

The effect of Islamic Finance on Inflation Behavior using a Bayesian Log-linear Model

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Abstract

This paper focused on developing a model to study the effect of Islamic finance on the inflation rate in top Islamic finance economies at 2012. For this purpose, as the available sample size is small, a Bayesian approach to regression model is used which contains key supply and demand side factors in addition to the ratio of Islamic finance assets to GDP as potential determinants of inflation rate. In the suggested model, inflation rate variable shows an apparent right skewness and the efficiency of log transformation for this variable is confirmed via Box-Cox approach. To give Bayesian estimators of the regression parameters, we have implemented an MCMC approach including 100,000 iterations in the WinBUGS software. The results show that Islamic finance is a significant determinant of inflation in selected Islamic countries in which its increase could decline the rate of inflation in the corresponding country. Also the Bayesian estimation of the other parameters shows that, although increase of money growth and exchange rate growth lead to higher inflation rates, increasing GDP growth decline the inflation.

Keywords: Islamic Finance Assets, Inflation Rate, Bayesian Approach, Log-Linear Regression.

1. Introduction

Management of the annual price level changes within a country, known as the inflation rate, is one of the important economic issues for policy makers. Actually there are a large number of researchers trying to recognize key determinants of inflation in different countries. From the economic perspective, these determinants have been categorized to supply side, demand side and structural factors. Supply side factors are those economic factors which cause inflation by increasing cost of the production. Some important supply side factors include output growth, capital formation, oil and import prices, tax and wage levels, and exchange rate. Demand side factors lead to higher inflation via creating more buying requests for goods and services in the country.

Some important demand side factors are money growth, private consumption expenditure and government consumption expenditure. On the other hand, every factor which leads to inflation by deepening the distance between supply and demand in the economy categorize in the structural factors of inflation. Inelasticity of supply, rigidity in government expenditure and inability of financial system to absorb savings and lead them into the production, are important structural factors which create inflation in an economy.

In this paper we try to examine the relationship between Islamic finance as a structural factor and inflation to see whether the Islamic finance is capable to reduce inflation by absorbing and managing domestic savings. For this purpose, we have chosen top 15 largest Islamic finance economies and construct a Bayesian linear regression model to examine the most important inflation determinants in these economies.

There are a vast number of researches which generally try to find inflation determinants which some are reviewed in what follows. In 1997, Campillo and Miron examined the determinants of country-level inflation rates for a sample of sixty-two countries during the period 1973-94. They found out that prior inflation experience plays an important role in inflation performance. As another result, they showed that economic fundamentals, such as openness, political instability, and tax policy have large effects in determining inflation rate. Also, Mohanty and Klau (2001) studied the determinants of inflation in emerging economies. They used the quarterly changes in the variable data in 14 emerging countries during the 1990s. They found out that the output gap, money supply and wage level as well as some supply side factors like exchange rates, import price and oil price have a significant influence on inflation. Hammermann and Flanagan (2007) used a panel data analysis for 19 transition economies, during 1995 to 2004. Their model suggests that a central bank's incentive towards higher short-run inflation is a key reason for observed outcomes. Also, unanticipated shocks to supply and demand are important determinants of cross-country inflation. Kandil and Morsy (2009) studied the determinants of inflation in Gulf Cooperation Council during the period 1970 to 2007. For this purpose, they used two domestic factors, government spending and the money supply, and two external factors, nominal effective exchange rate and a weighted average of price in major trading partners. They found out that in both short run and long run, the inflation rate in major trading partner is the most relevant factor.

On the other hand, some researchers tried specifically to examine the effects of financial system on Inflation. Among them, Zaman et al. (2010), Using a VAR model, examined the relationship between financial development, growth and inflation in Pakistan during 1974-2007. The results show that there is just a unidirectional relationship from inflation to financial development in Pakistan both in the long-run and short-run. Also recently, Damian (2012) used the monthly data during 2007 to 2011 to examine the effects of financial crisis to inflation rate in Romania. The results show that the vulner-

ability of financial system during the financial crisis period has a positive effect on inflation rate.

