

Rethinking about Determinants of Inflation in Ghana: Which Econometric Model Tell the True Story

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Abstract

This study examines the factors that influence inflation in Ghana over the sample period of 1965-2012, using the Bayesian Model Selection (BMS) techniques to address issues of model uncertainty. Using data from the world development indicators, the study found real output growth, population growth rate, broad money, exchange rate, lending rate and budget deficit as some of the key factors contributing to Ghana's inflation. The study recommends among others Bank of Ghana to adopt a low official interest rate as it has a transmission mechanism.

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Keywords: Bayesian Model Selection, Ghana, Inflation

1. Introduction

There have been lot of debate on the determinants of inflation in Ghana. This debate seems to have no conclusion at site due to the problems of uncertainty inherent in economic models used in previous studies to assess the cause on inflation in Ghana. In addition, there have not been any known empirical studies in Ghana that addresses the problem of model uncertainty.

Inflation is one of the problematic macroeconomic variables that occupy a central place in the management of most economies. Most empirical studies like Vinayathan (2013), Shahbaz (2013) and Bittencourt (2012) on the link between inflation and economic performance identify inflation to have a negative influence on a country's economic performance. The rate of inflation is considered very critical in many economies due to the fact that it mostly used as one of the indicators to determine a country's economic performance. Based on negative influence of inflation on economic performance, various governments adopted inflation targeting as the anchor of monetary policy to achieve price stability which form part of the Economic Recovery Programme and the Structural Adjustment Programme developed by the Bretton Wood institution for developing economies.

Both at the empirical and theoretical levels, economists have differed in their analysis of the causes of inflation. As a result, their prescribed solutions for inflation have also differed. Specifically, the debate about the causes of inflation is generally between the monetarists and the structuralists. The monetarists hold the view that sustained money growth in excess of the growth of output produces inflation (Meltzer, 2009). He argue that secular inflation cannot persist without a corresponding increase in the money supply over and above the growth in real output. In this regard, inflation can only be reduced by slowing down growth in money supply. The monetarists are of the believe that maintaining a stable price level through control of the money supply would take care of economic imbalances and rigidities that occur in developing countries.

The structuralists on the other hand assert that inflationary pressures can exist independently of monetary conditions. In their view, inflation is due mainly to supply rigidities in key sectors of the economy and so money supply is the effect, rather than the cause of inflation (Pennant-Rea & Emmont, 1990). The structuralists believe that the direction of causation runs from identified bottlenecks in different sectors of the economy to low output and then to rising prices and finally to increases in the money supply. For instance, bottlenecks in the agricultural sector have an adverse effect on food production, which results in an increase in the general prices of food. Cost of living then goes high and this in turn, leads to high money wages. Similarly, lack of foreign exchange in many developing countries leads to balance of payments deficits, which often results in currency devaluation and import restrictions. Such measures lead to an increase in the prices of imported goods and their substitutes and this has an adverse effect on domestic prices. An increase in the general price level then implies that the money supply has to be further increased since the inability to accommodate the price increase will have a negative impact on the recurrent and development expenditures. The structuralists suggest that to be able to run a modern economy at low inflation, governments need an income policy.

Chibber and Shaffik (1991) conducted study on the effects of bank and fund policy reforms on inflation in selected African countries using regression analysis and concluded that inflation in Ghana was, indeed, a monetary phenomenon. In the said study, they noted that devaluation led to a reduction in the rate of monetization and inflation implying that it has a positive impact on government budget.

Contrary to the above assertion, however, Dordunoo (1994) argues that rapid exchange rate depreciation and resultant increases in import prices are the main causes of Inflation in Ghana. Also, with the aid of error

correction model, Sowa (1996) estimated an inflation equation for Ghana and concluded that its inflation was influenced more by output volatility than monetary factors. The study, however, did recognize the significant of money supply on inflation. Again, using the bounds test and other econometric approaches, Adu and Marbuah (2011) concludes that real output, nominal exchange rate, broad money supply, nominal interest rate and fiscal deficit play a dominant role in the inflationary process in Ghana. They contends that while changes in money depend both on long-run disequilibrium and short-run changes in Ghana's inflation rate, there is no feedback causality from inflation to short-run changes in money.

