Determinants of Private Investment in Iran based on Bayesian Model Averaging

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Abstract
Due to the importance of investment as one of the determinants of the economic growth, in this study, the effects of 19 explanatory variables on private investment and their ranking in Iran's economy will be examines by Bayesian Model Averaging (BMA) approach. The results show that the growth of capital imports (by probability of 1) and the growth of GDP (by probability of 0.68) are the most important factors variables in investment equation. The variable of the ratio of companies' taxes (by probability of 0.50) comes the second- ranked. Nominal variables such as inflation rate, money growth and the ratio of bank credits to the private sector to Non-oil GDP don't have much of importance in private sector investment. Moreover, interest rates and tax rate doesn't have important effect on investment developments during the sample period.

1-Introduction
The experience of successful developing countries shows that investment has a pivotal role in economic growth in these countries.Some economists argue that when studying investment in developing countries, special features not accounted for in traditional theories of investment should be considered. Agénor and Montiel list six of those factors (1999, P. 97-99). First, financial variables may influence private investment because of underdeveloped financial systems and financial repression. Second, foreign exchange rationing and the

exchange rate in the free market may influence investment decisions because of the importance of imported capital goods. Third, due to their importance in the production process in developing countries, imported intermediate goods should be taken into account in the specification of relative prices. Fourth, debt overhang inhibits investment because of the possibility of higher taxes to finance future debt service. Fifth, public investment has played an important role in the process of capital formation in developing countries. It may have a positive or negative effect on private investment depending on whether public investment is complementary to or a substitute for private investment. And sixth, macroeconomic instability and its resulting uncertainty, which have characterized developing countries, may have an important effect on private investment.

Besides, Iran's economy is heavily dependent on Foreign exchange revenues from the sale of a massive resource of oil and its price volatility and other economic instability and thereby increasing risk of investment has significantly affected the process of forming the capital.

In experimental and theoretical studies, a very range of variables are considered as determinants of investment.

In this study, we are going to assess the effect of three factors including internal environment variables (such as production growth, the share or structure of economic sectors in production and business cycles), external environment variables (like oil exports and import) and price and monetary variables (Like rate and the amount of credit, exchange rate and inflation) on investment changes in Iran's economy estimates and significance of each rating should be evaluated.

The experts of econometrics have always been facing uncertainty to select the correct variable and the correct model (the type and proxy of variables). Based on theory, a very range of variables including the price, structural variables (like the share of each sector), trade (like the export and import) and scale variables (like production) effect investment.

While we can`t include all these variables in usual economic analysis methods, researchers use a restricted combination of variables in model based on theory and taste. "Bayesian Averaging Model" has been developed to resolve this problem in literature of Bayesian econometrics. This method not only overcomes the uncertainty to choose the effective variables but also solve the problem of uncertainty to choose the optimum model.

In this article we address the problems of uncertainty to choose the model and estimates with methods of "Bayesian averaging model (BMA)" and do a precise and comprehensive study about the effects of factors influencing the investment in Iran's economy.

Section 2 presents a brief review of theoretical and empirical literature on investment. Section 3 provides the empirical results of the study and we conclude in section 4.

2- Theoretical Literature

Several studies in the field of investment and factors affecting on it have been done. Many of these studies focus on FDI. In the following we refer to a number of studies in this field.

Table (1): Empirical Studies

The Researcher(s)	The Subject	The Data	The Results

Table (1): Empirical Studies

Arbeláez & Ruiz (2012)	Macroeconomic antecedents to U.S. investment in Latin America	-	This study investigates the antecedents of U.S. FDI into Latin American countries, while paying special attention to the relationship between trade agreements and FDI inflows. This study also investigates concern for the foreign exchange market as a source of uncertainty to FDI. The empirical investigation uses a fixed effects panel data model to maximize degrees of freedom and to control for cross-country and inter-temporal heterogeneity.
Morrissey & Udomkerdmongkol (2011)	Governance, Private Investment and Foreign Direct Investment in Developing Countries	46 developing countries (1996–2009)	Political stability is found to be the most important aspect of governance in terms of the relationship between FDI and domestic private investment: an increase in FDI has the greatest effect on reducing private investment (but increasing total investment) in politically stable regimes.
Escribá & Murgui (2009)	Government policy and industrial investment determinants in Spanish regions	Spanish regions (1980-2000)	The results indicate that investment has been sensitive to public infrastructure, particularly in the 1980s, while the effect of human capital was felt throughout the period.
Gryglewicz, Huisman & Kort (2008)	Finite project life and uncertainty effects on investment	-	The present paper studies investment projects with finite project life, and the results show that, in contrast with the existing theory, investments may be accelerated by increased uncertainty. It is shown that this particularly happens at low levels of uncertainty and when project life is short.
Mendoza Lugo (2008)	The Differential Impact of Real Interest Rates and Credit Availability on Private Investment:Evidence from Venezuela	Venezuelan (1983-2000)	This paper indicates that there is an evidence of asymmetries between the growth rate of private investment and financial variables; however, an increase of real interest rates in periods of credit contraction does not stimulate private investment. In addition, when the economy faces a credit constraint, a negative shock to credit availability causes a higher contractionary effect on the growth rate of private investment. Thus, the findings are not totally in line with the

Table (1): Empirical Studies

			predictions of the financial liberalization theory.
Galan & Gonzalez-Benito (2006)	Distinctive determinant factors of Spanish foreign direct investment in Latin America	103 Spanish multinational companies	This study indicates that cultural affinity is the most crucial determinative factor for the selection of this destination.
Sadik & Bolbol (2003)	Arab External Investments	Arab countries (1975-2000)	The paper indicates that the total value of capital outflows from the Arab countries during 1975–2000 at between US$212 and 323 billion.
Sun, Tong &Yu (2002)	Determinants of foreign direct investment across China	China (1986-1998)	This study shows that the cumulative FDI relative to cumulative domestic investment has a negative impact on the new FDI.
M. Voss (2002)	Public and private investment in the United States and Canada	US and Canada (1947-1996)	The results for both countries show that there is no evidence of crowding in due to complementarities between public and private investment; in fact, innovations to public investment tend to crowd out private investment.

3- Data and empirical results

In both theoretical and empirical studies, many different kinds of variables have been considered as significant determinants of private investment. So in this research, by application of the method of Bayesian averaging model(BMA), the effects of influential factors on private investment which have been regarded in previous studies are investigated.

3-1-explanatory variables

We just consider 19 kinds of variables affecting private investment regarding to limitation of access to data of variables. The explanatory variables applied in this research are from "Time series" data and with "constant price" in 1376 and between1338 to 1390. All the data gathering from world bank`s statistics, Statistical Center of Iran.

The variables are regarded based on growth rate and Ratio though all the variables are static (the results of unit root test for variables being static, are not brought here due to thrift). We categorize the variables in three groups: Variables of Internal atmosphere, variables of exterior atmosphere and price variables. Now we will give few remarks about some variables of this model.

- The dependent variable used in model of private investment growth is defined the variable of private investment. Hence all the variables are static we use the rate of private invetment growth instead of its surface.
- We use the ratio of logarithm of value added (in four divisions: industry, Social services, agriculture and construction) divide on internal gross non-oil products (non-oil GDP), as effective variables to private investment. In various parts of economy the growth of products have probably different effects on private investment. For example in agriculture division we expect the value added have less influence on private investment toward the other parts.
- The trend is applied as technology indicator and other variables which gradually change and influence the private investment.
- The ratio of companies' taxes is achieved from companies' taxes divide on non-agricultural production.
- The business cycles variable has been derived based on Filter Hdryk Pryskat.
- The ratio of money to produce(t-1) variable is used as an indicator of monetary imbalance in the economy .

3-2-Analyzing "Bayesian averaging model" (BMA)

One of the most important privileges about BMA analyzing is the high level of trust to coefficients estimated in explanatory variables. Cause these coefficients are not estimated based on just one model but it is derived from model averaging of estimated coefficients in every single variable with 65536 recapitulations or effective samplings. The posterior mean of each coefficient (from model averaging) are calculated in this way:

$$\hat{\beta}_1 = \sum_{t=1}^{I} \lambda_i \hat{\beta}_{1i}$$

(1)

λ_i Is the possibility of "i" numbers of model and β_{1i} is an estimation of β_1 which is gained in case of M_i model being. Table 2 showing the Post mean: the posterior mean of each coefficient (from model averaging), Post Standard Error: the posterior standard deviation of each coefficient (from model averaging) and the posterior probability: the posterior probability that each variable is non-zero (in percent)

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Now we are going to analyze regarding to the results of table 2.

Table 2 : The estimation for the Model of private investment in Iran by BMA method

Variable	(Post mean)	Post Standard error(post sd)	(P)
Intercept	-0.1963	0.451833	100.0
Non-oil GDP growth	0.7078	0.605457	68.5
Interest rate	0.0051	0.025991	6.8

Log(Exchange rate)	0.00004149	0.005160	2.8
growth of capital Imports	0.4253	0.084639	100.0
Log (ratio of companies' taxes)	-0.05657	0.071061	50.1
Non-oil Exports growth	0	0.000000	0.0
Inflation rate	-0.003771	0.042621	2.0
The ratio of bank credits to the private sector	-0.01097	0.047370	9.0
Log(lagged ratio of money to GDP)= Monetary imbalance	0.007375	0.038586	18.5
Money growth	-0.00789	0.078036	2.9
Business cycle	0.05837	0.180154	12.0
Oil Exports growth	0.0005471	0.009336	1.1
Lagged Dependent variable	-0.000436	0.010699	0.9
Labor force growth	0.319	1.148030	12.2
Trend	-0.0006225	0.007257	13.0
share of service sector	0.004242	0.044854	1.8
share of transportation sector	0.006003	0.040534	3.4
share of industry sector	0.001738	0.023443	1.3
share of agriculture sector	-0.006387	0.040491	3.7

The second column on the right hand is the latest weight mean of the coefficients of each variable, the third column is the error of the latest distribution criterion of the coefficients and the 4th column is the probability of occurrence of any of the variables in 524288 times of effective sampling of the models. In consideration of the column of the probability of occurrence of each descriptive variable, we may find out that, among the descriptive variables in question, some variables may affect the private investment (there is a certain probability of the same on the investment model). Results of the table No. 2 may be explained as follows:

- Growth of capital imports with probability 100% ,has certain impact to private investment with relatively high coefficient 0/42. Hence we get to a strong certainty about the positive impact of this variable. Therefore, any restrictions on the capital imports can have restrictive effect on private investment.

- Non-oil GDP growth with probability 68.5% and high coefficient 0.7 is accounted the second influential factor on volatility of private investment. Hence Increase of non-oil GDP stimulate private investment growth in Iran's economy that is corresponded with theory.

- Logarithm of the ration of companies' taxes with the probability of 1 and 50% and the coefficient of -0.05 is considered as the third effective factor on the growth of investment in Iran. By increase in the ration of the companies' taxes, the growth of private investment in Iran may be decreased. Although, the coefficient sign accords with the economic theories, but the mentioned effective size is weak. Therefore, it seems that the tax rates in the sample period of the research are a determining factor in evolution of the private investments.

- Logarithm of lagged ratio of money to GDP as the index of monetary imbalance with the probability of 18.5%, and the coefficient of 0.007, trend variable (with the probability of 13% and the coefficient of -0.006), growth of labor force variable (with the probability of 12.2% and the coefficient of 0.3) and the business cycle variable (with the probability of 12% and the coefficient of 0.05) has a low effect on the growth of private investment in the economy of Iran.

- Share of the various economic sections (services, industry, transportation and agriculture) with the probability of less than 4% has low effect on the investment evolutions.

- Growth of the oil exports (with the probability of 1.1%) and growth of the non-oil exports (with the probability near 0%) have low effect on private investment. It seems that the oil revenues is arisen only through the canal of the capital imports, and may affect the changes in the private investments.

- Other variables, such as the nominal variables, for instance the inflation, balance of the bank credits to the nongovernmental sector, money growth, rate of the bank credits, logarithm of the margin of the exchange rate and the lagged of dependent variable, have no meaningful effect on the investment of the private sector. Especially, against our expectation, the sign of the coefficient of the bank credits, is positive, which is compatible with the opinions of the financial oppression in the economy of Iran. It seems that the increase in the rate of interest with more equipment of the savings, has provided more financial resources for investment. In other word, the rates of interest in the economy of Iran, in general, is less than the threshold which may confine the private investment. Indeed, the systems of extreme control on granting the bank credits may frustrate the relevant rates in investment. In this line, only the variable of the commercial courses may confirm the behavior compatible with the private investment cycle in the economy of Iran.

3-3- Selection of Optimum Models

After selection of model under BMA method, we may extract 5 first model, which may be of the highest level of inclution probability, respectively. The latest probability of each model may be calculated in accordance with the following equation on the basis of Bayes Rule (by the application of R Software).

$$P(M_i \big| y) = \frac{p(y|M_i)p(M_i)}{p(y)} \tag{2}$$

The results of estimate of the most probable models (5 most possible models) are shown in the table No. 3.

Table 3 : Five optimization model

Models & variables	The first model	The second model	The third model	The fourth model	The fifth model
intercept	-0.035018	-0.381536	0.007663	-0.398356	-0.307908
Non-oil GDP growth	0.904381	0.975954	0	1.131922	0
The ratio of bank credits	0	0	0	0	0
Log(Exchange rate)	0	0	0	0	0
growth of capital Imports	0.409288	0.397241	0.494191	0.396164	0.475931
Log (ratio of companies' taxes)	0	-0.097693	0	-0.114017	-0.109810
Non-oil Exports growth	0	0	0	0	0
Inflation rate	0	0	0	0	0
The ratio of bank credits to the private sector	0	0	0	0	0
Log(lagged ratio of money to GDP)= Monetary imbalance	0	0	0	0.016597	0
Money growth	0	0	0	0	0
Business cycle	0	0	0	0	0.529580
Oil Exports growth	0	0	0	0	0
Lagged Dependent variable	0	0	0	0	0
Labor force growth	0	0	0	0	0
Trend	0	0	0	0	0
share of service sector	0	0	0	0	0
share of transportation sector	0	0	0	0	0

share of industry sector	0	0	0	0	0
share of agriculture sector	0	0	0	0	0
P	0.091	0.069	0.058	0.048	0.046
BIC	-31.503886	-30.949065	-30.603201	-30.219987	-30.152264
R^2	0.613	0.642	0.567	0.667	0.635

The first model with two descriptive variables of non-oil GDP growth and growth of capital imports, is the most probable model (with the latest probability of 0.09) for analysis of the factors effective on the investment. Growth of the capital imports is selected in all 5 first models, which are of the highest probability. Furthermore, the probability of occurrence of 5 first models among 2^{19} or 524288 models estimated, are, approximately equal to 31%, which is a high percentage.

The second row from the lower part in the table 3, shows the BIC Bayesian Information Criterion of each model. Such a criterion is generally applied for selection of the optimum model. The lower the rate of the mentioned criterion or the higher the rate of absolute value, the model in question is placed in a higher rank from the point of view of fit and simplicity. The first model with the Bayesian Information Criterion BIC of -31.50 is considered as the best model. The last row in the table No. 3 shows the determination coefficient of each model. As the descriptive variables of each model is different, therefore, the determination coefficient of the models is not an appropriate criterion for selection from among them.

4-Conclusions

In the present paper, by the application of the Model averaging by the R Software, the effect of 19 explanatory variables on private investment in the economy of Iran is examined. The averaging methods are applied in the models with the larger dimensions, in which all possible sub-models (here 2^{19} i.e. 524288 models) are estimated. Then, the average of the coefficient of each variable is calculated in all models. In this averaging, the weights may be determined on the basis of the Bayesian rule and the probability of each model. Private investment growth variable is the dependent variable in the present research. On the basis of the results obtained, the growth of capital imports with the probability of 100% and the coefficient of 0.42 and the low standard error of 0.08 has a positive and important effect on the growth of private investment. Therefore, any restriction on the capital imports may be considered as a discouraging factor on private investment. Growth of non-oil GDP with the probability of 68.5% and the coefficient of 0.7 and the standard error of 0.6 is the second effective factor on the private investment, which is in accordance with the existing theoretical fundamentals. Also, the oil revenues arising from the import channels of the capital goods, may affect the private investment. Although, the logarithm of the ration of the company's taxes with the probability of 50.1% affect the private investment, but the coefficient size (-0.050 is too small). Therefore, it does not seem that during the sample period, the investment evolutions

in the economy of Iran are affected by the taxation policies. In consideration of the low probabilities for the other variables, especially regarding the nominal variables such as inflation, balance of the bank credits to the nongovernmental sectors, and the monetary policies and changes, such as changes in the interest rate, it seems that none of the mentioned factors may have important effect on the private investment. In reality, against our expectation, the sign of the coefficient of the rate of bank facilities is positive which is in accordance with the theories of the financial depression in the economy of Iran. It seems that the decrease in the rate of interest with decrease in the savings and transfer of the financial resources toward the non-productive assets, have restraint effect on the private investment. Indeed, the extreme control systems in granting the bank facilities have frustrated the part of such facilities and the relevant rates in investment.

In consideration of the results obtained and the meaningful effect of the variable of import of the capital goods, paying attention to the import of the capital goods in foreign trading policies, especially at the time of foreign exchange restrictions may be essential for support of the private investment and the economic growth and development.

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