An Example of the Bayesian Econometric Analysis : A case study of the Aus Rice production in Bangladesh

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Often we have a question in case of a variable in time series data, what will be the next value of the variable in next time period (second, hour, month, year for example). The experiences we have got so far for the variable is pretty important because there are some judgments about the value, which every rational living being always consider from the past living world all around. The data we have got from the different preferred time interval, gives us the prior knowledge, which leads us to the posterior knowledge through the present status about the data. Probability in this sense gives us some numbers or an exact number to pin down the present decision so that we can lead our self to the desired location in a certain time interval or, in a certain time.

However, on the solid ground of the Bays theorem, I have tried to find out the probability of the mean production of the Aus Rice in Bangladesh.

I have the data, available from the year 1973/1974 to 2012/2013. The data is collected from the official website of the Bangladesh Bank. Therefore it is possible to compare the result which I have found and the information about the true production of the years after 2012/2013, which I do not have.

The source code is provided, where you will find all the information. I have used by following Bayesian Econometric methods.

I have considered that I have the data on the years before 1973/1974, which follows the gamma distribution with mean around the mean of the year from 1973/1974 to 2012/2013.

I have also considered that, from the before, the data is highly volatile and the variability of the data is very big. Of course in real sense, I do not available those data in my hand.

$\beta \sim N(m, \sigma^2 M)$
$\mu \sim N(m, \sigma^2/v)$

$$f(\beta;\sigma^2) \; = \; \frac{1}{(2\pi\sigma^2)^{k/_2}} |M|^{-\frac{1}{2}} exp\left\{\left[-\frac{1}{2\sigma^2}\right](\beta - m)'|M|^{-1}(\beta - m)\right\}$$

$y_t \sim i.i.d. \;\; N(\mu, \sigma^2)$

$$f(y|\mu;\sigma^2) \; = \; \frac{1}{(2\pi\sigma^2)^{T/_2}} exp\left\{\left[-\frac{1}{2\sigma^2}\right](y - \mu.1)'(y - \mu.1)\right\}$$

$1_{T\times 1}$
$\mu \sim N(m, \sigma^2/v)$

$$f(\mu;\sigma^2) \; = \; \frac{1}{(2\pi\sigma^2/v)^{1/_2}} exp\left\{\left[-\frac{1}{2\sigma^2/v}\right](\mu - m)^2\right\}$$

$\{Z_i, i = 1,2, \ldots, N\}$

$$\bar{m} = \frac{1}{N}\sum_{i=1}^{N} Z_i$$

$v = N$

$$m^* = \left(\frac{v}{v+T}\right)m + \left(\frac{T}{v+T}\right)\bar{y}$$

$$\bar{y} = \frac{1}{T}\sum_{i=1}^{T} y_t$$

$$\mu|y;\sigma^2 \sim N(m^*, \frac{\sigma^2}{v+T})$$

$$y \sim N(m.1, \sigma^2(I_T + \frac{1.1'}{v}))$$

$$\hat{\mu} = \left(\frac{v}{v+T}\right)m + \left(\frac{T}{v+T}\right)\bar{y}$$

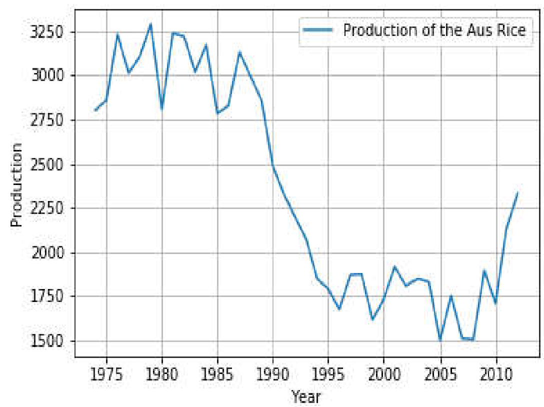
$$Z = m + Z^0 \times v^{\frac{1}{2}}$$

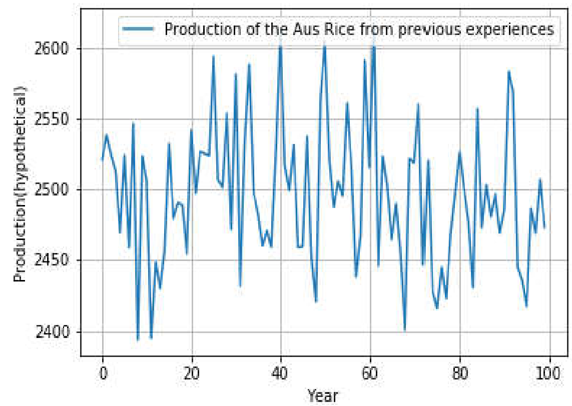
$$\mu = m^* + \mu^0 \times (\frac{\sigma^2}{v+T})^{\frac{1}{2}}$$

