The Economics of Landownership, Land Tenure, Population Processes, and the Rate of Rent in 1930s Rural China

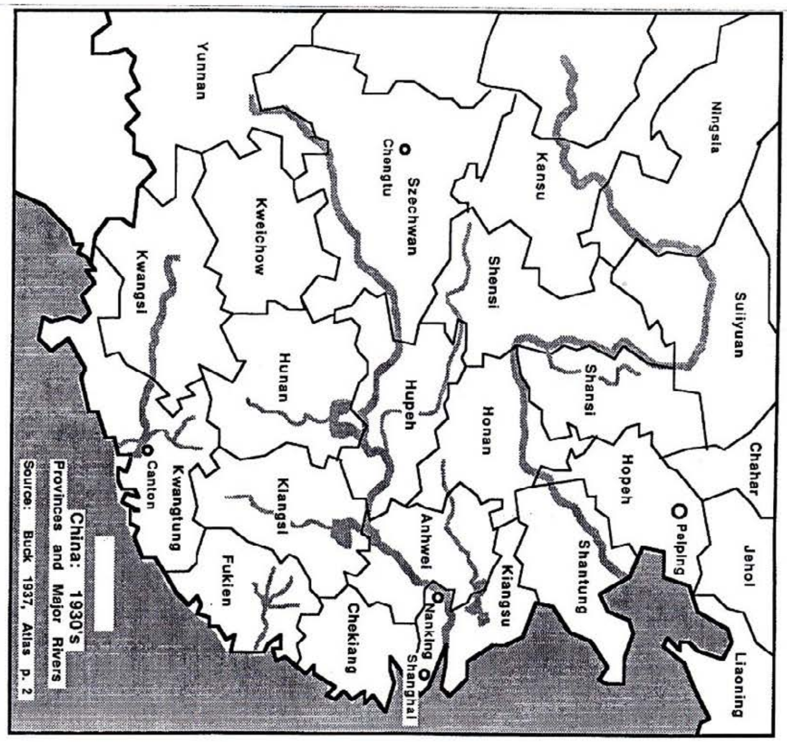
by

Linda Gail Arrigo, PhD and Matthew R. Marler, PhD.

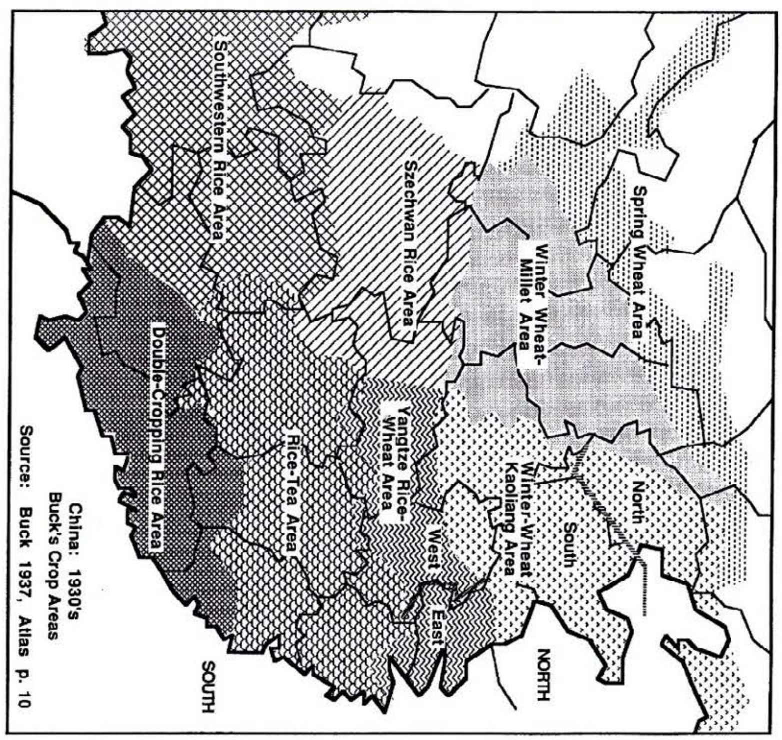
Abstract: Several large-scale surveys of rural China were conducted in the decade prior to the invasion of China by Japan in 1937. These surveys have led to many controversies over the degree of inequality prior to the 1949 Chinese Communist Revolution, and whether demographic processes in effect alleviate inequality in peasant society (i.e. the Lenin versus Chayanov debate). With computational and simulation tools available from the 1980s on, Arrigo evaluated these surveys and sought to simulate the economic and demographic processes that might match the empirical Chinese data, completing a compendious Ph.D. thesis (Arrigo, 1996) and comparing also surveys of prerevolutionary Russia and contemporary Bangladesh. Marler has taken on a planned series of extensions of Arrigo's work to achieve greater precision, using more modern computing power and more generalized theory. Here we focus on a simulation of Population Processes Generating the Landownership Distribution, in particular, the random elements of partition in inheritance.

Introduction

China is divisible into 11 regions that are reasonably homogeneous with respect to climate, terrain, waterways and other geographic features. These regions have each a characteristic economy based on major crop (wheat, rice), number of growing seasons, water and land transportation, and resultant population density. These are displayed in the next figure. Besides plot size information from rural China (circa 1937) we have information on plot size distributions in late 19th century rural Russia and late 20th century rural Bangladesh. These distributions have been the subject of scholarly study and polemics. We are exploring theoretical analyses by simulating processes that might produce the plot size distribution, starting with the simplest possible process of differential reproductive rates and equipartition of the inherited land, that is "partible inheritance" in contrast to primogeniture of aristocratic Europe.



China: 1930's
Provinces and Major Rivers
Source: Buck 1937, Atlas p. 2



China: 1930's
Buck's Crop Areas
Source: Buck 1937, Atlas p. 10

Simulations:

Only two of many simulations are presented here in detail.

The simulations assume that in each generation the landowners have surviving male offspring according to a Poisson distribution truncated at n = 8. In each generation, if a landowner has sons, his plot is divided evenly among those sons for the next generation (that is "partible inheritance"). In each generation, if a landowner has no sons, his lot is given randomly to one of the inheriting landowners from another family.

Each simulation works with 10,000 hectares of land, initially divided equally among 10,000 – a small number of landless males, also referred sometimes as fathers and landowners. Each simulation begins with 100 or 300 landless men, who are treated as though they have landholdings of size 0 hectares, and their sons inherit plots of size 0 hectares. The reproductive rate, that is the parameter of the Poisson distribution is a function of the size of the male owner's land:

lambda = 1.01 + 0.25*(lotsize – mean lotsize)

or

lambda = 1.01 + 0.75*(lotsize – mean lotsize).

The value 1.01 adjusts for the fact that the distribution is truncated. The parameter whose values are 0.25 and 0.75 is the "differential".

The 4 plots are: (a) stationary distribution of the log of the standardized lot size, that is, lotsize/mean_lot_size; (b) plot of number of hectares per plot by group of 4 generations, called a slice; (c) plot of number of landless men per slice; (d) plot of mean and standard deviation of plot size per percentile of the stationary distribution.

Values for the differential rate of reproduction are 0.05, 0.1, 0.15, 0.25, 0.5, 0.75 and 0.0 (equal rate of reproduction of landed and landless.

Model 1 Simplest partible inheritance model with birth rate independent of land ownership.

Figure 1 Convergence of Model 1 to stationary distribution

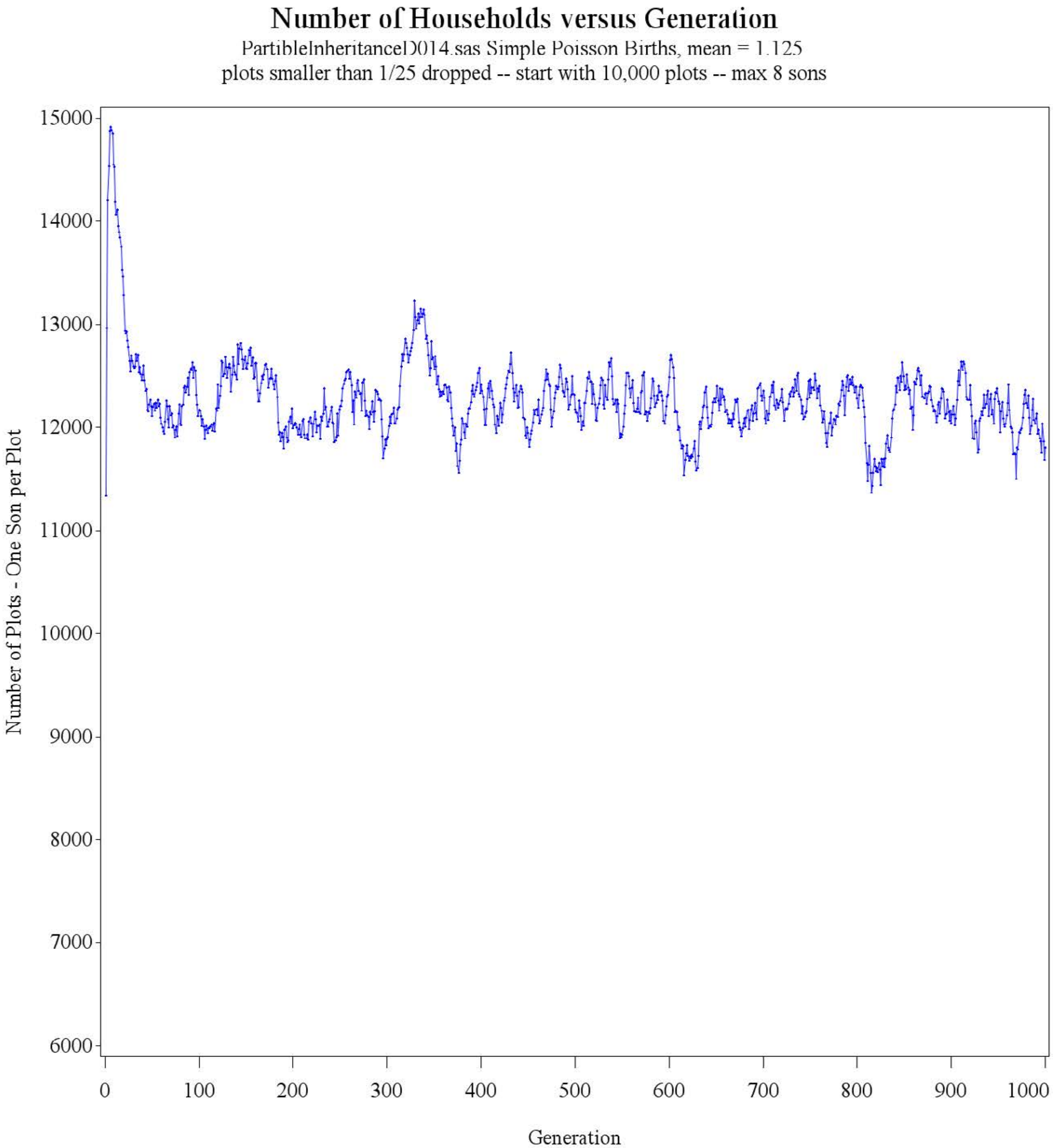


Figure 2 Frequency distribution of plot size Model 1 log scale.

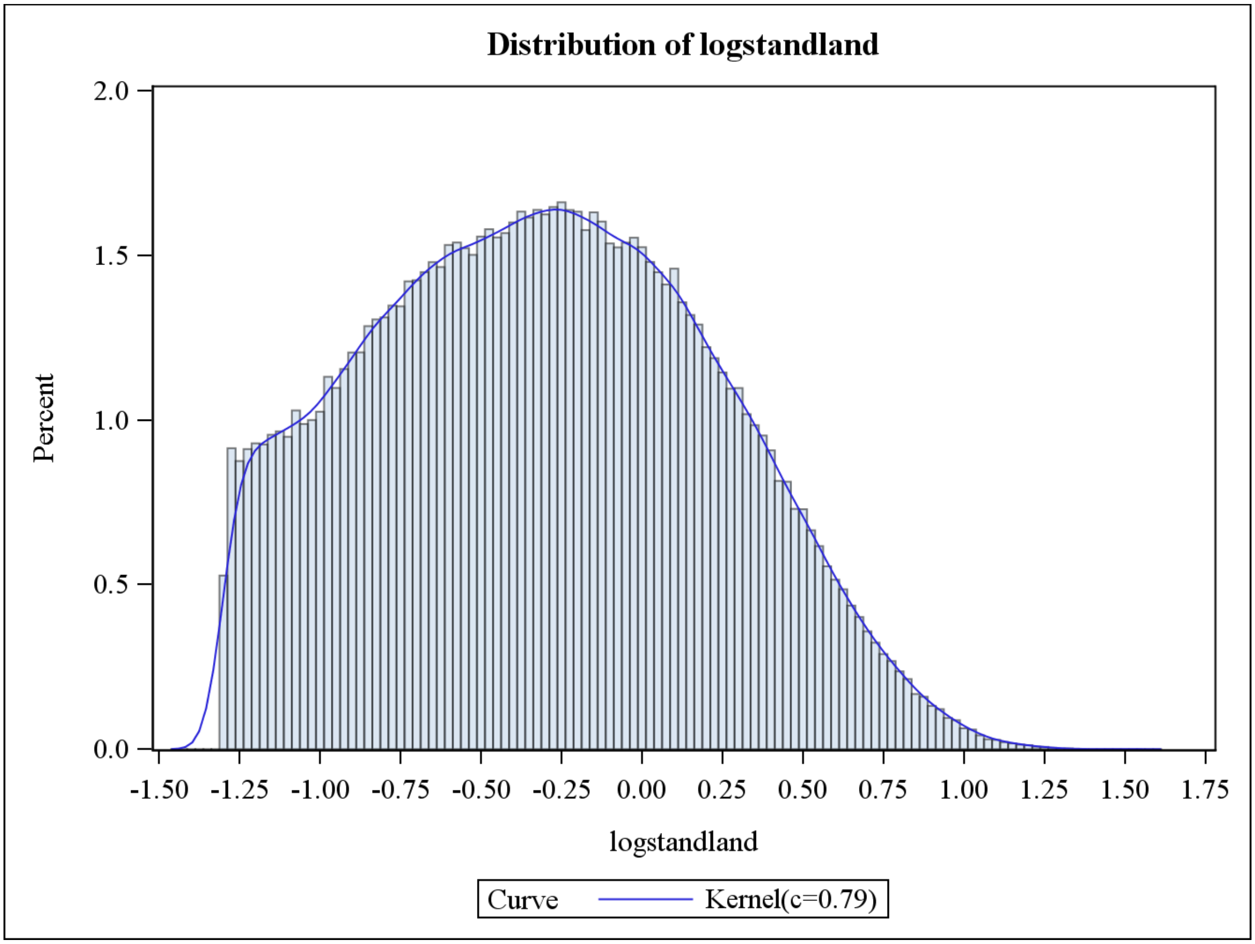
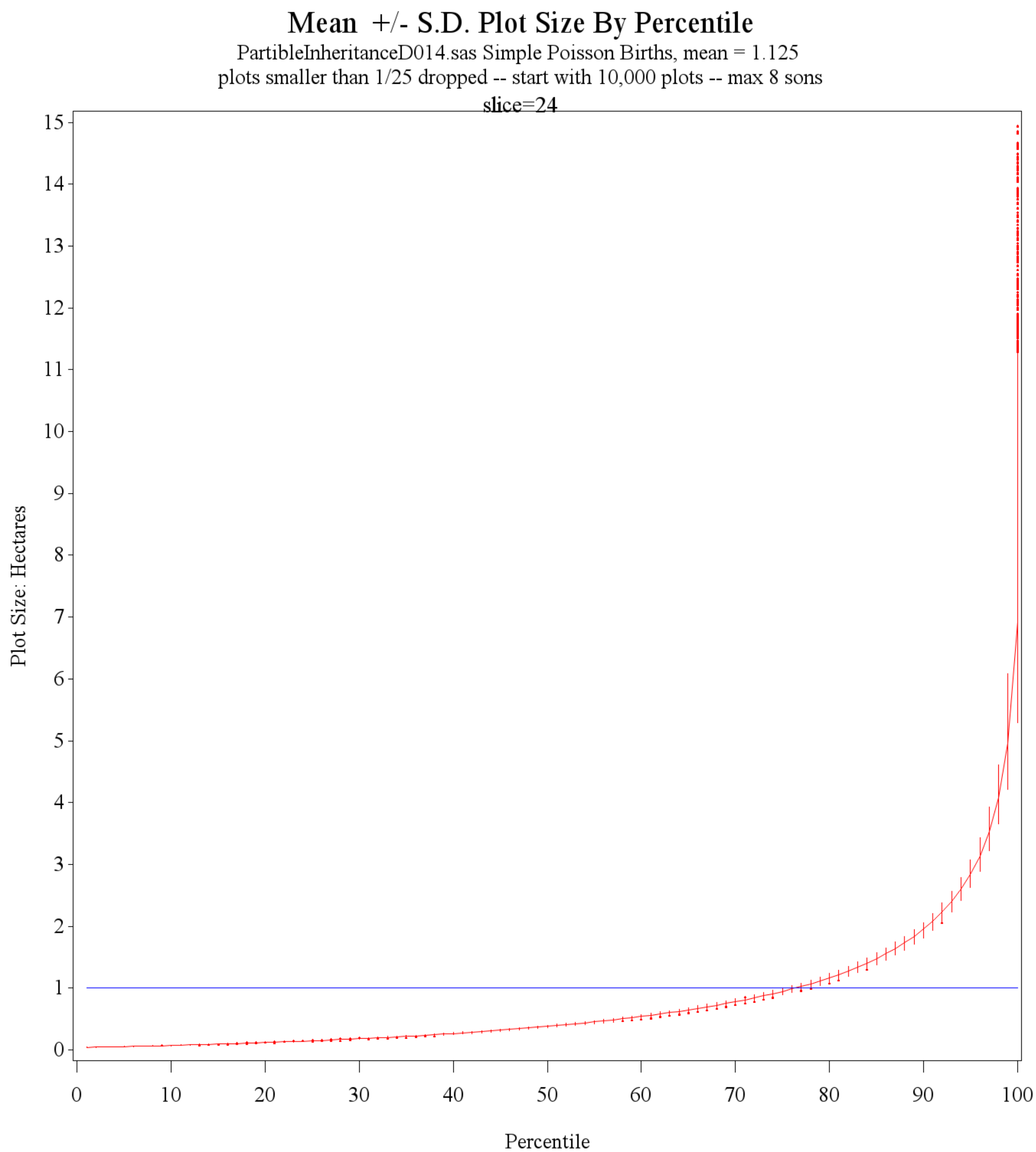

Distribution of logstandland
Percent
2.0
1.5
1.0
0.5
0.0
-1.50
-1.25
-1.00
-0.75
-0.50
-0.25
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
logstandland
Curve
Kernel(c=0.79)

Figure 3 Arrigo Displacement Graph of Model 1 Displacement = 0.46 (transposed frequency histogram, with percentiles as abscissa, mean +/- sd as ordinate.) The blue line displays the uniform distribution.



Model 2 Partible inheritance model with birth rate an increasing function of land ownership.

Figure 4 Convergence of Model 2 to stationary distribution

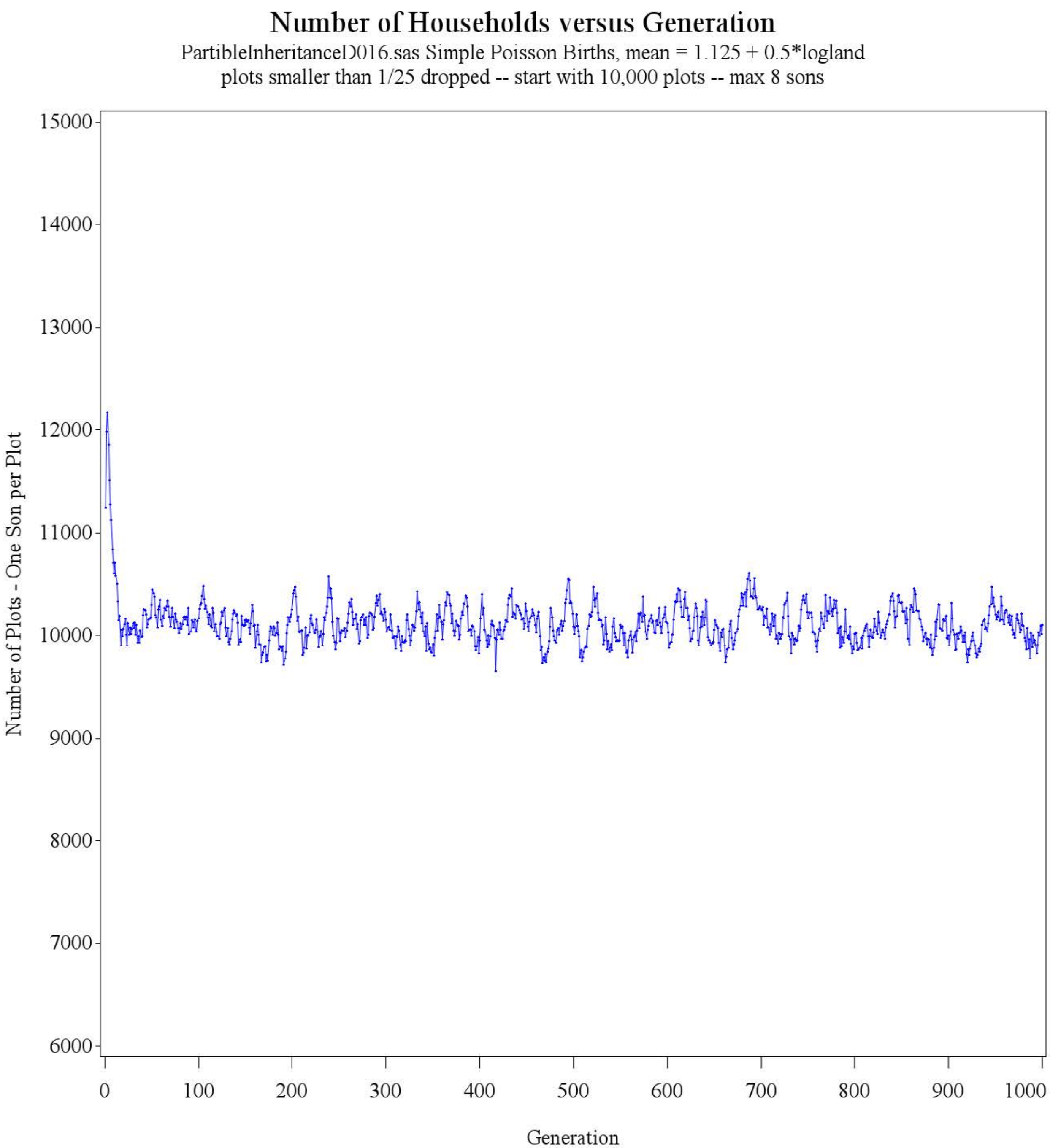


Figure 5 Frequency distribution of plot size Model 2 log scale.

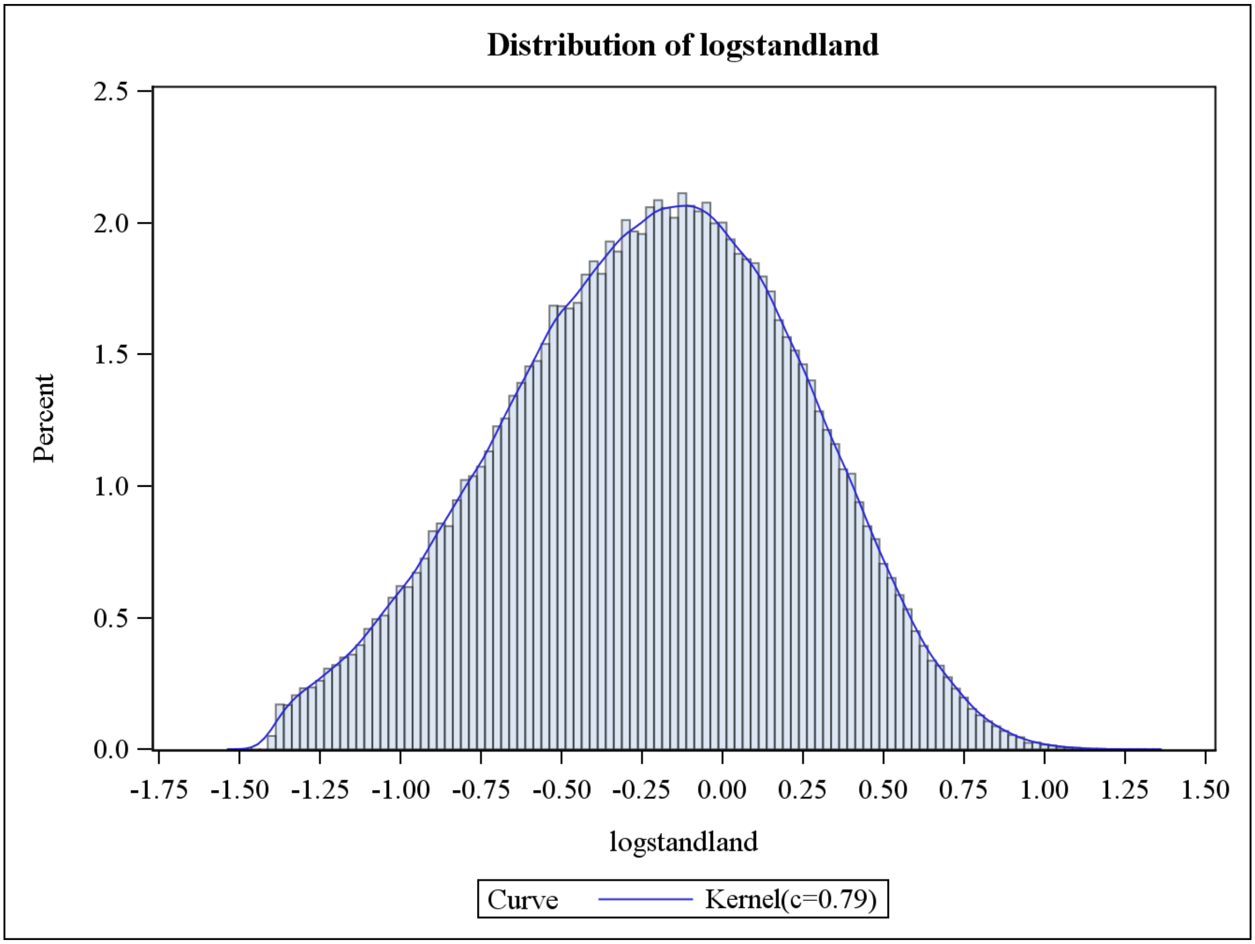
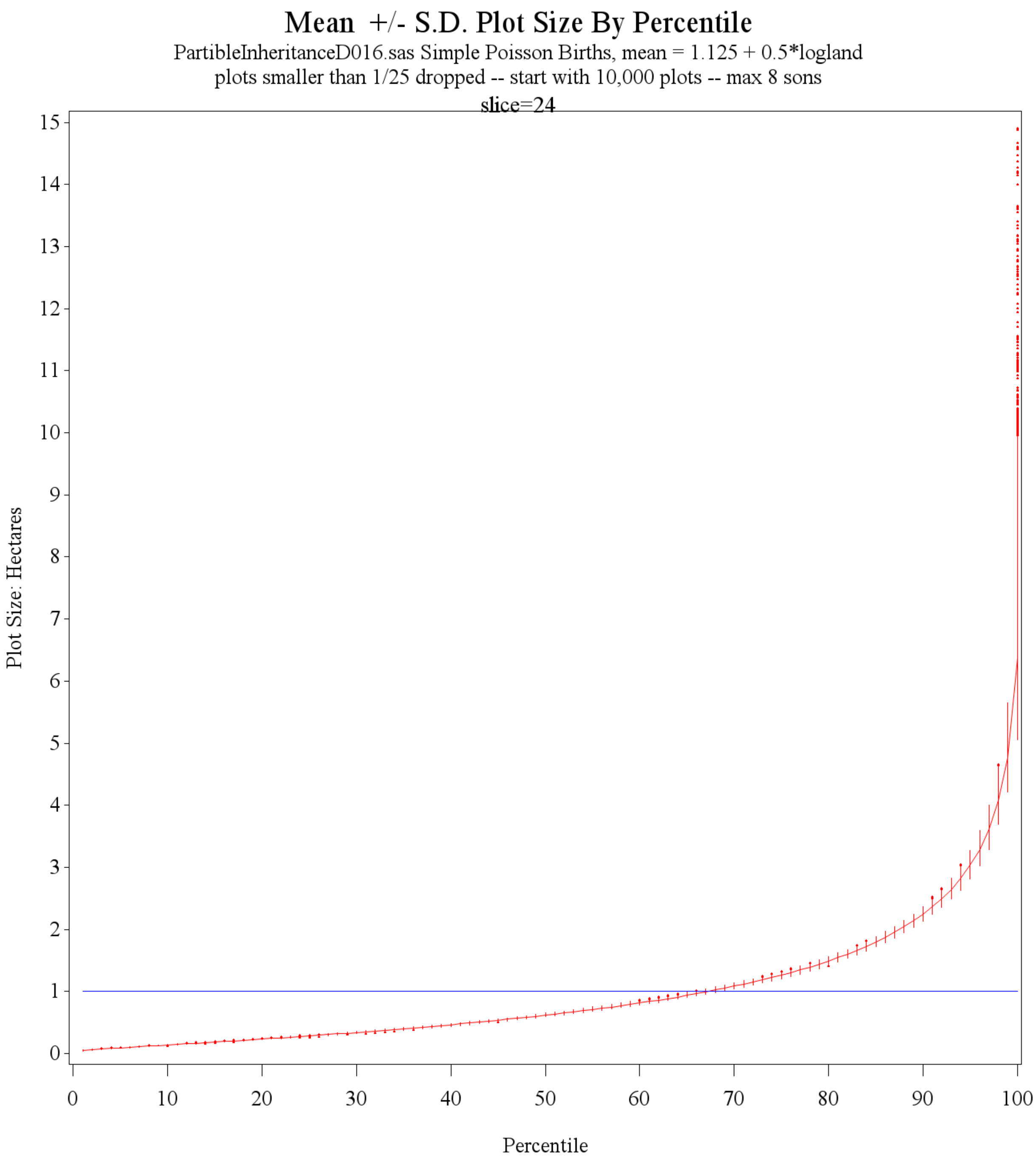

Distribution of logstandland
Percent
2.5
2.0
1.5
1.0
0.5
0.0
-1.75 -1.50 -1.25 -1.00 -0.75 -0.50 -0.25 0.00 0.25 0.50 0.75 1.00 1.25 1.50
logstandland
Curve
Kernel(c=0.79)

Figure 6 Arrigo Displacement Graph of Model 2 Displacement = 0.38



In the rest of the simulations, each simulation was run for 200 generations, and the results were grouped into “slices” of 20 generations for some statistical summaries

Comparisons of Models – figures

In the figures and table, the simulation results are presented in this order:

Differential = 0.05	Differential = 0.15
Differential = 0.25	Differential = 0.50
Differential = 0.75	Differential = 0.00

A. Number of households, including landless, per generation.

B. Number of landless men per generation.

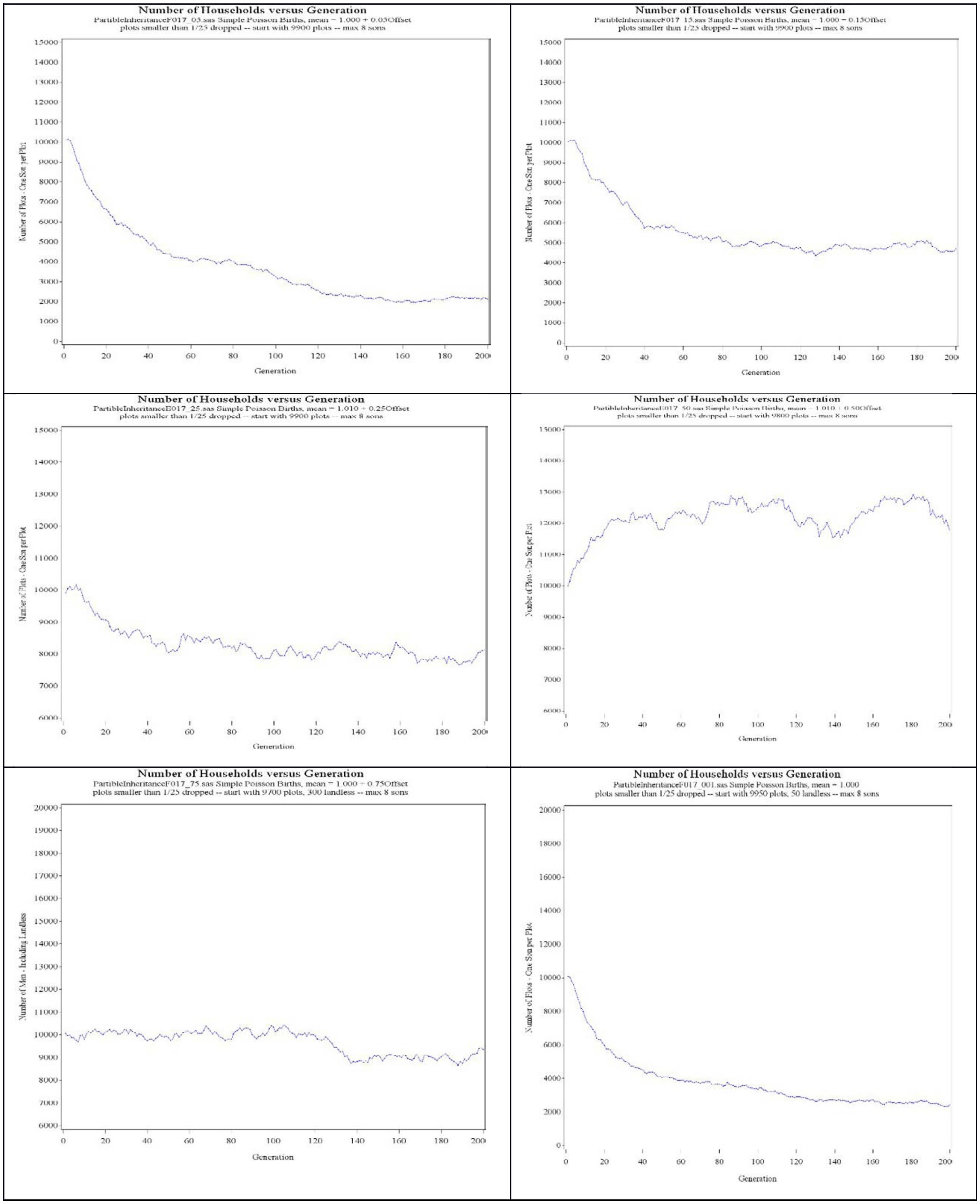
C. Distribution of log of plot size in stationary state; the large blip on the left hand side is the plot sizes less than 1/25 Hectare, which revert to size 0 and are picked up by other landowners.

D. Displacement graph of stationary distribution; this is essentially the transposed histogram, with the mean +/- sd of plot size in each percentile of the distribution.

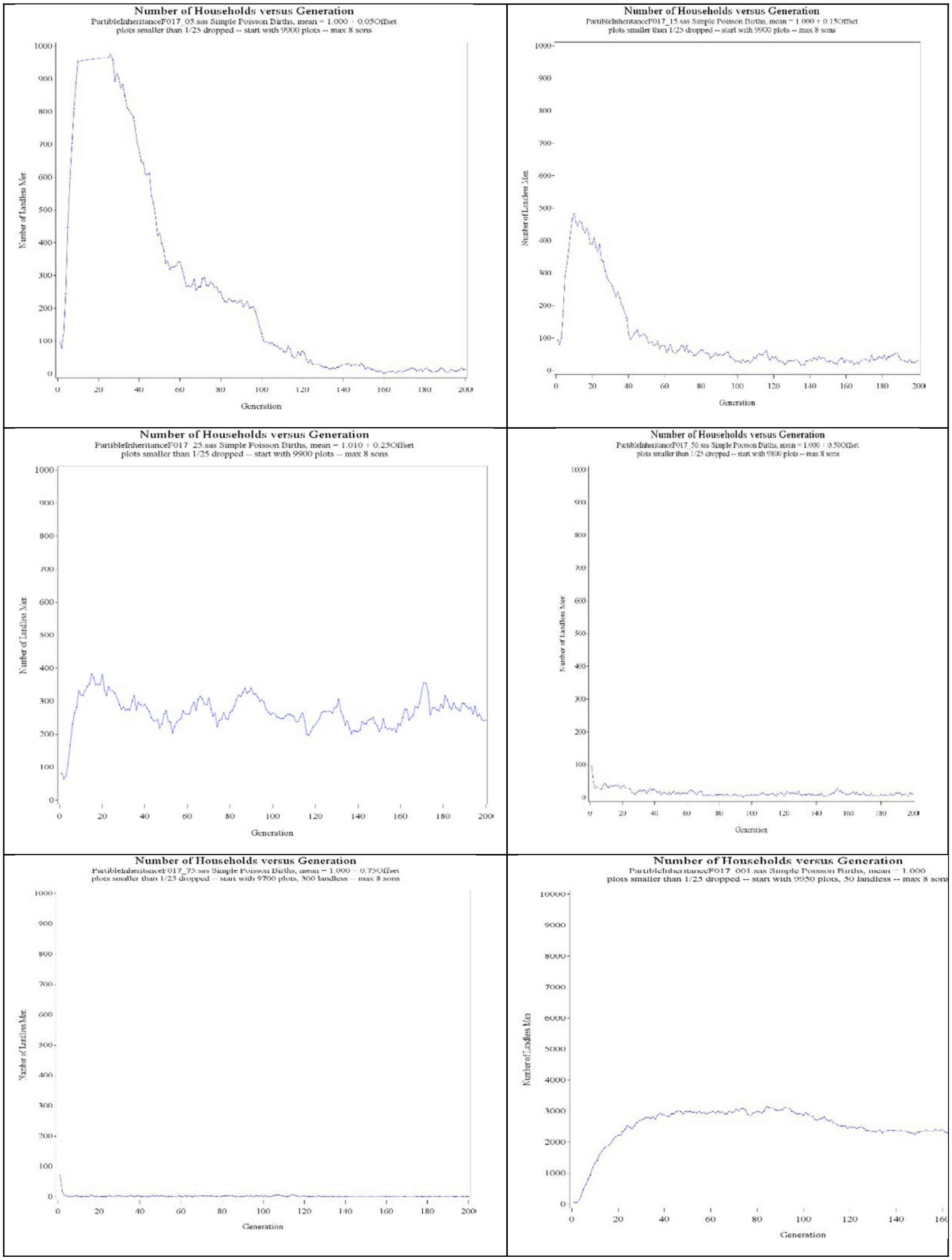
E. Evolution of “displacement”, the fraction of land that is in plot sizes larger than average that would be sized at or below average with a uniform distribution.

F. Evolution of mean plot size.

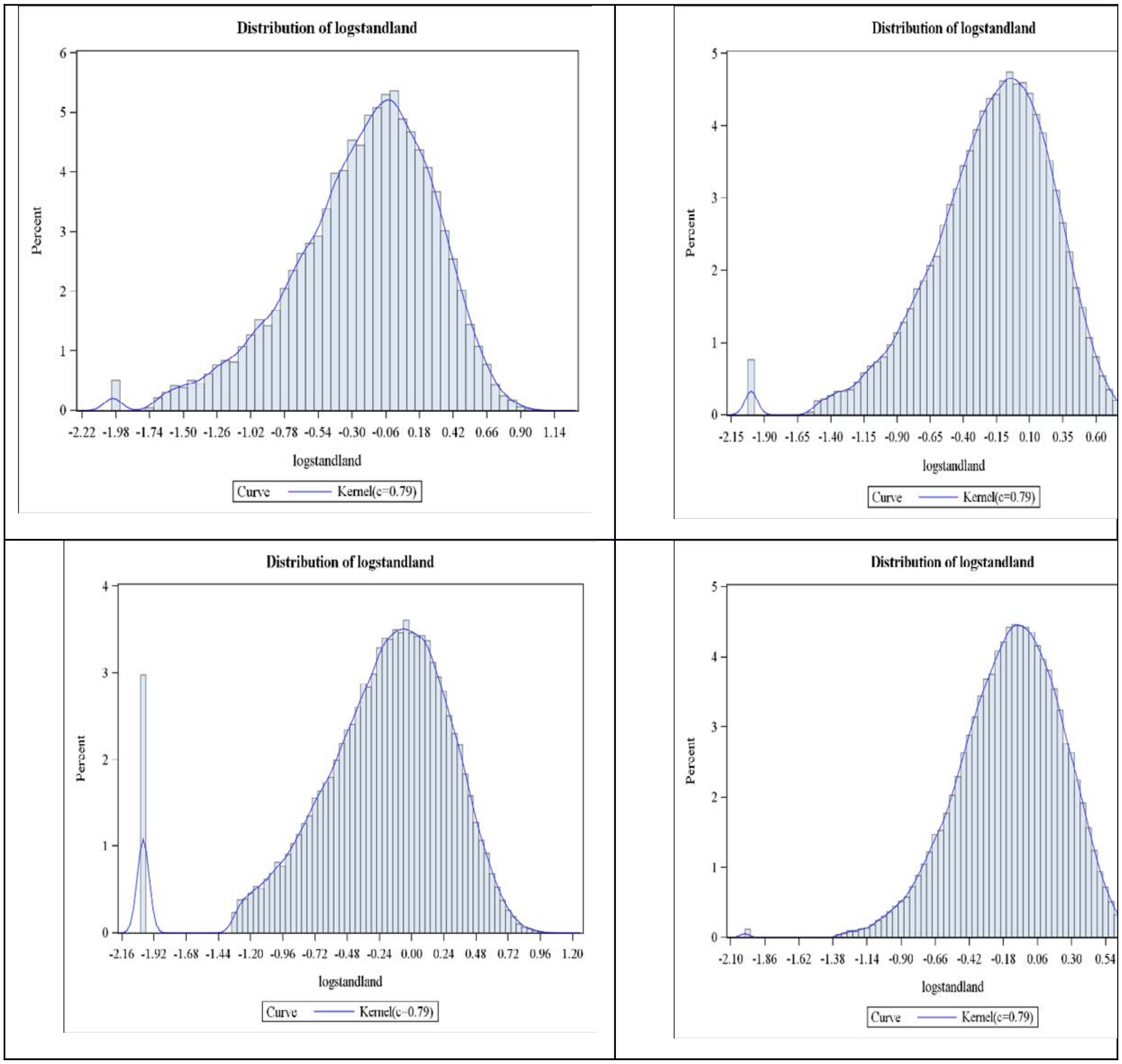
A. Evolution of number of households:

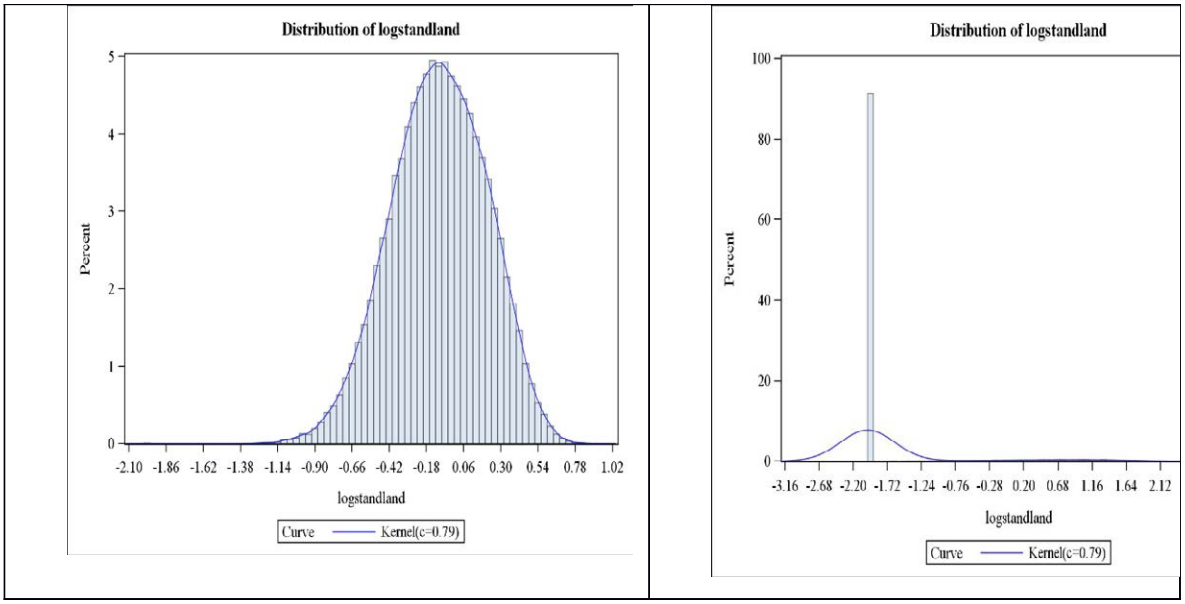


B. Evolution of number of landless men.

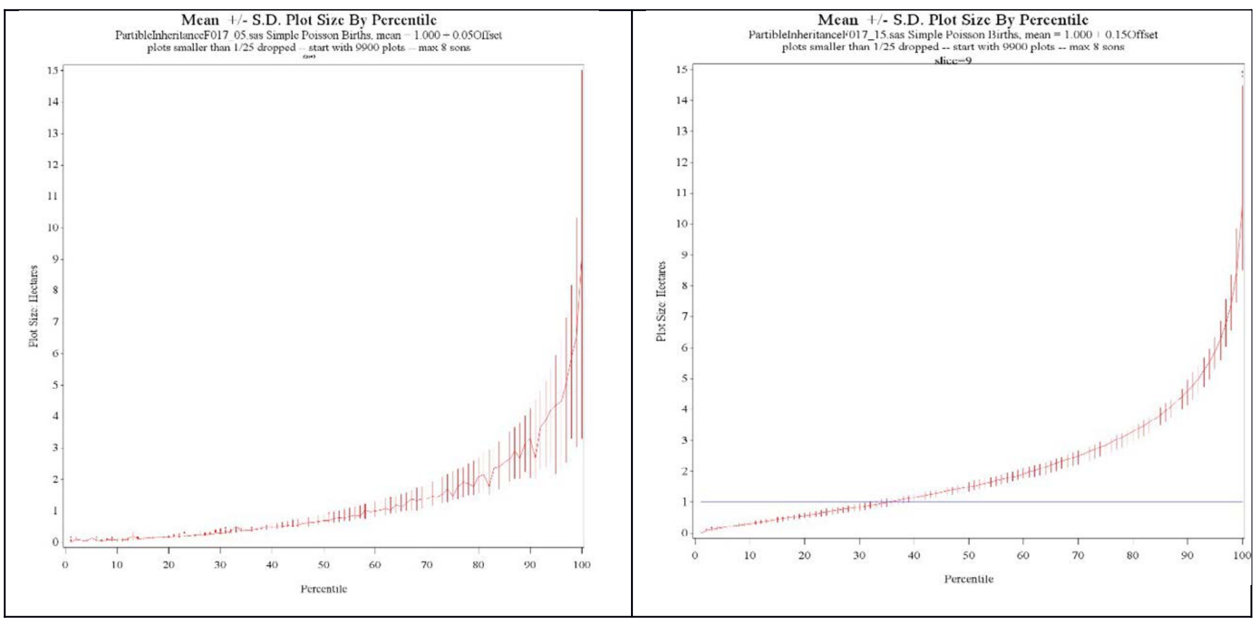


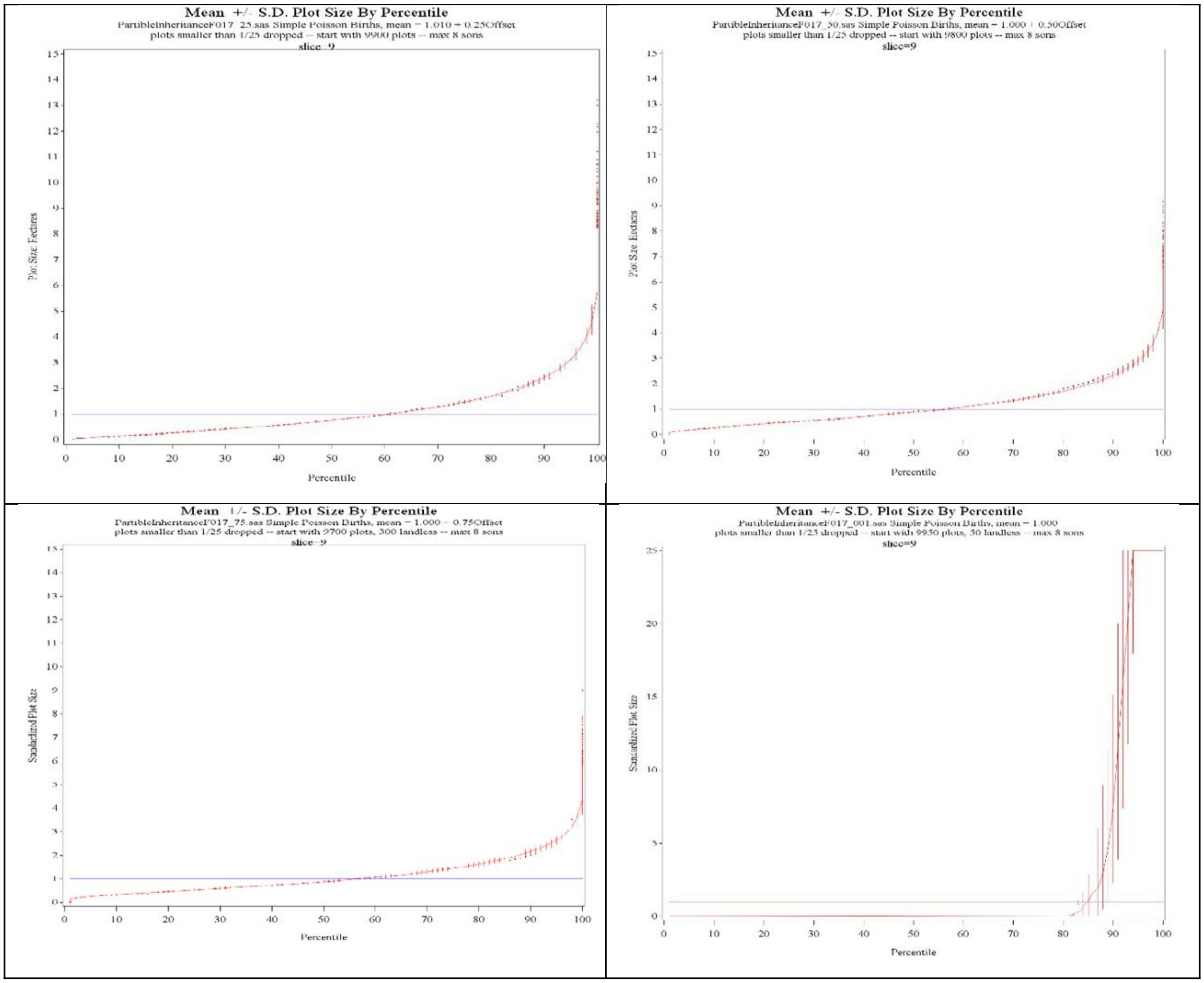
C. Stationary plot size histograms



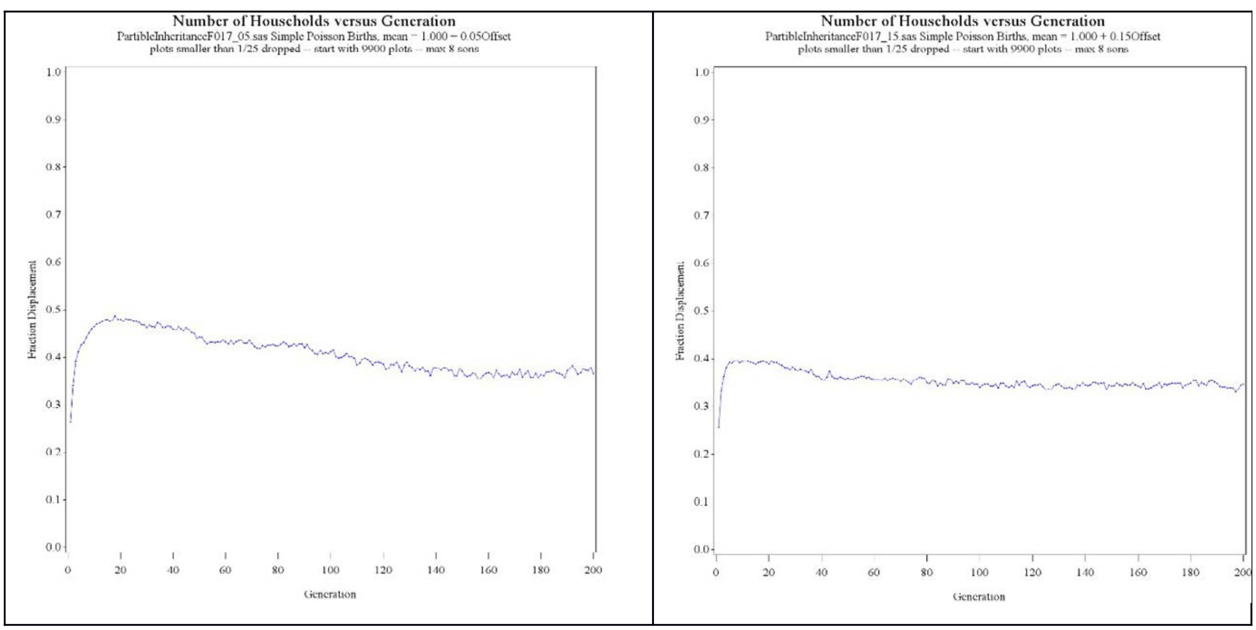


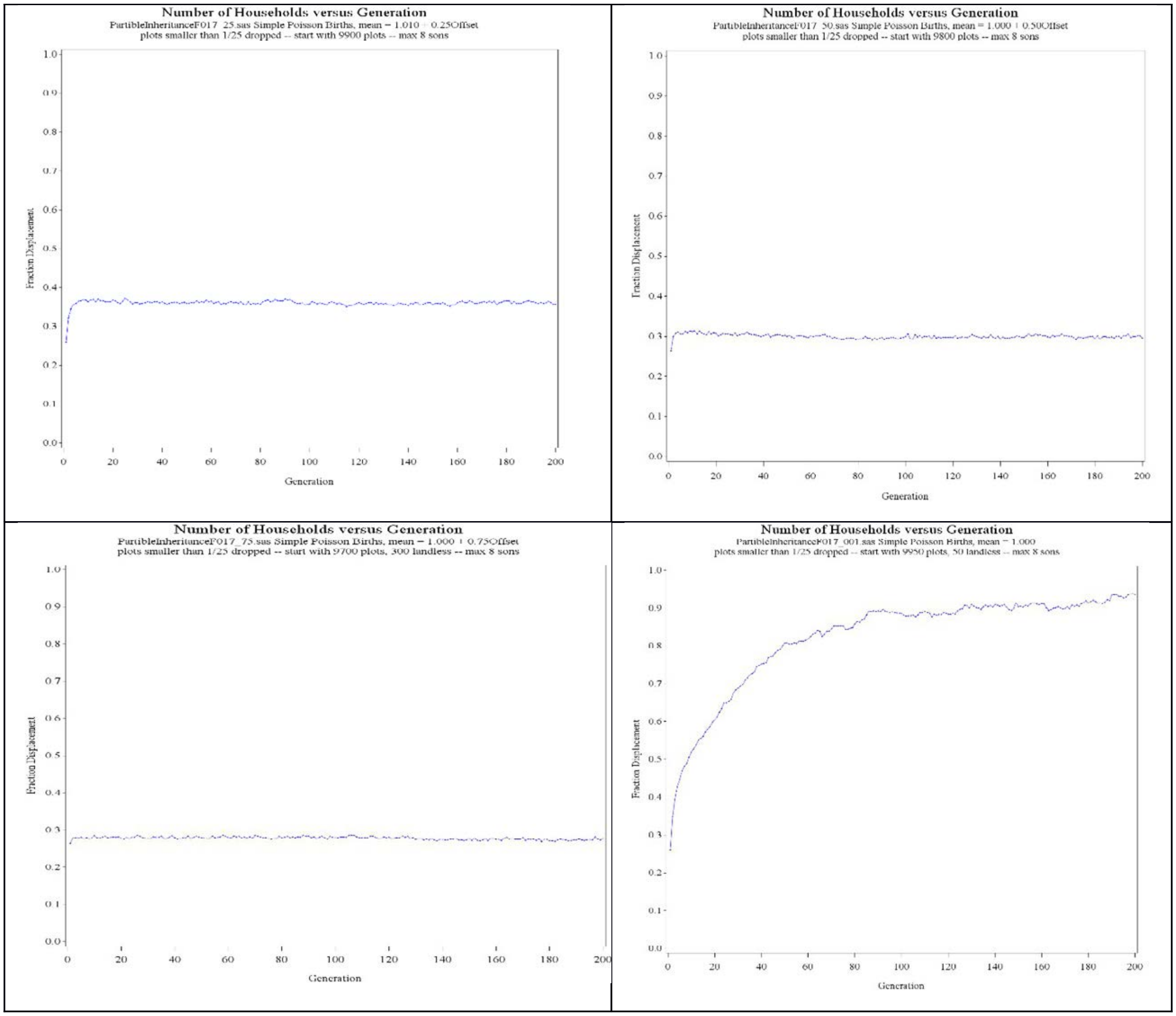
D. Stationary Displacement Plots:



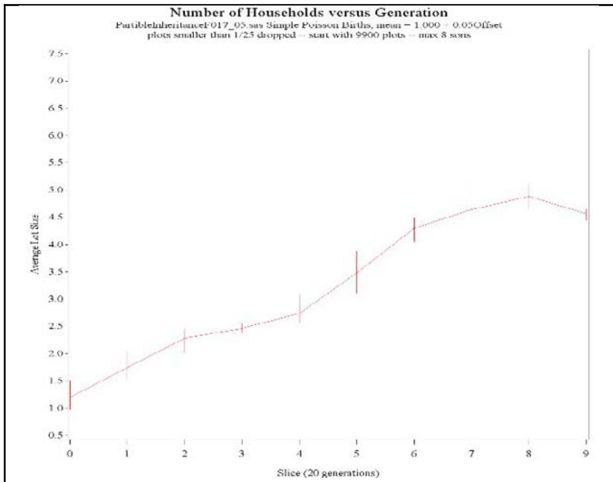


E. Evolution of fraction of land displaced

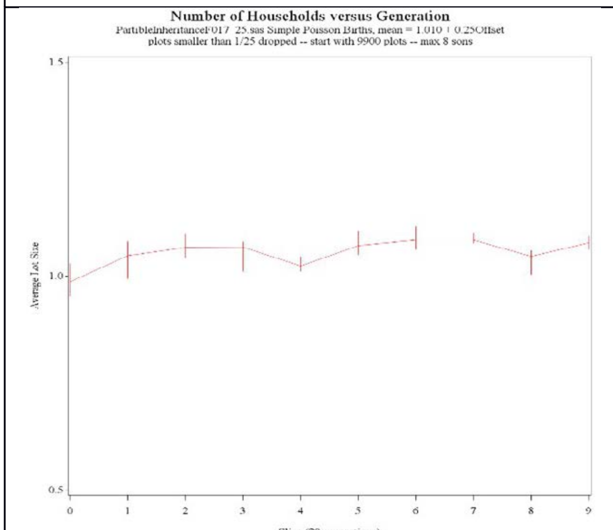


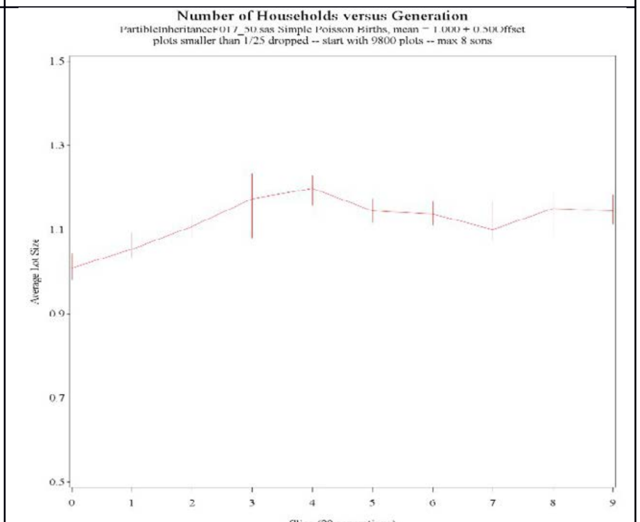

Number of Households versus Generation
PartibleInheritanceF017_25.sas Simple Poisson Births, mean = 1.010 + 0.25Offset
plots smaller than 1/25 dropped -- start with 9900 plots -- max 8 sons
Fraction Displacement
Generation
Number of Households versus Generation
PartibleInheritanceF017_50.sas Simple Poisson Births, mean = 1.000 + 0.50Offset
plots smaller than 1/25 dropped -- start with 9800 plots -- max 8 sons
Fraction Displacement
Generation
Number of Households versus Generation
PartibleInheritanceF017_75.sas Simple Poisson Births, mean = 1.000 + 0.75Offset
plots smaller than 1/25 dropped -- start with 9700 plots, 300 landless -- max 8 sons
Fraction Displacement
Generation
Number of Households versus Generation
PartibleInheritanceF017_001.sas Simple Poisson Births, mean = 1.000
plots smaller than 1/25 dropped -- start with 9950 plots, 50 landless -- max 8 sons
Fraction Displacement
Generation

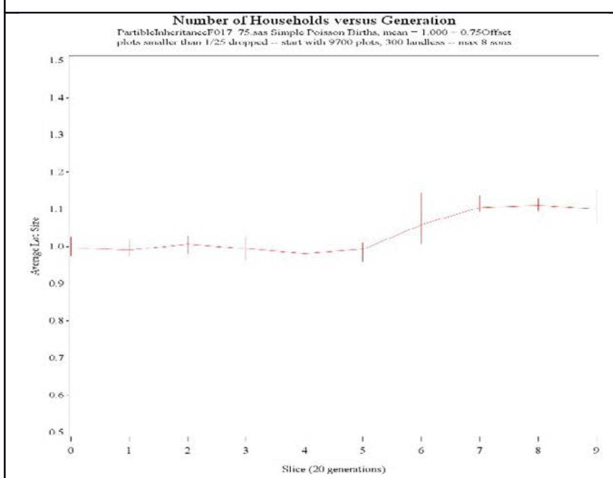
F. Evolution of mean plot size

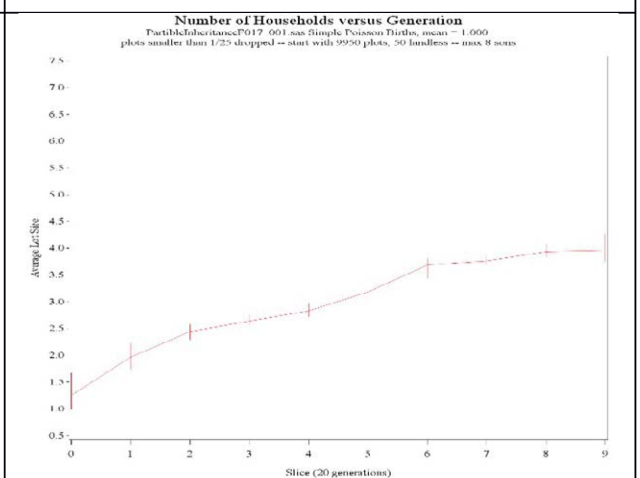


Yikes! Work to do.









Summary statistics of displacement in stationary state

Min	Max	Mean	Median	Std Dev
0.3567	0.3826	0.3697	0.3693	0.0062523

Min	Max	Mean	Median	Std Dev
0.3303	0.3547	0.3448	0.3447	0.0065042

Min	Max	Mean	Median	Std Dev
0.3572	0.3668	0.3617	0.3615	0.0027961

Min	Max	Mean	Median	Std Dev
0.2931	0.3053	0.2995	0.2998	0.0026092

Min	Max	Mean	Median	Std Dev
0.2691	0.2823	0.2738	0.2735	0.0028429

Min	Max	Mean	Median	Std Dev
0.9117	0.9382	0.9260	0.9280	0.0093839

Discussion:

It seems that the simulations take 40 – 100 generations to approach the (approximate) stationary distribution.

It is not possible for the reproductive rate of the landless to equal the reproductive rate of the landed.

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