

# Missing Data In PROC MCMC

In [1]:

```
data miss_birth;
  input low mother_age mother_wt socio alcohol
    prev_preterm hist_hyp uterine_irr phy_visit;
  label low='Indicator for Birth Weight'
    mother_age='Mother''s age'
    mother_wt='Weight at Last Menstrual Period'
    socio='Socio-Economic Status'
    alcohol='Did the mother drink during pregnancy?'
    hist_hyp='History of Hypertension'
    prev_preterm='Previous Preterm Labors'
    uterine_irr='Uterine Irritability'
    phy_visit='Physician Visit in 1st Trimester';
cards;
1 28 120 2 1 1 0 1 0
1 29 130 3 0 0 0 1 1
1 34 . 1 1 0 1 0 0
1 25 105 2 0 1 1 0 0
1 25 85 2 0 0 0 1 0
1 27 . 2 . 0 0 0 0
1 23 97 2 0 0 0 1 1
1 24 128 1 0 1 0 0 1
1 24 . 2 0 0 1 0 0
1 21 165 3 . 0 1 0 1
1 32 105 3 1 0 0 0 0
1 19 91 3 1 1 0 1 0
1 25 115 2 0 0 0 0 0
1 16 . 2 0 0 0 0 1
1 25 92 3 1 0 0 0 0
1 20 150 3 1 0 0 0 1
1 21 . 1 . 0 0 1 1
1 24 155 3 1 1 0 0 0
1 21 103 2 0 0 0 0 0
1 20 125 2 0 0 0 1 0
1 25 89 2 0 1 0 0 1
1 19 102 3 . 0 0 0 1
1 19 . 3 1 0 0 1 0
1 26 117 3 1 1 0 0 0
1 24 138 3 0 0 0 0 0
1 17 130 2 1 1 0 1 0
1 20 120 1 1 0 0 0 1
1 22 . 3 . 1 0 1 1
1 27 130 1 0 0 0 1 0
1 20 80 2 1 0 0 1 0
1 17 110 3 1 0 0 0 0
1 25 105 2 0 1 0 0 1
1 20 . 2 0 0 0 0 0
1 18 148 2 0 0 0 0 0
1 18 110 1 1 1 0 0 0
1 20 121 3 1 1 0 1 0
1 21 100 2 . 1 0 0 1
1 26 96 2 0 0 0 0 0
1 31 102 3 1 1 0 0 1
1 15 110 3 0 0 0 0 0
1 23 187 1 1 0 0 0 1
```

1	20	.	1	1	0	0	0	0
1	24	105	1	1	0	0	0	0
1	15	115	2	0	0	0	1	0
1	23	120	2	0	0	0	0	0
1	30	142	3	.	1	0	0	0
1	22	130	3	1	0	0	0	1
1	17	120	3	1	0	0	0	1
1	23	110	3	1	1	0	0	0
1	17	.	1	0	0	0	0	1
1	26	154	2	0	1	1	0	1
1	20	105	2	.	0	0	0	1
1	26	190	3	1	0	0	0	0
1	14	101	2	1	1	0	0	0
1	28	95	3	1	0	0	0	1
1	14	100	2	0	0	0	0	1
1	23	94	2	1	0	0	0	0
1	17	.	1	.	0	1	0	0
1	21	130	3	1	0	1	0	1
0	19	182	1	0	0	0	1	0
0	33	155	2	0	0	0	0	1
0	20	105	3	1	0	0	0	1
0	21	108	3	.	0	0	1	1
0	18	107	3	1	0	0	1	0
0	21	.	2	0	0	0	0	0
0	22	118	3	0	0	0	0	1
0	17	103	2	0	0	0	0	1
0	29	123	3	1	0	0	0	1
0	26	113	3	.	0	0	0	0
0	19	95	2	0	0	0	0	0
0	19	150	2	0	0	0	0	1
0	22	95	2	0	0	1	0	0
0	30	107	2	0	1	0	1	1
0	18	100	3	1	0	0	0	0
0	18	.	3	1	0	0	0	0
0	15	95	1	.	0	0	0	0
0	25	118	3	1	0	0	0	1
0	20	120	2	0	0	0	1	0
0	28	120	3	1	0	0	0	1
0	32	121	2	0	0	0	0	1
0	31	100	3	0	0	0	1	1
0	36	.	3	.	0	0	0	1
0	28	120	2	0	0	0	0	0
0	25	120	2	0	0	0	1	1
0	28	167	3	0	0	0	0	0
0	17	122	3	1	0	0	0	0
0	29	150	3	0	0	0	0	1
0	26	168	1	.	0	0	0	0
0	17	113	1	0	0	0	0	1
0	17	113	1	0	0	0	0	1
0	24	90	3	1	1	0	0	1
0	35	121	1	.	1	0	0	1
0	25	.	3	0	0	0	0	1
0	25	125	1	0	0	0	0	0
0	29	140	3	1	0	0	0	1
0	19	138	3	1	0	0	0	1
0	27	124	3	1	0	0	0	0
0	31	215	3	1	0	0	0	1
0	33	109	3	1	0	0	0	1
0	21	185	1	1	0	0	0	1
0	19	189	3	0	0	0	0	1

0	23	.	1	0	0	0	0	1
0	21	160	3	.	0	0	0	0
0	18	90	3	1	0	0	1	0
0	18	90	3	1	0	0	1	0
0	32	132	3	0	0	0	0	1
0	19	132	2	0	0	0	0	0
0	24	115	3	0	0	0	0	1
0	22	95	2	1	0	0	0	0
0	22	120	3	.	0	1	0	1
0	23	.	2	0	0	0	0	0
0	22	130	3	1	0	0	0	0
0	30	95	3	1	0	0	0	1
0	19	115	2	0	0	0	0	0
0	16	110	2	0	0	0	0	0
0	21	110	2	1	0	0	1	0
0	30	153	2	0	0	0	0	0
0	20	.	2	0	0	0	0	0
0	17	119	2	0	0	0	0	0
0	17	119	2	.	0	0	0	0
0	23	119	2	0	0	0	0	1
0	24	110	2	0	0	0	0	0
0	28	140	3	0	0	0	0	0
0	26	133	2	1	1	0	0	0
0	20	169	2	0	1	0	1	1
0	24	.	2	0	0	0	0	1
0	28	250	2	1	0	0	0	1
0	20	141	3	0	1	0	1	1
0	22	158	1	.	1	0	0	1
0	22	112	3	1	1	0	0	0
0	31	150	2	1	0	0	0	1
0	23	115	2	1	0	0	0	1
0	16	112	1	0	0	0	0	0
0	16	135	3	1	0	0	0	0
0	18	229	1	0	0	0	0	0
0	25	140	3	0	0	0	0	1
0	32	134	3	.	1	0	0	1
0	20	.	1	1	0	0	0	0
0	23	190	3	0	0	0	0	0
0	22	131	3	0	0	0	0	1
0	32	170	3	0	0	0	0	0
0	30	110	2	0	0	0	0	0
0	20	127	2	0	0	0	0	0
0	23	123	2	.	0	0	0	0
0	17	120	2	1	0	0	0	0
0	19	105	2	0	0	0	0	0
0	23	130	3	0	0	0	0	0
0	36	175	3	0	0	0	0	0
0	22	.	3	0	0	0	0	1
0	24	133	3	0	0	0	0	0
0	21	134	2	0	0	0	0	1
0	19	235	3	.	0	1	0	0
0	25	95	3	1	1	0	1	0
0	16	135	3	1	0	0	0	0
0	29	135	3	0	0	0	0	1
0	29	154	3	0	0	0	0	1
0	19	147	3	1	0	0	0	0
0	19	147	3	.	0	0	0	0
0	30	137	3	0	0	0	0	1
0	24	110	3	0	0	0	0	1
0	19	184	3	1	0	1	0	0

```

0 24 110 2 0 1 0 0 0
0 23 110 3 0 0 0 0 1
0 20 120 2 0 0 0 0 0
0 25 . 1 . 0 1 0 0
0 30 112 3 0 0 0 0 1
0 22 169 3 0 0 0 0 0
0 18 120 3 1 0 0 0 1
0 16 170 1 0 0 0 0 1
0 32 186 3 0 0 0 0 1
0 18 120 2 0 0 0 0 1
0 29 . 3 1 0 0 0 0 1
0 33 117 3 0 0 0 1 1
0 20 170 3 1 0 0 0 0
0 28 134 2 0 0 0 0 1
0 14 135 3 . 0 0 0 0
0 28 130 2 0 0 0 0 0
0 25 120 3 0 0 0 0 1
0 16 95 2 0 0 0 0 1
0 20 158 3 0 0 0 0 1
0 26 160 2 0 0 0 0 0
0 21 115 3 0 0 0 0 1
0 22 . 3 0 0 0 0 0
0 25 130 3 0 0 0 0 1
0 31 120 3 . 0 0 0 1
0 35 170 3 0 1 0 0 1
0 19 120 3 1 0 0 0 0
0 24 116 3 0 0 0 0 1
0 45 123 3 0 0 0 0 1
;
run;

```

Please enter the name of the SAS Config you wish to run. Available Configs are: ['oda', 'local'] oda

```

5                                         The SAS System
Monday, May 16, 2022 02:29:00 PM

24      ods listing close;ods html5 (id=saspy_internal) file=_tomods1 options(bitmap_
mode='inline') device=svg style=HTMLBlue;
24      ! ods graphics on / outputfmt=png;
25
26      data miss_birth;
27          input low mother_age mother_wt socio alcohol
28              prev_preterm hist_hyp uterine_irr phy_visit;
29          label low='Indicator for Birth Weight'
30              mother_age='Mother''s age'
31              mother_wt='Weight at Last Menstrual Period'
32              socio='Socio-Economic Status'
33              alcohol='Did the mother drink during pregnancy?'
34              hist_hyp='History of Hypertension'
35              prev_preterm='Previous Preterm Labors'
36              uterine_irr='Uterine Irritability'
37              phy_visit='Physician Visit in 1st Trimester';
38      cards;
228  ;
229  run;
230
231
232
233
234      ods html5 (id=saspy_internal) close;ods listing;
235

```

236

## Determine who is missing and if there is overlap.

In [3]:

```

proc means data=miss_birth nmiss;
  var low mother_wt alcohol prev_preterm hist_hyp;
  title 'Variables with Missing Values';
run;

data miss_birth;
  set miss_birth;
  if mother_wt = . then m_weight=1;
  else m_weight=0;

  if alcohol = . then m_alcohol = 1;
  else m_alcohol = 0;
run;

proc freq data=miss_birth;
  tables m_weight*m_alcohol;
  title 'Variables with Missing Values';
run;

```

### Variables with Missing Values

#### The MEANS Procedure

Variable	Label	N Miss
low	Indicator for Birth Weight	0
mother_wt	Weight at Last Menstrual Period	24
alcohol	Did the mother drink during pregnancy?	26
prev_preterm	Previous Preterm Labors	0
hist_hyp	History of Hypertension	0

### Variables with Missing Values

#### The FREQ Procedure

Frequency Percent Row Pct Col Pct	Table of m_weight by m_alcohol			
	m_weight	m_alcohol		
		0	1	Total
0	145	20	165	
	76.72	10.58	87.30	
	87.88	12.12		
	88.96	76.92		

Table of m_weight by m_alcohol			
m_weight	m_alcohol		
	0	1	Total
1	18	6	24
	9.52	3.17	12.70
	75.00	25.00	
	11.04	23.08	
Total	163	26	189
	86.24	13.76	100.00

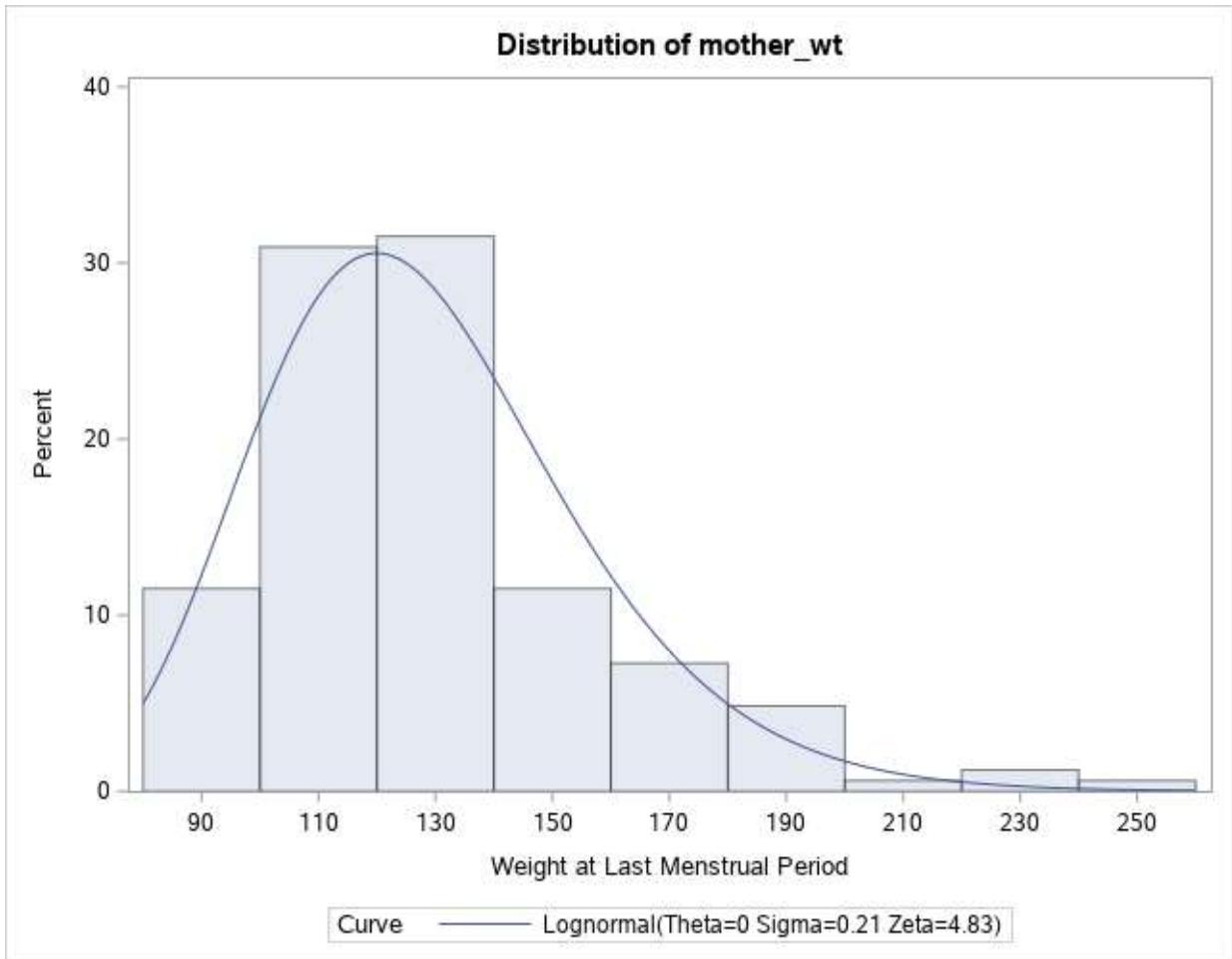
## Checking the Distribution of the Variables with Missings.

```
In [5]: ods select histogram;
proc univariate data=miss_birth;
  var mother_wt;
  histogram mother_wt / lognormal;
run;

ods select histogram;
proc univariate data=miss_birth;
  var alcohol;
  histogram alcohol / midpoints=0 1;
run;
```