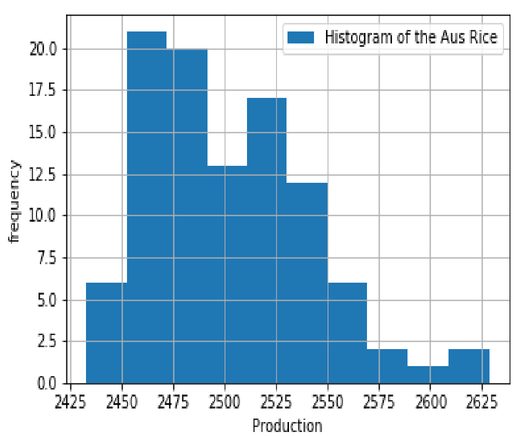
$$f(y;\sigma^2) \; = \; \frac{1}{(2\pi\sigma^2)^{T/_2}} \left|I_T + \frac{1.1'}{v}\right|^{-\frac{1}{2}} exp\left\{\left[-\frac{1}{2\sigma^2}\right](y - m.1)'\left|I_T + \frac{1.1'}{v}\right|^{-1}(y - m.1)\right\}$$

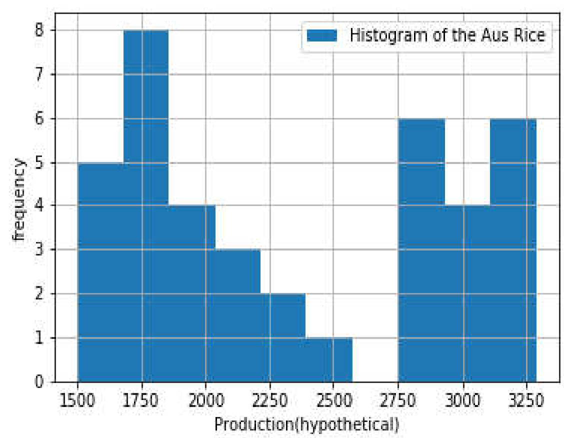
$$f(\mu|y;\sigma^2) \; = \; \frac{1}{\left[\frac{2\pi\sigma^2}{(v+T)}\right]^{1/_2}} exp\left\{\left[-\frac{1}{\frac{2\sigma^2}{(v+T)}}\right](\mu - m^*)^2\right\}$$

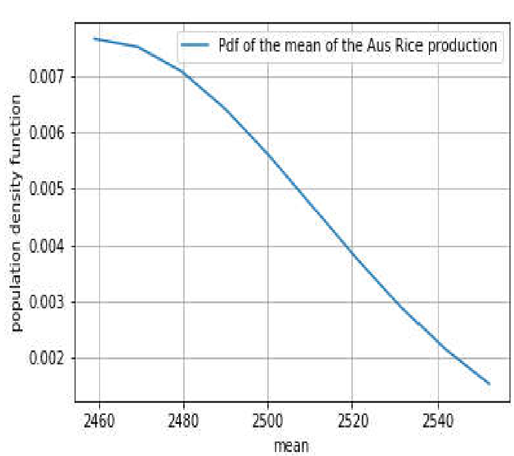
$$\sigma_0^{2\prime} = \frac{v_0\sigma_0^2 + \sum_{i=1}^{n}(x_i - \bar{x})^2 + \frac{n_0.n}{n_0+n}(\mu_0 - \bar{x})^2}{v_0 + n}$$


Production of the Aus Rice
Production
Year


Production of the Aus Rice from previous experiences
Production(hypothetical)
Year


Histogram of the Aus Rice
frequency
Production


Histogram of the Aus Rice
frequency
Production(hypothetical)


