CHAPTER IV

ESTIMATES OF NET SHIFT IN POPULATION-ADJUSTED TO INTERCENSAL CHANGES IN THE RURAL-URBAN STATUS OF LOCALITIES IN A STATE AND ITS GEOGRAPHIC SUB-DIVISIONS.

4.1 Introduction:

The last chapter described how the estimates of net shift can be determined at various levels on the basis of assumptions which are comparatively better than those involved in the usual residual models. Still however, the above models need further modification, in view of the fact that, no consideration has been made while developing these
models, with regard to the possible classificational changes in the 'rural' and 'urban' status of localities which might occur from census to census. As discussed in Chapter-II, the main factors assignable to such intercensal changes in the status of certain localities are the changes caused due to variation in the definition of 'urban' or 'rural' from census to census, and changes caused due to progress in the process of economic development of a particular locality during the intercensal period. As a result, a locality classified as 'rural' at a particular census may qualify to be recognised as 'urban' at the succeeding census or an urban locality at a particular census may fail to retain its urban status and may acquire a rural status at the succeeding census.

In view of such intercensal changes in the status of localities, it is quite pertinent to incorporate necessary adjustments for such changes in the estimational procedures, particularly to avoid undue inflation or deplation in the estimates of net shift in population. More
clearly, if no adjustments for such changes are considered, for instance, the whole population of a locality which has undergone a change in the status from 'rural' to 'urban' shall contribute towards the rural-to-urban shift in population in the total estimate of net shift in urban areas, and which is not in fact the real transfer of population from rural to an urban area of the state. Such changes may, however, be considered as a progress towards urbanisation but not as rural-to-urban migration.

The main attempt in the present chapter has therefore been made towards introducing further modifications, in Models I and II discussed in chapter III, for the estimation of net shift in the population of urban and rural areas of the state and its geographic sub-divisions by introducing necessary adjustments due to classificational changes in the status of localities of the state. Secondly, on the basis of the above adjusted estimates, procedure for estimating internal rural-to-urban net shift in population has also been developed in section 4.3 of this chapter.
4.2 Modification in Models I and II:

The modification can be introduced by obtaining comparable rural and urban territories over the intercensal period by making suitable adjustments in the total population at the initial and the terminal census. The territories or localities which are to be considered for such adjustments would include newly classified urban localities and declassified urban localities. Where, however, the reclassification of localities involves annexations and retrocessions or a radically different set of boundaries for the units in question, there are serious problems in adjusting the statistics, which may be insurmountable. U.N. Manual VI [61] describes some of the devices that can be used to handle these difficulties. A mathematical scheme has also been devised in this direction by the author [35] for working out comparable urban population by size class of urban localities in an article entitled, "Measurement of Population Concentration in Urban Localities" published in the Quarterly Bulletin of Economics and Statistics, April-June, 1981, Vol.XXI - No.2."
The proposed modification would in fact, depend on the availability of necessary data on the classificational changes made between the two censuses under consideration. For development of the procedure, following terms are defined:

Let

(i) $\hat{u}_{ih}$ and $\hat{x}_{ih}$ = Adjusted estimates of net shift in population of urban and rural areas respectively of the $h$th district of the $i$th sub-division of the state during the intercensal period $(o, t)$.

(ii) $v_{ih}^{o}$ and $v_{ih}^{t}$ = Populations at the initial and terminal census of the newly classified urban localities at the terminal census in the $h$th district of the $i$th sub-division of the state.

(iii) $v_{ih}^{o}$ and $v_{ih}^{t}$ = Populations at the initial and terminal census respectively of the declassified urban localities at the terminal census in the $h$th district of the $i$th sub-division of the state.
(iv) $\hat{u}_{ih}^o$ and $\hat{u}_{ih}^t$ = Adjusted populations of the urban areas of the $h$th district of the $i$th sub-division of the state at the initial and the terminal census respectively.

(v) $u_{ih}^p$ = Adjusted mid-period estimated population of the urban areas of the $h$th district of the $i$th sub-division of the state.