### Variables with Missing Values

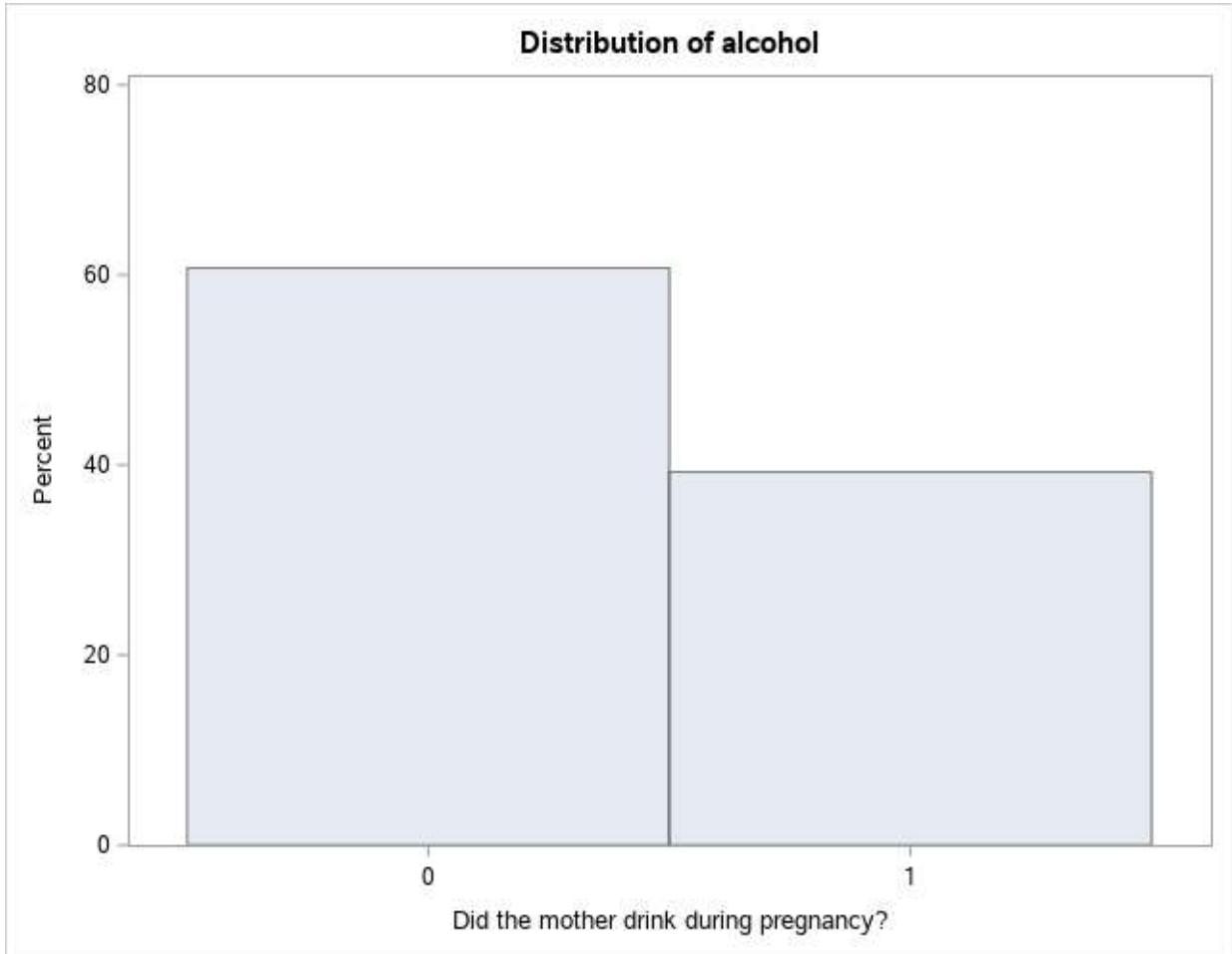
#### The UNIVARIATE Procedure



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### Variables with Missing Values

The UNIVARIATE Procedure



## Time for PROC MCMC (Hint: Work from the bottom.)

In [6]:

```

proc mcmc data=miss_birth outpost=missbirthout diag=all
propcov=quanew nbi=10000 ntu=5000 nmc=300000 thin=10
mchistory=brief plots(smooth)=all seed=27513 statistics=all;
parms (gamma0 gamma1 gamma2) 0;
parms (alpha0 alpha1 alpha2 alpha3) 0;
parms (beta0 beta1 beta2 beta3 beta4) 0;
parms sigma2 1;
prior gamma: alpha: beta: ~ normal(0, var=100);
prior sigma2 ~igamma(shape=2.001, scale=1.001);

p1 = logistic(gamma0 + gamma1*hist_hyp + gamma2*prev_pretrm);
model alcohol ~ binary(p1) monitor=(1 2 10);

mu = alpha0 + alpha1*alcohol + alpha2*hist_hyp + alpha3*prev_pretrm;
model mother_wt ~ lognormal(mu,var=sigma2) monitor=(random (3));

p = logistic(beta0 + beta1*alcohol + beta2*hist_hyp + beta3*mother_wt + beta4*prev_p
model low ~ binary(p);
title "Bayesian Analysis of Low Birth Weight Data";
run;
```

## The MCMC Procedure

<b>Number of Observations Read</b>	189
<b>Number of Observations Used</b>	189

Missing Data Information Table				
Variable	Number of Missing Obs		Observation Indices	Sampling Method
alcohol	26	6 10 17 22 28 37 46 52 58 63 69 76 82 88 92 103 110 120 129 137 ...		Inverse CDF
mother_wt	24	3 6 9 14 17 23 28 33 42 50 58 65 75 82 93 102 111 118 126 138 ...		N-Metropolis

Parameters				
Block	Parameter	Sampling Method	Initial Value	Prior Distribution
1	gamma0	N-Metropolis	0	normal(0, var=100)
	gamma1		0	normal(0, var=100)
	gamma2		0	normal(0, var=100)
2	alpha0	N-Metropolis	0	normal(0, var=100)
	alpha1		0	normal(0, var=100)
	alpha2		0	normal(0, var=100)
	alpha3		0	normal(0, var=100)
3	beta0	N-Metropolis	0	normal(0, var=100)
	beta1		0	normal(0, var=100)
	beta2		0	normal(0, var=100)
	beta3		0	normal(0, var=100)
	beta4		0	normal(0, var=100)
4	sigma2	N-Metropolis	1.0000	igamma(shape=2.001, scale=1.001)

Tuning History				
Phase	RWM Scale		RWM Acceptance Rate	
	Low	High	Low	High
1	2.380	2.380	0.502	0.814
2	4.221	12.05	0.229	0.314
3	4.221	14.25	0.197	0.280

Burn-In History				
RWM Scale		RWM Acceptance Rate		
Low	High	Low	High	

Burn-In History					
RWM Scale		RWM Acceptance Rate			
Low	High	Low	High		
4.221	14.25	0.202	0.273		

Sampling History					
RWM Scale		RWM Acceptance Rate			
Low	High	Low	High		
4.221	14.25	0.203	0.279		

### Bayesian Analysis of Low Birth Weight Data

#### The MCMC Procedure

Posterior Summaries						
Parameter	N	Mean	Standard Deviation	Percentiles		
				25	50	75
gamma0	30000	-0.5806	0.1800	-0.7006	-0.5793	-0.4579
gamma1	30000	-0.0984	0.8490	-0.6513	-0.0835	0.4670
gamma2	30000	0.9242	0.4634	0.6167	0.9193	1.2317
alpha0	30000	4.8477	0.0251	4.8308	4.8479	4.8647
alpha1	30000	-0.0355	0.0398	-0.0622	-0.0354	-0.00884
alpha2	30000	0.1264	0.0846	0.0693	0.1263	0.1833
alpha3	30000	-0.0567	0.0493	-0.0901	-0.0566	-0.0235
beta0	30000	1.2813	1.0250	0.5784	1.2562	1.9618
beta1	30000	0.7013	0.3832	0.4444	0.7035	0.9565
beta2	30000	1.8725	0.7532	1.3597	1.8563	2.3677
beta3	30000	-0.0221	0.00819	-0.0274	-0.0218	-0.0164
beta4	30000	1.3358	0.4558	1.0261	1.3291	1.6416
sigma2	30000	0.0561	0.00622	0.0517	0.0557	0.0599
alcohol_6	30000	0.4932	0.5000	0	0	1.0000
mother_wt_9	30000	137.4	32.3080	114.5	134.0	156.0
alcohol_10	30000	0.4145	0.4926	0	0	1.0000
mother_wt_58	30000	137.3	32.1919	115.0	133.4	156.0
alcohol_63	30000	0.3226	0.4675	0	0	1.0000
mother_wt_183	30000	134.8	32.1446	112.1	130.8	153.5

Posterior Intervals					
Parameter	Alpha	Equal-Tail Interval		HPD Interval	
gamma0	0.050	-0.9354	-0.2320	-0.9356	-0.2325
gamma1	0.050	-1.8151	1.5241	-1.7743	1.5438
gamma2	0.050	0.0160	1.8391	0.0182	1.8407
alpha0	0.050	4.7981	4.8962	4.7979	4.8959
alpha1	0.050	-0.1136	0.0428	-0.1144	0.0418
alpha2	0.050	-0.0394	0.2929	-0.0397	0.2922
alpha3	0.050	-0.1531	0.0393	-0.1535	0.0386
beta0	0.050	-0.6545	3.3831	-0.7452	3.2727
beta1	0.050	-0.0572	1.4511	-0.0835	1.4225
beta2	0.050	0.4463	3.4113	0.3861	3.3420
beta3	0.050	-0.0392	-0.00703	-0.0387	-0.00656
beta4	0.050	0.4582	2.2429	0.4493	2.2328
sigma2	0.050	0.0451	0.0696	0.0444	0.0685
alcohol_6	0.050	0	1.0000	0	1.0000
mother_wt_9	0.050	83.9083	210.5	81.0816	204.6
alcohol_10	0.050	0	1.0000	0	1.0000
mother_wt_58	0.050	84.5836	209.9	78.7194	201.7
alcohol_63	0.050	0	1.0000	0	1.0000
mother_wt_183	0.050	82.6934	208.6	78.4302	199.5

Parameter	gamma0	gamma1	gamma2	alpha0	alpha1	alpha2	alpha3	beta0	beta1	b
gamma0	1.0000	-0.1458	-0.3721	0.0144	-0.0096	0.0021	-0.0050	-0.0102	0.0093	-0.1
gamma1	-0.1458	1.0000	-0.0814	-0.0301	0.0528	0.0252	-0.0180	0.0199	-0.0141	-0.1
gamma2	-0.3721	-0.0814	1.0000	-0.0096	0.0165	0.0007	0.0074	0.0002	-0.0247	0.1
alpha0	0.0144	-0.0301	-0.0096	1.0000	-0.5767	-0.1704	-0.2163	-0.0353	0.0013	-0.
alpha1	-0.0096	0.0528	0.0165	-0.5767	1.0000	0.0264	-0.1820	0.0153	-0.0087	0.1
alpha2	0.0021	0.0252	0.0007	-0.1704	0.0264	1.0000	-0.0431	-0.0356	0.0045	0.
alpha3	-0.0050	-0.0180	0.0074	-0.2163	-0.1820	-0.0431	1.0000	0.0001	0.0084	-0.1
beta0	-0.0102	0.0199	0.0002	-0.0353	0.0153	-0.0356	0.0001	1.0000	-0.2193	0..
beta1	0.0093	-0.0141	-0.0247	0.0013	-0.0087	0.0045	0.0084	-0.2193	1.0000	0.1
beta2	-0.0005	-0.0671	0.0198	-0.0113	0.0045	0.1023	-0.0171	0.2130	0.0014	1.1
beta3	0.0069	-0.0173	0.0019	0.0397	-0.0127	0.0365	-0.0038	-0.9667	0.0578	-0..
beta4	-0.0019	0.0137	-0.0230	-0.0021	-0.0069	-0.0050	0.0073	-0.0400	-0.1152	0.1

Parameter	gamma0	gamma1	gamma2	alpha0	alpha1	alpha2	alpha3	beta0	beta1	b
<b>sigma2</b>	0.0022	0.0059	-0.0034	-0.0111	0.0092	-0.0052	-0.0019	0.0101	-0.0036	0.1
<b>alcohol_6</b>	0.0847	-0.0221	-0.0287	0.0245	-0.0320	-0.0017	0.0039	-0.0286	0.1261	0.1
<b>mother_wt_9</b>	0.0055	-0.0017	0.0036	0.0497	-0.0539	0.3177	-0.0288	-0.1240	-0.0171	0.1
<b>alcohol_10</b>	0.0246	0.3457	-0.0491	-0.0391	0.0722	0.0207	-0.0283	-0.0019	0.0817	-0.1
<b>mother_wt_58</b>	-0.0066	0.0037	0.0037	0.0077	0.0226	0.3006	-0.0435	-0.1198	0.0093	0.1
<b>alcohol_63</b>	0.0842	-0.0055	-0.0230	0.0340	-0.0473	-0.0097	-0.0013	0.0104	-0.0597	-0.1
<b>mother_wt_183</b>	-0.0009	0.0036	0.0058	0.0990	-0.0525	-0.0292	-0.0229	0.0230	-0.0124	0.1