Policy makers in Ghana might not have been able to keep inflation at desired rates because of their inability to determine the appropriate predictors of inflation and its nature. In this way, any policy prescription administered as an antidote would be ineffective once a wrong diagnosis of the problem has been made. Thus before any measures are taken to cure inflation, it is imperative that, policy makers take a proper diagnostic approach to determine the variables that establish a long-run stationary state relationship with inflation. According to Alnaa and Ahiakpor (2011), these variables could include interest rate, money supply, Gross Domestic Product (GDP) and the exchange rate. In this way, appropriate determination could be made taking into consideration the above mentioned variables for the right policy measures to be implemented.

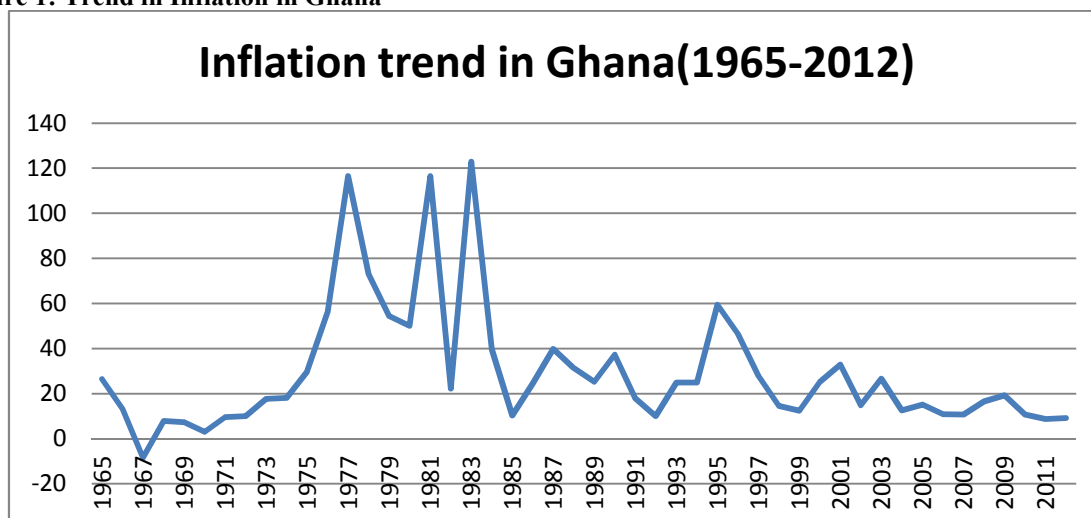
The fact has been established that most empirical studies on causes of inflation in Ghana use few independent variables. In addition, different conclusions are drawn from empirical studies on inflation depending on the model adopted. Therefore, for the Ghanaian economy, the question of the main causes of inflation remains an open question. This study therefore adopts the Bayesian model Selection (BMS) techniques to addresses the issue of model uncertainty associated with previous studies in determining the causes of inflation in Ghana. The contribution of this study is to provide essential variables relevant for the determination of inflation in Ghana from 1965 to 2012 in order to provide policy makers with an important tool that should inform policy. The rest of this paper is structured as follow. Sections 2 briefly present the inflation outlook in Ghana. Section 3 presents the methodology of the study. Section 4 presents Data, empirical results and discussion. Finally, section 5 supplies some concluding remarks.

2. Inflation outlook in Ghana

According to the World Bank (2012) report, policy inconsistencies by most Africa countries often made it difficult for them to achieve the targeted rates of inflation in their respectively countries, thus allowing their living standards at the devastating whims of inflation.

Ghana is one of the countries whose economy has suffered the devastating effects of high inflation during the late 1970s. Though the country chalked enormous success at keeping inflation very low during the early days of post independence, the rate of inflation rocketed very high between 1972 and 1983, rising up to 123% in 1983 (McKay and Sowah, 2004). Throughout this period till the introduction of the Economic Recovery Programme (ERP) and the Structural Adjustment Programme (SAP) in 1983, the rate of inflation still remained relatively high as presented in Figure 1. The inflation targeting policy contain in the ERP and SAP strategies saw the inflation rate of the country falling but was not sustained. This is because; no sooner had the country returned to democratic rule in 1992 than inflation soared in double digits, 28% by late 1994. Figure 1 shows the volatile nature of inflation trend in Ghana from the 1965 to 2012.