(vi) $\hat{r}_{ih}^o$ and $\hat{r}_{ih}^t$ = Adjusted population of the rural areas of the $h$th district of the $i$th sub-division of the state at the initial and the terminal census respectively.

(vii) $r_{ih}^p$ = Adjusted mid-period estimated population of the rural areas of the $h$th district of the $i$th sub-division of the state.
(viii) \( u_{ih} \) and \( r_{ih} \) = Intercensal exponential growth rate of the adjusted urban and rural populations respectively of the \( h \)th district of the \( i \)th sub-division of the state.

(ix) \( \hat{u}_{ih} \) and \( \hat{r}_{ih} \) = Intercensal rate of net shift in the adjusted population of the urban and rural areas respectively of the \( h \)th district of the \( i \)th sub-division of the state.

Now since populations of the declassified urban localities in the \( h \)th district has not been included in the urban population of the \( h \)th district enumerated at the terminal census and the population at the terminal census of the newly classified urban localities in the \( h \)th district was not included in the urban population of the \( h \)th district enumerated at the initial census, the adjusted and comparable populations for the urban areas of the \( h \)th district at the
initial and the terminal census can therefore be obtained through the following equations:

\[ \hat{u}_{ih}^{P} = u_{ih}^{P} - v_{ih}^{O} \quad \ldots (4.1) \]

\[ \hat{u}_{ih}^{t} = u_{ih}^{t} - u_{ih}^{t} \quad \ldots (4.2) \]

The mid-period estimated population \( \hat{u}_{ih}^{P} \) can also be obtained as under.

\[ \hat{u}_{ih}^{P} = \bar{u}_{ih}^{P} - \frac{1}{2} (v_{ih}^{O} + u_{ih}^{t}) \quad \ldots (4.3) \]

Similarly, the adjusted rural population of the \( h \)th district of the \( i \)th sub-division can be obtained as under:

\[ \hat{r}_{ih}^{P} = r_{ih}^{P} - u_{ih}^{O} \quad \ldots (4.4) \]

\[ \hat{r}_{ih}^{t} = r_{ih}^{t} - v_{ih}^{t} \quad \ldots (4.5) \]

The mid-period estimated population \( \hat{r}_{ih}^{P} \) can be obtained as under.

\[ \hat{r}_{ih}^{P} = \bar{r}_{ih}^{P} - \frac{1}{2} (u_{ih}^{O} + v_{ih}^{t}) \quad \ldots (4.6) \]
On obtaining the adjusted urban and rural populations through the above equations for the initial and terminal census, the adjusted intercensal exponential growth rates can be obtained as under:

\[
\hat{u}_{i}^{\text{ih}} = \log_e \left( \frac{\hat{u}_{i}^{\text{ih}}}{u_{i}^{\text{ih}}} \right) \quad \ldots \quad (4.7)
\]

and

\[
\hat{r}_{i}^{\text{ih}} = \log_e \left( \frac{\hat{r}_{i}^{\text{ih}}}{r_{i}^{\text{ih}}} \right) \quad \ldots \quad (4.8)
\]

Now assuming that the natural growth rate of the district would not vitiate much due to reclassification of certain localities in that district, the adjusted rate of net shift in the hth district of the ith sub-division can be obtained as under.

Considering urban areas we have

\[
\hat{u}_{i}^{\text{ih}} = \hat{u}_{i}^{\text{ih}} - \hat{u}_{i}^{\text{ih}}
\]

or

\[
\hat{u}_{i}^{\text{ih}} = \hat{u}_{i}^{\text{ih}} - \hat{u}_{i}^{\text{ih}}(u_{i}^{\text{ih}} - \hat{u}_{i}^{\text{ih}}) u_{i}^{\text{ih}}^{-1}
\]

(Assumption-II)
or \( u_{ih} = u_{ih} \left[ 1 - (1 - \frac{u_{ih}}{u_{ih}}) \right] \) ... (4.9)

Substituting the value of \( u_{ih} \) and \( u_{ih} \) in equation (4.9)

\[
\hat{u}_{ih} = u_{ih} (1 - \alpha_u)(1 + e_u)(1 + u_{si}) \quad \ldots \quad (4.10)
\]

Similarly for rural areas the equation for adjusted rate of net shift in the population of hth district can be written as under.

\[
\hat{r}_{ih} = r_{ih} (1 - \alpha_r)(1 + e_r)(1 + r_{si}) \quad \ldots \quad (4.11)
\]

Now the adjusted estimates \( \hat{u}_{ih} \) and \( \hat{r}_{ih} \) can be obtained as under:

\[
\hat{u}_{ih} = u_{ih} \cdot \hat{u}_{ih}
\]

or \( \hat{u}_{ih} = u_{ih} \cdot u_{ih} (1 - \alpha_u)(1 + e_u)(1 + u_{si}) \) (4.12)

and \( \hat{r}_{ih} = r_{ih} \cdot r_{ih} (1 - \alpha_r)(1 + e_r)(1 + r_{si}) \) (4.13)

An implied fact which emerges from the above equations
(4.12) and (4.13) is that estimational constants and proportion of errors at different levels have been assumed to hold good in case of the present modified model also.

The adjusted sub-divisional estimates and state level estimates can now be obtained only by aggregating the above district level estimates over all the sub-divisions and the state respectively. Necessary equations for the same can directly be written without any further explanation.

If $\hat{u}_i$ and $\hat{r}_i$ represent the adjusted sub-divisional estimates, we have

$$\hat{u}_i = \sum_{h=1}^{n_i} \hat{u}_{ih}$$  \hspace{1cm} \ldots (4.14)

$$\hat{r}_i = \sum_{h=1}^{n_i} \hat{r}_{ih}$$  \hspace{1cm} \ldots (4.15)

$$\hat{u}_s = \sum_{i=1}^{n} \sum_{h=1}^{n_i} \hat{u}_{ih}$$  \hspace{1cm} \ldots (4.16)
Thus, equations (4.10) to (4.19) provide us the adjusted estimates of net shift at district, sub-division and state level by urban and rural areas. These estimates are more reasonable and nearer to relalities as compared to those obtained under Model-I and Model-II

The above equations can also provide estimates of net shift in the total population at different levels by aggregating them in the relevant manner.


Internal rural-to-urban migration is such an
important element in internal migration, particularly in developing countries, that there is a great interest in measuring it by some means. The usual residual method or the modified models developed in Chapter-III and in section 4.2 of the present chapter cannot be suitably used for the present purpose, since they provide an extent of net shift in the population of urban areas due to both external as well as internal migration streams, as such they are not capable to provide exclusively the desired estimate due to internal migration only. Secondly any suitable method would work best when the urban or rural areas are defined in terms of whole administrative units and changes in classification are rarely made. Method for working out comparable urban and rural areas at two consecutive censuses has already been discussed in the earlier section 4.2 of this chapter.

According to United Nations Manual[ 61 ], an internal rural-to-urban net shift can be measured simply by
applying the state level survival rates to its urban population. In mathematical terms it can be explained through the following equation

\[ M^r_s = u_s^t - u_s^o \cdot \frac{p^t_s}{p^o_s} \]  \hspace{1cm} (4.19)

where the terms of the above equation are defined as under:

(i) \( M^r_s \) = Intercensal estimate of net shift due to internal rural-to-urban migration streams and counter streams.

(ii) \( u_s^o \) and \( u_s^t \) = Populations of urban areas of the State at the initial and terminal censuses respectively.

(iii) \( p^o_s \) and \( p^t_s \) = Total populations of the state at initial and terminal censuses respectively.

Ann R. Miller [41] has obtained estimates of net intercensal migration after making necessary adjustment for
reclassifications and annexations for individual large American cities and their metropolitan rings using the above technique.

U.S. Department of Agriculture has also obtained internal rural-to-urban migration for the farm population in the United States and Canada with the help of the above technique.

The assumption of equality of survival rates of total population and the urban population which has been adopted in the above referred U.N. Method may not, however, always hold true particularly in developing countries. Because survival rates which are ultimately the functions of mortality rates have been significantly different in respect of urban and rural areas, and as such the above equality cannot provide most reasonable estimates of internal rural-to-urban net shift in population of the urban areas of the state.
Nigel Crook, and Tim Dyson \[42\] has recently published estimates of net rural-to-urban population transfer in India during the decades 1961-61, 1961-71 and 1971-81. His estimates are based on an assumption that the natural growth rates of rural and urban areas of India are almost equal. Such assumption has been made on the basis of the results indicated by the Sample Registration System in India. Under the above assumption the urban population of India at initial census has been projected to the date of terminal census by applying the intercensal growth rate of total population and the difference between the actual urban population at the terminal census and the projected population has been treated as an estimate of net rural-to-urban migration.

The above approach also, can not be universally adopted unless the involved assumption is tested and found to be acceptable for an individual state for which the desired estimate of rural-to-urban net shift in population has to be obtained. Secondly this approach will not present
exclusively the estimate of net rural-to-urban net shift, since it would also involve an element of external migration unless the same is absent during the period under study.

4.3.1. Development of the present model:

The change in rural and urban population may occur due to the incidence of mortality, fertility, internal migration and external migration. Secondly, in addition to above components, the change will also take place due to reclassification of urban and rural localities from one census to another as has already been discussed in the earlier section. The incidence of all these components may vary to an important degree by groups of age and sex. Of all the above components, however, changes due to internal rural-to-urban migration has the most significant contribution particularly in determining the total change in the urban population during an intercensal period, and which is the main concern of the present attempt.
We have already discussed the development of the methods for determining the estimates of total net shift in the state i.e. $\hat{M}_s$, total net shift in the urban areas of the state i.e. $\hat{U}_s$, and total net shift in the rural areas of the state i.e. $\hat{R}_s$. Of these estimates, as we have seen, that $\hat{M}_s$ represent the adjusted estimate of net shift in the population of the state due to external migration, whereas $\hat{U}_s$ and $\hat{R}_s$ represent adjusted estimates of total net shift in the population of urban and rural areas of the state due to external as well as internal migration streams. The desired estimate of internal rural-to-urban net shift can therefore be obtained if under certain assumption the estimate of external component of net shift in the population of urban areas of the state can be determined. Since the estimate of external component of net shift when subtracted from the total net shift $\hat{U}_s$ would result into residual component of net shift due to internal rural-to-urban migration streams in the urban areas of the state.
In the present attempt, I have made an assumption that ratios of the total net shift to the rate of external net shift for the urban areas and the whole state may almost be equal. The assumption, though not tested separately, but is considered on the fact that external inward and outward movements of population in the state are generally confined to the urban areas of the state and therefore the ratios considered above for urban areas and the state may not vary significantly.

For developing necessary equations based on the above assumption, following additional terms have been defined.

(i) \( \hat{\phi}_s \) = Intercensal rate of net shift in the urban population of the state.

(ii) \( \hat{\theta}_s \) = Adjusted intercensal rate of net shift in the total population of the state.

(iii) \( \hat{w}_s\) = Estimate of net shift in the urban population of the state due to external migration streams and counter streams during the intercensal period \((o, t)\).
(iv) \( r_s^e \) = Estimate of net shift similar to above for rural areas.

(v) \( u_s^P \) = Adjusted mid-period estimated urban population of the state during the intercensal period \((o, t)\). 

(vi) \( r_s^P \) = Adjusted mid-period estimated rural population of the state during the intercensal period \((o, t)\). 

(vii) \( \hat{P}_s \) = Adjusted mid-period estimated total population of the state during the intercensal period \((o, t)\). 

(viii) \( V_s^o \) and \( V_s^t \) = Total populations at the initial and terminal census respectively of the declassified localities in the state at the terminal census.

(ix) \( U_s^o \) and \( U_s^t \) = Total populations at the initial and the terminal census respectively of the newly classified urban localities in the state at terminal census.
Hence according to our assumption of equality of ratios, we have the following equations:

\[
\frac{M_s}{u_0 s} = \frac{M_s}{\Theta_s} \quad \text{where} \quad \Theta_s = \frac{M_s}{P_s} \quad \ldots \quad (4.20)
\]

or

\[
u_0 s = \frac{M_s}{P_s} \cdot \Theta_s \quad \ldots \quad (4.21)
\]

Substituting the value of \( \Theta_s \) in the above equation we have

\[
u_0 s = \frac{M_s}{P_s} \quad \ldots \quad (4.22)
\]

The value of \( \hat{P}_s \) can be determined as under.

\[
\hat{P}_s = \nu_0 s + \hat{r}_s
\]

or

\[
\hat{P}_s = \Sigma \Sigma \nu_0^{i h} \hat{P}_{i h} + \Sigma \Sigma \nu_0^{i h} \hat{r}_{i h}^{i h} \quad \ldots \quad (4.23)
\]

Substituting the values of \( \nu_0^{i h} \) and \( \hat{r}_{i h} \) from equations (4.3) and (4.6) respectively in the above equation (4.23), we have
\[
\hat{p}_s = \sum_{i=1}^{n} \sum_{h=1}^{n_i} \left( \bar{w}_{ih} - \frac{1}{2} (v_{ih}^o + u_{ih}^t) \right) \\
+ \sum_{i=1}^{n} \sum_{h=1}^{n_i} \left( r_{ih} - \frac{1}{2} (v_{ih}^t + u_{ih}^c) \right)
\]

or \( \hat{p}_s = \bar{p}_s - \frac{1}{2} (V_s^o + V_s^t) - (U_s^o + U_s^t) \)

or \( \hat{p}_s = \bar{p}_s - (\bar{v}_s + \bar{u}_s) \)

... (4.24)

where \( \bar{v}_s \) and \( \bar{u}_s \) represent the mid-period estimated populations of all the declassified urban localities and the newly classified localities in the state during the intercensal period \((o, t)\).

Now the equation for the external component of the net shift in the urban population of the state can be written as under:

\( u^s = \hat{p}_s \cdot \phi_s \)

Substituting the values of \( \hat{p}_s \) and \( \phi_s \) in the above equation, we have
\[ u_s^e = \left( u_s - \frac{1}{2} (V_s + U_s) \right) \frac{M_s^\wedge}{P_s} \]

or
\[ u_s^e = \frac{M_s^\wedge [ u_s - \frac{1}{2} (V_s + U_s) ]}{P_s - (V_s + U_s)} \] ... (4.26)

Hence with the help of the estimate of total net shift in the urban areas i.e. \( M_s^\wedge \) and the estimate \( u_s^e \) due to external net shift in the urban population, our desired estimate of internal rural-to-urban net shift in the urban population can be obtained through the following equation:

\[ u_s^r = u_s - u_s^e \]

or
\[ u_s^r = \frac{M_s^\wedge [ (P_s - u_s) - (V_s + U_s) + \frac{1}{2} (V_s + U_s) ]}{P_s - (V_s + U_s)} \] ... (4.27)

Thus above equation (4.27) would provide us the estimate of net shift in the urban population of the state \( \delta \) due to internal rural-to-urban migration streams. This model can also be suitably applied to determine similar estimates at geographic sub-divisional levels of the state. An application
of this model has been demonstrated on the population of Gujarat, India in Chapter VI of this thesis.

Here of course, a little uniformity in the systems of data collection and their presentation has been assumed for all developing countries for which the model has been designed. In particular, where such classification as available from the Indian Census publication in respect of urban-rural areas and data on their reclassification from census to census are not available, the present model may not be much suited. Such situations may therefore be considered as limitations of the present model.