Pdf of the mean of the Aus Rice production
population density function
mean

```
# -*- coding: utf-8 -*-
"""
Created on Mon Jul  6 16:23:08 2020

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"""
from __future__ import division
import numpy as np
import scipy as sp
import pandas as pd
import matplotlib.pyplot as plt
from scipy import *

import os
os.chdir('C:\\Users\shahrear\Desktop\play\GRAPH')
os.getcwd()

#test = pd.read_csv("C:/Users/shahrear/Desktop/play/GRAPH/play3.csv", index_col=0)
test = pd.read_csv("C:/Users/shahrear/Desktop/play/GRAPH/play3.csv")
test.head()

BRP = test['AusRiceProduction']
Time = test['Period']


BRP1 = np.array([BRP])
N = np.size(BRP1)
BRP0 = np.random.gamma(2500,1,100)
Y = np.size(BRP0)
BRP_BAR1 = np.sum(BRP1)/N
BRP_BAR0 = np.sum(BRP0)/Y

v = Y
m_star = (v /(v+N))*BRP_BAR0 + (N/(v+N))*BRP_BAR1

mu_0 = np.arange(0,1,0.1)
s2_0 = 100
v_0 = 50


s2 = (np.sum((BRP1-BRP_BAR1)**2))/(N-1)
s21_0 = ((v_0*s2_0)+np.sum((BRP1-BRP_BAR0)**2) + ((v_0*v)/(v_0+v)*(mu_0 - BRP_BAR0)**2))/(v_0+v)
mu = m_star + mu_0*((s21_0/(v+N))**(1/2))

pdf_mu = (1/((2*sp.pi*s2)/(v+N))**(1/2))*np.exp((-(mu-m_star)**2)/((2*s2)/(v+N)))

plt.plot(Time,BRP)
plt.plot(BRP0)
plt.plot(mu,pdf_mu)
plt.hist(BRP)
plt.hist(BRP0)

fig = plt.figure(figsize=(50,50), dpi=100)
fig,(ax1) = plt.subplots(1, 1, sharex=True, sharey=True)
ax1.plot(Time,BRP)
ax1.legend(['Production of the Aus Rice'])
ax1.set_xlabel('Year')
ax1.set_ylabel('Production')
ax1.grid()
plt.show()
```

```
plt.draw()
fig.savefig('Aus1.png', format='png')
fig.savefig('Aus1.pdf')
plt.close(fig)

fig = plt.figure(figsize=(50,50), dpi=100)
fig,(ax1) = plt.subplots(1, 1, sharex=True, sharey=True)
ax1.hist(BRP)
ax1.legend(['Histogram of the Aus Rice'])
ax1.set_xlabel('Production(hypothetical)')
ax1.set_ylabel('frequency')
ax1.grid()
plt.show()
plt.draw()
fig.savefig('Aush1.png', format='png')
fig.savefig('Aush1.pdf')
plt.close(fig)

fig,(ax2) = plt.subplots(1, 1, sharex=True, sharey=True)
ax2.plot(BRP0)
ax2.legend(['Production of the Aus Rice from previous experiences'])
ax2.set_xlabel('Year')
ax2.set_ylabel('Production(hypothetical)')
ax2.grid()
plt.show()
plt.draw()
fig.savefig('Aus0.png', format='png')
fig.savefig('Aus0.pdf')
plt.close(fig)

fig = plt.figure(figsize=(50,50), dpi=100)
fig,(ax2) = plt.subplots(1, 1, sharex=True, sharey=True)
ax2.hist(BRP0)
ax2.legend(['Histogram of the Aus Rice'])
ax2.set_xlabel('Production')
ax2.set_ylabel('frequency')
ax2.grid()
plt.show()
plt.draw()
fig.savefig('Aush0.png', format='png')
fig.savefig('Aush0.pdf')
plt.close(fig)


fig = plt.figure(figsize=(50,50), dpi=100)
fig,(ax1) = plt.subplots(1, 1, sharex=True, sharey=True)
ax1.plot(mu,pdf_mu)
ax1.legend(['Pdf of the mean of the Aus Rice production'])
ax1.set_xlabel('mean')
ax1.set_ylabel('probability')
ax1.grid()
plt.show()
plt.draw()
fig.savefig('Auspdf.png', format='png')
fig.savefig('Auspdf.pdf')
plt.close(fig)
```

Reference: 1. Time Series Analysis
-- James D. Hamilton
2. Wikipedia

Note: