

Example of multiple regression analysis: the determinants of cpi in united arab e...

[Economics](#), [Money](#)



Abstract

Econometrics analysis is crucial in developing models that are useful in estimating economic variables. However, development of suitable models is crucial in ensuring that their forecasts are accurate. That involves applying suitable model estimation techniques as well as testing for the estimated parameters' significance. This study applies multiple regressions to analyze the determinants' of CPI in United Arab Emirates considering the economy's data for 30 years with an objective of establishing those factors that have a significant effect on CPI. In that respect, the study analyzes five variables including GDP per capita growth (annual %), Money and Quasi money (M2) as % of GDP and Oil Rents (% of GDP), as well as Natural Gas Rent (% of GDP). To achieve the objective, the study review past analysis on the topic and provides a statistical analysis by developing a multiple regression model for all the variables as well as testing for its significance. Finally, the study is important as it helps identify the factors that economic agents should focus on, in their bid to address the inflation problem. Thus, the study would be of importance to the authorities responsible for fiscal and monetary policies in an economy.

- Introduction

Economic variables are normally interacted with some variables having an effect on the others. In that respect, a change in one could result to a change in the other either directly or inversely depending o their nature of correlation. In that respect, establishing the relationship between the variables requires an estimation of their model's variables and testing for their correlation and extent of the effect that the exogenous variables have

on the endogenous variables. In that respect, this analysis seeks to demonstrate the application of multiple regression in establishing the nature and extent of relationship between economic variables in an economy. To achieve the objective, the analysis uses the case of United Arab Emirates for which the effect of GDP per capita growth, Natural Gas Rent, Oil Rent as well as Money & Quasi Money and Merchandise Imports for UAE on CPI is analyzed using 30 years data. To begin with, the analysis sets the hypothesis to be tested and provides a literature review in reference to the specific variables effect on CPI. Further, the analysis discusses the methodology that is applied and uses Wessel software to perform the analysis, estimating the CPI regression model and the variables parameters. In addition, several tests seek to establish the nature of the relationship among the variables and between them as well as CPI while establishing the parameters' significance and suitability as estimators of CPI in the economy.

Hypothesis:

The null hypothesis being tested states that there is a correlation between the variables while the alternative hypothesis states that the variables have no correlation.

Null Hypothesis. $H_0: \beta_1 = \beta_2 = \beta_3 = \dots = \beta_i$

Alternative Hypothesis. $H_A: \beta_1 \neq \beta_2 \neq \beta_3 \neq \dots \neq \beta_i$

- Literature review

Past research

Studies on the factors affecting CPI have been done by economists with national and international focus. However, the studies were different given

their differences in the data applied in regard to the period covered, sample size, country studied as well as the selected variables. Some of the studies are as follows.

- In 1997, Papi and Lim studied the Turkey economy's CPI determinants using data for the years 1970 to 1995. The study applied the Johansen Co Integration method and concluded that CPI is dependent on wages, money supply, exports and imports prices as well as exchange rate.
- In 2000, Adeji and Liu studied the Republic of Iran's CPI determinants using data for the period 1989 to 1999 with application of the Johansen co-integration method. The study had the findings that money supply was a key determinant of CPI for the economy.
- In 2009, Khalim and Abdullah explored the determinants of CPI for Pakistan economy with application of the Johansen method and data for the period between 1972 and 2008. The study found out that GDP per capita, key imports and export prices as well as inputs for key industries were the main determiners of CPI. (Bashir, Nawaz, Yasin, & Khan, 2011)

In that view, researches have been done on the determinants of CPI based on different time periods and techniques. Thus, different sets of variables have been studied including GDP, imports and M2 which have been analyzed. For better comparison with this analysis, the study looks at the studies that were done by researchers including Khan and Naqvi in 1989, Hossain in 1989 and Nasim in 1995. In 2007, Khan et al analyzed the factors for the Jordan economy. The analysis showed that an increase in merchandise imports resulted to an increase in inflation, with a 1% imports increase for the economy resulting to a 0.73% increase in short-run

inflation. On the other hand, growth in GDP had a negative impact on inflation with a change in 1% for the Jordan economy resulting to a 0.32% reduction in inflation. Finally, money supply was indicated to have no significant effect on the economy's inflation. (Jaradat, Al-Zeaud & Al-Rawahneh, 2011) In the overall results, the study found out that the three factors' model had R-Squared of 0.721950 which meant that the model explained 72.20% of CPI variation. On the other hand, the model had an adjusted R-Squared of 0.646802 hence an implication that the model's variables that passed the t-test explained 64.68%. (Jaradat et al, 2011)

- Methodology & Analysis

Research Method

The study applies quantitative analysis method with use of multiple regressions where a regression line and the exogenous variables' parameters are estimated for the UAE CPI model.