Finally some Islamic economists focused on the role of Islamic banking and finance in controlling Inflation. Hasin and Majid (2011) analyzed the role of Islamic banks in the monetary transmission mechanism in Malaysia. They used ARDL model by quarterly data from 1991 to 2010 and showed that the same as conventional banking, Islamic banking system in Malaysia could be considered as a channel for monetary transmission mechanism. Shahzad et al. (2012) in a conceptual framework tried to show that Islamic financial system has the ability to put inflation at zero level. The authors assert that Islamic economic and financial system by real sector of economy supports money creation process and so this process does not lead to inflation. Sarwer et al. (2013) used interview method to analyze the effects of Islamic banking on the economic development of Pakistan. According to the results, Islamic banking could be more convenient for economic development in Pakistan. Ayuniyyah et al. (2013), using VAR and VECM models tried to examine the effects of Islamic banking on Inflation and output in Indonesia during 2004 to 2009. In this paper, authors had used the monthly data of industrial production index, consumer price index as representatives for output and inflation and used the monthly data of total Islamic deposits, total Islamic financing and some other variables for showing Islamic Banking performance in Indonesia. Their results show that although all Islamic banking variables are important determinants of output, but there is no significant relationship between Islamic banking variables and inflation in Indonesia.

All above reviewed literature, focused just on one Islamic country and examined just the effect of Islamic finance on Inflation. Actually, it seems that among current literature, there is no comprehensive study including Islamic finance factor in addition to key supply and demand side factors to study inflation determinants of important Islamic finance economies. In this paper, since the sample size is small (as a result of few number of countries with considerable Islamic finance and unavailability of some supply and demand side factors for those countries), we will propose a Bayesian linear regression model, which is preferred over the likelihood approach for small sample sizes, to examine Islamic finance in addition to key demand and supply side factors on the inflation rate in top 15 largest Islamic finance countries. Also, using some graphical and inferential devices, the need for a logarithmic transformation seems necessary for the original inflation rate variable to make its distribution symmetric. In our proposed model, output growth and exchange rate are included as the supply side factors, money growth is the key demand side factor and the ratio of Islamic finance assets to GDP entered to analyze the effect of Islamic finance, as a structural factor, on inflation. An important characteristic of our proposed model is that the inflation rate at 2012 is regressed on the supply and demand side factors of 2011 to allow more predictability power for the upcoming year inflation.

The rest of the paper is organized as follows. The description and the exploratory analysis of the Inflation data are given in Section 2. Section 3 presents the Bayesian model structure and framework including its prior and posterior distributions to be used for parameter estimation. The proposed model will be applied to the inflation data in Section 4. Also the posterior point estimation of the parameters along with the graphical and numerical goodness of fit summaries of the model are presented in this Section. Finally, Section 5 includes some concluding remarks and possible further works.

2. Data Description

Since the main purpose of this paper is analyzing the effect of Islamic finance on inflation rate, we have chosen the top 15 largest Islamic finance economies based on the Islamic Finance Development Report (2013). Figure 1 shows the amount of Islamic finance assets in the selected countries at 2012 which are acquired from the mentioned report. The other variables dealing with in this paper are extracted from the World Bank Data Bank (Available at: <http://databank.worldbank.org>).

We have used the annual changes in the Consumer Price Index (CPI) of each country at 2012 as the Inflation Rate variable denoted by π now on. For the possible predictors of the inflation rates of the selected Islamic countries, we have chosen the most important demand side and supply side factors to cover both demand pull and cost push inflation, in addition to the Islamic finance as a structural factor. We have used money growth at 2011 as a demand side factor and gross domestic product and exchange rate at 2011 as key supply side factors. Table 1 gives some brief descriptions and notations for these variables that will be used in the data analysis. It should be mentioned that since the inflation rate as a dependent variable has a nature of year to year growth, we have also used all the independent factors in the growth form (or annual changes). Also for the Islamic finance assets data, we have used the ratio of Islamic finance assets of each selected country in 2012 to the current GDP of that country in 2012.

2.1. Exploratory Data Analysis

To assess the potential effect of the above introduced explanatory variables on the inflation rate response variable of the selected Islamic countries at 2012, we should examine the marginal association structure between each variable and the interesting response variable. It should be noticed that two of countries (Switzerland and United Arab Emirates) are excluded from the sample due to unavailable INF variable which leads to a sample of 13 selected Islamic countries for further analysis.

1. Islamic Corporation for the Development of the Private Sector (ICD) and Thomson Reuters, available at: www.icd-ibd.org.

Figure 2 presents histogram of INF variable along with the curve of estimated density function which indicates a non-ignorable right skewness and the need for some transformation to make the distribution of this variable symmetric. This high skewness is a

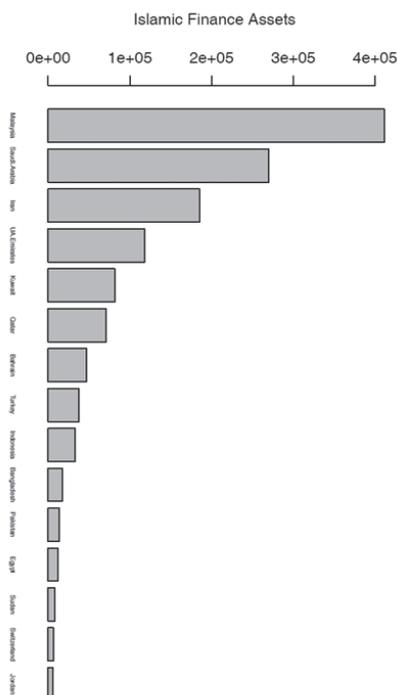


Figure 1: Islamic finance assets in the selected countries at 2012

Table 1: description and notation for the economic factors

Notation	Stands for	Description
<i>MG</i>	Money Growth	Annual changes in the volumes of money and quasi money in each country.
<i>ER</i>	Exchange Rate growth	Annual changes in the currency value per US dollar in each country.
<i>GDP</i>	Gross Domestic Product growth	Economic Growth; Annual changes in the constant price level of gross domestic product in each country.
<i>IFAG</i>	Islamic Finance Assets to GDP	Total Islamic finance assets divided by GDP.

result of large number of Islamic countries with less inflation rates and a few number of Islamic countries with high inflation rates which fall in the right tail of the distribution. As was illustrated in Figure 2, the INF variable is a rightly skewed variable which need some appropriate transformation to make its distribution symmetric. To study the appropriate transformation needed for INF, one can use the Box-Cox parametric power transformation proposed by Box and Cox (1964) to reduce anomalies such as non-additivity, non-normality and heteroscedasticity. This family of power transformations is defined for positive variable, as:

Figure 3 shows the profile log-likelihood plots of the INF variable for the parameter of the Box-Cox power transformation,. According to this plot, we can choose the logarithm transformation for the INF variable as the confidence interval is centered around zero value. Now we study the relationship between different potential factors, which were described in the previous subsection, and the interesting dependent variable. Figure 4, 5, 6 and 7, respectively shows bivariate scatter plot of explanatory variables, GDP, MG, ER and IFAG versus logarithm of INF variable. Also each Figure includes the marginal box plot of variables in the scatter plot axis along with the fitted simple linear regression line.

$$Y_i^{(\lambda)} = \begin{cases} \frac{(Y_i^\lambda - 1)}{\lambda} & \text{if } \lambda \neq 0 \\ \log(Y_i) & \text{if } \lambda = 0 \end{cases}$$

where λ is an appropriate number which maximizes the profile log likelihood of $Y^{(\lambda)}$.

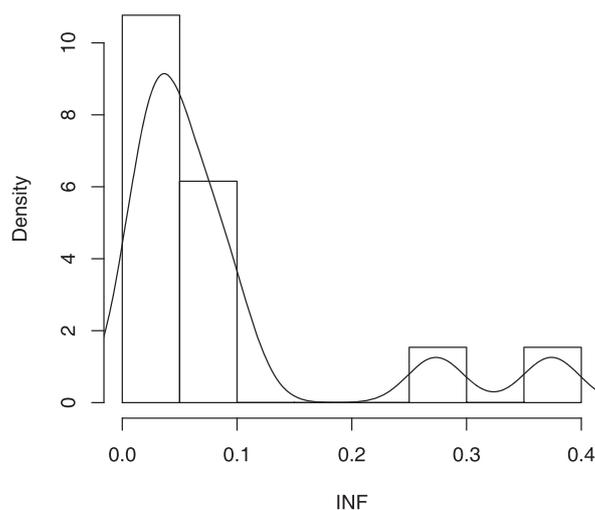


Figure 2: Histogram of INF variables across 2008:2012 years

Figure 8 illustrates the correlation matrix for the set of all interesting variables, where the association strength is illustrated via colors. Actually darker colors mean larger absolute value of correlation. According to this Figure all explanatory variables are considerably correlated with the INF variable. Also, some low correlations exist between explanatory variables of interest.

3. The Bayesian Linear Regression Model

Normal regression models are the most popular models in statistical science. They are based on the initial work of Sir Francis Galton in the late years of the 19th century

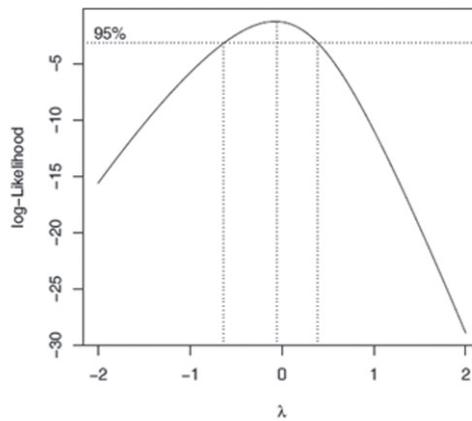


Figure 3: Profile log-likelihood plots of the INF variable for the parameter of the Box-Cox power transformation, λ

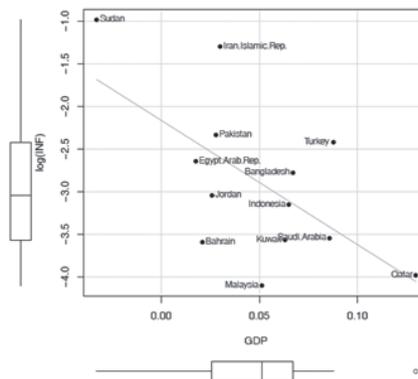


Figure 4: Scatter plot of $\log(\text{INF})$ versus GDP for Islamic Countries

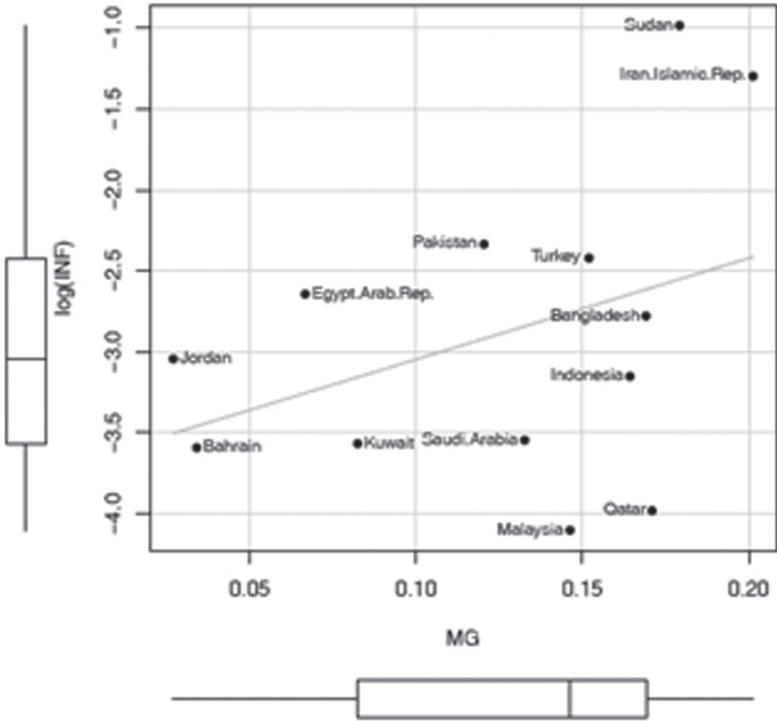


Figure 5: Scatter plot of log (INF) versus MG for Islamic Countries

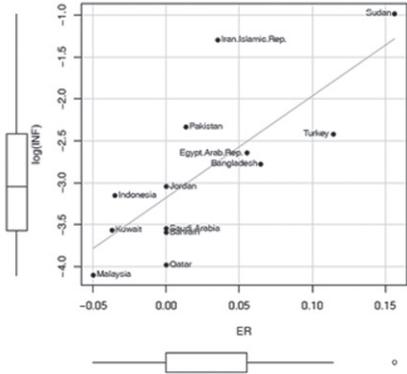


Figure 6: Scatter plot of log(INF) versus ER for Islamic Countries

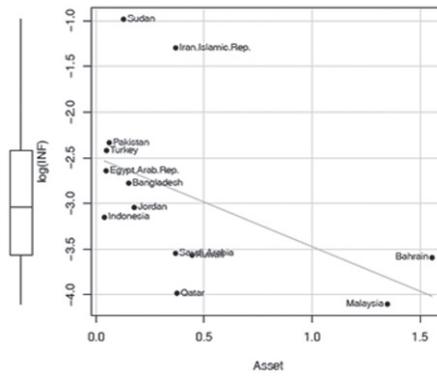


Figure 7: Scatter plot of log (INF) versus IFAG for Islamic Countries

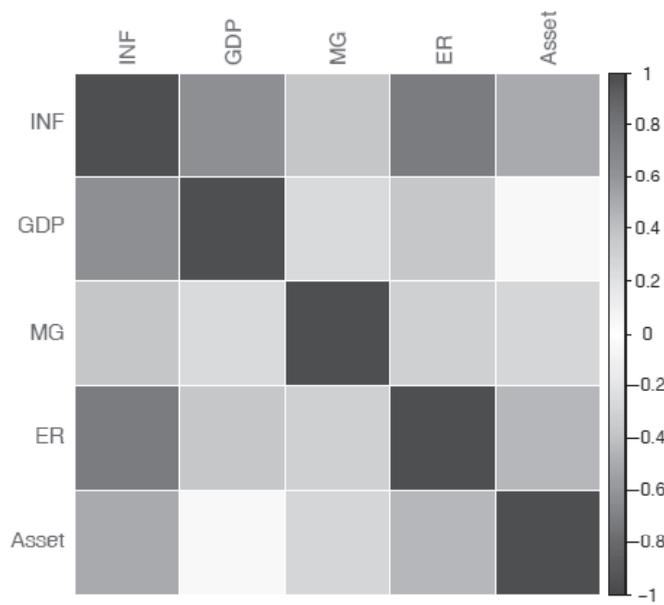


Figure 8: Correlation Matrix of the set of explanatory variables and response variable

(Stanton, 2001). In normal regression models, the response variable is considered to be a continuous random variable defined in the whole set of real numbers following the normal distribution with the mean parameter as a function of explanatory variables and some regression coefficients. To analyze the effect of the potential explanatory variables on Log (INF), we will apply a Bayesian regression approach which is recommended and preferred over likelihood approach when the sample size is small. let us assume the following distribution and model equation for the INF response variable:

$$\begin{aligned} \text{Log}(INF_c) | X &\approx N(\mu_c, \sigma^2), \quad c = 1, \dots, 13 \\ \mu_c &= \alpha_0 + \alpha_1 IFAG_c + \alpha_2 MG_c + \alpha_3 ER_c + \alpha_4 GDP_c \end{aligned} \quad (1)$$

where σ^2 and $\alpha = (\alpha_0, \alpha_1, \dots, \alpha_4)$ are the set of regression parameters under estimation. Also, c denotes the index for the set of 13 Islamic countries available in the sample. In normal regression models, the popular approach is to assume that all parameters are a priori independent having the structure:

$$\begin{aligned} \pi(\alpha, \tau) &= \prod_{j=0}^4 \pi(\alpha_j) \times \pi(\tau) \\ \alpha_j &\approx N(\mu_j^\alpha, \sigma_j^2), \quad \text{for } j = 0, \dots, 4 \\ \tau &\approx \text{Gamma}(a, b), \end{aligned}$$

where $\tau = 1/\sigma^2$ and the gamma prior used for τ corresponds to an inverse gamma prior distribution for the original variance parameter, σ^2 , with prior mean and variance given by,

$$\begin{aligned} E(\sigma^2) &= \frac{b}{a-1} \\ \text{var}(\sigma^2) &= \frac{b^2}{(a-1)^2(a-2)} \end{aligned}$$

When no information is available, a usual choice for the prior mean, μ_j^α is the zero value. This prior choice centers our prior beliefs around zero, which corresponds to the assumption of no effect of explanatory variables, on the response and express our prior doubts about this relationship. The prior variance σ_j^2 of the effect α_j , is set equal to

a large value to represent high uncertainty or prior ignorance. Similarly, for τ we use equal low prior parameter values a and b , setting in this way its prior mean equal to one and its prior variance large. Actually, we use the following low informative prior distributions for the vector of model parameters:

$$\alpha_j \approx N(0,1000), \quad j = 0, \dots, 4, \quad \tau \approx \text{Gamma}(0.01, 0.01) \quad (2)$$

where it is assumed that $\sigma_j^2 = 10^3$ to show uncertainty about the value of α_j . Also we have assumed $a = b = 0.01$ which results in $E(\tau) = 1$ and $V(\tau) = 100$. Hence the posterior function of the vector of parameters $\Theta = (\alpha, \sigma^2)$, would be:

$$\pi(\Theta | \text{Log}(INF), X) = \frac{L(\Theta | \text{Log}(INF), X) \times \pi(\Theta)}{\int_{\Theta} L(\Theta | \text{Log}(INF), X) \times \pi(\Theta) d\Theta},$$

where the likelihood function is defined as follows,

$$L(\Theta | \text{Log}(INF), X) = \frac{\exp\left(-\sum_{c=1}^{13} \frac{(\text{Log}(INF_c) - mu_c)^2}{2\sigma^2}\right)}{\sigma \sqrt{2\pi}},$$

and the integral in the denominator is a 6 dimensional integral over elements of Θ .

4. Results of The Model Estimation

To obtain numerical results of parameter estimation for the previously mentioned model we have implemented an MCMC approach in the WinBUGS software (Ntzoufras, 2009; Spiegelhalter et al. 2003; Gilks et al. 1996). Table 1 presents the results of the Bayesian parameter estimation for the parameters in equation 1. To draw inferences, we have performed the iterative Gibbs sampling procedure in 100,000 iterations, ignoring the first 90,000 iterations as burn-in to get closer to the convergence, so that the inferences about the model parameters are obtained using 10,000 remaining iterations. We use the posterior mean of each parameter as its estimate and the sample standard deviation as the estimated standard deviation of the parameter of interest. Also to examine if the posterior simulations of the model

parameters have been stabilized, Figure 9 and Figure 10 have been plotted using posterior summaries of the model parameters in the last 10,000 iterations.

Table 2: Results of Bayesian Parameter Estimation of Inflation data (significant codes at 0.05).

Par.	Posterior Mean	S.D
<i>Intercept</i>	-2.81 *	0.38
<i>IFAG</i>	-0.57 *	0.29
<i>MG</i>	5.10 *	2.51
<i>ER</i>	5.13 *	2.66
<i>GDP</i>	-12.54 *	3.56
σ	0.43 *	0.12

Actually, Figure 7 plots out the running posterior mean in the last 10,000 iterations, with 95% confidence intervals against iteration number and Figure 8 illustrates the trace plots of the posterior sample values versus iteration for different model parameters. These plots show that for the last 10,000 iterations of the MCMC procedure, the posterior sample values and their means for all the model parameters have a stable state with no considerable fluctuations which means that the chain has been converged acceptably. Figure 11 plots a smoothed kernel density estimate for each parameter. As is expected the posterior density for the regression coefficient are bell shaped and normal and the density for the variance looks like an inverse gamma distribution.

To assess goodness of fit for the suggested model, we could estimate the Bayesian counterpart of coefficient of determination (the well known R^2). We know that the precision parameter, τ (and the variance σ^2), indicates the precision of the model. If the precision τ is high (σ^2 low), then the model can accurately predict (or describe) the expected values of the response variable. Therefore, we can rescale this quantity using the sample variance of the response variable, namely, s_y^2 , using the R_b^2

statistic given by

$$R_B^2 = 1 - \frac{\tau^{-1}}{s_Y^2} = 1 - \frac{\sigma^2}{s_Y^2}$$

This quantity can be interpreted as the proportional reduction of uncertainty concerning the response variable achieved by incorporating the explanatory variables in the model. The results of model fitting leads to $R_B^2 = 0.78$.

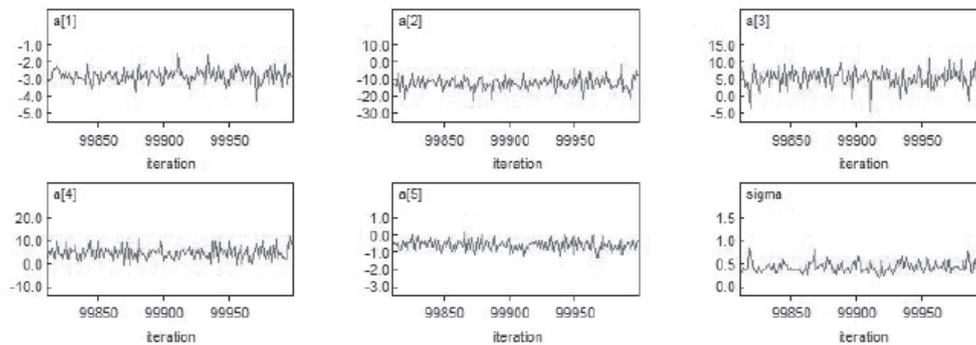


Figure 9: Trace plots of the posterior sample values against iteration number

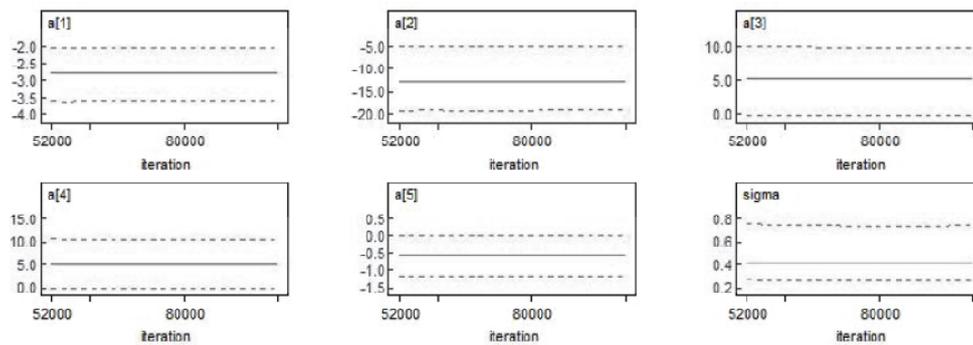


Figure 10: Runin posterior mean with 95% confidence intervals against iteration number

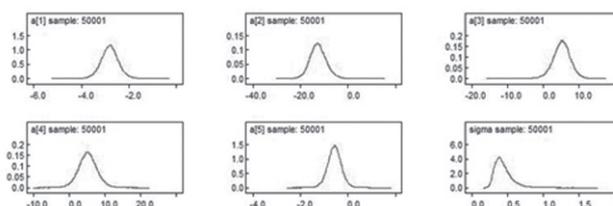


Figure 11: smoothed posterior kernel density estimate for the parameters

To check the independence assumption for the residuals, we have calculated the Durbin Watson statistic and its Bayesian P-value, which indicates:

$$DW = 1.94, P - Value = 0.29$$

and accepts the independence assumption. Also examination of the standard residuals show that all of them are included between -2 and 2, so that there is no outlying observation. According to the results of this table, when MG increases by 1 percent, the expected value of Inflation will be multiplied by (1+0.05) or the value of inflation will be increased by 5 percent of the original value. Also a 1 percent increase in ER variable has to some extent the same effect as MG on the INF response variable. In contrast, the results illustrate that increase in GDP and IFAG will be followed by a lower average inflation rate value. Actually 1 percent increase in GDP growth or the ratio of Islamic finance assets to GDP, respectively would decline INF value by 12.5 or 0.6 percent of the original INF value. The results presented in Table 1 lead to the following economic interpretations:

- As the results of suggested model indicate, Islamic Finance is a significant determinant of inflation in the selected Islamic countries. In fact, when its ratio to GDP increases, the inflation rate would decline. This shows that, Islamic financial system in the selected countries, as a structural factor, has been successful in directing people's savings into production process.
- The fitted model suggests that money growth is one of the most important determinants of inflation in the selected Islamic countries. This finding confirms the famous Friedman expression, "Inflation is always and everywhere a monetary phenomenon" (Friedman, 1963). So for inflation management in Islamic countries, similar to other countries, a sound monetary policy is required.
- The results show that in Islamic countries, to some extent, inflation could be controlled by GDP growth. It means that in the selected Islamic countries, increasing domestic product could decline inflation rate

- The model suggests that in the selected Islamic countries, exchange rate growth is an important determinant of inflation. According to the results, increasing the exchange rate growth or currency devaluation in the selected countries lead to an increase in inflation.

5. Conclusion

Inflation is one of the most important macroeconomic variables which affect on all policy making measures. This fact pushed many researchers to work on the recognition of main inflation determinants. These determinates are often categorized in demand side, supply side and structural factors. One of the main structural factors that affects on inflation is inability of financial system to absorb and direct people's savings into production process. In this way, instead of going through investment and production, people tries to buy more goods and services with their money and, especially in a case of inelastic supply, this will intensify the distance between demand and supply which deepen the inflation phenomenon. In contrast, efficient financial system will decline the inflation rate in the economy by leading savings into investment and production.

Here, one of the main questions is that whether the Islamic finance has been successful in directing money to investment and controlling the inflation in Islamic countries. This paper tried to construct a comprehensive model which considers simultaneous effects of Islamic finance and some key demand and supply side factors on the inflation rate in 15 largest Islamic finance assets economies. Since the sample size in the study is small (due to the few number of countries with considerable Islamic finance and unavailability of some supply and demand side factors for Islamic countries), the Bayesian regression model have been chosen for this purpose.

In this model, the annual change of consumer price index in selected Islamic countries at 2012 is considered as the dependent variable. Using some graphical and inferential devices, the need for a logarithmic transformation seems necessary for the original inflation rate variable to make its distribution symmetric. The predictors of the model consist of money growth as key demand side factor and exchange rate growth and GDP growth as key supply side factors all extracted for 2011. We have also considered the ratio of Islamic finance assets to GDP of selected Islamic countries at 2012 in the model as a predictor which shows the development of Islamic finance in the corresponding country.

What makes this study different from the previous similar studies are three points: 1) this study used all important countries which apply Islamic finances, to analyze the effect of Islamic finance on inflation while the previous researches only focused on one country. 2) Our proposed model considered key demand and supply side factors in

addition to the Islamic finance but the previous researchers mostly examined only the effect of Islamic banking and finance on inflation. 3) Since the sample of important economies who use Islamic finance is small we used the Bayesian approach for constructing the inflation model for these countries but all previous researches had used popular likelihood approach which is reliable in the case of large sample sizes. To give Bayesian estimators of the regression parameters, we have implemented an MCMC approach including 100,000 iterations in the WinBUGS software. The goodness of fitted model is also accepted using some graphical and numerical Bayesian summaries. Particularly, the Bayesian counterpart of R-squared statistic for the suggested model is around 80 percent which means that the selected predictors could explain about 80 percent of the variation in inflation dependent variable. Also the estimation results suggest that Islamic finance is a significant determinant of inflation in selected Islamic countries. Actually one percent increase in the ratio of Islamic finance to GDP will decline the inflation by 12.5 percent of its original value. This result confirms that the Islamic financial system in the selected countries could efficiently use by policy makers for controlling the inflation rate. On the other hand, money growth, as a key demand side factor, affects the inflation in the selected countries positively in a way that one percent increase in money growth will increase the inflation level by 5 percent of its original value. According to the estimation results, GDP growth and exchange rate growth are the other significant determinants of inflation where one percent increase in each of them will respectively decline inflation by 0.6 percent and increase inflation by 5 percent of its original value.

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