Parameter	gamma0	gamma1	gamma2	alpha0	alpha1	alpha2	alpha3	beta0	beta1	b
<b>gamma0</b>	0.0324	-0.0223	-0.0310	0.000065	-0.00007	0.000033	-0.00004	-0.00188	0.0	
<b>gamma1</b>	-0.0223	0.7208	-0.0320	-0.00064	0.00178	0.00181	-0.00075	0.0173	-0	
<b>gamma2</b>	-0.0310	-0.0320	0.2148	-0.00011	0.000305	0.000029	0.000169	0.000118	-0	
<b>alpha0</b>	0.000065	-0.00064	-0.00011	0.000632	-0.00058	-0.00036	-0.00027	-0.00091	0.0	
<b>alpha1</b>	-0.00007	0.00178	0.000305	-0.00058	0.00159	0.000089	-0.00036	0.000624	-0	
<b>alpha2</b>	0.000033	0.00181	0.000029	-0.00036	0.000089	0.00716	-0.00018	-0.00309	0.0	
<b>alpha3</b>	-0.00004	-0.00075	0.000169	-0.00027	-0.00036	-0.00018	0.00243	6.206E-6	0.0	
<b>beta0</b>	-0.00188	0.0173	0.000118	-0.00091	0.000624	-0.00309	6.206E-6	1.0505	-	
<b>beta1</b>	0.000645	-0.00460	-0.00438	0.000013	-0.00013	0.000145	0.000159	-0.0861		
<b>beta2</b>	-0.00007	-0.0429	0.00692	-0.00021	0.000134	0.00652	-0.00064	0.1644	0.0	
<b>beta3</b>	0.000010	-0.00012	7.168E-6	8.184E-6	-4.16E-6	0.000025	-1.55E-6	-0.00812	0.0	
<b>beta4</b>	-0.00016	0.00532	-0.00487	-0.00002	-0.00013	-0.00019	0.000163	-0.0187	-	
<b>sigma2</b>	2.508E-6	0.000031	-9.87E-6	-1.74E-6	2.29E-6	-2.71E-6	-5.74E-7	0.000064	-8	
<b>alcohol_6</b>	0.00762	-0.00938	-0.00666	0.000308	-0.00064	-0.00007	0.000097	-0.0146		
<b>mother_wt_9</b>	0.0322	-0.0472	0.0539	0.0403	-0.0694	0.8685	-0.0458	-4.1047	-	
<b>alcohol_10</b>	0.00218	0.1446	-0.0112	-0.00048	0.00142	0.000864	-0.00069	-0.00095		
<b>mother_wt_58</b>	-0.0383	0.1006	0.0551	0.00626	0.0289	0.8189	-0.0690	-3.9539		
<b>alcohol_63</b>	0.00709	-0.00219	-0.00499	0.000400	-0.00088	-0.00039	-0.00003	0.00500	-	
<b>mother_wt_183</b>	-0.00516	0.0992	0.0870	0.0800	-0.0672	-0.0793	-0.0363	0.7579	-	

### Bayesian Analysis of Low Birth Weight Data

#### The MCMC Procedure

Monte Carlo Standard Errors			
Parameter	MCSE	Standard Deviation	MCSE/SD
gamma0	0.00131	0.1800	0.00725
gamma1	0.00664	0.8490	0.00783
gamma2	0.00336	0.4634	0.00725
alpha0	0.000220	0.0251	0.00877
alpha1	0.000348	0.0398	0.00874
alpha2	0.000965	0.0846	0.0114
alpha3	0.000402	0.0493	0.00815
beta0	0.0103	1.0250	0.0100
beta1	0.00318	0.3832	0.00830
beta2	0.00671	0.7532	0.00891
beta3	0.000083	0.00819	0.0101
beta4	0.00367	0.4558	0.00806
sigma2	0.000047	0.00622	0.00750
alcohol_6	0.00293	0.5000	0.00585
mother_wt_9	0.3898	32.3080	0.0121
alcohol_10	0.00303	0.4926	0.00614
mother_wt_58	0.4000	32.1919	0.0124
alcohol_63	0.00270	0.4675	0.00577
mother_wt_183	0.4050	32.1446	0.0126

Posterior Autocorrelations				
Parameter	Lag 1	Lag 5	Lag 10	Lag 50
gamma0	0.2178	0.0021	-0.0030	-0.0055
gamma1	0.2981	-0.0016	0.0050	-0.0041
gamma2	0.2351	-0.0031	-0.0036	0.0023
alpha0	0.3507	0.0245	-0.0025	0.0014
alpha1	0.3447	0.0280	0.0028	0.0006
alpha2	0.4520	0.1021	0.0220	-0.0001
alpha3	0.3113	0.0170	-0.0023	-0.0060
beta0	0.4248	0.0483	0.0099	0.0005
beta1	0.3544	0.0076	-0.0057	0.0021
beta2	0.3800	0.0190	0.0007	-0.0069
beta3	0.4259	0.0501	0.0100	0.0023

Posterior Autocorrelations				
Parameter	Lag 1	Lag 5	Lag 10	Lag 50
<b>beta4</b>	0.3168	0.0087	-0.0034	0.0058
<b>sigma2</b>	0.1358	0.0211	-0.0025	0.0010
<b>alcohol_6</b>	0.0141	-0.0049	0.0032	-0.0005
<b>mother_wt_9</b>	0.5643	0.1005	0.0241	0.0063
<b>alcohol_10</b>	0.0486	-0.0006	-0.0017	0.0046
<b>mother_wt_58</b>	0.6167	0.1134	0.0253	-0.0177
<b>alcohol_63</b>	0.0049	-0.0063	-0.0029	-0.0016
<b>mother_wt_183</b>	0.6217	0.1040	0.0237	-0.0006

Geweke Diagnostics		
Parameter	z	Pr >  z
<b>gamma0</b>	0.0455	0.9637
<b>gamma1</b>	0.2395	0.8107
<b>gamma2</b>	-1.1178	0.2636
<b>alpha0</b>	0.2189	0.8267
<b>alpha1</b>	0.3627	0.7168
<b>alpha2</b>	-0.5523	0.5808
<b>alpha3</b>	1.1893	0.2343
<b>beta0</b>	1.0358	0.3003
<b>beta1</b>	0.2290	0.8189
<b>beta2</b>	-0.9020	0.3671
<b>beta3</b>	-1.1672	0.2431
<b>beta4</b>	1.9776	0.0480
<b>sigma2</b>	2.0305	0.0423
<b>alcohol_6</b>	-0.4648	0.6421
<b>mother_wt_9</b>	-2.2632	0.0236
<b>alcohol_10</b>	0.2447	0.8067
<b>mother_wt_58</b>	0.0580	0.9537
<b>alcohol_63</b>	-0.3288	0.7423
<b>mother_wt_183</b>	-0.2720	0.7856

Raftery-Lewis Diagnostics		
Quantile=0.025 Accuracy=+/-0.005 Probability=0.95 Epsilon=0.001		
Parameter	Number of Samples	Dependence Factor

	Burn-In	Total	Raithby-Lewis Diagnostics		
Parameter	Number of Samples			Dependence Factor	
	Burn-In	Total	Minimum		
gamma0	3	4361	3746	1.1642	
gamma1	4	4689	3746	1.2517	
gamma2	3	4471	3746	1.1935	
alpha0	4	5038	3746	1.3449	
alpha1	4	4859	3746	1.2971	
alpha2	5	8182	3746	2.1842	
alpha3	4	5210	3746	1.3908	
beta0	5	5420	3746	1.4469	
beta1	4	4954	3746	1.3225	
beta2	4	4899	3746	1.3078	
beta3	6	8857	3746	2.3644	
beta4	4	4661	3746	1.2443	
sigma2	3	4050	3746	1.0812	
alcohol_6	2	39508	3746	10.5467	
mother_wt_9	10	10751	3746	2.8700	
alcohol_10	3	41104	3746	10.9728	
mother_wt_58	12	12570	3746	3.3556	
alcohol_63	2	33917	3746	9.0542	
mother_wt_183	13	13851	3746	3.6975	

Parameter	Heidelberger-Welch Diagnostics							
	Stationarity Test				Half-Width Test			
	Cramer-von Mises Stat	p-Value	Test Outcome	Iterations Discarded	Half-Width	Mean	Relative Half-Width	Test Outcome
gamma0	0.0445	0.9087	Passed	0	0.00275	-0.5806	-0.00474	Passed
gamma1	0.0630	0.7949	Passed	0	0.0121	-0.0984	-0.1227	Failed
gamma2	0.0612	0.8067	Passed	0	0.00676	0.9242	0.00732	Passed
alpha0	0.4395	0.0569	Passed	0	0.000436	4.8477	0.000090	Passed
alpha1	0.4360	0.0581	Passed	6000	0.000734	-0.0354	-0.0208	Passed
alpha2	0.1587	0.3642	Passed	0	0.00209	0.1264	0.0166	Passed
alpha3	0.1098	0.5390	Passed	0	0.000722	-0.0567	-0.0127	Passed

**Heidelberger-Welch Diagnostics**

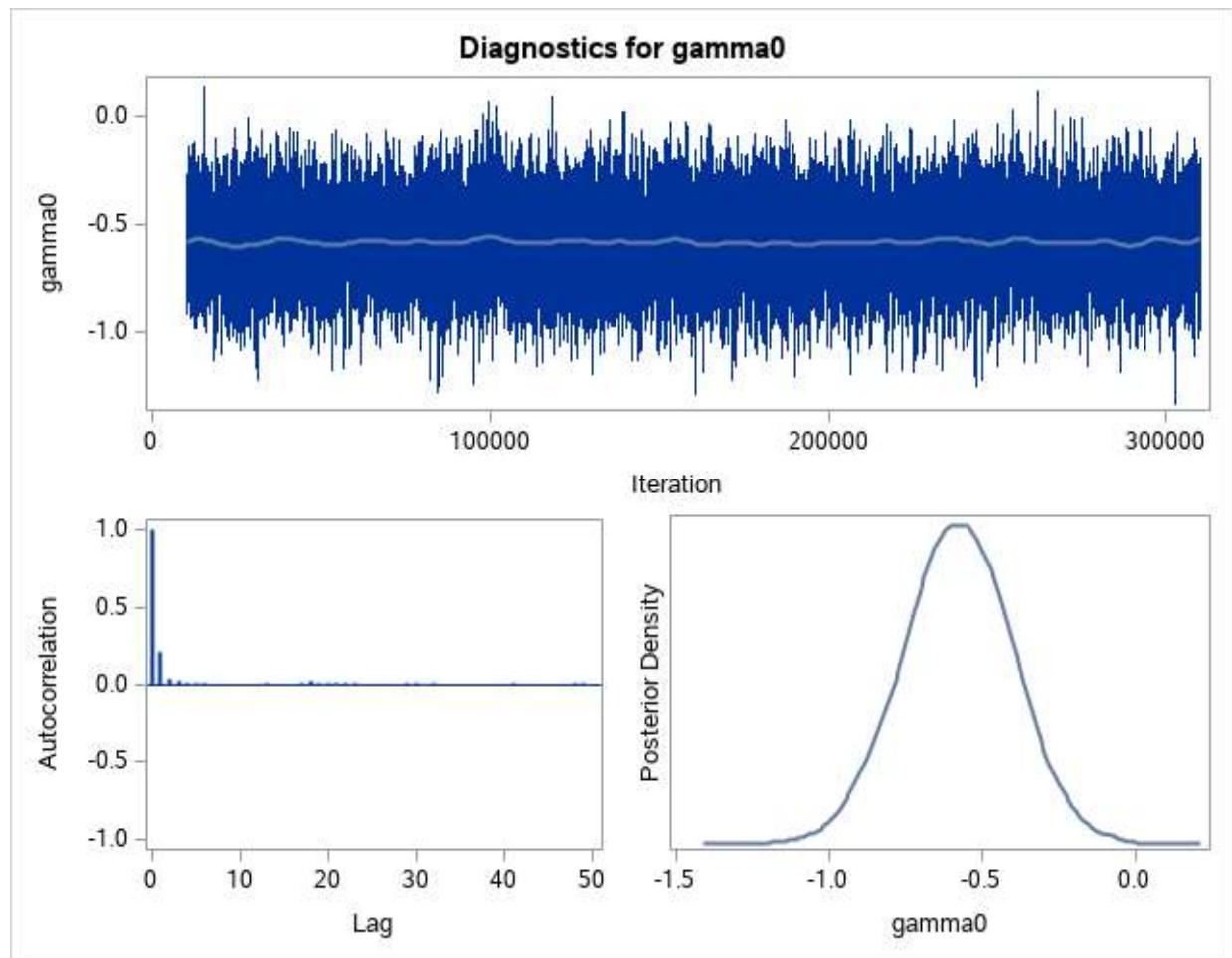
Parameter	Stationarity Test				Half-Width Test			
	Cramer-von Mises Stat	p-Value	Test Outcome	Iterations Discarded	Half-Width	Mean	Relative Half-Width	Test Outcome
<b>beta0</b>	0.3145	0.1231	Passed	0	0.0188	1.2813	0.0146	Passed
<b>beta1</b>	0.0455	0.9029	Passed	0	0.00547	0.7013	0.00780	Passed
<b>beta2</b>	0.1150	0.5162	Passed	0	0.0136	1.8725	0.00725	Passed
<b>beta3</b>	0.3660	0.0890	Passed	0	0.000155	-0.0221	-0.00702	Passed
<b>beta4</b>	0.2053	0.2575	Passed	3000	0.00752	1.3336	0.00564	Passed
<b>sigma2</b>	0.2763	0.1579	Passed	3000	0.000098	0.0561	0.00175	Passed
<b>alcohol_6</b>	0.0895	0.6390	Passed	0	0.00565	0.4932	0.0115	Passed
<b>mother_wt_9</b>	0.3666	0.0887	Passed	3000	0.8127	137.6	0.00591	Passed
<b>alcohol_10</b>	0.1604	0.3594	Passed	0	0.00557	0.4145	0.0134	Passed
<b>mother_wt_58</b>	0.1045	0.5630	Passed	0	0.8851	137.3	0.00645	Passed
<b>alcohol_63</b>	0.1571	0.3687	Passed	0	0.00580	0.3226	0.0180	Passed
<b>mother_wt_183</b>	0.2039	0.2600	Passed	0	0.8190	134.8	0.00607	Passed

Effective Sample Sizes			
Parameter	ESS	Autocorrelation Time	Efficiency
<b>gamma0</b>	19029.7	1.5765	0.6343
<b>gamma1</b>	16328.0	1.8373	0.5443
<b>gamma2</b>	19006.6	1.5784	0.6336
<b>alpha0</b>	13008.6	2.3062	0.4336
<b>alpha1</b>	13089.9	2.2919	0.4363
<b>alpha2</b>	7691.0	3.9007	0.2564
<b>alpha3</b>	15039.2	1.9948	0.5013
<b>beta0</b>	9996.9	3.0009	0.3332
<b>beta1</b>	14509.6	2.0676	0.4837
<b>beta2</b>	12594.3	2.3820	0.4198
<b>beta3</b>	9845.3	3.0472	0.3282
<b>beta4</b>	15395.6	1.9486	0.5132
<b>sigma2</b>	17755.1	1.6897	0.5918
<b>alcohol_6</b>	29179.8	1.0281	0.9727
<b>mother_wt_9</b>	6870.9	4.3663	0.2290
<b>alcohol_10</b>	26520.0	1.1312	0.8840

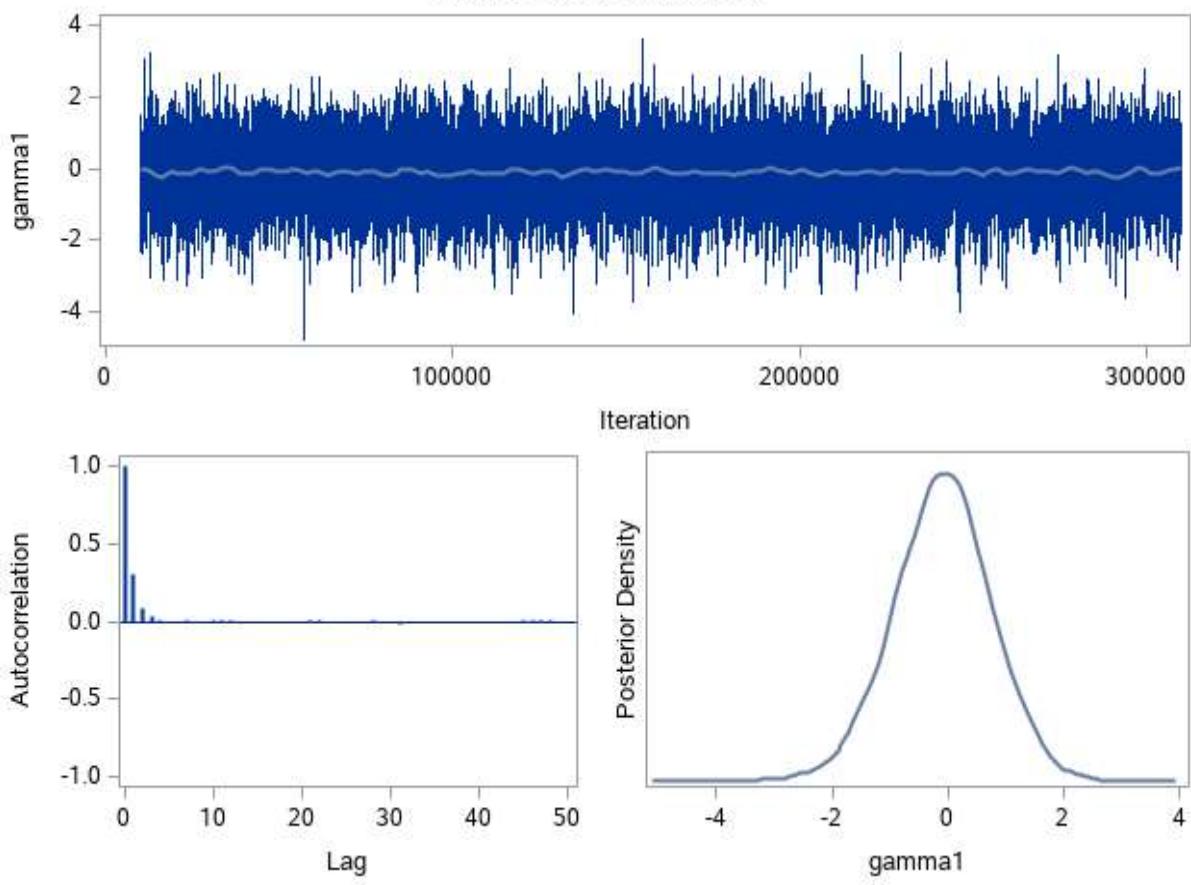
Effective Sample Sizes			
Parameter	ESS	Autocorrelation Time	Efficiency
mother_wt_58	6476.5	4.6321	0.2159
alcohol_63	30000.0	1.0000	1.0000
mother_wt_183	6300.4	4.7616	0.2100

