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Jalpaiguri District Migration History Between 1872–2011

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Abstract: *In social science research studies, human migration is an important aspect, which is an interdisciplinary research problem. Presently, History researchers are also attracted to it. In social science migration research problems such as when do the people move from one place to another, who moves, why do they move, what are the historical events associated with the movements, and what are the impacts when they live there are mainly studied herein. It is well known that historical data sets are not accurate as collected from scientific studies, or physical measurements. It is necessary to perform history research with efficient robust estimated historical data that can only be obtained from the derived probabilistic model based on the raw available data. The present paper studies migration problems of Jalpaiguri District, West Bengal, India from 1872 to 2011 using census data, based on parametric and nonparametric population growth trend models. It not only derives the efficient population growth data estimates during this period, but also concentrates on the above stated migration related social science research problems, from the derived parametric and nonparametric probabilistic models. It is noted herein that parametric model provides better estimates than nonparametric probabilistic models.*

Keywords: *Cubic spline; Jalpaiguri District; Gamma & Log-normal models; History of migration; Joint generalized linear models; Migration problems; Population growth trend.*

I. INTRODUCTION

Generally, migration explains the mobility of people from one area to another as permanently, or temporarily. Human migration is a primary problem in social science. Presently, it is considered as an important research topic in many subjects such as Demography, Economics, Geography, History, Statistics, Sociology etc. Internal migration history in the Indian subcontinent is mainly given in many books such as by Zacharia (1964), Chattopadhyaya (1987), Subba (1988), Dhar (1998), Samaddar (1999), Datta (2003), Godbole (2006). etc. West Bengal and North Bengal migration history are given in some books and research articles such as by Mitra (1952), Mitra (1962), Chattopadhyaya (1987), Subba (1988), Dhar, (1998), Samaddar (1999), Hazarika (2000), Datta (2003), Datta (2004), Godbole (2006), Sharma and Kumar (2012), Saha and Ghosh (2013), Saikia and Joe (2016), Das and Ansary (2017) etc.

The current paper aims to examine the migration related social science problems regarding Jalpaiguri district, so only the migration related literature of West Bengal, North Bengal and Darjeeling district are concentrated herein. Note a long historical tradition that North Bengal, Darjeeling and Jalpaiguri districts are strategically and geographically migrant-prone zones. In 1869, modernization of North Bengal, Darjeeling and Jalpaiguri had been started by connecting Western Duars with Jalpaiguri, and Eastern Duars with Goalpara, and Kalimpong with Darjeeling. So, the present study is started from 1969, or close of this year, as it was a turning point of the migration process.

Jalpaiguri district migration is a geo-historical phenomenon, as its geographical position converted it into a migrant-prone zone. Note that it is situated at the India's Himalayan borderland, therefore, it has received a series of migrations from time immemorial (Dhar, 1998; Samaddar, 1999; Subba, 1988). Jalpaiguri and Darjeeling districts are the junction between North-Eastern India and the rest of India. The hilly tracts of these two districts are still attractive for the people from abroad and different parts of India. Until the sixteenth century, many political centers of Bengal were located in Jalpaiguri and Darjeeling district, which encouraged immigration of people from different locations. After the termination of Gour, the Koch-Kamta kingdom origin illuminated the invited migration process. With the incorporation of the British rule over this area, modernization of Jalpaiguri and Darjeeling districts had been initiated with the development of communication, agriculture, tea industry, administrative, business, military services etc. The migration process was an invited migration during the British colonial period. During the post colonial period, a new type of migration termed as forced migration (or Refugee Migration) (Samaddar, 1999; Nanda, 2005; Das and Ansary, 2017; Saikia and Joe, 2016) was occurred in these districts due to many events such as India's partition, political disturbances in the hill areas (for example Chinese occupation of Tibet), poverty of Eastern Nepal, atrocities in East Pakistan, Babri Mosque broken, political disturbances in Assam etc. This migration process is still extensive due to political disturbances in Bangladesh and the adjacent State Assam (Das and Ansary, 2017; Saikia and Joe 2016).

India witnessed a voluminous overseas and internal migration in the nineteenth century (Chattopadhyaya, 1987). When Jalpaiguri and Darjeeling came under British imperial yoke, these two districts were a prominent migration region, which was reported in the note by Hon'ble Sir Richard Temple (1874, p.82). The above areas have already achieved and still are achieving significant experience of continuous and steady migrants flow from the adjacent border countries and different parts of India (Datta, 2003). At the time of Rangpur Revenue Survey in 1858-59, the permanently settled Jalpaiguri district population was 189,067 (Mitra, 1952). During the first census in 1871-72, the Jalpaiguri district recorded population was 327,985 (Jalpaiguri Census Handbook, 1961). Very close to the Bhutan war time, the estimated Western Duars population (from a survey of the Western Duars (1865-67)) was 49,620, which was not accurate (Mitra, 1952). In the Deputy Commissioner's special census, Western Duars population was 100,111 (Mitra, 1952). Considering errors in the population counting, it is noted that the migration process started from the adjacent districts to the fertile wasteland of the Western Duars as soon as British rule ensured the safety of life and property. It was reflected in the subsequent censuses as there were remarkable population increases. In 1881 it increased to 182,687, in 1891 to 296,348 and in 1901 to 410,606 (Saha and Ghosh, 2013).

The reported population data in the beginning censuses as stated above were not exact. Also, it may be true for all the subsequent censuses. Population census data may be inaccurate due to some problems such as absence of the family members during survey time, incorrect responses, wrongly tabulated data, observations are recorded from an unauthorized representative etc. Best of our knowledge, migration problems are very little studied based on robust estimated data using probabilistic modeling. The current paper aims to derive the robust estimate of Jalpaiguri district census population data from 1972 to 2011 adopting probabilistic modeling. One non-parametric cubic spline curve and two parametric fitted curves such as joint Lognormal and gamma and models have been developed for estimating the Jalpaiguri district population census data from 1972 to 2011. Model fitting has been verified using graphical analysis. Using the estimated census population data, historical events related with the migration problems have been located herein.

The paper is arranged as follows. The following section reveals the underlying principle of locating migration problems adopting historical population growth trends, and the subsequent sections reveals respectively materials and methods, results, and discussion and conclusion. The cubic spline model has been developed. It is derived that the response population growth fitted parametric mean trend curve is a non-linear polynomial of degree four of transformed time (t), while its variance is a non-linear polynomial of degree one of transformed time (t). It is

observed that the parametric models give an efficient estimate than the cubic spline model within the range. Both the derived models can predict the mean population growth at any time during the period from 1872-2011, which are more efficient and consistent than the recorded data.

II. MIGRATION STUDY ADOPTING HISTORICAL POPULATION GROWTH TRENDS

The population growth rate in a fixed region is always decreasing, otherwise population size will be infinite, which is impossible, if there is no emigration, or immigration (Goon, Gupta and Dasgupta, 2002). Thus, the population growth trend curve should be smoothly increasing that reveals no significant immigration. Therefore, at any time point interval, if there is an abnormal increase in the trend curve that reveals a significant immigration during that period. Practically, the abnormal increase of the mean trend curve can locate many migration related historical events. Also, the variance trend curve can locate some historical events during the considered time period, which are related with the migration problems. So, the present migration study is performed in the article using the mean and variance trend curves of population growth. The present paper aims to study social science migration research problems for Jalpaiguri district adopting the above principle based on the population growth trend curves. The concept of trend curve is illustrated in the following paragraphs.

A series of data based on time for a long period is known as time series data that contains four components such as Secular trend (or Trend) (T_t), Seasonal variation (S_t), Cyclical variation (C_t), and Irregular variation (I_t). In general, the trend is termed as the gradual movement and persevering of the series for a long period of time. The long term variation of a time series data for smooth upward increase, or downward decrease is termed as a trend, which is clearly illustrated in the books by Montgomery, Jennings and Kulachi, (2016); Shumway and Stoffer, (2017). The report presents the logical problem of separating trends from a historical time series data set by adopting the time series analysis. It derives the best secular trend from a historical time series data set. Generally, in history, secular trends can be expressed as illustrations. A historian illustrates the trend from his/her mass of material, a descriptive substance that reveals clearly the primary factors that have been at work.

For example, in history, many continuing and continuous processes exactly similar to secular trends had been illustrated by Schlesinger (1926, p. viii). Professor Schlesinger wrote in the preface of the book entitled- *Political and Social History of the United States,* that continuous pressures have been applied on the great progressive currents that have shaped the nation's life. In view of Professor Schlesinger, these pressures were, and still are (i) the continuous fight for greater democracy; (ii) the nationality growth; (iii) continuous production methods improvement and its distribution; (iv) the national boundaries expansion; (v) the struggling for social improvement, including children and women progress, the successive humanitarian reform activities and contest for free public schools.

The secular trend matter is definitely a particular case of historical illustrations, which consists of a significant numerical number series that are described by special non-statistical information. Generally, the historical trend problem is to present the best illustration possible of the main tendencies which these facts reveal. The statistician represents the historical illustration, not in words, but in mathematical equations representing lines or curves. Generally, the historical trends description in terms of secular trends is represented by probabilistic (or mathematical) models (Mills, 1932; Frickey, 1934). Therefore, the mathematical models, representing curves, or lines named as "secular trends" displays the use of someone's discretionary judgment.

Generally, the trend problem is a statistical statement that is transformed into a mathematical basis, containing the necessary examinations of the original data characteristics. There may be contrary opinions regarding the validity of the historical trend idea as a statistical statement. The above statistical expression can have no value, unless the developed methods are preceded by a wide thorough historical investigation, or theoretical exploration, or both, which should be raised on the factors behind the time series data, otherwise it should not be considered as the secular trend. Generally, a mathematical curve that reveals the trend is limited to equations such as the linear polynomial, simple logistic, Gompertz equation, logarithmic parabola that satisfy the original data characteristic variations. The equations as stated above only reveal the mean trend, assuming variance is constant, which is not true always for historical data. The above stated equations only represent the mean trend with constant variance that is not true always for historical data. Note that variance has its own interpretations, and it could occur due to many problems that are also associated with many historical events. For historical data with heteroscedastic variance, both mean and dispersion equations should be considered jointly (Lee, Nelder, Pawitan, 2017). Joint mean and dispersion trend functions are very little illustrated in statistical time series analysis (Montgomery, Jennings and Kulachi, 2016; Shumway and Stoffer, 2017).

III. MATERIAL & STATISTICAL METHODS

Materials

The article has developed Jalpaiguri district population growth trend equation from 1872 to 2011 based on the census data given by the Govt. of India, which is given in the site (from 1901 to 2011)--www.censusindia.gov.in/2011census/PCA/A-2_Data_Tables/19%20A-2%20West%Bengal.pdf, and from 1872 to 1891 these are recorded from Saha and Ghosh (2013). It is pointed out in the Introduction Section that Jalpaiguri population census data in 1872 were contradictory, also in the subsequent censuses there may be some errors in the census data. For ready reference, Jalpaiguri district population census data from 1872 to 2011 are given in Table 1.

Statistical Methods

Population census data are always positive integers that are discrete, finite and large. Note that discrete Binomial distribution is asymptotic normal for large sample size, and with small success probability (Goon et al., 2002). Therefore, for large sample size, a discrete response variable can be treated as continuous. In the current report Jalpaiguri district census population data are large positive integers, therefore, it may be treated as a continuous random response variable. For a positive continuous random response variable with constant variance, regression analysis can be performed under either the log-normal or the gamma model, while both give similar analysis (Firth 1988). For non-constant variance, analysis findings from the models may be different (Das and Lee, 2009). Under these situations, joint generalized linear models (JGLMs) are commonly used, which is clearly illustrated in the book by Lee, Nelder and Pawitan (2017). For ready reference, both the JGLMs are given shortly as follows.

Log-normal JGLMs: For a positive continuous response random variable y_i's with heteroscedastic variance (σ_i^2), and mean $\mu_i = E(y_i)$, satisfying $Var(y_i) = \sigma_i^2 \mu_i^2 = \sigma_i^2 V(\mu_i)$ say, where $V(.)$ is termed as variance function, the log transformation $z_i = \log(y_i)$ is generally considered to stabilize the variance $Var(z_i) \approx \sigma_i^2$, but the variance may not be stabilized always. For deriving an improved model, JGLMs for the mean and dispersion

are practically used. Assuming the response distribution as log-normal, the JGLM of the mean and dispersion model (response y_i, with $z_i = \log(y_i)$) are displayed by
$E(z_i) = \mu_{zi} = x_i^t \beta$, $Var(z_i) = \sigma_{zi}^2$, and $\log(\sigma_{zi}^2) = g_i^t \gamma$,

where x_i^t and g_i^t are the vectors of independent variables associated with the regression coefficients β and γ, respectively.

Gamma JGLMs: For **t**he response y_i's as above, its variance has two components such that σ_i^2 (free of mean changes) and $V(\mu_i)$ (depends on the mean changes), while $V(\cdot)$ is known as the variance function, which characterizes the GLM family distribution. For example, if $V(\mu) = \mu$, it is Poisson, and it is Gamma, or Normal according as $V(\mu) = \mu^2$, or $V(\mu) = 1$ etc. Gamma JGLMs mean & dispersion models are represented by

$$\eta_i = g(\mu_i) = x_i^t \beta \text{ and } \varepsilon_i = h(\sigma_i^2) = w_i^t \gamma,$$

where $g(\cdot)$ & $h(\cdot)$ are the GLM link functions for the mean & dispersion linear predictors respectively, and x_i^t, w_i^t are the vectors of explanatory variables, related with the mean and dispersion parameters respectively. Maximum likelihood (ML) method is used to estimate mean parameters, while the restricted ML (REML) method is adopted to estimate dispersion parameters (Lee, Nelder and Pawitan, 2017).

STATISTICAL & GRAPHICAL ANALYSIS

The response Japlaiguri district census population (JDCP) has been modeled by JGLMs with both Log-normal & Gamma distributions. Here JDCP is treated as the response, and the census time and a weighted variable (x) are treated as independent variables. Note that the weighted variable is taken according as the number of incidences occurred in the surrounding neighbor States or countries during the corresponding decade census year. The weighted variable x values are given in Table 1.

Here it is found that variance of the response (JDCP) is heteroscedastic, so the best JGLMs model has been considered based on the lowest Akaike information criterion (AIC) value (within each class) that minimizes both the squared error loss and predicted additive errors (Hastie et al. 2009, p. 203-204). According to the AIC criterion, both the JGLMs Log-normal (AIC=366.3360) and Gamma (AIC=366.1231) fits give similar outcomes as the AIC difference is less than one that is insignificant. The final JDCP Gamma and Log-normal JGLMs analysis outputs are presented in Table 2.

The derived JDCP (Table 2) probabilistic model is a data derived model that has been tested using model diagnostic tools in Figure 1. For the joint Gamma fitted JDCP models (Table 2), graphical diagnostic analysis is presented in Figure 1. Figure 1(a) presents the absolute residuals for the fitted JDCP against the fitted values that is almost flat linear straight line, indicating that variance is constant with the running means. Figure 1(b) displays the normal probability plot for the fitted JDCP mean model (Table 2) that does not show any lack of fit. Figure 1 does not reveal any discrepancy in the fitted JDCP model (Table 2) that shows that the Gamma fitted JDCP model is an approximate of its true model.

Table 1 : Original Population and estimated population growth trend for Jalpaiguri district from 1872 to 2011

Census Year	Jalpaiguri district census population (P_J)	Waits x	t=(Year-1941)/10	Cubic spline fitted P_J	Log-normal fitted P_J	Gamma fitted PJ	% increase of population
1872	327985	3	-7	321723.6	308507.4	309570.4	Nil
1881	383642	4	-6	396726	410445.3	411292.3	16.97
1891	453662	4	-5	471728.5	492699.7	493357.3	18.25
1901	546764	4	-4	547210	556197.4	556778.8	20.52
1911	663222	5	-3	622717.2	611028.9	611650.9	21.30
1921	695946	3	-2	710495.7	671169.3	671912.8	4.93
1931	740993	3	-1	825438.1	751926.9	752832.8	6.47
1941	847841	6	0	984971	870187.3	871259.3	14.427
1951	916747	8	1	1206845	1046040	1047239	8.13
1961	1359292	8	2	1513296	1303982	1305204	48.27
1971	1750159	10	3	1892447	1670924	1671976	28.76
1981	2214871	8	4	2338063	2166018	2166628	26.55
1991	2800543	8	5	2833358	2775433	2775387	26.44
2001	3401173	4	6	3355132	3410282	3409807	21.45
2011	3872846	4	7	3876906	3870374	3870650	13.87

Non-parametric trend estimation using cubic splines

The non-parametric function estimation has been clearly described in some research papers by Wahba (1990); Green and Silverman (1994); Ruppert, Wand and Carrol (2003). Generally, for trends fitting, one can use a known functional form that is called as a parametric model. If we adopt the smooth function even though its form is unknown, that is known as a non-parametric function. In this paper, we use a cubic spline as a non-parametric trend estimation method, and its fitting can be obtained using R-package given in (Lee, Roonnegaard and Noh, 2017).

IV. RESULTS

Table 2 presents the summarized findings of JDCP growth trend under both the log normal and gamma model analyses. It is derived herein that two terms are significant in the dispersion model under both the distribution. Here it is derived that both the lognormal and gamma fitted mean model of JDCP is a fourth degree function of time "t" without weighted variable x. Here time "t" is the transformed time, where t = (Year – 1941) /10 (shown in Table 1). In both the lognormal and gamma fitted mean model, t ($P<0.0001$), t^2 ($P<0.0001$) and t^4 ($P<0.0001$)

are significant, but t^3 (P=0.2018) is not significant. In both the mean model t, t^2, t^3 and t^4 are included due to functional marginality rule (i.e., if higher degree term is significant, then all its lower degree should be included) by McCullacgh and Nelder (1989). In the dispersion model, t (P=0.0052) and x (P=0.0325) are significant. Both the lognormal and gamma JGLMs fits give similar results (Table 2).

Gamma fitted JDCP mean ($\hat{\mu}$) model (Table 2) is

$$\hat{\mu} = \exp.(13.6776949 +0.1647137\ t +0.0192355\ t^2 +0.0003207\ t^3 -0.0002975\ t^4),$$

and the gamma fitted JDCP dispersion ($\hat{\sigma}^2$) model is

$$\hat{\sigma}^2 = \exp.(-10.1405 -0.5479\ t + 0.6734\ x).$$

Table 2: Gamma and Log-normal fitted population growth trend for Jalpaiguri district from 1872 to 2011

Model	Covariate	Gamma fit				Log-normal fit			
		Estimate	Standard error	t-value	P-value	Estimate	Standard error	t-value	P-value
Mean	Intercept	13.6776949	0.02030	673.731	<0.0001	13.6764637	0.02086	655.700	<0.0001
	t	0.1647137	0.00852	19.328	<0.0001	0.1647387	0.00872	18.888	<0.0001
	t^2	0.0192355	0.00214	8.972	<0.0001	0.0192934	0.00220	8.762	<0.0001
	t^3	0.0003207	0.00025	1.277	0. 2018	0.0003251	0.00026	1.264	0.2063
	t^4	-0.0002975	0.00004	-6.703	<0.0001	-0.0002989	0.00005	-6.550	<0.0001
Disper -sion	Intercept	-10.1405	2.0041	-5.060	<0.0001	-10.1364	1.9860	-5.104	<0.0001
	t	-0.5479	0.1954	-2.804	0.0052	-0.5455	0.1939	-2.813	0.0050
	x	0.6734	0.3144	2.142	0.0325	0.6754	0.3119	2.165	0.0308
AIC		**366.1231**				**366.3360**			

V. DISCUSSION & CONCLUSIONS

The article has examined the migration problems of Jalpaiguri district from 1872 to 2011 using the JDCP growth trend curves adopting the parametric and non-parametric methods. JGLMs under gamma and lognormal distributions are parametric JDCP growth trends, while the cubic spline is a non-parametric trend. It is pointed out in the introduction section that JDCP data may not be exact always. It is known that history research is always information based. Note that the exact information can only present many political, economic and social status of the society during the considered periods that are the main historical research interests. Practically, the historians examine the social science migration research problems with some simple arithmetic, illustrations, maps, graphs, percentage etc., (Datta 2004; Datta, 2003; Saha and Ghosh, 2013; Ghosh, 2013; Das and Ansary,

2017). There is no attempt to examine the recorded data using some probabilistic modeling. It is better to study history based on the efficient estimated data, which is very little observed in history research. Best of our knowledge, there is a little migration history study using JGLMs and cubic spline population growth trend curves. So, the present outcomes can't be compared with the previous similar studies, while the present results can be compared with the previous census records as in Table 1 and also in Figure 2.

Figure 2 presents the scattered plots of the recorded JDCP data, and the mean fitted cubic spline and gamma curves, against the time. Gamma fitted values are very close to the recorded census data than the cubic spline fit. For the boundary points, both the fitted JDCP trend curves are steady (Figure 2). Within the period 1872 to 2011 and also at the boundaries, the gamma fitted JDCP trend curve gives better estimates than the cubic spline model. In addition, both the cubic spline and the gamma fitted trend curves for JDCP provide efficient estimates in future and also in past. The mean JDCP fitted trend curves (Figure 2) reveal that population growth trend in the Jalpaiguri district was non-uniformly increasing that implies that immigrants occurred at different times during the period 1972 to 2011.

Figure 2 reveals that from 1872 to 1916, JDCP growth trend slope was very high (Table 3), implying that a large number of immigrants came to the Jalpaiguri district during that period. It is noted that the slope ($\tan\theta$) of the line segment is the tangent of the angle (θ) formed by the line segment along with the X-axis. From slope in Table 3 and Figure 2, it is noted that the migration process was increased from 1872 to 1916. Note that modernization of Darjeeling and Jalpaiguri was initiated in 1869, therefore, immigrants from different parts of India and also the neighboring border countries such as Tibet and Nepal came to the newly developing Jalpaiguri district (Saha and Ghosh 2013). In 1835, the British first acquired the hill territory, while it was mostly under forest, and some parts of the Jalpaiguri district was little inhabited (Dash, 1947, p.49). East India Company decided to improve Jalpaiguri and Darjeeling as a hill resort, and it provided an opportunity to the neighboring people to immigrate there. So, a large number of people from Sikkim and Nepal came to settle there.

Until 1850, Sikkim ruled over the present Siliguri subdivision that was populated by Rajbansis. Since the formation of the Jalpaiguri district 1869, the Brahman Bengalis, Kamrupis from Sylhet, Pandas from Orissa and a few other higher caste Bengali Hindus started to move into the district as government servants and professionals such as doctors and lawyers. Besides them, some Muslims from Noakhali and Tipperah (Comilla) districts came there as professionals, service-holders and moulvis. As merchants and traders many Marwari (from Rajasthan, Haryana) and Kayastha Bengali Hindus came here. With the started of the tea plantations in the Jalpaiguri district, a large number of tribal immigrants such as Santal, Munda and Oraon peasants from Santal Parganas and Chota Nagpur, along with Biharis (from Bihar), Nepalese and Dhangar Coolies numbering around 6000 came into Jalpaiguri district in 1877-78 (Govt. of Bengal 1877; Saha and Ghosh, 2013). They were employed in tea gardens, road construction and railway. Note that the British Govt. had taken control over India from East India Company in 1858.

Figure 2 shows that from 1916 to 1933, JDCP growth trend slope ($\tan\theta$) (Table 3) was the smallest, implying that there were almost no migrations to the Jalpaiguri district during that period.
From 1941 to 1951, JDCP growth trend slope is the second smallest, indicating that there were some migrations in that period. From 1951 to 1991, JDCP growth trend slope is the highest, indicating that maximum migrations occurred during that period. From 1991 to 2011, JDCP growth trend slope is the second highest, indicating that a large number of migrations occurred during that period.

From 1931 to 2011, there were different historical events that occurred in the adjacent States of India and the neighboring countries. The Indian freedom fighting revolution had been growing stronger day by day after 1921, and the freedom fighters were punished by the British Government, so they were forced to take shelter there

mainly from East Bengal. In 1947, independence of India, partitioning of India, and religious violence after independence of India in East Pakistan, many Hindus people were forced to come to India, Jalpaiguri and Darjeeling. During the post-independence period of India, many religious violences were occurred in East Pakistan (presently Bangladesh), which were continued strongly up to approximately 1966, and they were occurred there in several times such as 1970-71 (Independence of Bangladesh), 1992-1993 (Babri Mosque was broken in India), 2001-2003 (Political disturbances in Bangladesh), and it is still there. In 1971, due East Pakistan independence war, most of the Hindu families from East Pakistan were forced to come to India, Jalpaiguri and Darjeeling. This process of Hindu people migration from Bangladesh to India is still continued. From 1962, there were continuous political disturbances regarding Assamese and non-Assames (Bengalis, Behari, Marwari, Nepalese) in Assam, and it is still there. In 1980-1981, it was very strong, so many non-Assamese mainly Bengalis were coming to Jalpaiguri and North Bengal, and it is still present. From 1951, many people from Tibet were coming to Darjeeling and Japlaigiri due to being constantly under attack by China. After a decade of power wrangling between the king and the government, King Mahendra (ruled 1955–1972) scrapped the democratic experiment in 1960, and a "partyless" Panchayat system was made to govern Nepal. The political parties were banned and politicians imprisoned or exiled. So, many Nepales were coming to Jalpaiguri and Darjeeling. Migration in Jalpaiguri was reduced a little from 2001 to 2011.

Figure 3 presents the variance plot for cubic spline fit that shows that population growth variance in Jalpaiguri district was increasing from 1933 up to around 1984, and it was almost stable in the beginning and at the end. But Figure 4 displays the variance plot for the gamma fit that shows that population growth variance in Jalpaiguri district was increasing in the beginning from 1872 to 1916, after that up to 1932 it was almost stable, after that it was also increasing up to around 1983. Both the Figure 3 and Figure 4 show that population growth variance is very small from 1916 to 1933, while it was higher at other time points. This fact is also reflected in the both fitted mean plots (Figure 2). Thus, the variance plots Figure 3 and Figure 4 have many interpretations that are also related to some historical events as stated above.

The speedy migration growth in Jalpaiguri, backed by the colonial domination openly modified the traditional socio-economic structure in Jalpaiguri, while its Pre-British economy was nearly the Asiatic Mode typology (Marian, 1977). The village communities raised a nature of an enclave, production and consumption being directed by their own ethos and needs had promoted a culture of self-sufficiency that was not disturbed by any demographic variation like the pre-colonial immigration. Note that the post migration performed a major role in variation of the social and ecology organization of the Jalpaiguri district from time to time (Roy, 2005).

The immigration also inversely affected the agrarian structure in the Jalpaiguri district. The very low price of land attracted the immigrants. Also in the third Settlement (Roychoudhury, 1905; Xera, 1980), a huge number of people who were not born to the soil could receive lease from the Government as Jotedars in the newly settled areas (Roychoudhury, 1905; Xera, 1980). Many people acquired jotes through purchase. Increasing land price due to migration furthered transfer of jotes through sale to outsiders. Consequently, the number of jotes held by Rajbansis decreased, while those held by Upper Caste Bengali, Marwaris and others increased sharply (Xera, 1980). During the just post Independence period with the gradual increase of immigration land alienation increased by some Government's steps such as the West Bengal Estate Acquisition Act of 1953, Land Reforms Act of 1955, Land Reforms (Amendment) Act of 1971.

The Rajbansi Society was structured in terms of economic class definitions, or Varna differentiations. The society was almost egalitarian and it remained to be so even though the structural & functional variations between Jotedars, Adhiars and Chukanidars formalized by the instruction of a new community of Jotedars since 1895 whose background had induced them to plant the new culture of emerging class consciousness. Due to urbanism and English educated by the new Jotedars community, the old Jotedars society was affected. The new elitist outlook gradually influenced the Rajbansi Jotedars, and consequently, their caste consciousness slowly

disappeared. An urge gradually was felt among them for school education. The gradual spread of education inspired the Rajbansi Jotedars to accept the new functional and structural changed cultural society. The Rajbansis were tried by family professionals and were normally disinclined to change professions. Due to some external causes, some important changes were introduced in their attitude to accept the new professions. Professional changes in turn developed a class identity sense. For instance, the service class amongst the Rajbansis left their own villages for occupational reasons. The newly educated emerging middle class gradually received elitist status by replacing the old landlords. The transfer of jotes had many serious social implications. Some of the Rajbansi Jotedars who sold their jotes had turned into the tenants in the same land that they once owned. This has caused serious social reactions in the Rajbansi society. Consequently, many serious protest movements among the Rajbansi against the immigrants Jotedars occurred which were not properly recorded. Due to immigration, the early Rajbansi society was completely affected.

The paper has focused on many social science migration related research problems such as why do the immigrants move, when do they move, what are the historical events that are associated with the migration problems, and what are the economic, cultural and social effects of the Jalpaiguri district due to migration? Moreover, the paper has developed the estimated census population using statistical non-parametric and parametric methods. The derived estimates are nearly to the census data (Table 1 and Figure 2). Using the estimated model, the current paper has focused all the above migration related social science research problems for Jalpaiguri district. The conclusions are drawn herein from the derived Jalpaiguri district population growth trend mean and dispersion models, slope values, and along with mean and dispersion curves. All the methods are completely based on advanced statistical approaches. Note that percentage increase can be computed only at the census year. But in the present paper, the population growth can be observed at any point through the estimated trend models, slope value, mean plot curves, and also from variance plots, which are rarely studied in any migration related research articles. Note that all the considered methods in the report based on the estimated census population growth values, which are justified by model checking diagnostic plots. All the predictions satisfy the historical events that occurred during the period. Research should have higher faith on the above findings than those emanating from other approaches and models.

Table 3: Slope values at different time points for the segmented straight lines

From year, X-axis value (x1)	To Year, X-axis value (x2)	Y- axis value (y1)	Y- axis value (y2)	Slope tan(θ)
1872	1911	285714.29	678571.425	10073.25
1911	1931	678571.425	749999.995	3571.4285
1931	1941	749999.995	928571.42	17857.1425
1941	1951	928571.42	1071428.56	14285.714
1951	1991	1071428.56	2999999.99	48214.2857
1991	2011	2999999.99	3928571.42	46428.576

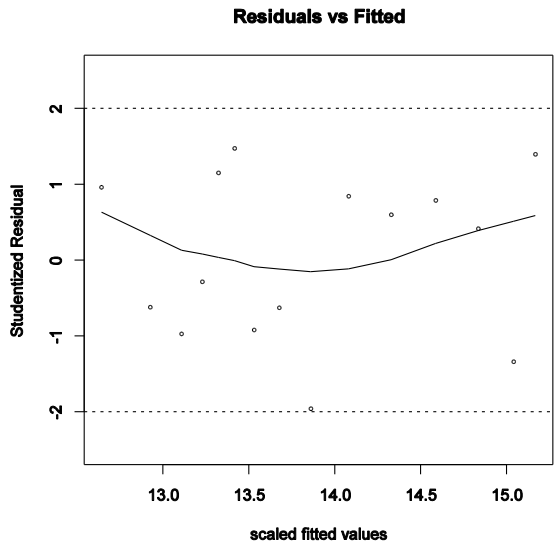

Figure1(a)

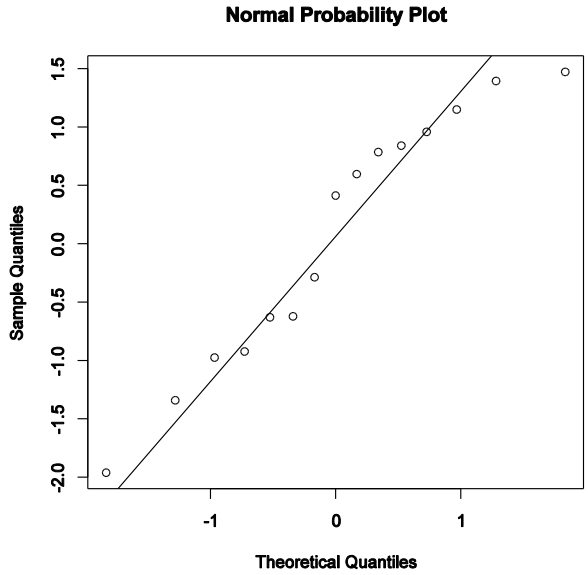

Figure1(b)

Figure 1: For the Gamma fitted models of Jalpaiguri population growth trend (Table 2), the (a) absolute student residuals plot with the fitted values, and (b) the normal probability plot for the mean

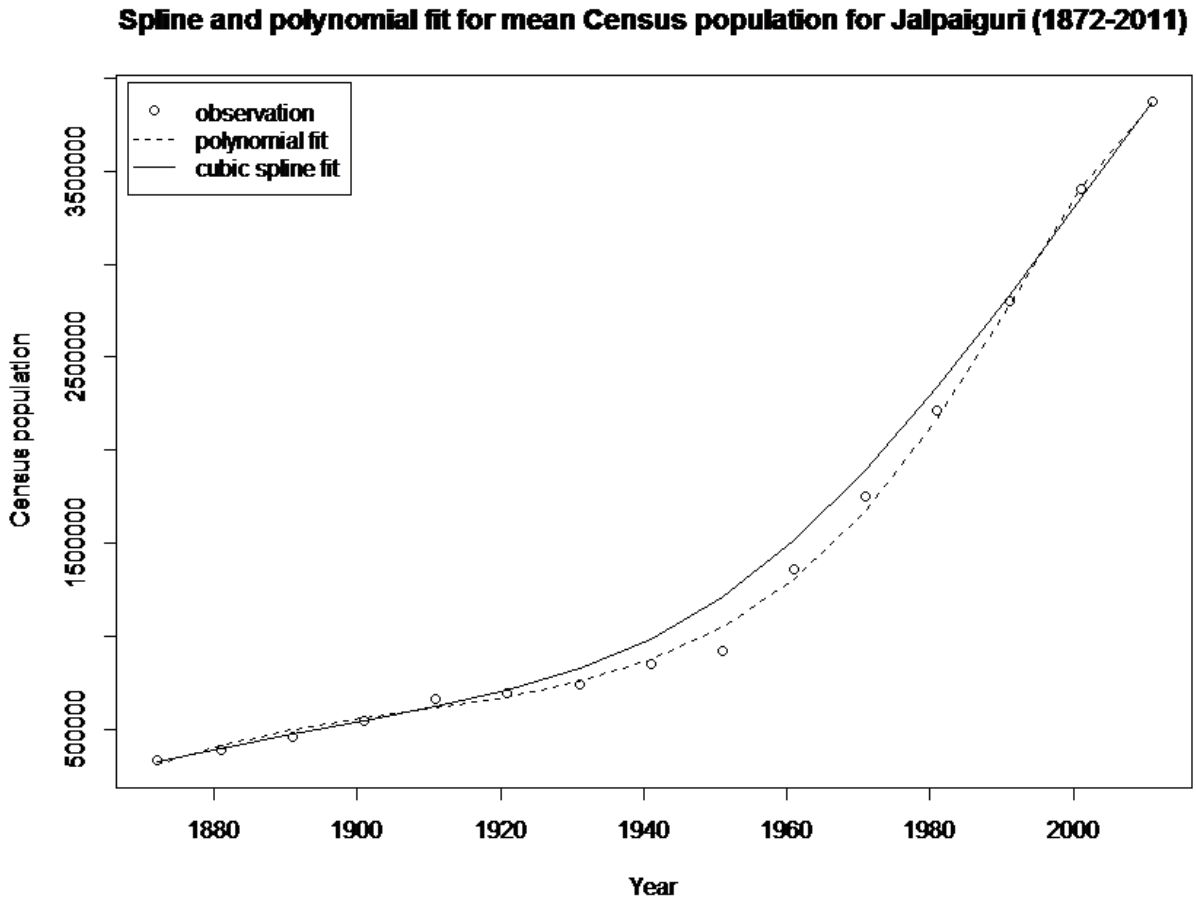

Figure 2: Scattered plot of the original observations and the smooth fitted mean trend curves for polynomial and cubic spline

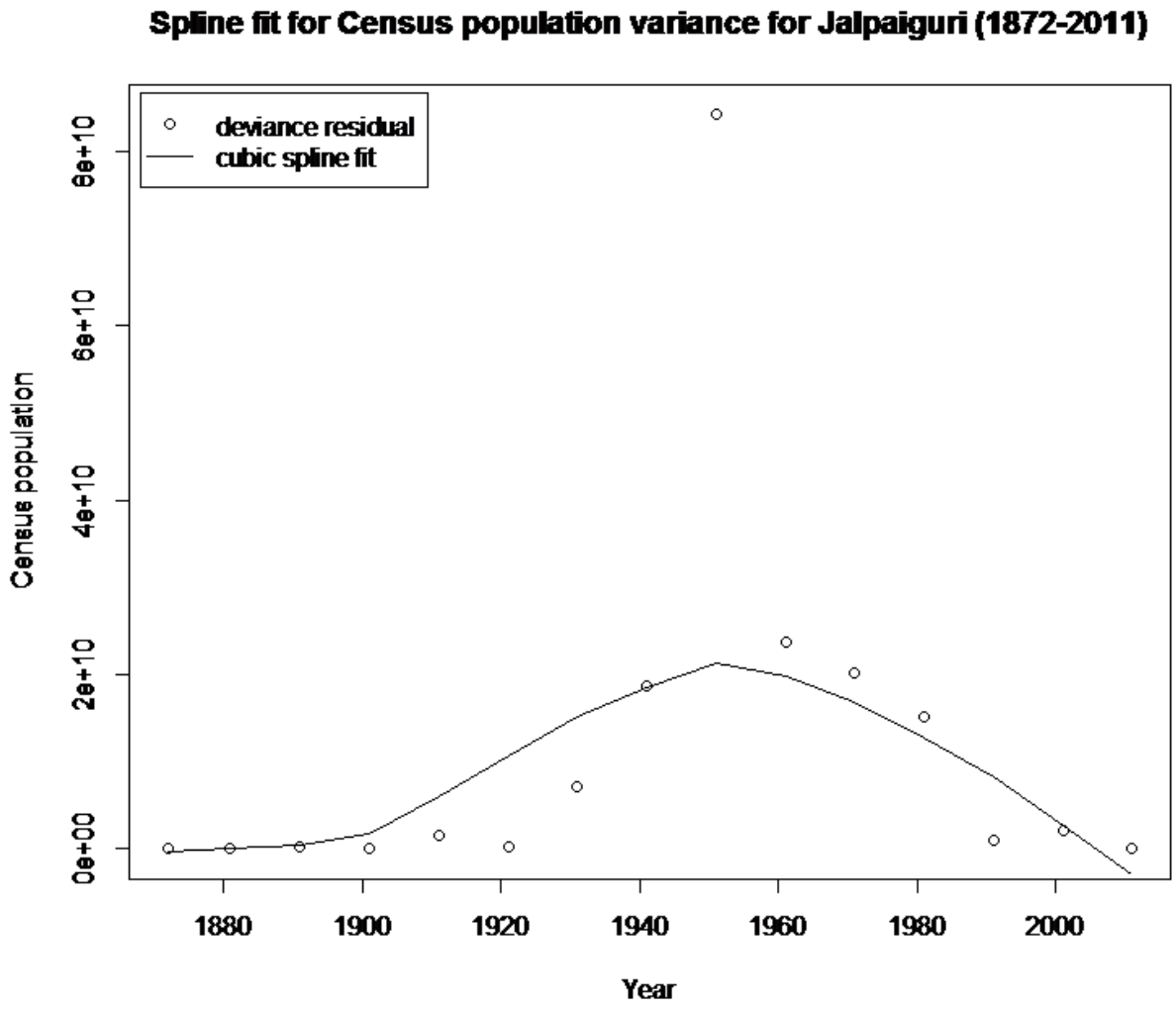

Figure 3: Scattered plot of the deviance residuals and dispersion plot of cubic spline

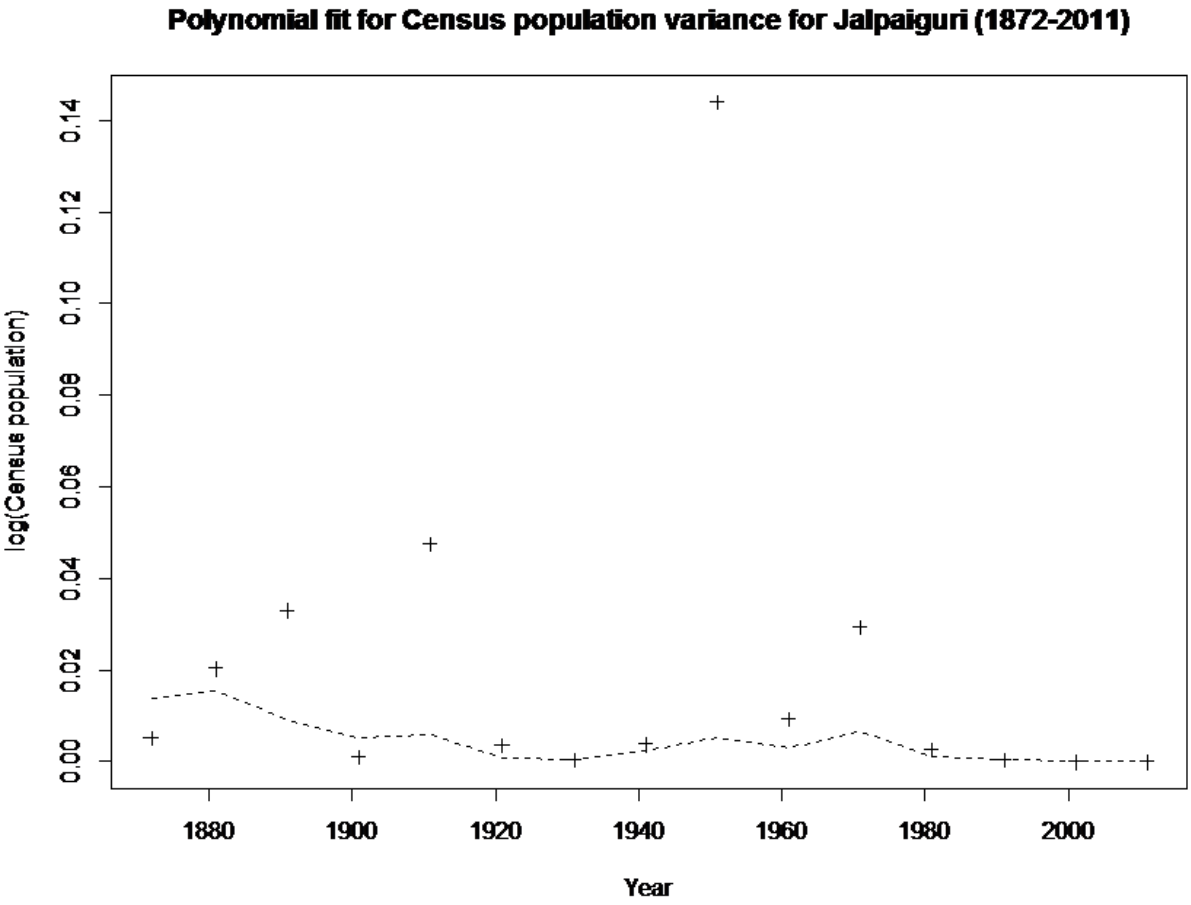

Figure 4: Scattered plot of the deviance residuals and dispersion plot of polynomial fit

Conflict of interest: The author confirms that this article content has no conflict of interest.

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