CHAPTER: III

METHODOLOGY

This chapter sketch is out briefly regarding the selection of study area, nature and sources of the data collection and several statistical methods adopted for analyzing the data in the light of objectives. The various phases of methodological aspects used to carry out the present study entitled “Growth and export performance of livestock sector in Gujarat” are discussed under the following broad headings.

3.1 Delineation of the study area
3.2 Nature and sources of data
3.3 Analytical framework

3.1 Delineation of the study area

3.1.1 Geographical location

Gujarat state is located on the west coast of India between 20°-6' to 24°-42' N latitude and 68°-10' to 74°-28' E longitude. It is bounded by the Arabian sea in the West, by the states of Rajasthan in the North and North-East, Madhya Pradesh in the East and Maharashtra in the South and South East. The state has an international boundary and has a common border with the Pakistan at the north-western fringe. Kachchh is the largest district lies North of peninsula, and on its Northern border is the large desert of Kachchh. The geographical area of Gujarat is 1,96,024 sq. km. which occupies round a 6 per cent of total area of India. The Forest area of Gujarat is approximately 21,539.27 sq. km. in the year 2014-15, which is about 11 per cent of total geographical area of the State. Gujarat is divided into eight Agro-climatic zones based on rainfall, soils and cropping pattern. Out of this, five are arid to semi arid in nature while remaining three is dry sub humid in nature. The climatic conditions over the state are mainly wet in the southern districts and desertic in north-west regions. It has long sea coast i.e. 1600 km on the Arabian Sea which forms the western and southern boundaries. The major ports include Kandala, Mandavi, Mundra, Okha, Porbandar, Veraval, Mahuva, and Hazira etc.
3.1.2. Demographic indicators

As per 2011 census, Gujarat population data show that it has a total population of 6.04 crore, an increase from 5.07 crore in 2001 Census which is accounted as 4.99 per cent of total Indian population. The population growth in this decade was 19.28 per cent while in previous decade, it was 22.48 per cent. The share of urban and rural population in the total population of the state is 42.6 per cent and 57.4 per cent, respectively. Literacy rate has shown an upward trend and it increased to 79.31 per cent. Among this, male literacy stands at 87.23 per cent while female literacy stands at 70.73 per cent. The population density increased from 258 sq. km. in 2001 to 308 sq. km. in 2011.

Besides, the Work Participation Rate (WPR) for the Gujarat works out to be 41.0 per cent, which is higher than the national average (39.8%). The total number of workers (who have worked for at least one day during the reference year) is 247.68 lakh. Furthermore, first time in the Census 2011, the marginal workers, i.e. workers who worked for less than six months in the reference year, have been subdivided in two categories, namely, those worked for less than 3 months and those who worked for 3 months or more but less than six months. In Gujarat, out of 247.7 lakh total workers, 203.7 lakh are main workers and the remaining 44.0 lakh are marginal workers. Amongst the 44.0 lakh marginal workers, 39.3 lakh (89.3%) worked for 3 to 6 months whereas only 4.7 lakh (10.7%) worked for less than 3 months in the state (Anon., 2016b).

3.1.3 Performance of the state livestock population over different livestock census

As per the 19th livestock census, Gujarat constitutes 5.29 per cent of total livestock population and 2.06 per cent of total poultry population in India during 2012. A comparative performance of livestock population of Gujarat over different livestock census is presented in Table 3.1. According to the latest livestock census conducted in 2012, livestock population has increased from 23.51 million in 2007 to 27.12 million in 2012 (excluding 0.29 million stray cattle) registering a positive growth of 15.36 per cent over the previous census. Out of the total livestock reported in 2012 census, population of cattle, buffalo, sheep, goats and pigs were 99.84 lakhs, 103.86 lakhs, 17.08 lakhs, 49.59 lakhs and 4.28 lakhs, respectively. The growth rate of the total population of cow, buffalo, goat, sheep and pig was 25.18 per cent, 18.37
per cent, 6.87 per cent, -14.68 per cent and -80.36 per cent, respectively over the previous census. Poultry population increased to 150.06 lakhs, registering a growth rate of 12.39 per cent over the previous census. Additionally, the pattern of livestock distribution among the total livestock pointed out that the contribution of buffalo population was the highest (38.28%), followed by cattle (36.80%), goat (18.28%) and sheep (6.30%) and other livestock species such as camel, pigs, mules, donkeys, horses and ponies have marginal contribution.

Table 3.1: Livestock population of Gujarat state: A comparative performance

<table>
<thead>
<tr>
<th>Species</th>
<th>2003</th>
<th>2007</th>
<th>2012</th>
<th>Growth Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(%) 2007-12</td>
</tr>
<tr>
<td>Cattle</td>
<td>7424.00</td>
<td>7975.72</td>
<td>9983.95</td>
<td>25.18</td>
</tr>
<tr>
<td>Buffaloes</td>
<td>7140.00</td>
<td>8773.57</td>
<td>10385.57</td>
<td>18.37</td>
</tr>
<tr>
<td>Sheep</td>
<td>2062.00</td>
<td>2001.56</td>
<td>1707.75</td>
<td>-14.68</td>
</tr>
<tr>
<td>Goats</td>
<td>4541.00</td>
<td>4640.14</td>
<td>4958.97</td>
<td>6.87</td>
</tr>
<tr>
<td>Horses &amp; ponies</td>
<td>18.00</td>
<td>14.00</td>
<td>18.26</td>
<td>30.43</td>
</tr>
<tr>
<td>Camels</td>
<td>53.00</td>
<td>38.45</td>
<td>30.42</td>
<td>-20.91</td>
</tr>
<tr>
<td>Pigs</td>
<td>351.00</td>
<td>21.79</td>
<td>4.28</td>
<td>-80.36</td>
</tr>
<tr>
<td>Mules</td>
<td>1.00</td>
<td>0.02</td>
<td>0.16</td>
<td>-</td>
</tr>
<tr>
<td>Donkeys</td>
<td>65.00</td>
<td>50.18</td>
<td>38.83</td>
<td>-22.6</td>
</tr>
<tr>
<td>Total Livestock</td>
<td>21655.00</td>
<td>23515.43</td>
<td>27128.20</td>
<td>15.36</td>
</tr>
<tr>
<td>Poultry</td>
<td>8153.00</td>
<td>13352.00</td>
<td>15005.75</td>
<td>12.39</td>
</tr>
<tr>
<td>Dogs#</td>
<td>1175.00</td>
<td>268.97</td>
<td>253.31</td>
<td>-5.82</td>
</tr>
<tr>
<td>Rabbits</td>
<td>17.00</td>
<td>9.11</td>
<td>8.66</td>
<td>-4.94</td>
</tr>
<tr>
<td>Elephants</td>
<td>NA</td>
<td>0.00</td>
<td>7.33</td>
<td></td>
</tr>
</tbody>
</table>

Anon., (2013b), #Excluding Stray Cattle and Stray Dogs, NA-Not Available,

Note: Figure ‘zero’ means either ’nil’ or negligible.

3.2 Nature and sources of data

For assessing the regional level performance and disparities, district is most suitable unit within the state for this study and based on the given current status of availability of data. In the present day and age, there is no lack of unanimity regarding the micro level planning. Therefore, it sounds rather feasible to develop the interest to examine the grass root development and for this reason, district has been chosen as the unit of analysis in this study. Although, the districts are the main focus of attention for measuring the livestock performance, the implications of the results
are further extended to overall agricultural development of the state and have been discussed whenever necessary. Inspite of myriad of factors shape the livestock sector development at the district level but here it was broadly studied under the population, production and productivity aspects.

The present study was undertaken using secondary sources. Integrated Sample Survey (ISS) that estimates the annual production of major livestock products is being conducted since 1977-78, as per guideline of Indian Agricultural Statistical Research Institute, which has been further, strengthened to estimate district level estimates from 1983-84 onward but data were considered from 1985-86 under study owing to decadal changes to capture the livestock performance over the last three decades. Therefore, necessary data of thirty years for districts-wise and state level pertaining to livestock population, production and productivity were compiled for the period from 1985-86 to 2014-15. This period was further classified into four sub-periods; 1985-86 to 1994-95 (Period-I), 1995-96 to 2004-05 (Period-II), 2005-06 to 2014-15 (Period-III) and 1985-86 to 2014-15 (Period IV). The district-wise and state level time series data on livestock population (includes crossbred cows, indigenous cows, buffalos, sheep, goat and poultry layer), livestock production (includes milk, egg and wool) and their productivity were collected from various issues of integrated sample survey published by the Directorate of Animal Husbandry (GOG) and various volumes of livestock census conducted by Department of Animal Husbandry (GOI). Furthermore, crossbred cows, indigenous cows, buffalos and goat were categorized in inmilk and milch animals. Poultry layer were taken as desi and improved poultry. The data on per capita availability for the state level were collected from 32nd survey report on the estimates of various livestock products, Bulletin of Animal Husbandry and Dairy Statistics published by Directorate of Animal Husbandry (GOG), while national level livestock production (includes milk, egg and wool), livestock GDP, value of output and per capita availability were brought together from the various issues of Basic Animal Husbandry and Fisheries Statistics published by Department of Animal Husbandry, Dairying and Fisheries, GOI, New Delhi.

Export data regarding major livestock products *i.e.* poultry products, meat and its products and dairy products were compiled from 1995-96 to 2014-15. The data were collected from published sources of Agricultural and Processed Food Products Export Development Authority (APEDA) and Directorate General of Commercial Intelligence and Statistics (DGCI&S). Export dynamics of livestock
products were analyzed for three different periods viz. Period-I (1995-96 to 2004-05), Period-II (2005-06 to 2014-15) and Period-III (1995-96 to 2014-15) by using Markov chain. Data on the population, exchange rate, GDP and per capita income of importing countries for livestock products, as well as export of global level livestock products were taken from Food and Agricultural Organization (FAO) database. Aerial distance between India and importing countries with respect to their capital were accessed via https://www.freemaptools.com/how-far-is-it-between.htm

3.3 Analytical framework

As agricultural development is multi-dimensional process, its impact cannot be captured fully by any single indicator. Moreover, an individual analysis of large number of indicators does not provide an integrated and comprehensible picture of reality. This implies the need for building up of a composite score/index of agricultural development based on various agricultural parameters. The collected data were analyzed with the help of various statistical tools to draw meaningful inferences keeping in view of the study. Various analytical techniques used in this study are discussed as under.

3.3.1 Tabular analysis

The tabular analysis was employed to work out growth pattern, instability and other useful interpretation in order to summarize the general characteristics of the sample data. Besides, simple statistical tools like averages and percentages were used to compare, contrast and interpret results if need arises.

3.3.2 Compound annual growth rate (CAGR)

Compound Annual Growth Rates (CAGR) for livestock population, production and productivity of different livestock products in different districts of the state is estimated using the following functional form,

\[ Y = ab^t \]  
\[ \ln Y = \ln a + t \ln b \]

Where:

- \( \ln Y \) = dependent variable (population, production and productivity)
- \( a = \) constant
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\[ b = \text{regression coefficient} \]
\[ t = \text{the time variable 1,2,3……n} \]

The compound growth rate was worked out as
\[ \text{CAGR} = \left( \text{Antilog of log } b - 1 \right) \times 100 \] \hspace{1cm} (3)

3.3.3. Point to point growth rate

A part from CAGR, the point to point compound growth rate was exercised for state as a whole and for that, ratio to natural log of the current year value to its base year data was calculated. This ratio was further divided by number of years and finally the point to point growth rate was obtained from the following formula.

\[ \text{Point to point growth rate (\%)} = \left[ e^{\text{Log} (Y_t / Y_0) / t} - 1 \right] \times 100 \] \hspace{1cm} (4)

Where,
\[ Y_0 = \text{Population/ Production/ Productivity in the base year} \]
\[ Y_t = \text{Population/ Production/ Productivity in the } t^{th} \text{ year (current year)} \]
\[ t = \text{Number of years (current year – base year)} \]

3.3.4. Instability index

There are several methods in economics widely used for the estimation of instability. However, there is lack of accord regarding the most suitable method for computation because each method has its own pros and cons. For instance, coefficient of variation gets over estimated particularly in time series data showing the long term trend behavior. Cuddy Dell Valle Index (CDI) is also used as measure of instability index instead of CV because this index de trends the given time series by adjusting CV with coefficient of determination (R^2). Another measure of instability is the ratio method, which estimates standard deviation in the ratio (Kumar et al., 2012b). This method has been used in the present study. Instability is free of unit, so easily comparable. It quantifies the deviation of a variable from underlying trend. The instability for production and productivity of various livestock population and products will be estimated using following form:

\[ \text{Instability Index} = \text{STDEV of log } (X_t / X_{t-1}) \] \hspace{1cm} (5)
Where,
STDEV = Standard deviation,
X_t = Production / productivity in the current year, and
X_{t-1} = Production / productivity in the in the previous year.

When there are no deviations from the trend, the ratio X_{t-1}/X_t is constant, and thus standard deviation in it is zero. As the series fluctuates more, the ratio of X_{t-1}/X_t also fluctuates more, and standard deviation increases (Angles et al. 2011).

3.3.5 Change in composition and direction of trade

In agriculture and allied sectors, the applicability of markov chain is widely used for trade dynamics, estimation and prediction of production, productivity, area substitution of crops, livestock population etc. Dent (1967) estimated the structural change in export commodity through first order markov chain. Several authors such as Ardesha (2009), Angles et al. (2011), Rampaul (2014), Gunabhagya et al. (2016) etc. had also used Markov chain in their study. It is an application of linear programming to the solution of a stochastic decision process that can be described by a finite number of states. A markov chain named after Andrey Markov is a mathematical system that undergoes transitions from one state to another on a state space. Although, it is a random process usually described as memory less since the next state depends only on the current state and not on the sequence of events that preceded it. In this study, first order markov process was used to study the shifts in the livestock population and trade pattern of major livestock product and thereby gain an understanding about the dynamics of the changes. However, in second order Markov chains, it is assumed that the probability of occurrence in the forthcoming period depends upon the state in last two periods. Similarly, in third order Markov chains, it is assumed that the probability of state in the forthcoming period depend upon the state in its last three periods. The probabilities associated with various state changes are called transition probabilities and matrix table is called Transitional Probability Matrix (TPM). Central to Markov chain analysis is the estimation of the transitional probability matrix P. The element P_{ij} of this matrix indicates the probability that exports/population was moving from country/population i to country/population j with the passage of time. The diagonal P_{ij} measures the probability that the
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Export/population share of a country/population is retained. In plain words, the diagonal element of TPM indicates the retention probability. Rows of the matrix show the loss to the other country/population whereas columns indicate export/population gained by the respective group. Hence, an examination of the diagonal element indicates the loyalty of an importing country to a particular country’s export. The average export to a particular country is considered to be a random variable which depends only on its past exports to that country and which could be denoted algebraically as:

\[ E_{ij} = \sum_{t=1}^{r} E_{it-1} P_{ij} + e_{jt} \]  \hspace{1cm} (6)

Where,

- \( E_{jt} \) = Exports from India during the year t to \( j^{th} \) country,
- \( E_{it-1} \) = Exports to \( i^{th} \) country during the year t-1,
- \( P_{ij} \) = The probability that exports will shift from \( i^{th} \) country to \( j^{th} \) country,
- \( e_{jt} \) = The error-term which is statistically independent of \( E_{it-1} \), and
- \( r \) = The number of importing countries.

The transitional probabilities \( P_{ij} \), which can be arranged in a \((c \times r)\) matrix, have the following properties:

\[ 0 \leq P_{ij} \leq 1 \]  \hspace{1cm} (7)

\[ \sum_{t=1}^{n} P_{ij} = 1, \text{ for all } i \]  \hspace{1cm} (8)

Thus, the expected export share of each country during period ‘t’ is obtained by multiplying the exports to these countries in the previous period \( (t-1) \) with the transition probability matrix. A method to derive parameter estimates when equality or inequality restriction is present is to make use of minimization of Mean Absolute Deviation (MAD) estimator. The transitional probability matrix is estimated in the linear programming (LP) framework by a method referred to MAD. If we employ this method in obtaining estimates of the transitional probabilities, the LP formulation is stated as,
Min O’ P* + Ie ------------------------ (9)

Subject to

XP* + v = y ------------------------ (10)

GP* = I ------------------------ (11)
P* ≥ 0 ------------------------ (12)

where, P* is a vector of the probabilities P_{ij}, 0 is a vector of zero, I is an appropriately dimensioned vector of country, e is the vector of absolute errors (|U|), y is the vector of exports to each country, x is a block diagonal matrix of lagged values of y, and v is the vector of errors and G is a grouping matrix to add the row elements of P arranged in P* to unity. Prediction for livestock exports was made by using the TPM,

B_t = B_0 * T ------------------------ (13)

B_{t+1} = B_{t+1} * T ------------------------ (14)

Where, B_0 is quantity exported in the base year, B_t is quantity exported in next year (predicted quantity), T represents TPM.

3.3.6 Export competitiveness

Assessment of competitiveness can be estimated with various indicators like domestic resource cost ratio, competitive advantage concept, encompassing segmented markets, differentiated products, economies of scale and so on. In present study, most widely used Nominal Protection Coefficient (NPC) was used for measurement of global competitiveness (Corden, 1971; Balassa and Achydlowsky, 1972; Gulati et al., 1990; Taylor and Philips, 1991; Kumar, 2010). A part from NPC, Revealed Comparative Advantage (RCA) was also computed (Batra and Khan, 2005; Rajarajan et al. 2007; Burange and Chaddha, 2008; Qammer and Baba, 2016).

3.3.6.1 Nominal Protection Coefficient (NPC)

NPC is ratio of a commodity’s domestic price to its international reference price. The rationale behind the computation of NPC is that it shows the divergence of domestic price from the international/border equivalent prices and thereby explains the level of protection to the particular commodity in a country and
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determining the degree of export competitiveness of a commodity. Such divergence
was mainly due to the presence of market interventions such as taxes, subsidies and
other policy instruments (Appleyard, 1987). NPC is computed by using following
equation,

\[ \text{NPC}_i = \frac{P_i \cdot \text{ER}}{P_i^b} \]  \hspace{1cm} \text{(15)}

Where, NPC\(_i\) is the nominal protection coefficient of the \(i^{th}\)
commodity; \(P_i^d\) is the domestic price of \(i^{th}\) the commodity in domestic currency; \(P_i^b\) is
the border price in international currency and ER is the exchange rate. Although, this
may not completely explain the level of competitiveness of a commodity for that
reason the wholesale price prevailing in the domestic market cannot be considered as
the export price (Deepika, 2001). Therefore, in the present study, a comparison has
been made between the unit price of exports (\(i.e.,\) export value/export quantity) in
India and the unit price in the world. Both the prices are given in US$ and are f.o.b.
prices. Thus,

\[ \text{NPC} = \frac{\text{India’s export price}}{\text{World export price}} \]  \hspace{1cm} \text{(16)}

Unit export prices were derived as the following,

\[ \text{Export Price (US$/tonnes)} = \frac{\text{Export Value}}{\text{Export Quantity}} \]  \hspace{1cm} \text{(17)}

If NPC ratio < 1 implies that the country has competitive advantage of that
commodities and further incentives for exports. Thus commodity is not protected.
If NPC ratio > 1 means lack of competitive advantage which is discouraged the export
of that particular commodity. Such commodity is being protected by the government
because under free trade, the price would be lower.

3.3.6.2 Revealed Comparative Advantage (RCA)

The concept of revealed comparative advantage was used by Balassa
(1965). The RCA measure the relative trade performance of individual countries in
particular commodities to the other countries. As per the measure of comparative
advantage, the fundamental assumption in the trade process is resource endowments,
economics of scale, national and international policies, technological superiority are
the certain classified factors that make country to have an advantage in exporting a
commodity to another country. This factor reflects in the inter-country relative price
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differences which are “revealed” in the comparative advantage of the trading countries. Therefore, RCA measures a country’s share of world exports of a commodity divided by its share of total world exports. The index for country $i^{th}$ for commodity $j^{th}$ is calculated as follows (Burange and Chaddha, 2008)

$$RCA_{ij} = \frac{\left(\frac{X_{ij}}{X_{wj}}\right)}{\left(\frac{X_i}{X_w}\right)} \hspace{1cm} (18)$$

Where,

- $X_{ij}$ = $i^{th}$ country’s (India) export of commodity $j$
- $X_{wj}$ = World exports of commodity $j$
- $X_i$ = Total merchandise exports of country $i^{th}$ (India)
- $X_w$ = Total merchandise world exports

However, the Balassa index can be modified to arrive at the following equation,

$$RCA_{ij} = \frac{\left(\frac{X_{ij}}{X_i}\right)}{\left(\frac{X_{wj}}{X_w}\right)} \hspace{1cm} (19)$$

If the RCA index for a particular commodity is greater than 1, then it is considered to have a comparative advantage in the exports of that commodity and vice-versa. If index value is unity, it shows comparative neutrality. The merit of RCA is that it takes into account advantage of export commodity with relative improvement in factor endowment and productivity. On the contrast, it cannot make a distinction in improvements in factor endowments and pursuit of appropriate trade policies by a country.

3.3.7 Gravity model

The gravity model has been one of the most successful empirical models in the international economics (Anderson, 2011). The most primitive form of the model was given by Ravenstein (1885) which was further elucidated by Tinbergen (1962) and Poyhonen (1963) who used the model empirically in the field of international trade. Applicability of the model in the present state of affairs is mainly attentive to export performance measurement. The basic gravity model is augmented with a number of variables to test whether they are relevant in explaining trade between countries (Zarzoso and Lehmann, 2003). These variables include GDP, distance, infrastructure, differences in per capita income and exchange rate. The gravity model used by Kumar (2010) was followed in the present study with certain
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extension. The simplest form of the gravity model surmises that the volume of exports
between any two trading partners is an increasing function of their national incomes,
and a decreasing function of the distance between them (Wall, 1999). The model
stirred by the universal law of gravitation that was discovered in 1687 by Newton who
proved that any two objects exert a gravitational force attractively on each other. The
magnitude of the force is proportional to the product of the gravitational masses of the
objects, and inversely proportional to the square of the distance between them. This
law has been further extended to bilateral trade between two countries which states
that the bigger and closer countries are to each other, the more trade is conducted
between them (Eita, 2008). Using the gravity model in present study is identifying
determinants influencing on export performance. The specific form of the function is
expressed as below,

\[
\ln X_{ij} = \alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j - \delta \ln D_{ij} \quad \text{(20)}
\]

Where, \(Y_i\) and \(Y_j\) denote national incomes of the trading countries and \(D_{ij}\) are the
distance between the two countries. This baseline model, when estimated, gives
relatively good results. However, there are several other factors which influence trade
levels. It is common to use dummy variables to capture contiguity effects, cultural and
historical similarities, regional integration and trade preference agreements, trade
policies and so on. Assuming that we wish to test \(p\) distinct effects, the model then
becomes:

\[
\ln X_{ij} = \alpha + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \gamma \ln Y_{int} + \delta \ln D_{ij} + \sum_{s=1}^{p} \lambda_s G_s
\]

\[
\text{-------- (21)}
\]

Finally, with regard to the gravity model of India’s export of livestock
products, the following model is used:

\[
\ln X_{ijt} = \alpha + \beta_1 \ln Y_{ijt} + \beta_2 \ln Y_{ijpct} + \beta_3 \ln Y_{int} + \beta_4 \ln Y_{inpct} + \beta_5 \ln Y_{ijpct} + \beta_6 \ln P_{jt} + \beta_7 \ln P_{it} + \beta_8 \ln E_{Rjt} + \beta_9 \ln ASIA_{jt} + \beta_{10} \ln E_{Ujt} + \beta_{11} \ln T_{Ojt} + \mu_i
\]

\[
\text{--------- (22)}
\]

(Here, \(i\) indicate the exporter (India), \(j\) are the trading partners (importer) and \(t\) is the
period under consideration). All the variables are expressed in natural logarithms
except dummy variables. The variables are expressed as below:
### Table 3.2: Explanations of variables, units and expected sign

<table>
<thead>
<tr>
<th>Code</th>
<th>Descriptions</th>
<th>Unit</th>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \ln X_{ijt} )</td>
<td>( X ) is the export, ( i ) denotes livestock sector, dairy products, meat and its products and poultry products to ( j )th importing country at time ( t )</td>
<td>Million US $</td>
<td></td>
</tr>
<tr>
<td>( \ln Y_{jit} )</td>
<td>GDP of the ( j )th importing country at time ( t )</td>
<td>Million US $</td>
<td>+</td>
</tr>
<tr>
<td>( \ln Y_{jipct} )</td>
<td>Per capita GDP of the ( j )th importing country at time ( t )</td>
<td>US $</td>
<td>±</td>
</tr>
<tr>
<td>( \ln Y_{inpct} )</td>
<td>Per capita GDP of ( i )th country (India) at time ( t )</td>
<td>US $</td>
<td>±</td>
</tr>
<tr>
<td>( \ln Y_{int} )</td>
<td>Livestock GDP of ( i )th country (India)</td>
<td>Million US $</td>
<td>±</td>
</tr>
<tr>
<td>( \ln D_{ij} )</td>
<td>Aerial distance between ( i )th country (India) and ( j )th importing country with respect to their capital</td>
<td>Kilometer</td>
<td>-</td>
</tr>
<tr>
<td>( \ln P_{jt} )</td>
<td>Populations of the ( j )th importing country at time ( t )</td>
<td>Million No.</td>
<td>±</td>
</tr>
<tr>
<td>( \ln P_{it} )</td>
<td>Populations of the ( i )th country (India) at time ( t )</td>
<td>Million No.</td>
<td>±</td>
</tr>
<tr>
<td>( \ln ER_{jt} )</td>
<td>Real Exchange Rate of country ( j ), units of foreign currency per Indian rupee (ratio of US dollar per Indian Rupee to US dollar per unit of importing country ( j )th currency)</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>( \text{ASIA}_{jt} )</td>
<td>Asian country dummy (If Asian country coded 1 and otherwise 0)</td>
<td>-</td>
<td>±</td>
</tr>
<tr>
<td>( \text{Eu}_{jt} )</td>
<td>European country dummy (If European country coded 1 and otherwise 0)</td>
<td>-</td>
<td>±</td>
</tr>
<tr>
<td>( \ln To_{jt} )</td>
<td>( To ) is nothing but trade openness. It is the ratio calculated by dividing total trade (export and import) of ( j )th importing country with total it’s GDP.</td>
<td>Million US $</td>
<td>+</td>
</tr>
<tr>
<td>( \beta_i’s )</td>
<td>( \beta_i’s ) are the coefficients of the explanatory variables</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>( \mu_i’s )</td>
<td>( \mu_i’s ) are the error-terms</td>
<td>-</td>
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</table>

### 3.3.7.1 Model framework and estimation procedure

Basically, gravity model is panel data technique. In contemporary times, application of panel data is widely utilized in socio-economic aspects, trade, and business analysis and so on. The beauty of panel data is that it is combination of cross-section and time series variable. So, it studied both time and space. Second advantage is taken care of individual heterogeneity. Such data are related to individual states, country, company etc. Third, it includes more degree of freedom. For instance, if there is one county and suppose there are twenty observation but including more country, the observation is increased meanwhile it cover more information. Therefore, model was estimated using balanced panel of 12 trading countries separately for dairy, poultry and meat and its products. Panel data is analysed in Pool Ordinary Least Square (OLS), Fixed Effects Model (FEM), Random Effect Model (REM) or Error
Component Model (ECM). A brief but lucid explanation of the estimation procedure is discussed here.

- **Pooled Ordinary Least Square (OLS):** It is restricted model. Pooling all the observation (cross section and time series) and run the regression of the panel data gives the pooled OLS results. It is needless to say that this approach, causes severe estimation problem and therefore, Pooled OLS are not an appropriate estimation device when panel data are used (Acharya, 2012). The main problem of the pooled model is that it does not allow for heterogeneity of countries. It does not estimate country specific effects and assumes that all countries are homogenous (Egger and Pfaffermayr, 2000; Elshehawy et al., 2014; Edwards and Alves, 2005). In other words, it assumes that regression coefficient is constant and same for all the country and does not vary over the time. Such assumption is rather strict to maintain. Pooling all the observation camouflage the heterogeneity, in data, which caused the error term may correlate with regressors which violate the assumption the Classical Linear Regression Model (CLRM). Such estimation is biased and inconsistent (Gujarati, 2012). Apart from explanatory variables, certain other time invariant and unobserved variables may correlate with regressor leads the problems of autocorrelation. Although, for the sake of comparison, it has been considered here. Therefore, to overcome this problem, FEM and REM captured such unobserved heterogeneity across individual. The only question is that they are correlated or not. If individual specific effects are correlated \( (\alpha_i) \) with regressor \( (X_i) \), FEM is used and if they are not correlated then REM is used.

- **Fixed Effects Model (FEM):** The word “fixed effect” is owing to fact that intercept may differ across subjects (Country here) but intercept does not vary over the time, *i.e.* time invariant (Gujarati, 2012). Intercept varies across the country due to their socio-economic condition, geography *etc.*, unlike pooled OLS that assumes the same intercept for all the country. The FEM considers the heterogeneity by estimating country specific effects (Edwards and Alves, 2005). The assumption here is individual specific effects \( (\alpha_i) \) are correlated with regressor \( (X_i) \), so correlation of \( \alpha_i \) and \( X_i \) is non zero. The problem in FEM is that variables that do not change over time such as distance, dummy variables are not taken into account. Such variables are wiped out during
estimation (Hatab et. al. 2010). Therefore, FEM approach does not measure the impact of time invariant variable (Gujarati, 2012).

- **Random Effect Model (REM) / Error Component Model (ECM):** The advantage of ECM over FEM is that intercept of individual unit is random and deviated from mean value (Gujarati, 2012). The assumption here is that individual specific effects ($\alpha_i$) are not correlated with regressor ($X_i$), so correlation of $\alpha_i$ and $X_i$ is zero. In other words, it assumes that individual specific effects ($\alpha_i$) are independent of regressor with each other and not autocorrelated with time series and cross section units, if they are correlated then ECM result is inconsistent (Gujarati, 2012). Besides, time constant and dummy variable are carefully taken care of by this approach. Individual specific effects ($\alpha_i$) are included in error term. Therefore, error component consists two terms viz. cross section or individual specific error and combined time series and cross section error, also called idiosyncratic term. Therefore, critical difference between fixed effects and random effects models is that the fixed effect model allows correlation between unobserved effect and the explanatory variable whereas the random effect requires no correlation between them. (Acharya, 2012). REM was analysed using Generalized Least Squares (GLS).

Above estimation does not figure out the appropriateness of using either FEM or REM. Therefore, Hausman (1978) has given a test which called Hausmans’ Specification Test. This test had chi square distribution and it was employed to choose the right model between FEM or REM. The null hypothesis is REM is suitable i.e. unobserved variable is not correlated with the explanatory variables. If null hypothesis is rejected (i.e. p-value is less than 0.05) then REM is not appropriate because unobserved variable is correlated with the explanatory. So, FEM is suitable in that case. In short, if the $P$-value is significant or less than 0.05, then fixed effects model is used. If $P$-value is greater than 0.05, then random effects model is the most efficient model (Elshehawy et al., 2014). Another test named Breusch-Pagan Lagrange Multiplier Test (LM test) was also applied to choose the right model between Pooled OLS and REM. Null hypothesis is Pooled OLS is preferred over REM.