Figure 1: Trend in Inflation in Ghana



Ghana's experience of inflation is nothing good to write home about due to it fluctuating nature. The country's

taste of double digit inflation was in 1965. The reason for this was during the early 1960s, the country adopted the “big push” development strategy which centred on massive industrialisation with emphasis on import substitution. Most infrastructure facilities for the development strategy was finance from the public coffer and this pressure of the public coffers resulted in the country experiencing huge budget deficit, overvalue of the currency and balance of payment difficulties. Combinations of these factors saw the economy to be stagnated with inflation rising to double digit value. This was followed by a brief period of respite during 1967-71 when inflation was below 10%. From 1972 and the years forward, inflation kept soaring reaching 123% in 1983 as shown in Figure 1. This trend is also reported in empirical work of McKay and Sowa (2004). Inflation was particularly high and volatile in the political turbulent period of 1970s and early 1980, but has persisted fluctuated throughout the implementation of the Economic Recovery Period since 1983. According to Aryeetey and Harrigan (2000), inflation has a lot of far reaching effects like increasing the cost of investment and as a result creates a great disincentive to investment with its attendant multiplier impacting negatively on the economy. In addition, inflation is a problem because it lowers incomes, discourages saving, makes productive inputs more expensive and may act as disincentive to hard work, thereby leading to sub-optimal per person real output growth or economic development (Pennant-Rea and Emmont, 1990).

3. Methodology

The rationale of the BMS approach is that for a given linear model with large number of explanatory variables (k), there are 2^k possible models which can be obtained by the selection of explanatory variables. Appropriate models with high likelihood are obtained by averaging across the large set of models and selecting variables which are relevant to the data generating process for a given set of parameter and model priors used (Raftery et al., 1997 and Fernandez, Ley and Steel, 2001). Parameter and model sampling in the context of the BMA approach are conducted with the aid of Markov Chain Monte Carlo Model composition (MC^3). The MC^3 method is used to indicate which model should be considered in computing the sums of posterior model and parameter probabilities by identifying the model with high posterior probability.

Given a linear regression model with β_i parameters and $i=0,1,2,\dots,k$. With k explanatory variables $x_1, x_2, x_3, \dots, x_k$, the general form of the regression is

$$y = \beta_0 + \sum_{i=1}^k \beta_i x_i + \varepsilon \quad (1)$$

Given k explanatory variables, there is a possibility of 2^k models to be obtained with the different combination of explanatory variables. The posterior distribution of the parameters β_i , given the data D , is an average of the posterior distribution of parameters under each model with weights given by the posterior model probabilities expressed as

$$P(\beta_i / D) = \sum_{j=1, \beta_i \in M_j}^{2^k} P(\beta_i / M_j) P(M_j / D)$$

The posterior model probability, $P(M_j / D)$ is given by

$$P(M_j / D) = \frac{l_D(M_j) P(M_j)}{\sum_{h=1}^{2^k} l_D(M_h) P(M_h)}$$

Where $l_D(M_j)$ is the marginal likelihood of the model M_j which is expressed as

$$l_D(M_j) = \int p(D / \beta_i, M_j) p(\beta_i) p(\beta_i / M_j) d\beta_i$$

Where $P(D / \beta_i, M_j)$ represents the sampling model corresponding to Equation 1. $P(\beta_i / M_j)$ is a prior probability distribution assigned to the parameters of model M_j , and $P(\beta_i)$ is the improper non informative prior for the parameters that are common to all models. The Zellner’s g-prior is the preferred choice of prior structure for the regression parameters in most BMA applications. The common improper non informative g-

prior structure for $P(\beta_i)$ is often expressed as

$$P(\beta_i) \propto \sigma^{-1}$$

Where σ is a scale parameter which represents the standard error of the regression represented in Equation 1.

Nonetheless, Fernandez et al. (2001) proposes a g-prior for $P(\beta_i / M_j)$ and suggest that a uniform prior represented as $g = 1 / \max\{n, k^2\}$. The authors show that such a g-prior leads to reasonable results.

With regards to model probability prior $P(M_j)$, the proposed prior distribution in the literature of BMA refers to uniform distribution prior expressed as

$$P(M_j) = p_j, \quad j = 1, 2, \dots, 2^k \quad \text{with} \quad \sum_{j=1}^{2^k} p_j = 1$$

Following Leamer (1978), the estimated posterior means and standard deviations of $\hat{\beta}_i$, $\hat{\beta}$, are constructed as

$$E(\hat{\beta} / D) = \sum_{j=1}^{2^k} \hat{\beta} P(M_j / D)$$

$$V(\hat{\beta} / D) = \sum_{j=1}^{2^k} (Var(\hat{\beta} / D, M_j) + \hat{\beta}^2) P(M_j / D) - E(B / D)^2$$

4. Data, empirical results and discussion

A yearly data ranging from the period 1970 to 2012 are collected from World Bank Development Index (WDI, 2012). There are a total of 23 variables used in the model estimation, including the inflation as the dependent variable.

Appendix A present the descriptive statistics of the variables used in the study. The result shows that on average inflation 32% with a minimum of 3% and a maximum of 123%. In addition, the average deficit (% GDP) is about 55.19 % with the lowest being 18.36 % and the maximum percent of 129.6%. Also, the average GDP growth is 0.011 or 1.1% with a minimum of -10 % and a maximum of 14%.

The results of the BMS analysis reported in Table 1 are obtained with the model prior set to $\frac{1}{2^k}$, where $k = 25$, k is the number of explanatory variables included in the model. The prior probability of the regression coefficients are constructed by using the Bayesian Information Criterion (BIC) for all the models. Moreover, the MC3 sampling employed are based on taking 2000 draws, from which 1000 draws are discarded as burn-ins replications in order to obtain model and coefficient posteriors. Different model priors are used in order to obtain posterior parameter and model results. This is essential in order to ensure robustness and consistency of our results. Also, to check the robustness of the model, different model apriori were used. These models apriori are; uniform apriori, random model apriori. However, the changing of the model apriori as shown in Appendix B do not have any significant effect on the results giving indication that the final model used in the study is robust.

With the results presented on Table 1, the importance of the covariates in explaining inflation in Ghana is given by the Probability Inclusion Posterior (PIP) reported in the second column. The PIP shows the percentage of the model space wherein a covariate is included. The last two columns contain the posterior means and standard deviation for each regression parameters, averaged across models. With these results, there is certainty that real output, population growth rate, broad money, exchange rate, lending rate and budget deficit are among the key variables that explain accurately inflation in Ghana.

Moreover, there is a high degree of certainty that real output, population growth rate, broad money, exchange rate, lending rate and budget deficit have considerable impact in determining inflation, given the posterior inclusion probability and the statistical significance of their posterior means averaged over the model space. Nonetheless, the degree of certainty of variable inclusion in the model reduces for the rest of the variables.

It is important to note that the BMS analysis aim at assessing the degree of certainty or uncertainty of specific variables to explain another variable of interests, thus, determinants of inflation in Ghana in the case of this paper.

Based on the level of significance (at least 5% level of significance) of the covariates averaged across model, the results of the BMS analysis reported in Table 1 shows the importance of covariates such as real output,

population growth rate, broad money, exchange rate, lending rate and budget deficit are the key factors in explaining school inflation in Ghana. The negative sign of real output indicates the damaging effect. In addition, the positive sign associated with population growth, broad money, exchange rate, lending rate and budget deficit indicate that a reduction in any of these variables leads to a reduction in inflation and vice versa.

Table 1 Bayesian model averaging results

Variables	PIP	PM	PSD
Deficit (% of GDP)	0.849	3.093	1.894
Official exchange rate	0.442	85.194	129.419
GDP growth (annual %)	0.387	-6.088	9.827
Population growth (annual %)	0.316	0.420	0.859
GDP per capita growth (annual %)	29.9	-1.773	4.737
Lending interest rate (%)	0.283	1.264	2.547
Broad money (% of GDP)	0.213	0.001	0.105
External debt stocks (% of GNI)	0.210	0.001	0.121
Domestic credit to the private sector (% of GDP)	0.206	-1.934	8.154
Gross national expenditure (% of GDP)	0.177	0.065	0.191
Gross domestic savings (% of GDP)	0.175	0.038	0.206
Crop production index	0.170	-0.032	0.347
Deposit interest rate (%)	0.159	-0.032	0.347
Urban population growth (%)	0.158	0.168	1.780
Stock traded, turnover ratio (%)	0.154	-0.480	9.153
Labour force participation rate	0.150	0.161	0.678
Customs and other import duties	0.139	0.006	0.090
Infrastructure development	0.136	-0.443	1.845
Taxes on goods and services	0.127	-0.144	1.859
Taxes on profit, income and capital gain	0.123	-0.143	1.383
Current account balance (GDP)	0.112	1.018	9.516
Market capitalisation of listed companies (% of GDP)	0.104	-0.051	0.284
Mean no. Regressors	5.3175		
Draws	2000		
Burnins	1000		
No. of model visited	1127		
Corr PMP	0.5713		
Shrinkage-Stat	Av=0.9767		
Model space	2^K		
Model prior	Uniform		
g-prior	UIP		

Source: Author's estimation

From the result, the budget deficit of the country has a significant effect on inflation. This means that as the country's budget deficit increases, general prices of goods and services also increases leading to increase inflation. The coefficient of the budget deficit is positive, thus indicating that a direct link between the two variables. This is because budget deficit, which comes as a result of government overspending, increases GDP which in effect increases aggregate demand, especially, in the short-run where demand pull inflation sets in. In the long run, however if government spending increases in the long run, it leads to both demand-pull (due to excess demand) and cost-push (due to input prices) inflation. There has always been evidence (across countries) to prove that a strong positive relationship exist between budget deficit and inflation during high inflation episodes (Catao & Terrones, 2005). This study is consistent with Alavirad and Athawale (2005) who measured and investigated the impact of budget deficit on inflation in the Islamic Republic of Iran and found budget deficits, as well as liquidity to have positive impact on inflation. Also, Solomon and de Wet (2004) also studied the coexistence of a relatively high inflation rate and high fiscal deficits for a prolonged period for the economy of Tanzania and established that due to monetization of the budget deficit significant inflationary effects are found for increases in the budget deficit.

The lending rate in the country is significant and positively influences the level of inflation in Ghana. This means that an increase in the lending rate increases the cost of capital which also implies that the cost of doing business increases. Increase in the cost of doing business will increase the cost of production which is also passed on to consumers in the form of increased prices. This finding is in line with the work of Catao and Terrones (2001) who were of the view that lending rates play an important role in the economy because they affect the demand for goods and services through borrowing costs. To them, changes in lending rates affect the public's demand for goods and services mainly by altering borrowing costs, the availability of bank loans, the wealth of households, and foreign exchange rates.

In addition, exchange rate is also found to influence positively the rate of inflation in Ghana. This means that increase in exchange rate in other words depreciation of the cedis would result in increase cost of imported goods and services. Another channel through which inflation is affected by exchange rate is through the import of raw material for the production of service by producers. The increased cost of production due to the depreciation in the exchange rate would eventually result in the increase in the general price level, hence inflation. The findings from the study is in conformity with the work of Alnaa and Ahiakpor (2011) who stated that lack of foreign exchange in many developing countries leads to balance of payments deficits, which often results in currency devaluation and import restrictions. Such measures lead to an increase in the prices of imported goods and their substitutes and this has an adverse effect on domestic prices. Dordunoo (1994) also conclude that rapid exchange rate depreciation and resultant increases in import prices are the main causes of inflation.

From the result in Table 1, broad money has been found to be significant and positively correlated with inflation. This is because increases in the currency in circulation in the economy leads to more money in the pockets of people which results in excess aggregate demand in the economy. Excess demand for goods and services results exerts an upward pressure on the prices of goods and services. The finding of this study confirm the works of Dwyer and Fisher (2009), Rolnick and Weber (1997) and Moroney (2002) who use different methodologies and data to study the link between inflation and broad money growth and found a positive correlation between the two variables.

Also, the rate of population growth is found to be significant and positively related inflation in Ghana. An upsurge of population figures in the country has the potential of increasing the aggregate demand for goods and services produced in the economy. This increase in the aggregate demand also generates demand-pull inflation. This is supported by the finding of (Schnepf, 2013) that even at the global level it has been said that world population growth all raises the specter of food price inflation and generate many questions about farm and food price movements. Again, Faria and McAdam, (2012) unveiled a relationship between inflation and population growth, in which inflation grows with population (a scale effect) and decreases with population growth (a growth effect). They concluded, also, by stating that when it comes to Standard, inflation is a population phenomenon.

The result from the study also reveals that real output is significant and inversely related to inflation. This shows that increases in the output levels leads to lower inflation. Once real output increases it implies an increase in the incomes of workers in general, which gives them additional purchasing power. This additional income leads to excess demand which in the end exerts an upward pressure on price levels in the economy. The finding is in conformity with the work of Mallik and Chowdhury (2001) who look at the relationship between inflation and GDP growth for four South Asian countries (Bangladesh, India, Pakistan, and Sri Lanka) and found evidence of a long-run negative relationship between GDP growth rate and inflation for all four countries.

5. Concluding comments

The main aim of this study was to address the issue of model uncertainty associated with previous studies in determining inflation in Ghana by adopting the Bayesian model selection technique as well as carrying out the empirical studies over a longer sample period of 1970-2012. Population growth rate, broad money, exchange rate, lending rate and budget deficit are found to be significant and positively related and real output growth also significant and negatively related to influencing inflation as suggested Kergozou and Ranchhod (2013), Umoru and Oseme (2013), Nenbee and Dubon, (2009) Catao and Terrones (2005) and Mallik and Chowdhury (2001)

To promote price stabilisation in the economic, the Bank of Ghana who need to adopt a low official interest rate as it has a transmission mechanism. The adoption of the low official interest rate turns to affect the spending, saving and investment behaviour of individuals and firms in the economy. For example, other things being equal, higher interest rates tend to encourage saving rather than spending, and a higher value of sterling in foreign exchange markets, which makes foreign goods less expensive relative to goods produced at home. So changes in the official interest rate affect the demand for goods and services produced in Ghana.

In addition, government should provide the legal environment for efficient allocation of credit to the private sector through the adoption of reforms to strengthen creditors' rights and enforce commercial contracts and establish incentive frameworks that will encourage domestic savings and investment which will result in output productivity of the country. Any future research on this issue should consider the possibility of exploring the TVP-VAR model in order to cater for time variations.

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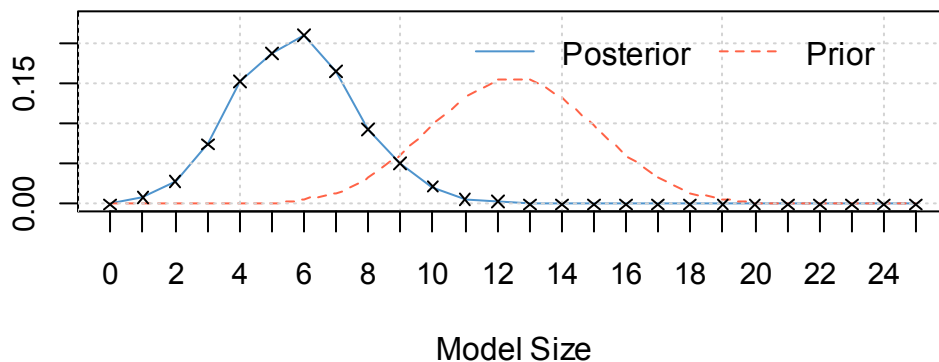
APPENDICES

Appendix A: Descriptive statistics of the variables

Variable	Mean	Std. Dev.	Min	Max
inflation	32.21	28.95	3.00	123.00
Growth growth	0.01	0.16	-1.00	0.14
Current account balance (% GDP)	5.48	1.01	3.91	6.94
Deficit (% of GDP)	55.98	31.34	18.36	129.61
Labour force participation rate	51.49	4.73	48.11	69.40
Broad money (% of GDP)	37.76	13.79	11.13	68.53
Population growth (annual %)	2.58	0.40	1.60	3.48
Government expenditure	12.55	5.62	4.30	27.61
Infrastructure development	0.68	0.45	0.29	1.66
Urban population growth (%)	38.76	7.60	29.19	52.52
Taxes on profit, income and capital gain	8.05	2.41	4.52	12.21
Crop production index	60.31	31.42	25.44	128.12
Domestic credit to the private sector (% of GDP)	7.92	4.90	1.54	16.12
Market capitalisation of listed companies (% of GDP)	13.77	6.12	1.15	34.33
Deposit interest rate (%)	18.12	6.84	9.00	36.00
Lending interest rate (%)	20.93	1.35	19.00	26.00
Official exchange rate	0.31	0.52	0.00	2.00
Gross domestic savings (% of GDP)	12.33	5.45	4.26	26.46
Stock traded, turn over ratio (%)	0.44	0.21	0.08	1.38
Taxes on goods and services	3.21	1.12	1.08	7.55

Appendix B: Results of different model aprior

Posterior Model Size Distribution
Mean: 5.7725



Posterior Model Probabilities
(Corr: 0.2735)