## Bayesian Analysis of Low Birth Weight Data

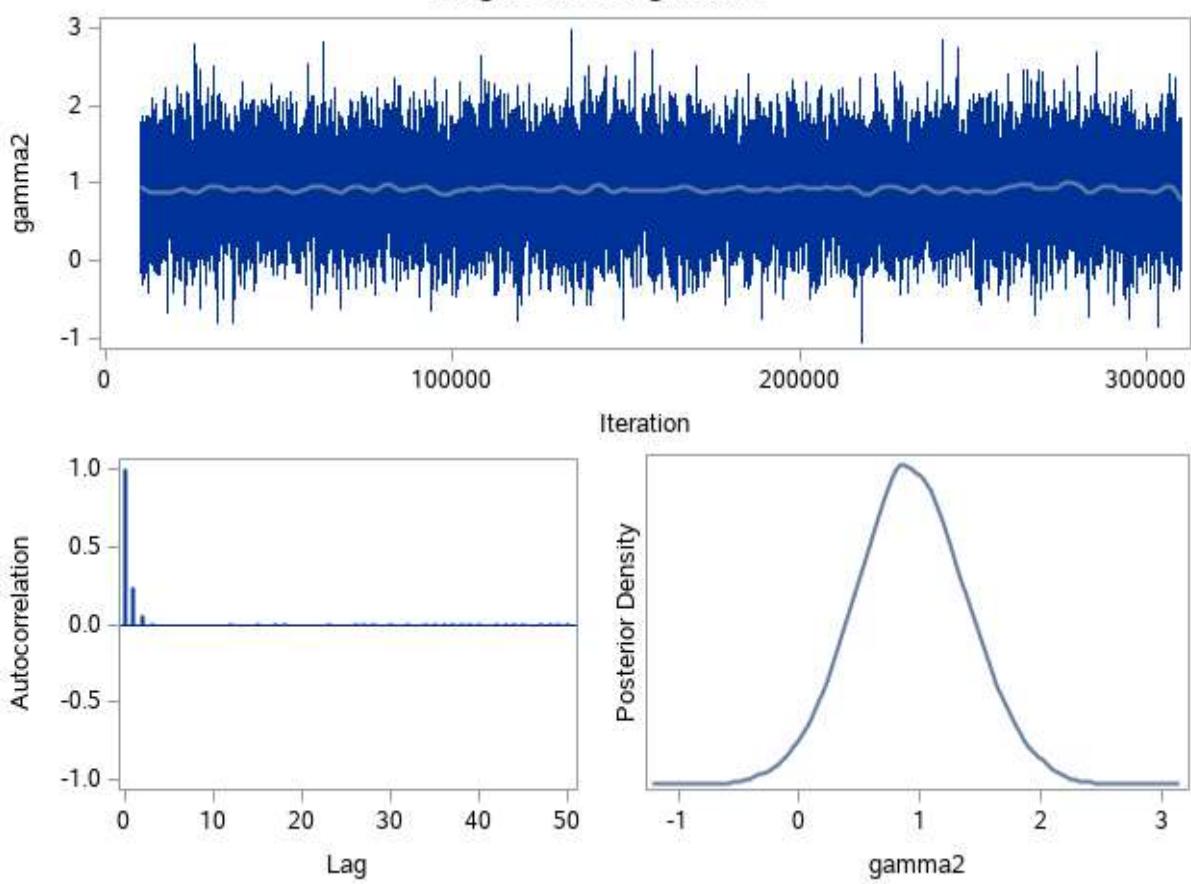
### The MCMC Procedure



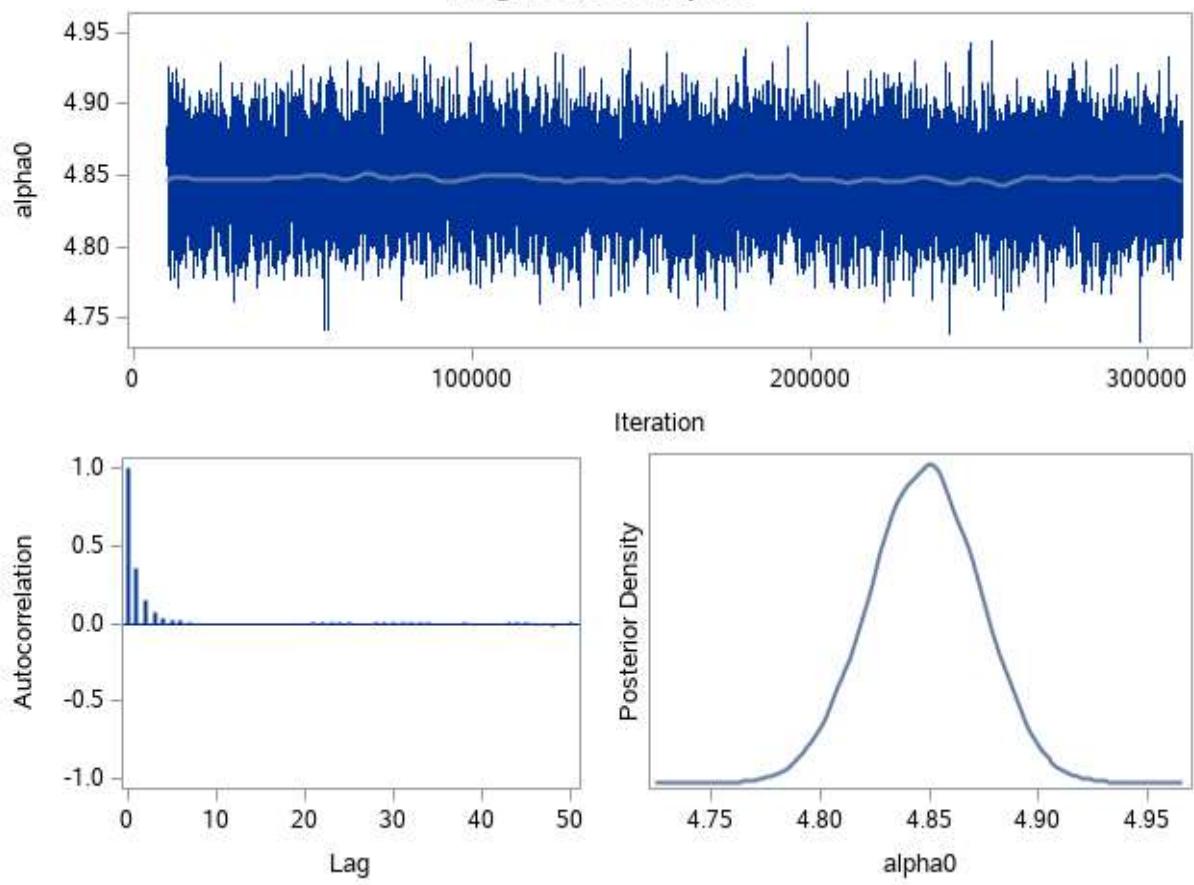
### Diagnostics for gamma1



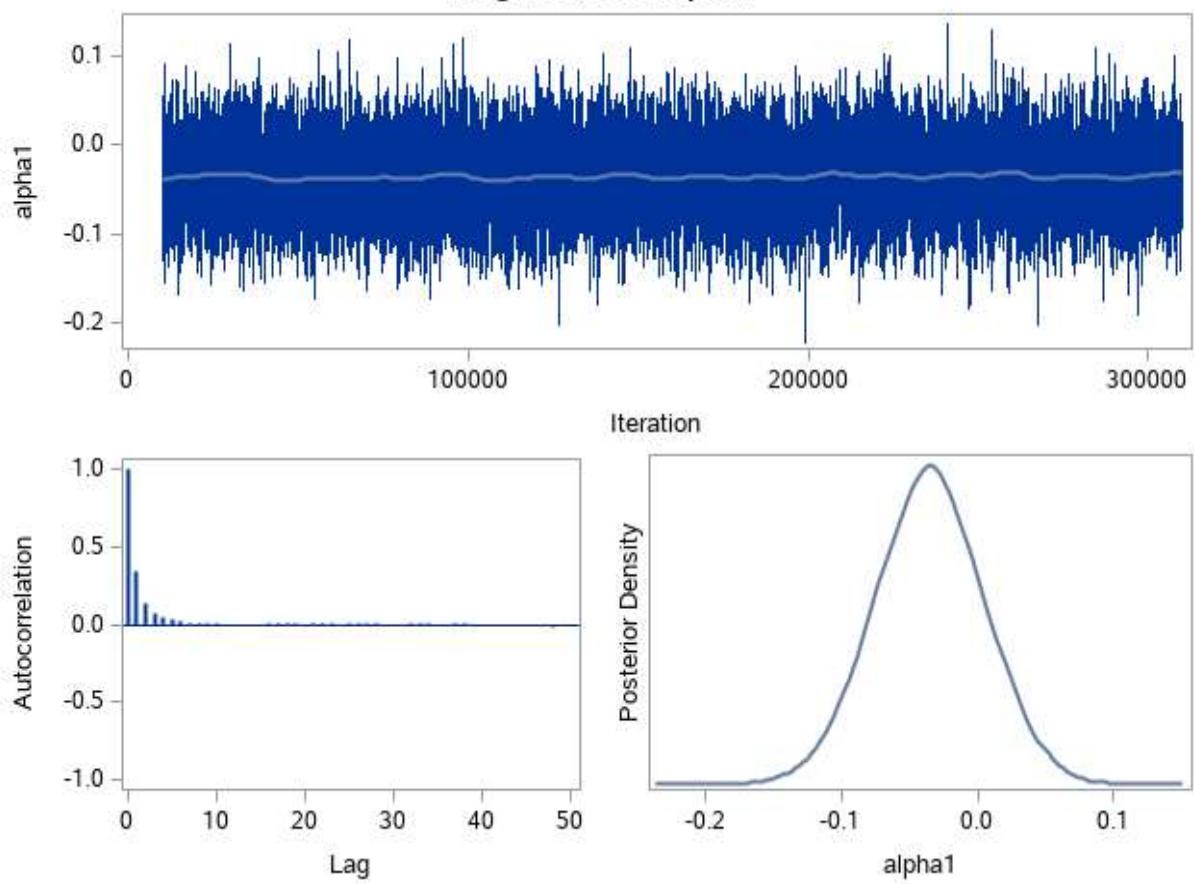
### Diagnostics for gamma2



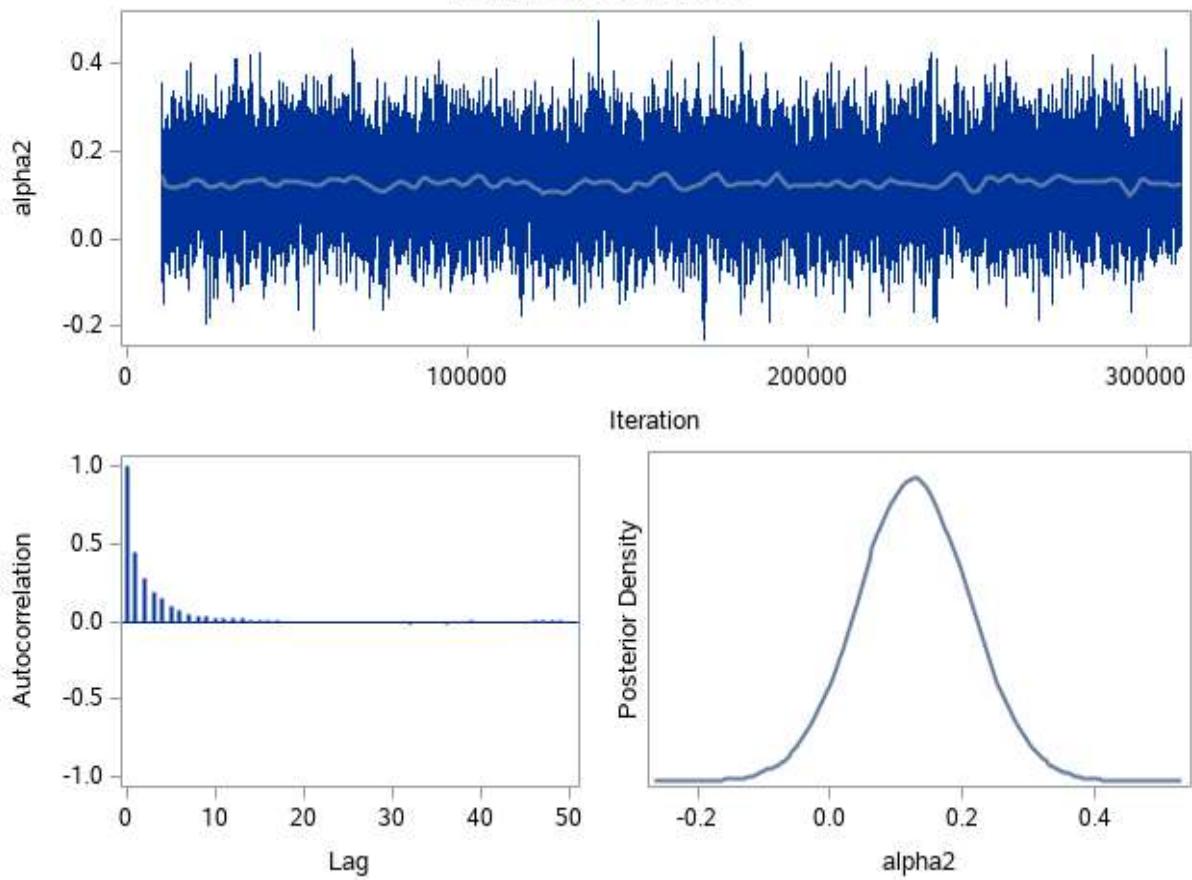
### Diagnostics for $\alpha_0$



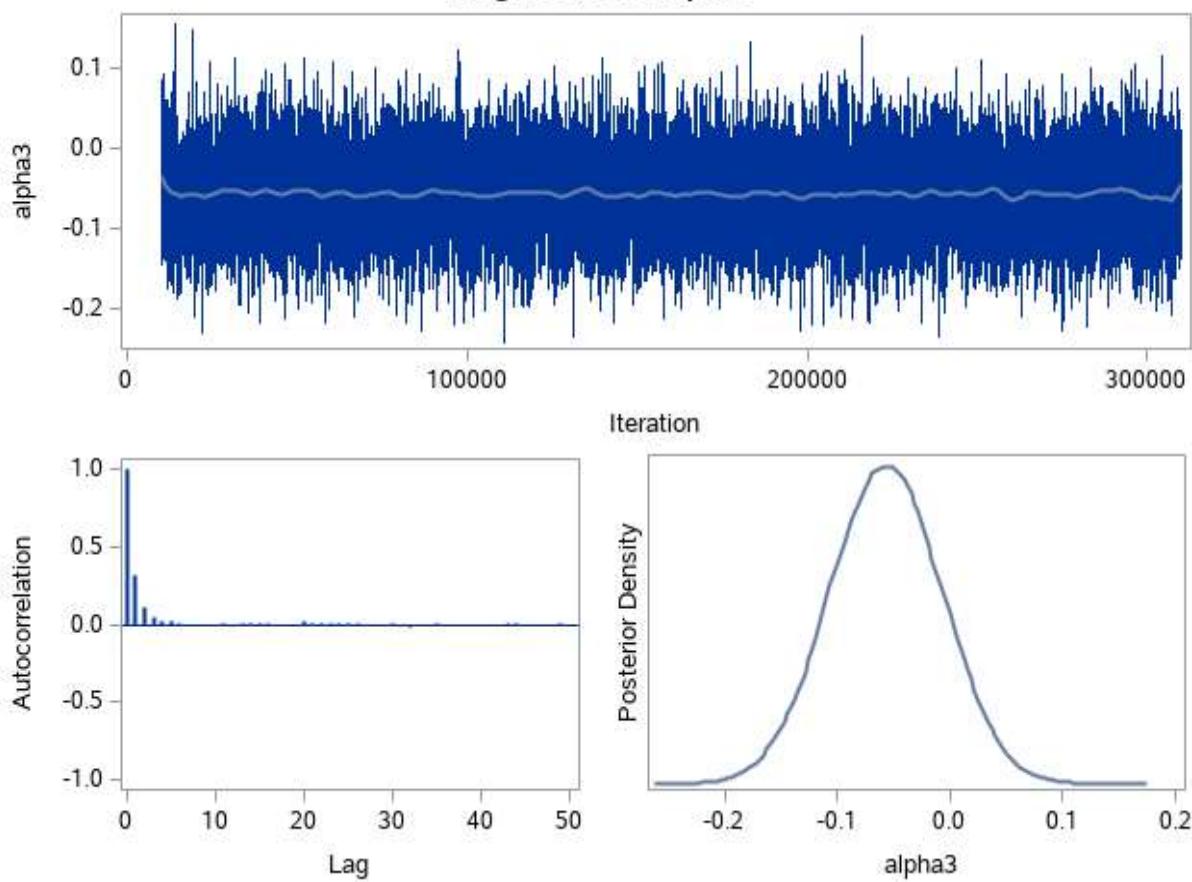
### Diagnostics for $\alpha_1$



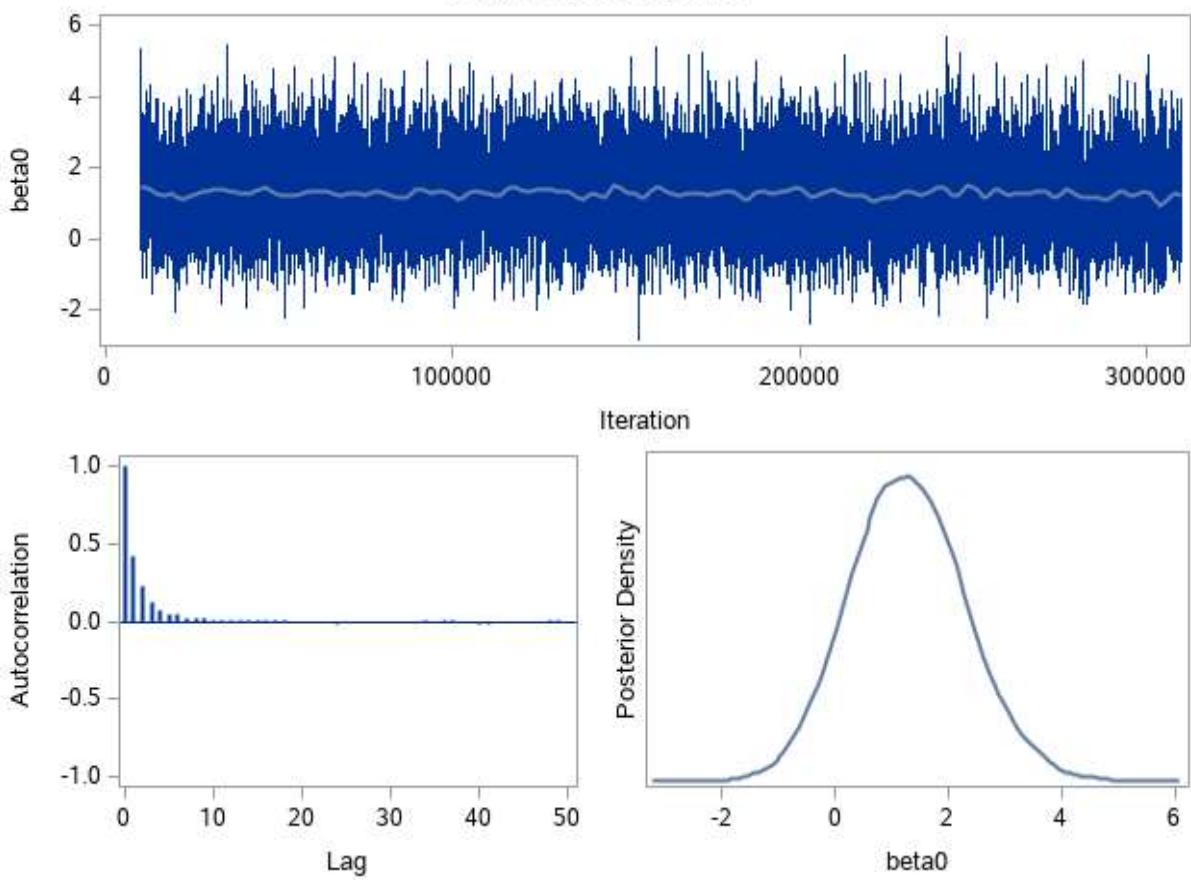
### Diagnostics for alpha2



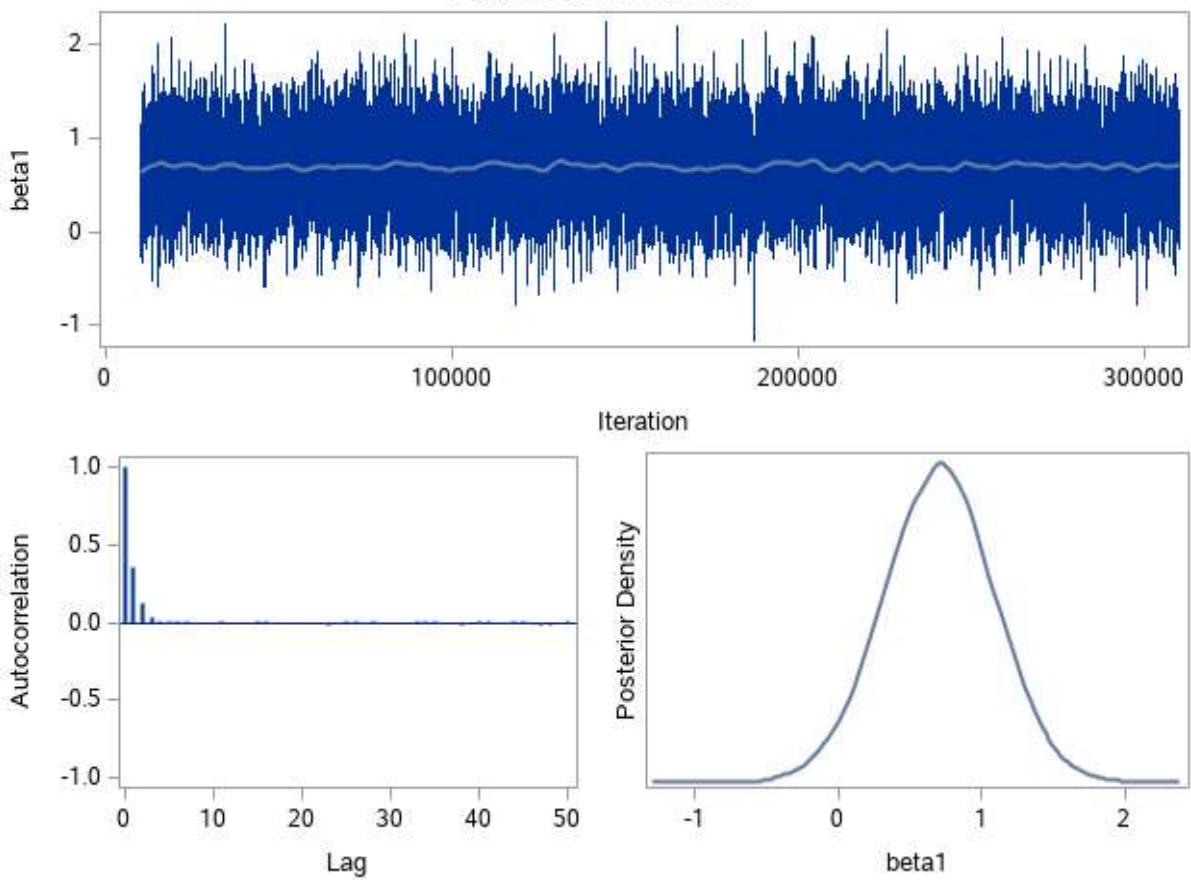
### Diagnostics for alpha3



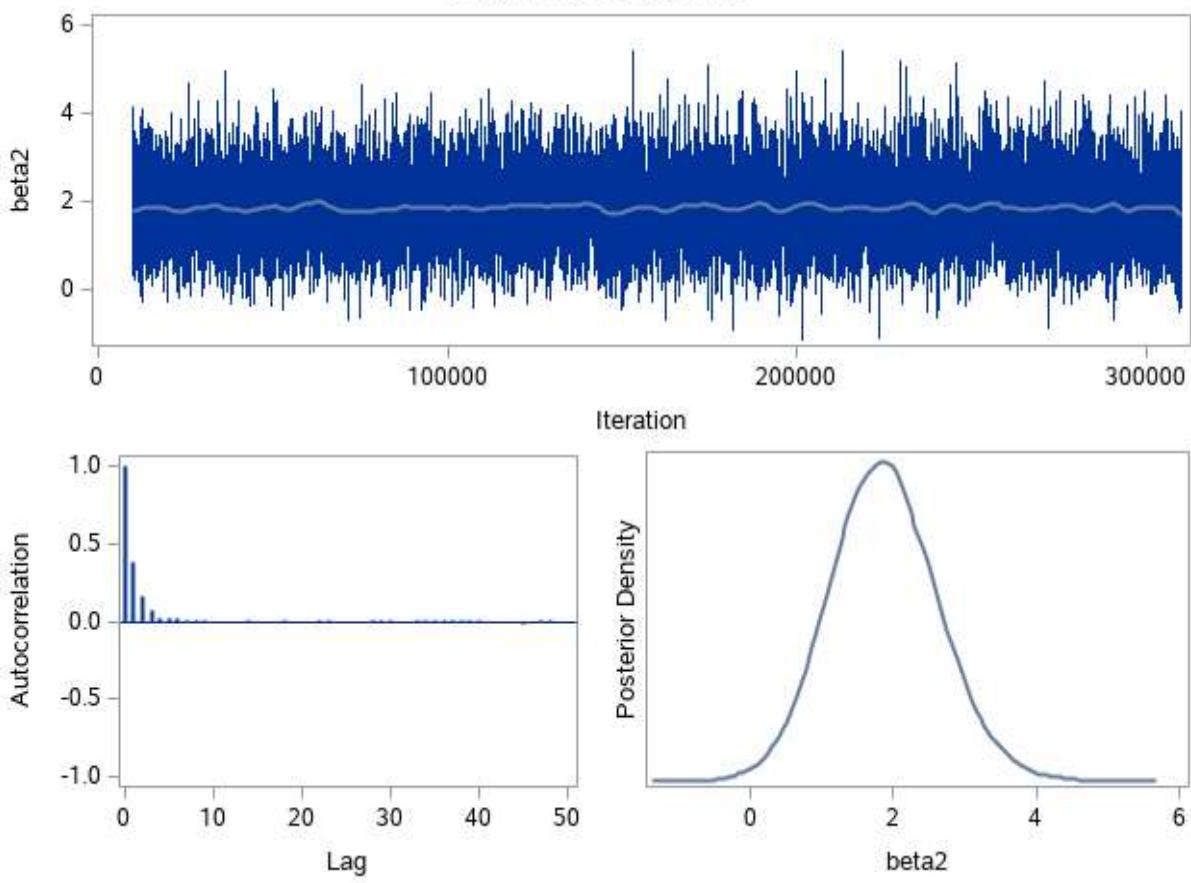
### Diagnostics for beta0



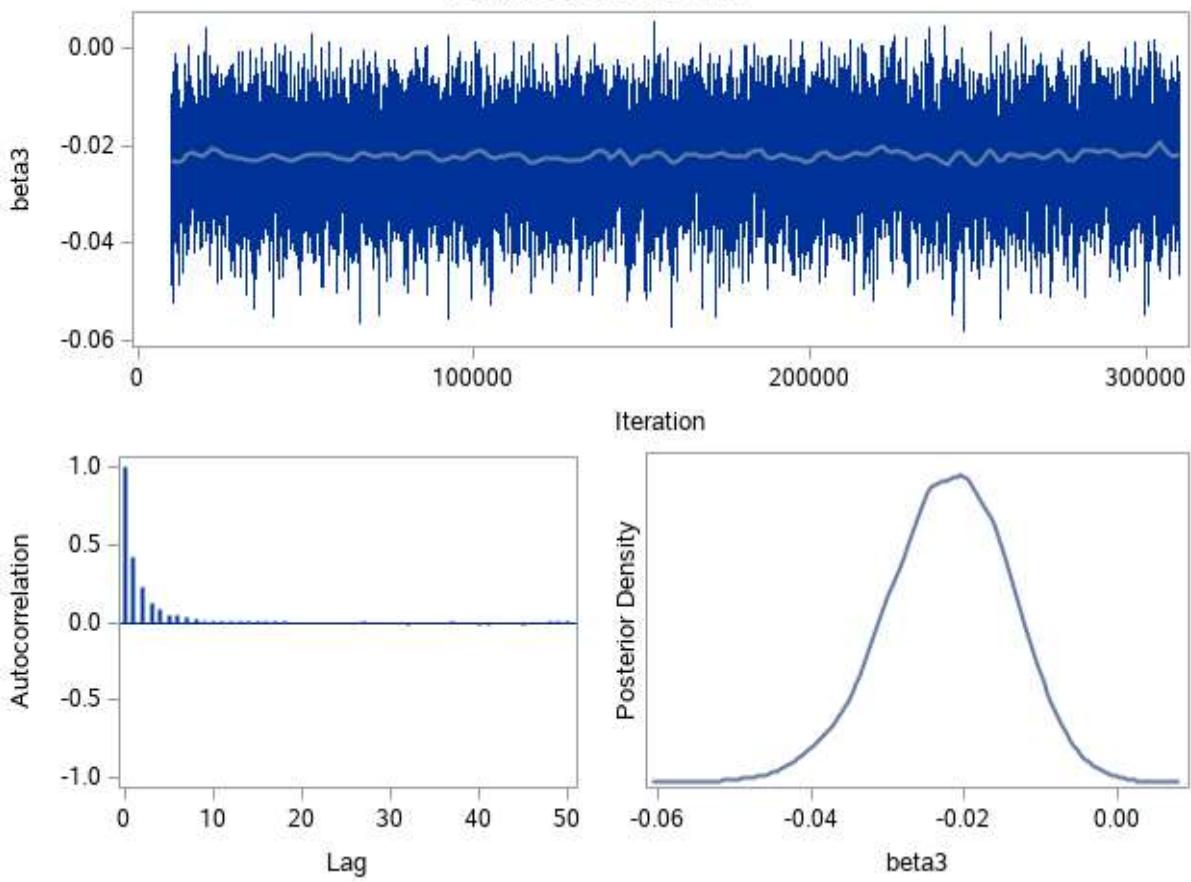
### Diagnostics for beta1



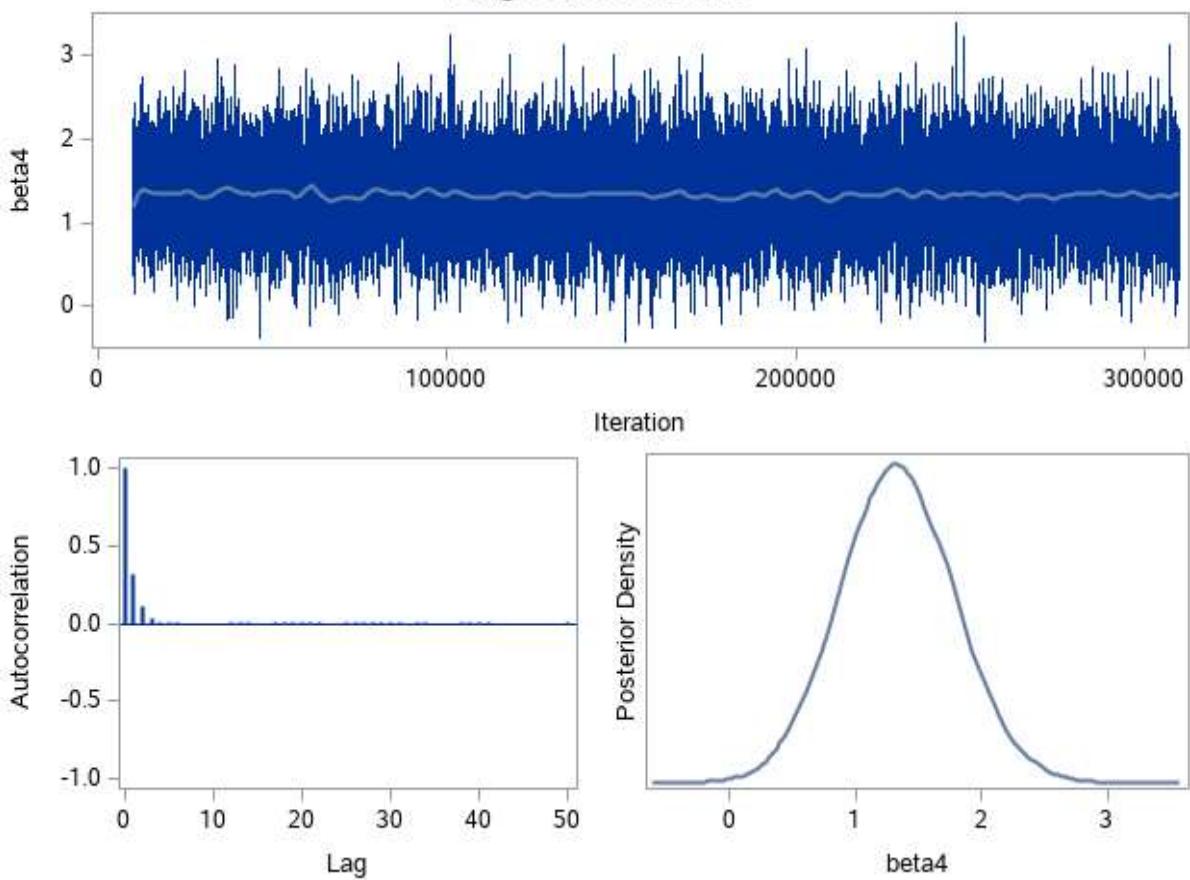
### Diagnostics for beta2



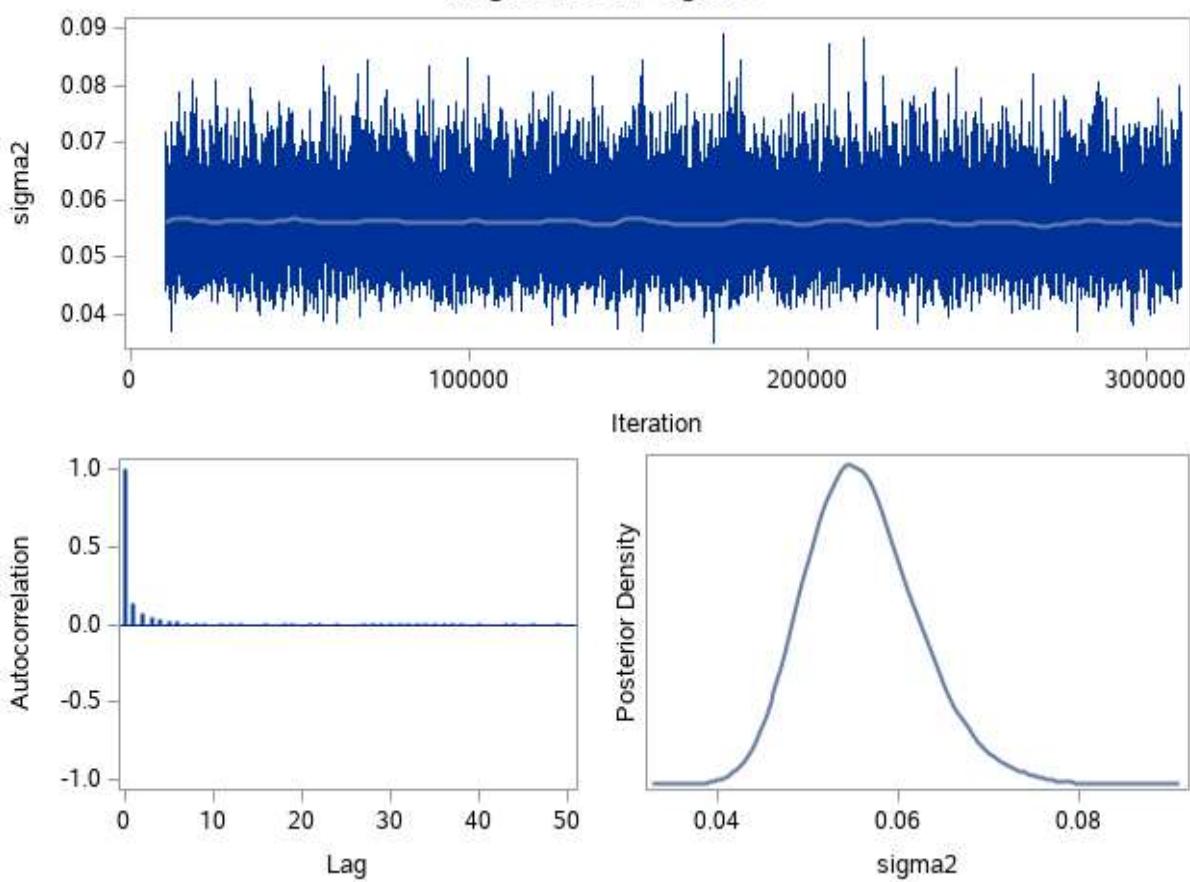
### Diagnostics for beta3



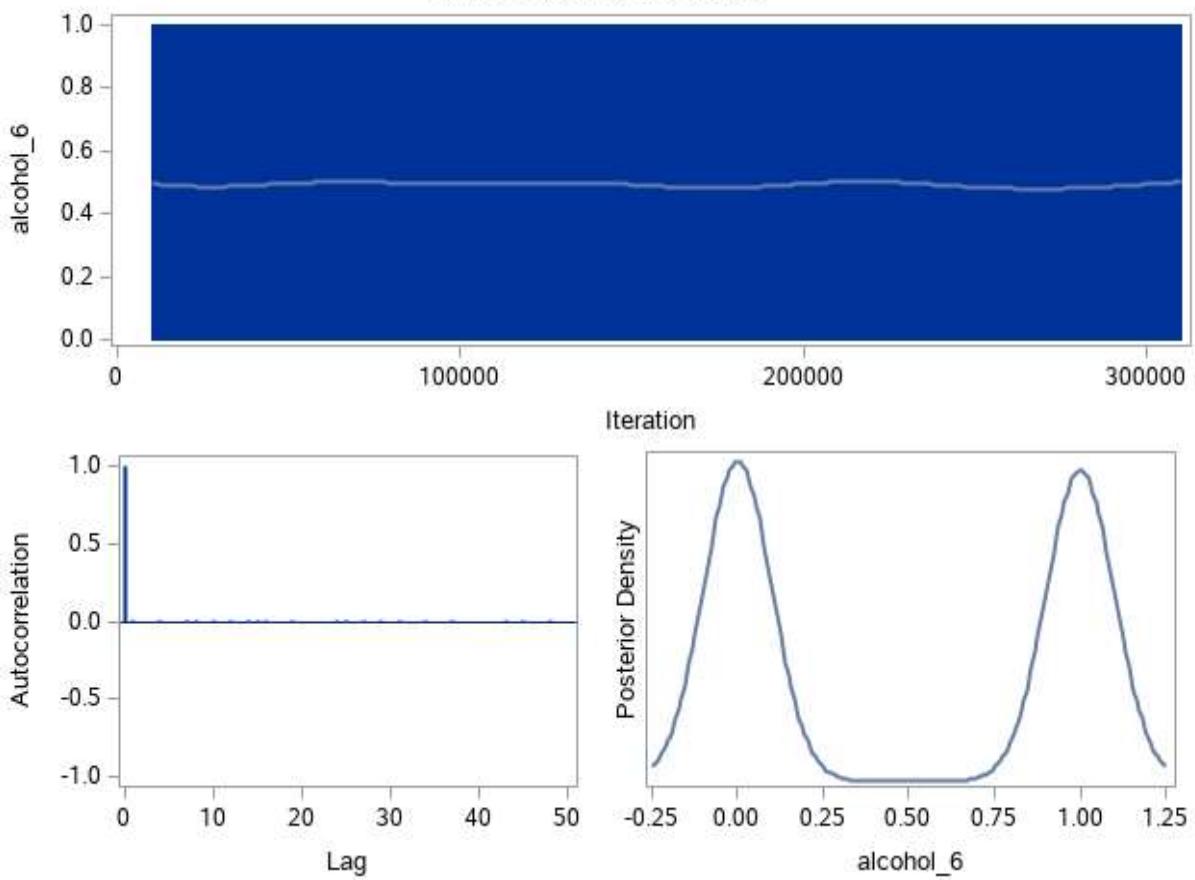
### Diagnostics for beta4



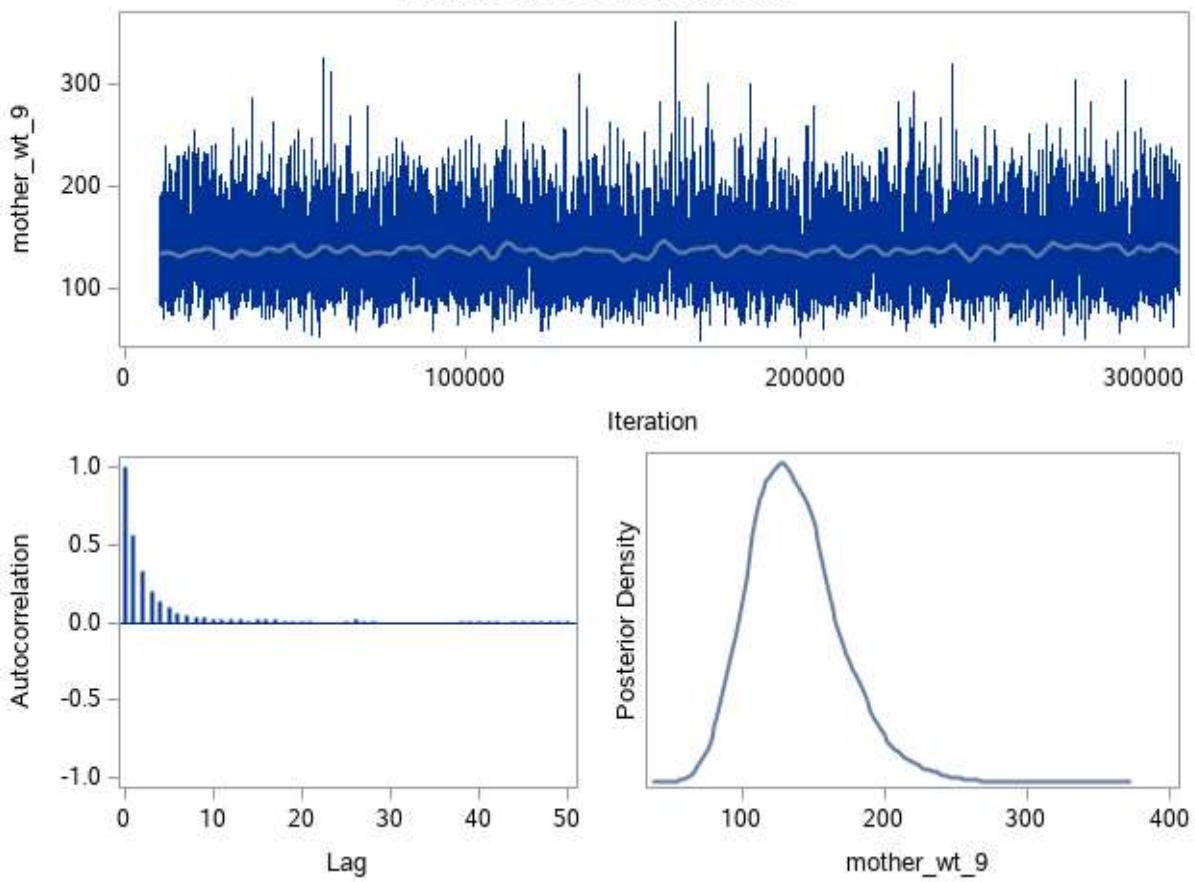
### Diagnostics for sigma2



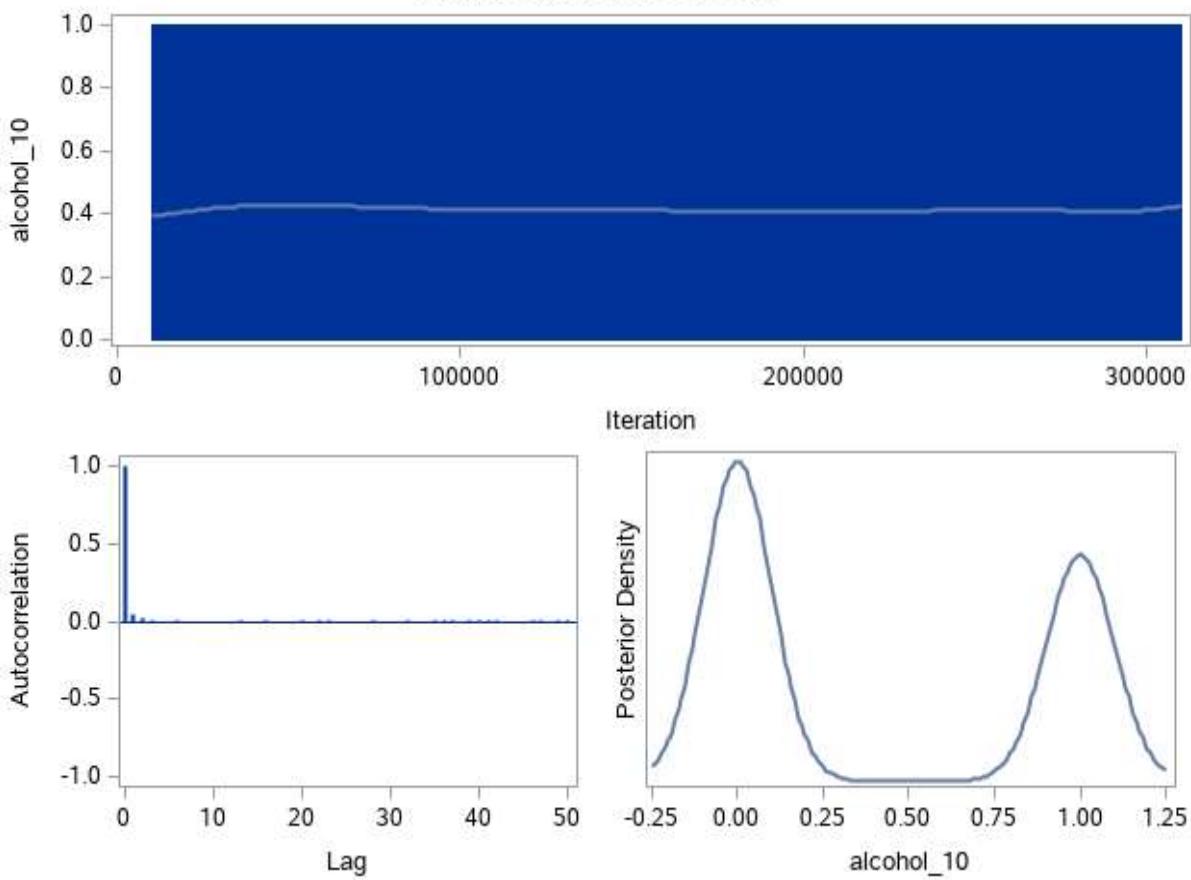
### Diagnostics for alcohol\_6



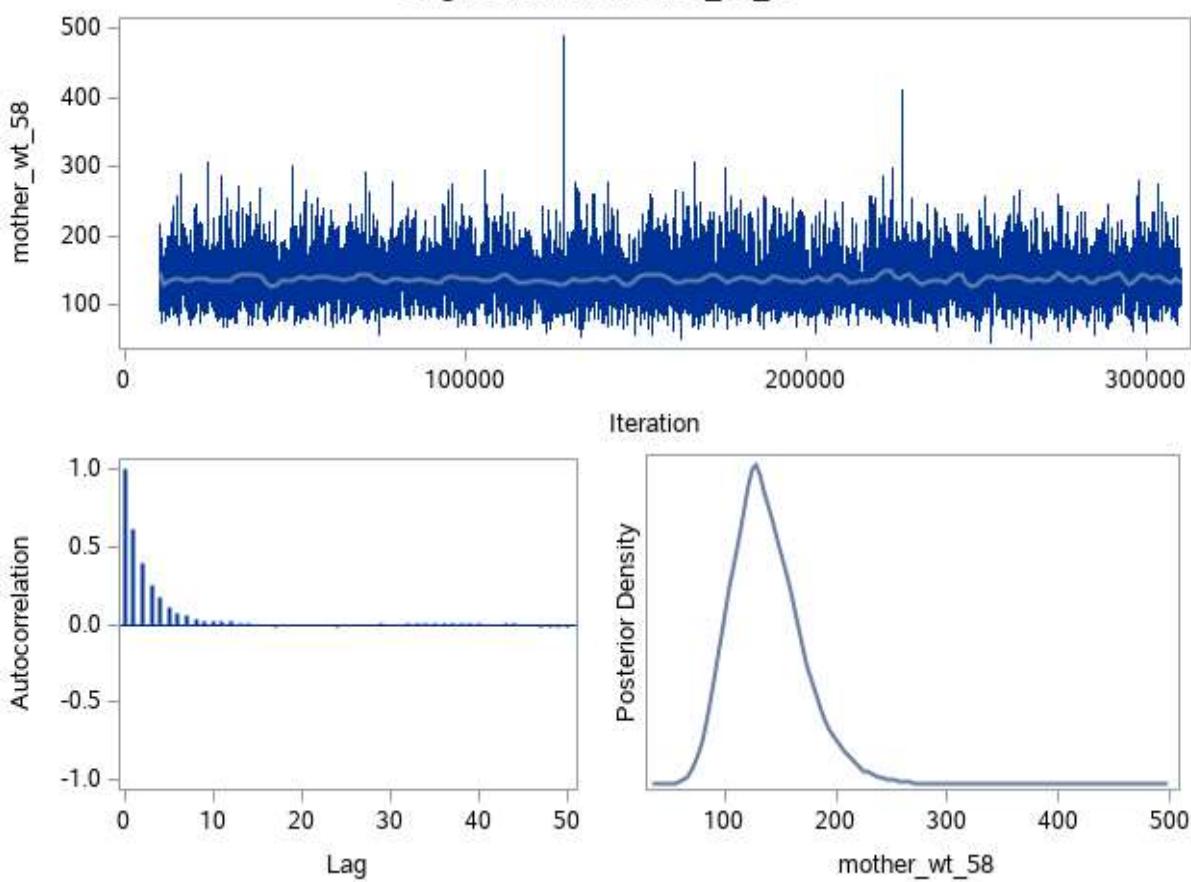
### Diagnostics for mother\_wt\_9



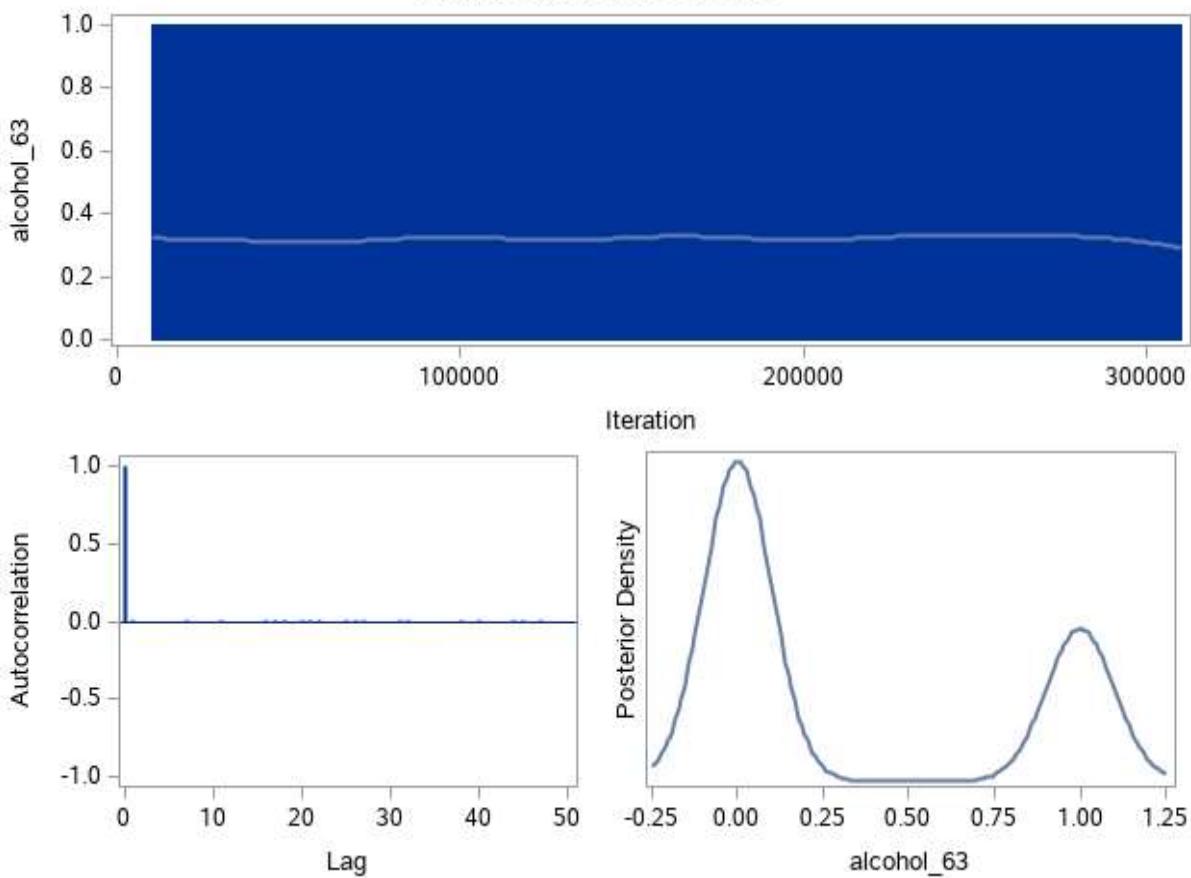
### Diagnostics for alcohol\_10



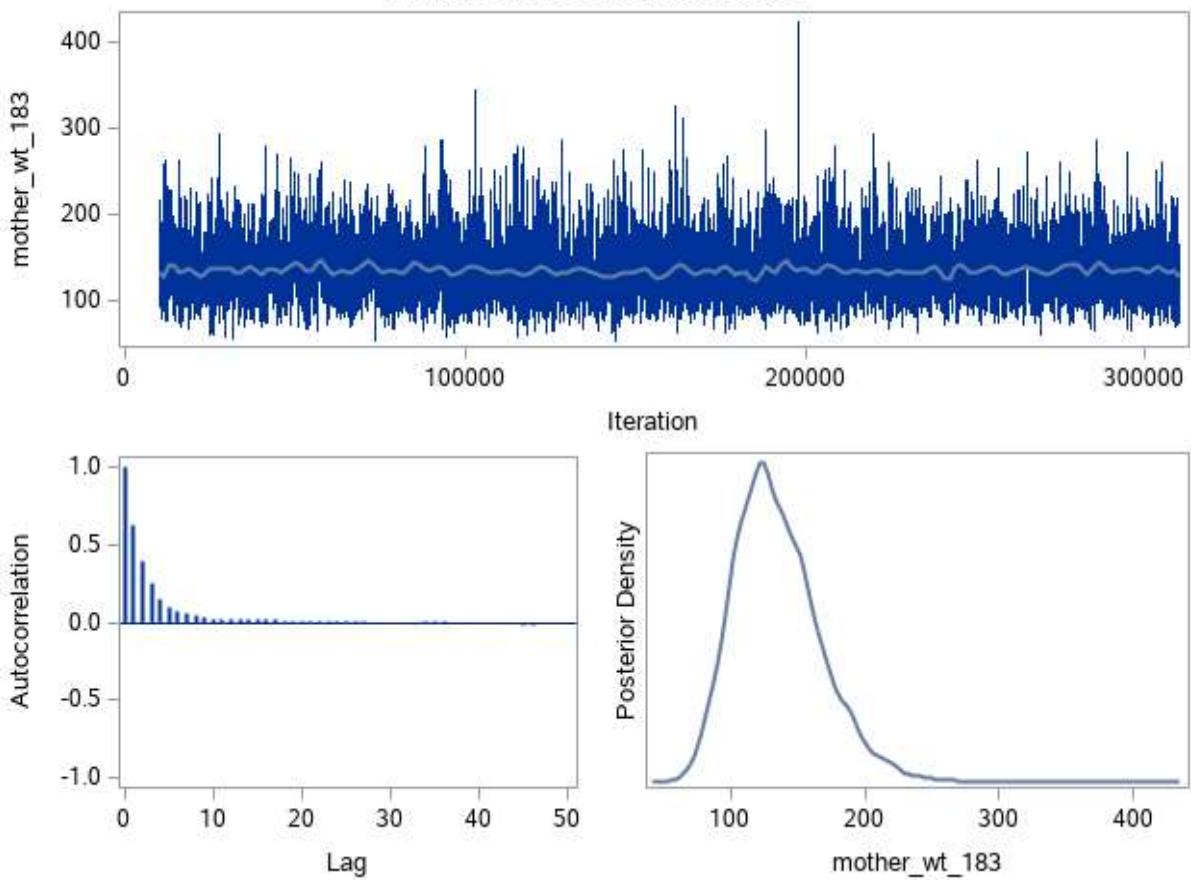
### Diagnostics for mother\_wt\_58



### Diagnostics for alcohol\_63



### Diagnostics for mother\_wt\_183



## Checking Distribution of Imputed Values.

```
In [7]: data mweight (keep= mother_wt_miss);
  set missbirthout;
  array weights{*} mother_wt_:;
  do i=1 to dim(weights);
    mother_wt_miss=weights(i);
    output;
  end;
run;

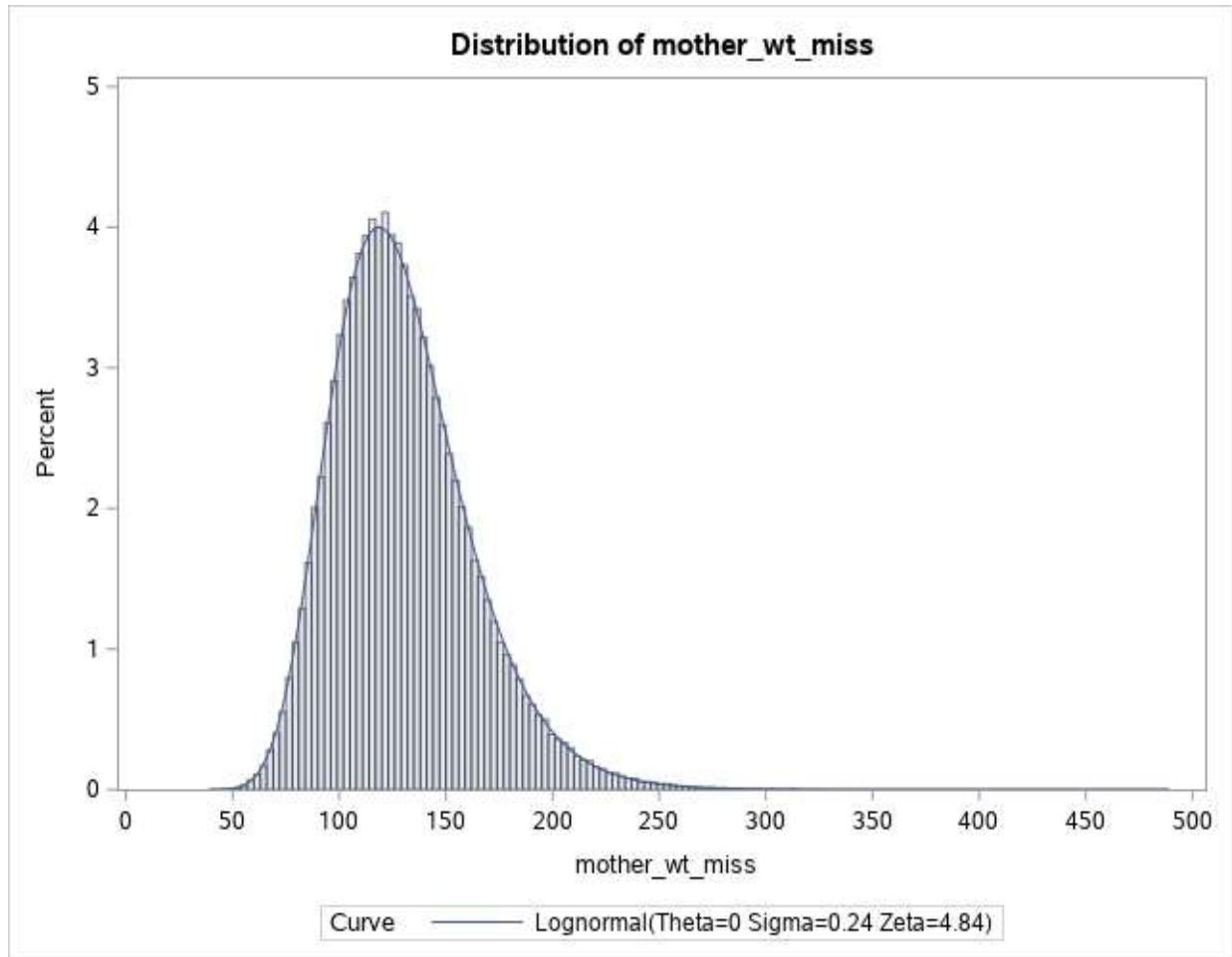
ods select histogram;
proc univariate data=mweight;
  var mother_wt_miss;
  histogram mother_wt_miss / lognormal;
run;

data malcohol (keep= alcohol_miss);
  set missbirthout;
  array alcohols{*} alcohol_:;
  do i=1 to dim(alcohols);
    alcohol_miss=alcohols(i);
    output;
  end;
run;

ods select histogram;
proc univariate data=malcohol;
  var alcohol_miss;
  histogram alcohol_miss / midpoints= 0 1;
run;
```

### Bayesian Analysis of Low Birth Weight Data

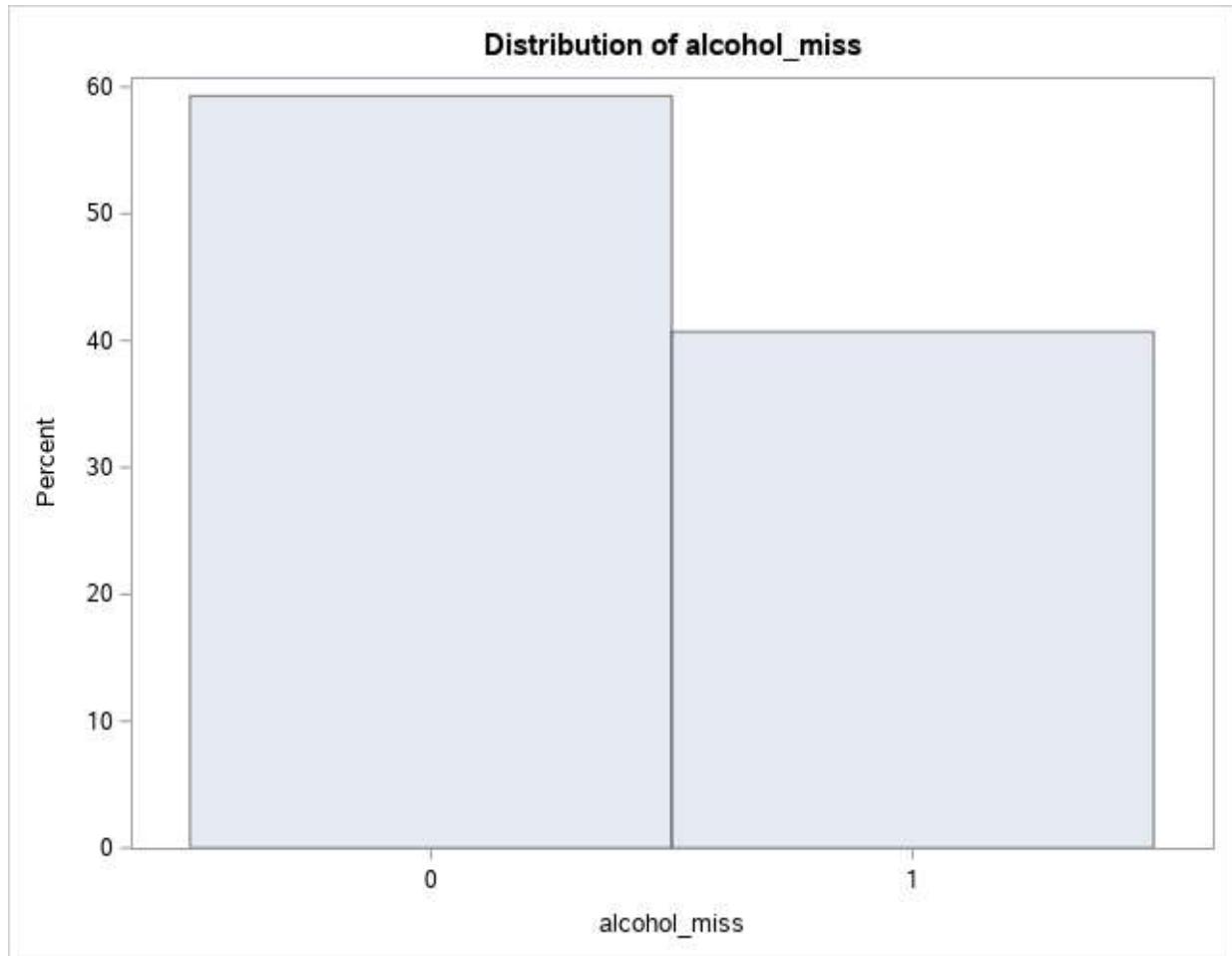
#### The UNIVARIATE Procedure



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### Bayesian Analysis of Low Birth Weight Data

The UNIVARIATE Procedure



In [ ]: