,2)

$$P(k=2)=e^{-\theta}q^{2}\,{}^{1}C_{0}\left(\frac{\theta p}{q}\right)^{1}+e^{-\theta}q^{2}\,{}^{1}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$=pe^{-\theta}\theta\left(q+\frac{\theta p}{2}\right)$$

3. Probability of households having three migrant (k = 3) from cluster three (j = 1,2,3)

$$p(k=3)=e^{-\theta}q^{3}\,{}^{2}C_{0}\left(\frac{\theta p}{q}\right)^{1}+e^{-\theta}q^{3}\,{}^{2}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}+e^{-\theta}q^{3}\,{}^{2}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}$$
$$=q^{2}pe^{-\theta}\theta+p^{2}qe^{-\theta}\theta^{2}+\frac{p^{3}e^{-\theta}\theta^{3}}{6}$$

4. Probability of households having four migrant (k=4) from cluster four (j=1,2,3,4)

$$P(k=4)=e^{-\theta}q^{4}\,{}^{3}C_{0}\left(\frac{\theta p}{q}\right)^{1}+e^{-\theta}q^{4}\,{}^{3}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+e^{-\theta}q^{4}\,{}^{3}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+e^{-\theta}q^{4}\,{}^{3}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$
$$=q^{3}pe^{-\theta}\theta+\frac{3p^{2}q^{2}e^{-\theta}\theta^{2}}{2}+\frac{p^{3}qe^{-\theta}\theta^{3}}{2}+\frac{p^{4}e^{-\theta}\theta^{4}}{24}$$

5. Probability of households having five migrant (k = 5) from cluster (j =1,2,3,4,5)

$$P(k=5)=e^{-\theta}q^{5}\,{}^{4}C_{0}\left(\frac{\theta p}{q}\right)^{1}+e^{-\theta}q^{5}\,{}^{4}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+e^{-\theta}q^{5}\,{}^{4}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+e^{-\theta}q^{5}\,{}^{4}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}+e^{-\theta}q^{5}\,{}^{4}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}$$
$$=q^{4}pe^{-\theta}\theta+2q^{3}p^{2}e^{-\theta}\theta^{2}+p^{3}q^{2}e^{-\theta}\theta^{3}+\frac{q^{4}pe^{-\theta}\theta^{4}}{6}+\frac{p^{5}e^{-\theta}\theta^{5}}{120}$$

6. Probability of households having six migrant (k = 6) from cluster (j = 1,2,3,4,5,6)

$$P(k=6)=e^{-\theta}q^{6}\,{}^{5}C_{0}\left(\frac{\theta p}{q}\right)^{1}+e^{-\theta}q^{6}\,{}^{5}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+e^{-\theta}q^{6}\,{}^{5}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+e^{-\theta}q^{6}\,{}^{5}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$
$$+e^{-\theta}q^{6}\,{}^{5}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}+e^{-\theta}q^{6}\,{}^{5}C_{5}\left(\frac{\theta p}{q}\right)^{6}\frac{1}{6!}$$
$$=q^{5}pe^{-\theta}\theta+\frac{5}{2}q^{4}p^{2}e^{-\theta}\theta^{2}+\frac{5}{3}q^{3}p^{3}e^{-\theta}\theta^{3}+\frac{5}{12}q^{2}p^{4}e^{-\theta}\theta^{4}$$
$$+\frac{5}{120}qp^{5}e^{-\theta}\theta^{5}+\frac{5}{720}p^{6}e^{-\theta}\theta^{6}$$

7. Probability of households having seven migrant (k = 7) from cluster (j = 1,2,3,4,5,6,7)

$$P(k=7)=e^{-\theta}q^{7\,6}C_{0}\left(\frac{\theta p}{q}\right)+e^{-\theta}q^{7\,6}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+e^{-\theta}q^{7\,6}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+e^{-\theta}q^{7}\,{}^{6}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$
$$+e^{-\theta}q^{7}\,{}^{6}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}+e^{-\theta}q^{7}\,{}^{6}C_{5}\left(\frac{\theta p}{q}\right)^{6}\frac{1}{6!}$$
$$+e^{-\theta}q^{7}\,{}^{6}C_{6}\left(\frac{\theta p}{q}\right)^{7}\frac{1}{7!}=q^{6}pe^{-\theta}+3q^{5}p^{2}e^{-\theta}\theta^{2}$$
$$+\frac{5}{2}q^{4}p^{3}e^{-\theta}\theta^{3}+\frac{5}{3}q^{3}p^{4}e^{-\theta}+\frac{1}{8}q^{2}p^{5}e^{-\theta}\theta^{5}$$
$$+\frac{1}{120}qp^{6}e^{-\theta}\theta^{6}+\frac{1}{5040}p^{7}e^{-\theta}\theta^{7}$$

8. Probability of households having seven migrant (k = 8) from cluster (j = 1,2,3,4,5,6,7,8)

$$P(k=8) = e^{-\theta} q^{8}\, {}^{7}C_{0} \left(\frac{\theta p}{q}\right) + e^{-\theta} q^{8}\, {}^{7}C_{1} \left(\frac{\theta p}{q}\right)^{2} \frac{1}{2!}$$
$$+ e^{-\theta} q^{8}\, {}^{7}C_{2} \left(\frac{\theta p}{q}\right)^{3} \frac{1}{3!} + e^{-\theta} q^{8}\, {}^{7}C_{3} \left(\frac{\theta p}{q}\right)^{4} \frac{1}{4!}$$
$$+ e^{-\theta} q^{8}\, {}^{7}C_{4} \left(\frac{\theta p}{q}\right)^{5} \frac{1}{5!} + e^{-\theta} q^{8}\, {}^{7}C_{5} \left(\frac{\theta p}{q}\right)^{6} \frac{1}{6!}$$
$$+ e^{-\theta} q^{8}\, {}^{7}C_{6} \left(\frac{\theta p}{q}\right)^{7} \frac{1}{7!} + e^{-\theta} q^{8}\, {}^{7}C_{7} \left(\frac{\theta p}{q}\right)^{7} \frac{1}{8!}$$
$$= q^{7} p e^{-\theta}\theta + \frac{7}{2} q^{6} p^{2} e^{-\theta}\theta^{2} + \frac{7}{2} q^{5} p^{3} e^{-\theta}\theta^{3} + \frac{35}{24} q^{4} p^{4} e^{-\theta}\theta^{4}$$
$$+ \frac{35}{120} q^{3} p^{5} e^{-\theta}\theta^{5} + \frac{7}{240} q^{2} p^{6} e^{-\theta}\theta^{6} + \frac{1}{720} q p^{7} e^{-\theta}\theta^{7}$$
$$+ \frac{1}{40320} p^{8} e^{-\theta}\theta^{8}$$

Estimation:

This distribution involves two parameters and P. These are estimated by equating the observed mean and proportion of zero'th cell with their corresponding theoretical values.

$$P_0 = e^{-\theta}$$

$$\hat{\theta} = -\ln(P_0) \tag{8}$$

and $m = \frac{\theta}{p}$

$$\hat{p} = \frac{\theta}{m} \tag{9}$$

where,

P_0: denotes the observed proportion of the zero'th cell

m: denotes the observed mean

In this way the estimates $\hat{\theta}$ and $\hat{P}$ are the parameters θ and P can be obtained from equation (8) and (9) respectively.

2.1.2 Model A_2

If we change the second assumption in the model A_1, describing the number of individuals per clusters Z, has the truncated geometric distribution.

$$P[Z'=k]=\frac{q'^{k-1}p'}{1-q'^{N}},k=1,2,3,........N'$$
$$q'=1-p'$$

where,
N is the maximum number of individuals in a cluster from the household.
Then the new model A_2 becomes

$$P[X=0]=e^{-\theta},\ \text{for}\ \ j=0$$
$$P[X=k]=\frac{e^{-\theta}q'^{k}}{1-q'^{N}}\sum_{j=1}^{k}\binom{k-1}{j-1}\left(\frac{\theta p'}{q'}\right)^{j}\Big/ j!$$

for $k = 1, 2, 3\ldots\ldots\ldots\ldots N$

1. Probability of households having one migrant (k = 1) from cluster one (j = 1)

$$P(k=1)=\frac{e^{-\theta}q}{1-q^{N}}\left(\frac{\theta p}{q}\right)$$
$$=\frac{p}{\left(1-q^{N}\right)}e^{-\theta}\theta$$

2. Probability of households having two migrant (k = 2) from cluster two (j = 1,2)

$$P(k=2)=\frac{e^{-\theta}q^{2}}{\left(1-q^{N}\right)}{}^{1}C_{0}\left(\frac{\theta p}{q}\right)^{1}+\frac{e^{-\theta}q^{2}}{\left(1-q^{N}\right)}{}^{1}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$=\frac{qpe^{-\theta}\theta}{\left(1-q^{N}\right)}+\frac{p^{2}e^{-\theta}\theta^{2}}{2\left(1-q^{N}\right)}$$

3. Probability of households having three migrant (k = 3) from cluster three (j = 1,2,3)

$$P(k=3)=\frac{e^{-\theta}q^{3}}{\left(1-q^{N}\right)}{}^{2}C_{0}\left(\frac{\theta p}{q}\right)^{1}+\frac{e^{-\theta}q^{3}}{\left(1-q^{N}\right)}{}^{2}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+\frac{e^{-\theta}q^{3}}{\left(1-q^{N}\right)}{}^{2}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}=\frac{q^{2}pe^{-\theta}\theta}{1-q^{N}}+\frac{qp^{2}e^{-\theta}\theta^{2}}{1-q^{N}}+\frac{p^{3}e^{-\theta}\theta^{3}}{1-q^{N}}\frac{1}{6}$$

4. Probability of households having four migrant (k = 4) from cluster four (j = 1,2,3,4)

$$P(k=4)=\frac{e^{-\theta}q^{4}}{\left(1-q^{N}\right)}{}^{3}C_{0}\left(\frac{\theta p}{q}\right)^{1}+\frac{e^{-\theta}q^{4}}{\left(1-q^{N}\right)}{}^{3}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+\frac{e^{-\theta}q^{4}}{\left(1-q^{N}\right)}{}^{3}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+\frac{e^{-\theta}q^{4}}{\left(1-q^{N}\right)}{}^{3}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$
$$=\frac{q^{3}pe^{-\theta}\theta}{\left(1-q^{N}\right)}+\frac{3}{2}\frac{q^{2}p^{2}e^{-\theta}\theta^{2}}{\left(1-q^{N}\right)}+\frac{3}{6}\frac{qp^{3}e^{-\theta}\theta^{3}}{\left(1-q^{N}\right)}+\frac{1}{24}\frac{p^{4}e^{-\theta}\theta^{4}}{\left(1-q^{N}\right)}$$

5. Probability of households having five migrant (k = 5) from cluster five (j = 1,2,3,4,5)

$$P(k=5)=\frac{e^{-\theta}q^{5}}{\left(1-q^{N}\right)}{}^{4}C_{0}\left(\frac{\theta p}{q}\right)+\frac{e^{-\theta}q^{5}}{\left(1-q^{N}\right)}{}^{4}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+\frac{e^{-\theta}q^{5}}{\left(1-q^{N}\right)}{}^{4}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+\frac{e^{-\theta}q^{5}}{\left(1-q^{N}\right)}{}^{4}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$
$$+\frac{e^{-\theta}q^{5}}{\left(1-q^{N}\right)}{}^{4}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}=\frac{q^{4}pe^{-\theta}\theta}{\left(1-q^{N}\right)}+2\frac{q^{3}p^{2}e^{-\theta}\theta^{2}}{\left(1-q^{N}\right)}+\frac{q^{2}p^{3}e^{-\theta}\theta^{3}}{\left(1-q^{N}\right)}$$
$$+\frac{1}{6}\frac{qp^{4}e^{-\theta}\theta^{4}}{\left(1-q^{N}\right)}+\frac{1}{120}\frac{p^{5}e^{-\theta}\theta^{5}}{\left(1-q^{N}\right)}$$

6. Probability of households having six migrant (k = 6) from cluster six (j = 1,2,3,4,5,6)

$$P(k=6)=\frac{e^{-\theta}q^{6}}{\left(1-q^{N}\right)}{}^{5}C_{0}\left(\frac{\theta p}{q}\right)+\frac{e^{-\theta}q^{6}}{\left(1-q^{N}\right)}{}^{5}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$
$$+\frac{e^{-\theta}q^{6}}{\left(1-q^{N}\right)}{}^{5}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+\frac{e^{-\theta}q^{6}}{\left(1-q^{N}\right)}{}^{5}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$

$$+\frac{e^{-\theta}q^{6}}{\left(1-q^{N}\right)}\,{}^{5}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}+\frac{e^{-\theta}q^{6}}{\left(1-q^{N}\right)}\,{}^{5}C_{5}\left(\frac{\theta p}{q}\right)^{6}\frac{1}{6!}$$

$$=\frac{q^{5}pe^{-\theta}\theta}{\left(1-q^{N}\right)}+\frac{5}{2}\frac{q^{4}p^{2}e^{-\theta}\theta^{2}}{\left(1-q^{N}\right)}+\frac{5}{3}\frac{q^{3}p^{3}e^{-\theta}\theta^{3}}{\left(1-q^{N}\right)}+\frac{5}{12}\frac{q^{2}p^{4}e^{-\theta}\theta^{4}}{\left(1-q^{N}\right)}$$

$$+\frac{1}{120}\frac{q^{1}p^{5}e^{-\theta}\theta^{5}}{\left(1-q^{N}\right)}+\frac{1}{720}\frac{p^{6}e^{-\theta}\theta^{6}}{\left(1-q^{N}\right)}$$

7. Probability of households having seven migrant (k = 7) from cluster seven (j = 1,2,3,4,5,6,7)

$$P(k=7)=\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{0}\left(\frac{\theta p}{q}\right)+\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$

$$+\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$

$$+\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}+\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{5}\left(\frac{\theta p}{q}\right)^{6}\frac{1}{6!}$$

$$+\frac{e^{-\theta}q^{7}}{\left(1-q^{N}\right)}\,{}^{6}C_{6}\left(\frac{\theta p}{q}\right)^{7}\frac{1}{7!}=\frac{q^{6}pe^{-\theta}\theta}{\left(1-q^{N}\right)}+3\frac{q^{5}p^{2}e^{-\theta}\theta^{2}}{\left(1-q^{N}\right)}$$

$$+\frac{5}{2}\frac{q^{4}p^{3}e^{-\theta}\theta^{3}}{\left(1-q^{N}\right)}+\frac{5}{6}\frac{q^{3}p^{4}e^{-\theta}\theta^{4}}{\left(1-q^{N}\right)}+\frac{1}{8}\frac{q^{2}p^{5}e^{-\theta}\theta^{5}}{\left(1-q^{N}\right)}$$

$$+\frac{1}{120}\frac{qp^{6}e^{-\theta}\theta^{6}}{\left(1-q^{N}\right)}+\frac{1}{5040}\frac{p^{7}e^{-\theta}\theta^{7}}{\left(1-q^{N}\right)}$$

8. Probability of households having eight migrant (k = 8) from cluster eight (j = 1,2,3,4,5,6,7,8)

$$P(k=8)=\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{0}\left(\frac{\theta p}{q}\right)+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{1}\left(\frac{\theta p}{q}\right)^{2}\frac{1}{2!}$$

$$+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{2}\left(\frac{\theta p}{q}\right)^{3}\frac{1}{3!}+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{3}\left(\frac{\theta p}{q}\right)^{4}\frac{1}{4!}$$

$$+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{4}\left(\frac{\theta p}{q}\right)^{5}\frac{1}{5!}+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{5}\left(\frac{\theta p}{q}\right)^{6}\frac{1}{6!}$$

$$+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{6}\left(\frac{\theta p}{q}\right)^{7}\frac{1}{7!}+\frac{e^{-\theta}q^{8}}{\left(1-q^{N}\right)}\,{}^{7}C_{7}\left(\frac{\theta p}{q}\right)^{8}\frac{1}{8!}$$

$$=\frac{q^{7}pe^{-\theta}\theta}{\left(1-q^{N}\right)}+\frac{7}{2}\frac{q^{6}p^{2}e^{-\theta}\theta^{2}}{\left(1-q^{N}\right)}+\frac{7}{2}\frac{q^{5}p^{3}e^{-\theta}\theta^{3}}{\left(1-q^{N}\right)}+\frac{35}{24}\frac{q^{4}p^{4}e^{-\theta}\theta^{4}}{\left(1-q^{N}\right)}$$

$$+\frac{7}{24}\frac{q^{3}p^{5}e^{-\theta}\theta^{5}}{\left(1-q^{N}\right)}+\frac{7}{240}\frac{q^{2}p^{6}e^{-\theta}\theta^{6}}{\left(1-q^{N}\right)}+\frac{1}{720}\frac{qp^{7}e^{-\theta}\theta^{7}}{\left(1-q^{N}\right)}+\frac{1}{40320}\frac{p^{8}e^{-\theta}\theta^{8}}{\left(1-q^{N}\right)}$$

***Estimation*:**

The model A_2 involves two parameters θ and P'. It is estimated in the same way as the parameters of model A_1.
It is given below

$$P_0 = e^{-\theta} \tag{10}$$

$$m=\theta\left(\frac{1}{p'}-\frac{Nq'^{N}}{1-q'^{N}}\right) \tag{11}$$

2.2 Fitting of the Model and its Interpretation

The model A_1 and A_2 are applied in relation to 2012 survey data for various socio-economic groups, viz. types of villages, different households size groups, caste group, economic and social status of the households. Once the estimation of , P and P' are obtained, the expected frequencies can be easily calculated.

The observed and expected frequencies are given in the Tables 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, and 18. For applying test, some last cells of the frequency are grouped. From these frequencies, it may be concluded that the proposed models describe the observed data well. This suggests that the proposed probability models for rural out-migration under consideration are a reasonable approximation to the situation at the micro-level. Thus, it may be useful in calculating the various probabilities of migrants connected with the process of migration from the households and also for predictions in specified population, which may be extremely helpful in evidence base decision making.

It is important to note that gives the average number of migrants per household (θ represents the average number of cluster per household whereas gives the average number of individuals per clusters).

2.2.1 Number of Migrants from Study Area

The model A_1 is fitted to the data with regard to the number of male migrants aged fifteen years and above from the household for two types of villages viz. remote and semi-urban respectively. Table 1 presents the value of $\hat{\theta}$, $\hat{P}$ and average number of migrants ($\hat{\theta}/\hat{P}$) from the remote and semi-urban villages. Whereas, the expected frequencies are given in Table 6. From Table 1, the value of $\hat{\theta}$ are found to be 0.6171, 0.2641 in the remote and in the semi-urban villages. While, the corresponding values of $\hat{P}$ are 0.6668 and 0.5429 in 2012 survey. It is observed that in the remote villages, the values of $\hat{\theta}$ and $\hat{P}$ are relatively higher than the semi-urban villages. It means that the average number of clusters form the households in the remote villages is more and the average number of individuals per clusters is less in comparison to the semi-urban villages. These findings on the pattern of out migrants are similar to the pattern observed in 1978, where average number of individual per cluster is less compared to the semi-urban villages.

Table 1: Average number of migrants per households ($\hat{\theta}/\hat{P}$) in remote and semi-urban villages, Varanasi, 2012.

Estimates of parameter	Type of Villages					
	Remote		Semi-urban		Total	
	1978	2012	1978	2012	1978	2012
$\hat{\theta}$	0.2639	0.6171	0.1178	0.2641	0.1959	0.4308
$\hat{P}$	0.7634	0.6668	0.7276	0.5429	0.7359	0.6041
$\hat{\theta}/\hat{P}$	0.3457	0.9255	0.1619	0.4865	0.2662	0.7131

However, the overall average number of migrants per households from remote and semi-urban villages from the study area ($\theta/p = 0.2662, 0.7131$) has been changed in last three decades. The increasing average numbers of migrants per households portrays an increasing propensity of adult male migration from the study area. Over 2.7 times increase in the average number of migrants per households may be primarily due to increasing man-land ratio in the absence of relative growth in employment opportunities. Thus, the existing imbalances in demand and supply of gainful employment opportunities in the region may be the key to continuously increasing number of migrants per households. Thus, the first hypothesis of the study *"there is no change in the dominance of* *male migration in eastern Uttar Pradesh"* is rejected here. It is also observed from the Table 6 that the model gives the good fit to the observed distribution for two types of villages.

2.2.2 Number of Migrants by Household Size

Households with at least one migrant are more prone to have new ideas and environments than households having no migration. Therefore, size of the household is an important factor for explaining the process of migration from the place of origin. The Model A_1 is also applied to the data for different sizes of the households and the values of $\hat{\theta}$, $\hat{P}$ and average number of migrants ($\hat{\theta}/\hat{P}$) per household from the remote and semi-urban villages is given in the Table 2.The expected frequencies for the household size (6-9) and (10 & above) are given in Table 7 and Table 8 respectively. From the present study, it is observed that in the remote villages the value of $\hat{\theta}$ is small and $\hat{P}$ is large for smaller size of households. However for larger size of the households $\hat{\theta}$ is large and $\hat{P}$ is small. It means that from the larger size of the households relatively more clusters move and there is larger number of persons in the clusters.

Table 2: Average number of migrants per households ($\hat{\theta}/\hat{P}$) by households size in remote and semi-urban villages, Varanasi, 2012.

Type of village	Estimates of parameter	Household Size					
		1978			2012		
		4-6	7-9	10 & Above	2-5	6-9	10 & Above
Remote	$\hat{\theta}$	0.1732	0.3620	0.6580	0.3932	0.5900	0.9808
	$\hat{P}$	0.9353	0.9050	0.7011	0.5784	0.7469	0.7106
	$\hat{\theta}/\hat{P}$	0.1852	0.4000	0.9385	0.6798	0.7899	1.3802
Semi-Urban	$\hat{\theta}$	0.0461	0.1216	0.5165	0.1058	0.3069	0.5248
	$\hat{P}$	0.0799	0.8850	0.7390	0.4947	0.5405	0.6426
	$\hat{\theta}/\hat{P}$	0.5770	0.1374	0.6989	0.2140	0.5679	0.8167

The values of $\hat{\theta}$ and $\hat{P}$ differ in the remote and semi-urban villages in all size of the households. The reason may be due to the fact that semi-urban villages are situated near Varanasi city. People from these villages migrate as commuters. Although, the value of $\hat{\theta}$ and $\hat{P}$ in the remote villages of all size of households are relatively large in comparison to the size of the households in semi-urban villages. It means that people migrate more from remote villages according to the size of households. According to the RDPG survey, the same pattern of migration has been found. The value of $\hat{\theta}$ and $\hat{P}$ for household size (7-9) in remote villages are larger than semi-urban villages. Therefore, at that time also, migration pattern from the remote villages was more compared to semi-urban villages. Thus, the pattern of out migration from households in the study areas by households size remains the same as reported in RDPG survey, 1978.

2.2.3 Number of Migrants by Caste Group

Caste is an essential determinant of the occupation, education and social status in the community. Therefore, it may be one of the factors of prime importance responsible for migration. Further, model A_1 is applied to the data for each caste group. For the purpose of this study, the researcher considered four caste groups namely upper caste, middle caste, scheduled caste and Muslims for comparison. The value of $\hat{\theta}$, $\hat{P}$ and average number of migrants ($\hat{\theta} / \hat{P}$) from the remote and semi-urban villages by each caste group are given in Table 3 and expected frequencies for each caste group are given in Tables 9, Table 10, Table 11 and Table 12 respectively. From the Table 3 it is observed that in the remote villages $\hat{\theta}$ is larger and $\hat{P}$ is small in upper caste, while $\hat{\theta}$ is small and $\hat{P}$ is higher in middle caste, schedule caste and

Table 3: Average number of migrants per households ($\hat{\theta}/\hat{P}$) by caste groups in remote and semi-urban villages, Varanasi, 2012.

Type of Village	Estimates of parameter	Caste Group							
		Upper caste		Middle caste		Scheduled caste		Muslims	
		1978	2012	1978	2012	1978	2012	1978	2012
Remote	$\hat{\theta}$	*NA*	0.8287	*NA*	0.5507	*NA*	0.6131	*NA*	0.7885
	$\hat{P}$	*NA*	0.6686	*NA*	0.6168	*NA*	0.7432	*NA*	0.8260
	$\hat{\theta}/\hat{P}$		1.2394		0.8929		0.8250		0.9545

Semi-Urban	$\hat{\theta}$	*NA*	0.3399	*NA*	0.2451	*NA*	0.2321	*NA*	0.3254
	$\hat{P}$	*NA*	0.4010	*NA*	0.5193	*NA*	0.5701	*NA*	0.7478
	$\hat{\theta}/\hat{P}$		0.8475		0.4720		0.4071		0.4352
Total	$\hat{\theta}$	0.3602	0.5771	0.1863	0.4013	0.1147	0.3902	0.1987	0.5074
	$\hat{P}$	0.7031	0.5436	0.7782	0.5707	0.8446	0.6503	0.6786	0.7592
	$\hat{\theta}/\hat{P}$	0.5123	1.0615	0.2394	0.7031	0.1358	0.6000	0.2928	0.6684

NA: not available

Muslims. i.e., people migrate more from upper caste and migrate less from middle caste, scheduled caste and Muslims. Now, in the semi-urban villages, the value of $\hat{\theta}$ is small and $\hat{P}$ is large in respective caste group. This shows that people migrate more from the remote villages compared to semi-urban villages. It was also observed in 1978 that the value of $\hat{\theta}$ is small and $\hat{P}$ is large as compare to 2012 survey. It means in the 1978 survey, the average number of clusters from the households was small and the average number of individuals per clusters was large. These findings reveal that migrant from the study area are more prone to move independently in comparison to three decades ago, when people used to migrate with other members of the family at same destination.

2.2.4 Number of Migrants by Economic Status

The number of migrants from a household has an important bearing on the economic characteristic of the households. Therefore, it may be important to capture the process of migration from any community by the economic condition of the households. The summary value of $\hat{\theta}$, $\hat{P}$ and average number of migrants per households ($\hat{\theta}/\hat{P}$) from the remote and semi-urban villagesas well as its fitting by model A_1 for different categories of the economic status are given in Table 4. Although, the expected frequencies for low, medium and high economic status are presented in Table 13, Table 14 and Table 15 respectively. In Table 4, the value of $\hat{\theta}$ and $\hat{P}$ indicate that the incidence of male out-migration increases with economic status. The value of $\hat{\theta}$ and $\hat{P}$ also show that incidence of migration pattern in the remote villages are higher compared

Table 4: Average number of migrants per households ($\hat{\theta}/\hat{P}$) by economic status in remote and semi-urban villages, Varanasi, 2012.

Type of Village	Estimates of parameter	Economic status					
		Low		Medium		High	
		1978	2012	1978	2012	1978	2012
Remote	$\hat{\theta}$	*NA*	0.5841	*NA*	0.6084	*NA*	0.6585
	$\hat{P}$	*NA*	0.6861	*NA*	0.6388	*NA*	0.6663
	$\hat{\theta}/\hat{P}$		0.8513		0.9524		0.9882
Semi-Urban	$\hat{\theta}$	*NA*	0.1831	*NA*	0.2847	*NA*	0.3380
	$\hat{P}$	*NA*	0.4996	*NA*	0.6188	*NA*	0.5529
	$\hat{\theta}/\hat{P}$		0.3665		0.4602		0.6113
Total	$\hat{\theta}$	0.088	0.3705	0.1898	0.4547	0.3615	0.4824
	$\hat{P}$	0.9072	0.6002	0.7619	0.6158	0.7271	0.6059
	$\hat{\theta}/\hat{P}$	0.0970	0.6173	0.2491	0.7385	0.4972	0.7962

NA: not available

to semi-urban villages. This table indicates that the migration pattern has been increased from last three decades with economic status in the study area.

2.2.5 Number of Migrants by Social Status

Migration process is affected to a great extent by social condition. It is reported that migrants in the developed countries are of medium or higher social groups, while in contrast migrants in developing countries come from the relatively low social status groups (Pryor, 1969) [11]. For the purpose of this section, social status has been computed for households according to type of households, caste, number of migrants from the households and educational and economic status of the households. Like economic status, the social status is categorized into three categories low, medium and high. Again, the model A_1 is applied to the data according to social status. The summary value of $\hat{\theta}$, $\hat{P}$ and average number of migrants ($\hat{\theta}/\hat{P}$) from the remote and semi-urban villagesare given in Table 5 and expected frequencies are presented in Tables 16, Table 17 and Table 18. From the Table 5, it is evident that the trends of out-migration according to social status follow the same pattern as observed in economic status. i.e. the value of $\hat{\theta}$ and $\hat{P}$ are higher in the remote villages compared to the semi-urban villages. This pattern again reinforces a higher propensity of migration from the remote villages compared to the semi-urban villages. This table also indicates that the propensity of migration has increased in the last three decades according to social status from the study area.

Table 5: Average number of migrants per households ($\hat{\theta}/\hat{P}$) by social status in remote and semi-urban villages, Varanasi, 2012**.**

Type of Village	Estimates of parameter	Social status					
		Low		Medium		High	
		1978	2012	1978	2012	1978	2012
Remote	$\hat{\theta}$	*NA*	0.5364	*NA*	0.6229	*NA*	0.6976
	$\hat{P}$	*NA*	0.6828	*NA*	0.6118	*NA*	0.7165
	$\hat{\theta}/\hat{P}$		0.7857		1.0182		0.9736
Semi-Urban	$\hat{\theta}$	*NA*	0.2555	*NA*	0.1997	*NA*	0.3483
	$\hat{P}$	*NA*	0.5061	*NA*	0.5883	*NA*	0.5551
	$\hat{\theta}/\hat{P}$		0.5049		0.3394		0.6275
Total	$\hat{\theta}$	0.0287	0.3927	0.3009	0.3886	0.5063	0.5170
	$\hat{P}$	0.9965	0.6024	0.8350	0.5732	0.7329	0.6385
	$\hat{\theta}/\hat{P}$	0.0288	0.6519	0.3604	0.6780	0.6908	0.8097

NA: not available

Table 6: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	observed	Expected		observed	Expected		observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	362	362.0	362.0	483	483.0	483	845	845.0	845.0
1	180	149.4	158.8	101	129.9	90.7	281	220.7	259.1
2	64	80.5	80.8	11	14.1	34.8	75	116.1	114.2
3	26	41.3	38.6	6	7.7	13.1	32	59.8	48.8
4	7	20.4	17.6	6	7.7	4.8	13	30.3	19.9
5	8	9.8	7.8	5	6.4	1.8	13	15.2	8.1
6	9	4.5	3.3	7	9.0	0.6	16	7.5	3.2
7	7	2.1	1.4	6 }	7.7	0.2	13	3.7	1.2
8+	8	1.0	0.6	4 }			12	1.8	0.5
Total	671	671	671	629	629	629	1300	1300	1300
$\hat{P}$		0.54			0.77			0.65	
$\chi 2$		91.3	144.3		106.9	509.2		146.4	467.8
d.f.		6			5			6	
N		8			7			8	

Table 7: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for the households size (6-9) in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	observed	Expected		Observed	Expected		observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	153	153.0	153.0	206	206.0	206.0	359	359.0	359.0
1	81	76.4	67.0	55	51.1	52.8	136	101.5	111.6

2	24	31.4	33.3	2			26	50.4	49.7
3	6	11.4	15.7	1	22.3	20.8	7	24.3	21.2
4	3			2			5	11.5	8.8
5	2			5			7	5.3	3.6
6	3	3.8	7.0	2			5	2.4	1.4
7	1			4	0.7	0.4	5	1.1	0.5
8+	3			3			6	0.5	0.2
Total	276	276.0	276.0	280	280.0	280.0	556	556	556
$\hat{P}$		0.55			0.74			0.65	
$\chi 2$		22.36	15.06		107.4	181.6		118.0	234.9
d.f.		3			2			6	
N		4			3			7	

Table 8: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for the households size (10 & above) in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	observed	Expected		observed	Expected		observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	72	72	72.0	71	71.0	71.0	143	143.0	143.0
1	49	58.2	54.7	28	27.4	27.5	77	79.6	82.7
2	36	35.0	34.6	9	13.1	13.0	45	46.5	46.8
3	20	18.2	20.0	5	5.9	5.9	25	25.3	24.5
4	4		10.6	3			7	13.1	12.0
5	4			0			4		
6	3	8.6	10.6	3	2.6	2.6	6	3.1	2.6
7	2			1			3	1.5	0.4
8+	2			0			2		
Total	192	192	192.0	120	120.0	120.0	312	312	312
$\hat{P}$		0.38			0.59			0.46	

$\chi 2$	6.35	2.45	8.9	9.5	11.6	51.8
d.f.	3		3		5	
N	4		4		6	

The model A_2 is also fitted to the same data. This model consists of three parameters θ, P' and N. It is difficult to estimate all these parameters simultaneously. We assume that the value of N is known. We estimate θ and P' by equation 10 and 11. The estimate of θ is the same as in the model A_1, while the estimate of P is change which is denoting by P' .

The model A_2 is fitted to the data for two types of villages, the value of N is assumed to be 8 and 7. The parameter P' is estimated and it is found the value

Table 9: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for upper caste in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village: Remote			Semi-urban			Total		
	observed	Expected Model A_1	Expected Model A_2	observed	Expected Model A_1	Expected Model A_2	observed	Expected Model A_1	Expected Model A_2
0	31	31.0	31.0	42	42.0	42.0	73	73.0	73.0
1	22	20.5	19.5	9	12.7	12.2	31	29.4	31.4
2	6	11.3	11.3	2 }			8	15.7	15.2
3	5	5.6	6.1	0 }			5	8.0	7.2
4	3 }			1 }			4 }		
5	1 }			0 }	4.3	4.8	1 }		
6	1 }	2.5	3.0	2 }			3 }	3.9	3.1
7	0 }			3 }			3 }		
8+	2			0 }			2 }		
Total	71.0	71.0	71.0	59	59.0	59.0	130.0	130.0	130.0
$\hat{P}$		0.44			0.71			0.56	
$\chi 2$		10.50	8.19		4.4	3.0		104.0	35.3
d.f.		3			1			3	
N		4			2			4	

Table 10: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for middle caste in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village: Remote			Semi-urban			Total		
	observed	Expected: Model A_1	Model A_2	observed	Expected: Model A_1	Model A_2	observed	Expected: Model A_1	Model A_2
0	226	226.0	226.0	252	252.0	252.0	478	478.0	478.0
1	98	80.1	90.5	48	56.1	51.4	146	116.1	138.6
2	31	44.3	43.9	3			34	62.2	59.9
3	14	23.7	20.2	4			18	32.8	25.0
4	1	12.4	8.9	3			4	17.0	10.1
5	5			4	13.9	18.6	9		
6	5	3.2	1.6	4			9	4.5	1.6
7	7	1.6	0.7	2			9	2.3	0.6
8+	5	0.8	0.3	2			7	1.1	0.2
Total	392	392	392.0	322	322.0	322.0	714	714	714
$\hat{P}$		0.58			0.78			0.67	
$\chi 2$		57.36	162.40		5.9	0.8		83.2	369.5
d.f.		6			1			6	
N		7			2			7	

Table 11: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for scheduled caste in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village: Remote			Semi-urban			Total		
	Observed	Expected: Model A_1	Model A_2	Observed	Expected: Model A_1	Model A_2	Observed	Expected: Model A_1	Model A_2
0	65	65.0	65.0	111	111.0	111.0	176	176.0	176.0
1	36	36.8	31.7	21	23.7	21.3	57	57.9	52.6

2	11	13.9	15.7	3			14	19.8	22.2
3	2			0			2		
4	1			1			2		
5	1	4.3	7.6	1	5.3	7.7	2	6.3	9.3
6	3			1			4		
7	0			1			1		
8+	1			1			2		
Total	120	120	120.0	140	140.0	140.0	260	260	260
$\hat{P}$		0.54			0.79			0.68	
$\chi 2$		3.75	2.04		1.7	0.02		9.0	4.9
d.f.		2			1			2	
N		3			2			3	

Table 12: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for Muslims in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village: Remote			Semi-urban			Total		
	Observed	Expected		Observed	Expected		Observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	40	40.0	40.0	78	78.0	78.0	118	118.0	118.0
1	24	28.9	25.8	23	24.9	21.6	47	51.3	46.7
2	16	13.7	14.6	3			19	19.8	21.5
3	5			2			7		
4	2			1			3		
5	1	5.4	7.7	0	5.1	8.4	1	6.9	9.8
6	0			0			0		
7	0			0			0		
8+	0			1			1		
Total	88	88	88.0	108	108	108	196	196	196
$\hat{P}$		0.45			0.72			0.60	
$\chi 2$		2.48	0.27		0.90	0.31		4.1	0.8
d.f.		2			1			2	
N		3			2			3	

Table 13: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above in low economic status in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	observed	Expected		observed	Expected		observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	150	150.0	150.0	209	209.0	209.0	359	359.0	359.0
1	76	70.7	65.0	28	33.5	31.2	104	85.0	96.2
2	20	31.2	32.1	4			24	42.2	40.4
3	9	12.5	15.1	2			11	20.6	16.5
4	1			2			3	9.9	6.5
5	4			0	8.5	10.8	4		
6	4	4.7	6.7	2			6	2.2	1.0
7	2			2			4	1.0	0.4
8+	3			2			5		
Total	269	269	269.0	251	251	251	520	520	520
$\hat{P}$		0.56			0.83			0.69	
$\chi2$		23.83	16.79		4.40	1.31		85.3	236.9
d.f.		3			1			5	
N		4			2			6	

Table 14: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above in medium economic status in remote and semi-urban villages, Varanasi, 2012

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	Observed	Expected		Observed	Expected		Observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	80	80.0	80.0	85	85.0	85.0	165	165.0	165.0
1	35	41.6	38.6	21	23.1	20.4	56	55.7	55.1
2	20	18.3	19.1	1			21	24.7	24.7

3	4			2			6	10.4	10.7
4	1			1			2		
5	1			1	4.9	7.6	2		
6	1	7.2	9.2	1			2	4.3	4.5
7	2			0			2		
8+	3			1			4		
Total	147	147	147.0	113	113	113	260	260	260
$\hat{P}$		0.54			0.75			0.63	
$\chi 2$		4.42	1.21		1.1	0.07		16.5	15.5
d.f.		2			1			3	
N		3			2			4	

Table 15: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above in high economic status in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	Observed	Expected		Observed	Expected		Observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	132	132.0	132.0	189	189.0	189.0	321	321.0	321.0
1	69	63.1	63.0	52	50.7	48.5	121	95.3	110.2
2	24	33.0	33.0	6	18.7	19.6	30	51.1	50.8
3	13	16.1	16.1	2			15	26.8	22.4
4	5	7.5	7.5	3			8	13.7	9.5
5	3			4	6.6	7.9	7	6.9	3.9
6	4	3.3	3.4	4			8	3.4	1.6
7	3			4			7	1.7	0.6
8+	2			1			3		
Total	255	255	255.0	265	265	265	520	520	520
$\hat{P}$		0.52			0.71			0.62	
$\chi 2$		26.78	26.46		28.2	22.62		69.8	179.0
d.f.		4			2			6	
N		5			3			7	

Table 16: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above for in low social status in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	observed	Expected		observed	Expected		observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	131	131.0	131.0	158	158.0	158.0	289	289.0	289.0
1	61	62.7	55.1	33	37.4	33.7	94	77.2	86.3
2	18	23.0	26.0	1			19	39.8	36.9
3	3			1			4		
4	2			2			4	20.2	15.3
5	1	7.3	12.0	3	8.6	12.3	4		
6	2			2			4		
7	3			2			5	1.2	0.4
8+	3			2			5	0.6	0.1
Total	224	224	224.0	204	204	204	428	428	428
$\hat{P}$		0.58			0.77			0.68	
$\chi 2$		7.20	3.42		2.8	0.05		62.5	242.6
d.f.		2			1			4	
N		3			2			5	

Table 17: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above in medium social status in remote and semi-urban villages, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village								
	Remote			Semi-urban			Total		
	observed	Expected		observed	Expected		observed	Expected	
		Model A_1	Model A_2		Model A_1	Model A_2		Model A_1	Model A_2
0	118	118.0	118.0	181	181.0	181.0	299	299.0	299.0
1	60	50.6	54.0	31	33.6	29.6	91	70.5	83.9
2	15	27.8	27.6	2			17	37.4	35.9

3	11	14.5	13.2	1			12	19.5	14.8
4	0	7.3	6.0	2			2	10.1	6.0
5	5			0	6.4	10.4	5		
6	4			1			5	2.6	0.9
7	4	1.7	1.1	1			5	1.3	0.3
8+	3			2			5	0.6	0.1
Total	220	220	220.0	221	221	221	441	441	441
$\hat{P}$		0.54			0.82			0.68	
$\chi 2$		59.43	91.44		1.3	0.24		62.8	273.9
d.f.		4			1			6	
N		5			2			7	

Table 18: Distribution of the observed and expected number of households by number of male migrants aged fifteen and above in high social status in remote and semi-urban, Varanasi, 2012.

Number of male migrants aged 15 and above per HH	Type of village: Remote			Semi-urban			Total		
	observed	Expected Model A_1	Expected Model A_2	observed	Expected Model A_1	Expected Model A_2	observed	Expected Model A_1	Expected Model A_2
0	113	113.0	113.0	144	144.0	144.0	257	257.0	257.0
1	59	59.8	57.3	37	38.5	38.1	96	91.2	97.0
2	31	30.7	30.7	8	15.5	15.5	39	46.6	45.9
3	12	14.4	15.4	4			16	22.9	20.7
4	5	6.4	7.3	2			7	11.0	8.9
5	2			2	6.0	6.3	4		
6	3	2.7	3.3	4			7		
7	0			3			3	2.3	1.5
8+	2			0			2		
Total	227	227	227	204	204	204	431	431	431
$\hat{P}$		0.50			0.71			0.60	
$\chi 2$		7.63	5.54		17.2	15.65		43.5	73.3
d.f.		4			2			4	
N		5			3			5	

of $\hat{P}$ slightly lower in the remote villages and higher in the semi-urban villages. When we fit for the different size of households, the value of N is assumed to be 4 for the size of households 10 and above. Here the estimated value of P' is found slightly smaller than . In low economic and social status groups, the value of N is smaller than higher economic and social status groups in the remote areas. The same pattern of N is found in the semi-urban areas. It is a fact that where the people are more educated, prosperous and advanced, the value of N is large. i.e., persons migrate more from high economic and social status compared to low economic and social status.

3. FINDINGS AND CONCLUSIONS

This paper portrays the probability models applied to explain the pattern of male out-migration from the study area and explains the distribution of households according to number of male migrants (age fifteen years and above) in different sets of the observed data. The suitability of proposed model is tested with primary data collected from remote and semi-urban areas of Varanasi, 2012. Findings highlight that the average number of clusters from the remote households is higher and the average number of individuals per clusters is lower in comparison to the semi-urban villages. The average number of migrants per household has increased with increasing size of households in the remote as well as in semi-urban villages. The average number of migrants per household is higher among upper caste followed by middle caste, Muslims and scheduled caste from the study area. Average number of migrants per household has increased over six times in the low economic status of the households. In the medium and high economic status of the households, average number of migrants per household is found to be around three and two times more respectively, over the last three decades.

The increasing average number of migrants per household portray that an increasing propensity of adult male migration from the study area. Over 2.7 times increase in the average number of migrants per household may be primarily due to increasing man-land ratio in the absence of relative growth in employment opportunities. Thus, the existing imbalances in demand and supply of gainful employment opportunities in the region may be the key to continuously increasing the number of migrants per households from the region.

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