Data collection

The analysis applies secondary data collection method that uses already published data on the study variables including the CPI, GDP per capita growth, Natural Gas Rent, Oil Rent as well as Money & Quasi Money and Merchandise Imports for UAE.

Software

In respect to the model's estimation, the analysis uses Wessel software to compute the variables' parameters and the test statistics as well as generate the distribution charts.

Variables and correlation

The model has six variables with CPI being the dependent variable dependent on the other five independent variables including GDP, Oil Rent, Gas Rent, M2 and Merchandise imports. The variables are explained as follows.

- CPI

CPI is a measure of inflation which reflects the annual general change in cost of services and goods to consumers. The cost's variation is subject to many factors that influence supply and demand of the goods and services. (The World Bank, 2014e) Such factors include the disposable income which is in-turn dependent on other factors as economic growth and employment among others. On the other hand, supply of goods and services is dependent on other factors that affect their production including Natural gas and oil prices which as the two are key source of energy. Further, cost of goods is also dependent on the goods availability through imports. Finally, the quantity of money circulating in an economy determines demand for goods and services hence their price. (Barron & Lynch, 1989)

- GDP per capita growth (annual %)

GDP per capita represents the gross domestic product per individual in an economy. It is calculated by dividing the gross value's sum for all producers resident in a country by the country's population. The variable's growth rate affects demand of goods and services as it determines the amount of income in an economy hence its influence on CPI. (The World Bank, 2014c) GDP growth per capita increase is an indication of increased output in an economy hence is expected to be negatively correlated with CPI as GDP

increase should result to reduction in price levels.

- Money and Quasi Money (M2) as percentage of GDP

The variable comprise of the sum of a country's currency outside demand deposits and banks, as well as foreign currency deposits and savings of the resident sectors other than the government. It defines money supply in an economy which determines the money available to purchase goods and services hence determining their demand and price. (The World Bank, 2014d) Money supply is expected to be positively correlated with CPI as an increase in money circulating in an economy results to high demand for goods and services hence a rise in price.

- Oil rent

The variable is the difference between the crude oil value at the global price and its production cost. It has the capacity of determining the affordability of oil that is a key goods' production component, hence its effect on their supply and price. (The World Bank, 2014a) Oil rent is expected to be positively correlation to CPI as its rise would result to rise in price levels since it imposes a higher production cost for goods and services.

- Natural gas rent

The component refers to the difference between natural gas at world price and its production cost. That difference determines the affordability of gas by producers hence its effect of an economy's production. In that respect, its effect on supply of goods translates to an effect on their prices. (The World Bank, 2014b) The variable is expected to be positively correlation with CPI as an increase in the difference between the oil's world price and its production cost is an implication of high goods production cost for goods and services

which results to higher prices.

- Merchandise imports

Imports determines the supply of goods in an economy hence their prices. In that respect, the imports by UAE from the Arab world have an effect in that they determine goods' prices within the economy hence their effect on inflation. (The World Bank, 2014f) The variable is expected to be negatively correlated to CPI as imports increases results to a decrease in price of local goods hence decreasing CPI.

Analysis

The analysis uses 30 years economic data to estimate the regression model for five exogenous variables being GDP per capita growth, Oil Rent, Natural Gas Rent, Money & Quasi Money and Merchandise imports while CPI is the endogenous variable. Thus the regression equation is of the following form.

Where:

$Y = \text{CPI}$.

$X_1 = \text{GDP per capita growth (annual \%)}$.

$X_2 = \text{Money and Quasi money (M2) as \% of GDP}$.

$X_3 = \text{Oil Rents (\% of GDP)}$.

$X_4 = \text{Natural Gas Rent (\% of GDP)}$.

$X_5 = \text{Merchandise Imports from economies in the Arab World (\% of total merchandise imports)}$. (Lacobucci & Churchill, 2010)

- Analysis, results and interpretation

Using the 30 years data for the three variables of GDP, M2 and Merchandise import, the variables correlation coefficients, the CPI model and its

coefficients are estimated and the results given as follows.

- Correlation

Correlation coefficients measures the nature of relationship between variables with its value ranging from 0 to 1 where a value close to zero indicates a weak correlation between the variables while a value close to one shows a strong relationship between the variables. (Clements & Hendry, 2011) In that respect, the partial correlation coefficients showing the relationship between the CPI and the five independent variables are calculated as given below.

- GDP per capita growth = -0. 44669

The negative correlation shows that an increase in GDP by one unit results to a decrease in CPI by 0. 44669 units and vice versa.

- M2 = 0. 091791

The positive correlation shows that an increase in GDP by one unit results to an increase in CPI by 0. 0. 091791 units and vice versa. In addition, the smaller value shows a low correlation between the variables.

- Oil rent = 0. 308235

The positive correlation shows that an increase in Oil Rent by one unit results to an increase in CPI by 0. 308235 units and vice versa.

- Gas Rent = 0. 58146

The positive correlation shows that an increase in Gas Rent by one unit results to an increase in CPI by 0. 58146 units and vice versa.

- Merchandise = -0. 23134

The negative correlation shows that an increase in merchandise import by one unit results to a decrease in CPI by 0. 23134 units and vice versa.

In view of the above correlations, the rank for the highest to the lowest correlation for the variables begins with the Gas rent, GDP per capita growth, Oil, Merchandise import and the least being M2.

- Multiple regression

With reference to the above results, it is clear that the three variables model results to 0. 26 R² and 0. 176 R² adjusted. That means all the model's variables explain only 26% of UAE's inflation while the variables that pass the t-test explain 17. 8% of CPI. In that view, the three variable model is weak hence a need to make it more effective for UAE economy. In that view, this analysis adds the oil and Natural gas rent variable to improve the model's forecasting. With that, the new model to be estimated analyzes five variables and the results are provided as follows.

In view of the above five variables model, 1. 36517 of UAE's CPI is autonomous and does not depend on any of the five variables. In that respect even when all the other variables are zero, there will be an inflation equivalent of 1. 365% in UAE. On the other hand, the other coefficients show the proportion by which CPI changes when each variable is changed by one unit. In that respect, CPI changes on the inverse direction and by 0. 161579 when annual GDP per capita growth changes by 1%. In addition, a unit changes in M2 changes CPI by 0. 0195% on the inverse direction. Further, change in a unit of merchandise results to an inverse change in CPI by 0. 701211. However, a unit of oil rent or natural gas rent change results to change in CPI in the same direction by 0. 206761 and 1. 27875 respectively. Using the model, the interpolation forecasts for CPI as well as the residual errors in the estimation are as shown on the following table.

The forecast line of fit as well as the model's residuals is shown by the following charts.

Establishing a model's suitability involves a number of tests. In that respect, the following tests are applied to establish the CPI model's suitability as a forecaster of the UAE inflation.

- T-test

The test requires setting an alpha level of 0.05 which sets the level of risk that is expected. The degree of freedom is also necessary which is $n-2$ where n is the total elements per group. Thus, the alpha value for this test being 0.05 and the degree of freedom being $(30-2) = 28$. (Stock & Watson, 2003)

The following table contains the estimated parameters' t-statistics for the UAE CPI model.

Given the large t-statistic values for GDP, Oil, Gas and Merchandise, the null hypothesis that their coefficients are equal to zero is rejected. On the other hand, the small value of M2's t-statistic results to acceptance of the null hypothesis for the variable stating that its coefficient is zero.

Using the P-values:

The p-values explain the significance of the t-statistics. The positive P-value for the intercept and the slope gives the probability that there is evidence against the null hypothesis that the model's parameters equals zero. Thus, there is evidence against null hypothesis for some variables while there lacks evidence for some variables as explained after the p-values table.

(Makridakis & Wheelwright, 2008)

The p-value shown on the above table with GDP, Oil, Gas and Merchandise

variables having values that are less than the 0-05 significance level results to rejection of the null hypothesis and an indication that their t-statistics test are significant since they are not equal to zero. On the other hand, the p-value for M2 which is greater than the 0. 05 significance level is an indication that the variable is insignificant. Thus, given the values, they rank in significance from the best as Gas, GDP, Oil and merchandise while M2 is insignificant.

- F-tests:

The test checks for the overall model's significance by calculating F-statistic and using the null hypothesis which states that all model's parameters are zero at 0. 05 significance level.

$$H_0: \beta_1 = \beta_2 = \beta_3 = \dots = \beta_i = 0$$

$$H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \dots \neq \beta_i \neq 0 \text{ for at least one variable.}$$

The table below presents the estimated values.

In view of the model's F-statistic of 8. 39 which is within the range of 5 to 25 degree of freedom, the null hypothesis is accepted. Thus, using the 0. 05b significance level, the model can be said to weak in determining CPI for UAE economy. (Pesaran & Taylor, 1999)

- Restriction:

Restriction in a model exists when one or more of the model's coefficients are equal to zero. In that respect, acceptance of the null hypothesis for this model with t-test which states that the coefficients are not equals to zero is an indication of an unrestricted model. Thus, the UAE CPI model estimated in this analysis is unrestricted given that the coefficients are not equal to zero.

(Davidson & MacKinnon, 1993)

- R squared and Adjusted R squared:

The results for the model's R2 as well as the adjusted R2 are as shown on the table below.

R2 - Test

$R^2 = [\text{Explained Variation} / \text{Total variation}]$ The test is a measure of how the used data is close to the regression line of fit and the R2 is referred to as coefficient of determination. The value is easy to estimate and gives the percentage of the dependent variables variation that can be explained by the estimated model. The value ranges from zero to 100% with zero being an indication that the estimated model does not explain the dependent variable's variation while a value of 100% is an indication that all the dependent variables variation is explained by the model. The model's R2 equals 0. 62647 which means that 62. 65% of the CPI can be explained by all the variables estimated function. (Stock & Watson, 2003)

R2 Adjusted.

Adjusted R2 is a measure of the percentage of variation that is explained by the estimators that pass the t-test. In addition, the measure penalizes for addition of variables and coefficients that are not significant to the model. (Pesaran & Taylor, 1999) In that respect and in reference to the table above, 55. 17% of UAE's CPI is explained by the four variables that pass the t-test with an exception of M2 which has failed the t-test.

- Multicollinearity:

Multicollinearity exists when there are two or more coefficients that are

highly correlated for a multiple regression model. It can be identified if the coefficients are insignificant and there is a rejection of the hypothesis that the coefficients equals zero with use of F-test. (Davidson & MacKinnon, 1993)

In addition, it can be tested using the formula

$VIF = 1 / [1 - R^2_j]$ where R^2_j is the R^2 for the estimator in the model.

A VIF that is above 5 is an indication of multicollinearity hence the estimator have no meaning.

Regressing all the variables, the following R^2 values are estimated and used to calculate the VIF values for each coefficient as follows.

$R^2_1 = 0.199531$, $VIF_1 = 1 / [1 - 0.199531] = 1.249267617$

$R^2_2 = 0.008426$, $VIF_2 = 1 / [1 - 0.008426] = 1.008497601$

$R^2_3 = 0.095009$, $VIF_3 = 1 / [1 - 0.095009] = 1.104983364$

$R^2_4 = 0.3381$, $VIF_4 = 1 / [1 - 0.3381] = 1.51079082$

$R^2_5 = 0.053517$, $VIF_5 = 1 / [1 - 0.053517] = 1.05654301$

In view of the above VIF values that are less than 5, the model do not have multicollinearity problem. (Clements & Hendry, 2011)

- Heteroscedasticity:

Heteroscedasticity is experienced when the error terms do not have constant variance. Using the residuals' graph to test for heteroscedasticity, a small sample as the one used in this case should have residual that are larger and near the mean of the distribution. (Pesaran & Taylor, 1999) In that respect, residual that are relatively the same size for all values is an indication that there is no heteroscedasticity that warrants concern for the estimated

UAE CPI model.

Possible tests for this are the Goldfeld-Quandt test is applied as the error term either decreases or increases consistently as shown in the plot. Thus, the Goldfeld -Quandt test for heteroskedasticity is applied for comparison of variances of error terms of the data's sub groups for variable M2 which has the least R2 of 0. 008426. The null hypothesis' states that error terms have a constant variance while the alternative hypothesis states that the variance of the error terms is not constant. In that respect and in view of the following results for the test, the heteroscedasticity test is interpreted.

In view of the above test results, the p-values for all the groups are positive and large hence there being no substantial evidence against the null hypothesis that the error terms have constant variance. In that respect, the model is homoscedastic. (Clements & Hendry, 2011)

- Observations/Findings

Normal distribution

In linear regression models, error terms are assumed to have a normal distribution. This can be demonstrated by the residual frequency histogram and chart for the UAE data as follows.

In view of the histogram and the chart, it is clear that the model's residuals have a normal distribution in line with the assumption hence the model being a suitable estimator of CPI for the UAE economy. (Clements & Hendry, 2011)

Model's adequacy

In light of the analysis results and tests, it can be concluded that the five variable CPI econometric model developed for the UAE economy is adequate for use in forecasting the economy's inflation. In that respect, the model can be expected to provide reliable forecasts that can be relied upon by the policy makers. (Davidson & MacKinnon, 1993)

Thus, the result answers the study question on the effect that the five variables have in determining the UAE's CPI. In addition, the results are in agreement with the literature review argument that the three variables are correlated to the economy's CPI. However, the analysis has gone ahead to test for the correlations' significance hence identifying M2 as the weakest determiner of CPI for the UAE economy hence its insignificant parameter.

In view of the two models that have been estimated with the first being the three variables model, it is clear that both shows that GDP and Merchandise have a significant effect on inflation. On the other hand, M2 is not a significant variable in determining inflation; a finding that is in line with the literature review findings of GDP and merchandise being significant determiners while M2 is insignificant. However, the three variables model is not an effective estimator of CPI in UAE given the low R2 and adjusted R2 values. (Clements & Hendry, 2011)

Finally, considering the model's adjustment by adding the Oil and Gas rent variables, there is an improvement for the model showing an increased effect of all the variables. In addition, the R2 and adjusted R2 increases significantly as an indication of enhanced efficiency for the model's estimation. However, only four variables remain significant while M2 is still

an insignificant determiner of inflation. Thus, the model's improvement with inclusion of oil and gas can be explained by the fact that UAE economy is highly dependent on production and sale of oil and gas. (Montgomery et al, 2001)

- Conclusions

The analysis have confirmed the past study results and the expected correlation between the variables. However, the first test with three variables that were analyzed in the 2007 study provides a less effective model that needed to be improved hence the addition of Oil and Gas rent. In line with the literature review findings that the five variables determines the price change in an economy, the estimated model is found to have significant coefficients that can be used as estimators of UAE's CPI given the strong correlation between the variables. Further, the model is found to be unrestricted and have no heteroscedasticity and multicollinearity problems in addition to its residual errors having a normal distribution. The five variables are also identified as being responsible for explaining 62% of the total CPI variation in UAE. However, only 55. 17% of CPI variation is explained by four variables that pass the t-test with an exception of M2. That is considering the analysis has indicated that GDP, Oil, Gas and Merchandise are significant determiners of CPI while M2 is not as it has failed the t-test. In that respect, the four variables are significant estimators of CPI as their change have a significant effect of the Consumer Price Index for the United Arab Emirates economy. In conclusion, the model is found to be a good estimator of UAE's CPI with acceptance of null hypothesis stating that, a correlation exists between the independent and dependent variables.

Reference list

Barron, J. & Lynch, G. 1989. Economics. London: Richard D. Irwin Inc.

Bashir, F., Nawaz, S., Yasin, K. & Khan, J., 2011. Determinants of Inflation in Pakistan: An

Econometric Analysis. Australian Journal of Business and Management Research,

1. 5. pp. 71-82.

Clements, M. & Hendry, D., 2011. The Oxford Handbook of Economic Forecasting.

Oxford: Oxford University Press.

Davidson, R. and MacKinnon, G., 1993. Estimation and Inference in Econometrics. Oxford:

Oxford University Press.

Jaradat, M., Al-Zeaud, H. & Al-Rawahneh, H. 2011. An Econometric Analysis of the

Determinants of Inflation in Jordan. Journal on Finance and Economics, ISSN: 1450-2889 Issue 15.

Lacobucci, D. & Churchill, G., 2010. Marketing Research: Methodical Foundations. 10th Ed. Ohio: South-Western College Publishers.

Makridakis, S. & Wheelwright, S., 2008. Forecasting Methods and applications. 3rd Ed.

New Delhi: Wiley India Pvt. Ltd.

Montgomery, D., Vining, G. & Peck, E. 2001. Introduction to Linear Regression

Analysis. 3rd Ed. New York: John Wiley & Sons.

<https://assignbuster.com/example-of-multiple-regression-analysis-the-determinants-of-cpi-in-united-arab-emirates-research-paper/>

Pesaran, H. & Taylor, L. 1999. “Diagnostics of IV Regressions.” Oxford Bulletin of Economics and Statistics, 61, pp. 255-281.

Stock, J. & Watson, M. (2003). Introduction to Econometrics. Boston: Wesley.

The World Bank, 2014a. Oil Rent. [Online] Available at:

[Accessed 19 April 2014]

The World Bank, 2014b. Natural Gas Rent. [Online] Available at:

[Accessed 19 April 2014]

The World Bank, 2014c. GDP Per Capita Growth. [Online] Available at:

[Accessed 19 April 2014]

The World Bank, 2014d. Money and Quasi Money (M2). [Online] Available at:

[Accessed 19 April 2014]

The World Bank, 2014e. Consumer Price Index. [Online] Available at:

[Accessed 19 April 2014]

The World Bank, 2014f. Merchandise Imports. [Online] Available at:

[Accessed 19 April 2014]

Appendices

Appendix 1: Data for the 30 years beginning 1983 to 2013.

Source: (The World Bank, 2014)