Determinants of private investment in Egypt: an empirical analysis

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Abstract

Purpose – This paper aims to study the determinants of private investment in Egypt while accounting for uncertainty associated with financing decisions of the firm using time series analysis over the period 1982-2015. The analysis is based on Tobin's (1969) Q-theory of investment. The variables used in the empirical model are investment rate, average q index, prices of capital goods, internal finance and external finance.

Design/methodology/approach – This research is concerned with the model specification of a dynamic Average Q model. In that respect, the current research describes the data, presents the empirical methodology and estimates the Average Q model of investment and obtains the results. The empirical procedures and results of studying the average Q model. It includes testing for the unit root in the time series, vector error correction model (VECM) and cointegration long run analysis, and finally estimations of the model under uncertainty and empirical results.

Findings – Stochastic shocks to the determinants of private investment in Egypt have their impact on investment rate. The representation of impulse response in VECM shows that a one standard deviation shock to the value of the firm has a positive impact on investment rate. Stochastic shocks to both internal finance and external finance have slightly positive response from investment rate. Also, a stochastic shock to investment rate has a positive yet declining response from itself. However, a stochastic shock to prices of capital goods has a negative impact on investment rate. The representation of variance decomposition in VECM shows that investment rate is positively affected yet at a declining rate by a one standard deviation shock in both internal and external finance during the period 1982-2015. Also, a stochastic shock in the value of the firm or in the prices of capital goods has a slightly positive impact on investment rate.

Originality/value – Investment and capital accumulation are the main vehicles for economic growth and development. There have been fluctuations in Egypt's investment rates since mid-1970s due to variations in saving rates. Thus, it is important to present some policy implications that could potentially assist the enhancement of the Egyptian economy. In that respect, the estimated results of the empirical model show that changes in the prices of capital goods in Egypt are significant factors that have negative impact on investment rate. Prices of imported capital goods in Egypt are affected by foreign exchange market conditions in the form of significant changes in the pound exchange rate. Thus, foreign exchange market reforms, as adopted recently in the Egyptian economy and improvements in trade balance, are important steps to alleviate obstacles that hinder investment. Regarding the source of finance, the estimated results showed that changes in both internal and external finance have a positive impact on investment rate. In this case, it is the firm's decision to choose the method of financing its investment depending on factors such as its market value, institutional size and capacity and the opportunity cost of the funds used in financing the required investment.

Keywords Uncertainty, Time series analysis, Investment spending, Q theory

Paper type Research paper

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1. Introduction

Investment and capital accumulation are the main vehicles for economic growth and development. There have been fluctuations in Egypt's investment rates since mid-1970s due to variations in saving rates associated with changing consumption patterns under market-oriented system and given the availability of foreign exchange reserves. This resulted in facing some economic challenges such as low economic growth, high unemployment rate, fiscal imbalances and trade balance deficits. Therefore, it is important to study the determinants of capital spending. The Government of Egypt has started serious steps to boost the Egyptian economy and create incentives to furnish for attracting investment opportunities. These include an open door policy, privatization programs, economic reform programs, enhancing the legal system, modernizing the financial sector and building institutional capacities.

In 1974, an open door policy was adopted which led to increasing the remittances of workers, and foreign investment and in turn a sizeable increase in economic growth. In 1991, an economic reform and structural adjustment program was launched to increase the economy's rate of growth, attract foreign and domestic investment and encourage the role of private investment through privatization program. Because investment climate remains challenging, Egypt continues its efforts in 2016 with the implementation of a comprehensive economic reform program to address the economy's fiscal and structural imbalances. The program includes the devaluation of the Egyptian Pound, the imposition of a new value-added tax (VAT), fuel and electricity subsidy cuts and a new civil service law. Structural efforts are trying to furnish a stable macro-economic environment to stimulate the economy, improve its productive capacity, increase exports, lower the rates of inflation and unemployment and increase investment. The issuance of a new investment law no. 72/2017 is expected to improve the ease of doing business, increase transparency for foreign investors and attract funds needed to invest in mega projects such as industrial and logistics zone around the Suez Canal, creation of a new national administrative capital and the development of mineral extraction opportunities.

Investment decisions are subject to uncertainty of market conditions and are affected by fundamental factors such as irreversibility of capital investment process, adjustment costs related to installation of new capital, delivery lags of machinery orders and information imperfection in financial markets. The present research focuses on only some of these factors and considers a variant of the neoclassical theory of investment, namely, the average Q model.

The rest of the paper is organized as follows: Section 2 discusses the average Q model. Section 3 presents the econometric model, empirical methodology and estimation results. Finally, Section 4 gives conclusion and policy implications.

2. Average Q model

The Q-theory of investment was introduced and elaborated by Tobin (1969, 1993) to link the unobservable expectation of the real or shadow price of capital to observable factors in the financial market. In this way, Q gathers all the relevant information of future expectations needed by a firm for an investment decision.

One measure of the demand for investment is given by average Q (Q_t^A), defined as the ratio of the market value of the firm to the replacement cost of the existing capital stock. That is, $Q_t^A = \frac{V_t}{p_t^I k_t}$ where V_t is the firm value, p_t^I is the price of capital good, and k_t is the capital good.

It is worth indicating that average Q could be equal to marginal Q$\left(Q_t^M = \frac{\frac{\partial V}{\partial k}}{p_t^I}\right)$ under certain conditions, where the latter is denoted as the increase of the present value of a firm's profit corresponding to an additional increase in a capital stock. In general, researchers use the observable average Q rather than the unobservable marginal Q. If adjustment costs depend on capital only, they will show diminishing returns to scale and profit increase will be less than proportional increase in capital i.e. $Q_t^M < Q_t^A$.

Substitution between these two measures of Q is subject to the following factors: production and adjustment cost functions are linearly homogeneous, capital is homogeneous, product and factor market are competitive and investment decisions are separated from financial decisions.

According to Jorgenson (1963), q = 1 indicating equality between purchase price of capital and its discounted sum of future marginal revenue product (price = marginal revenue). In contrast, Brainard and Tobin (1968) assume that q ≠ 1 because purchase price of capital is not equal to discounted sum of future marginal revenue product. They are equal without adjustment costs. This is considered fundamental in investment models.

The empirical investment model studied here is based on average Q as a variant of the neo-classical economic theory for a profit-maximizing firm. A benchmark model is based on the demand for investment that accounts for both: the proportional change of capital stock available at the beginning of the period, and the new investment determined by the distributed lags of new orders reflecting the change in the desired capital stock.

The benchmark model is the backbone mathematical equation that is used to obtain an empirical investment equation for a profit-maximizing firm. The firm's maximization problem is:

$$MAX_{Ls,Ks}\ E_t\left[\sum_{s=t}^{\infty}((1+r)^{-(s-t)}\{F((L_s, K_s\colon \tau_s) - G(I_s, K_s\colon \tau_s) - w_s L_s - p_s^I I_s))\right]$$

Subject to:

$$I_s \equiv K_s - (1-\delta)K_{s-1}$$

where δ is a geometric decreasing pattern of depreciation.

The firm chooses inputs that will support the maximization of the discounted sum of expected cash flow. This reveals that firm maximizes its market value rather than maximizing cash flows at a moment.

The elements of the firm value equation could be defined as follows:

E_t is an expectation operator, r is the discount rate, L is labor input, K is capital input, I is gross investment, w is price of labor, p is price of capital good, τ is stochastic technology shock.

$F(L_S, K_S\colon \tau_S)$ is the production technology function.

$G(I_S, K_S\colon \tau_S)$ is the adjustment cost function for the new investments that could include internal and external costs. Adjustment cost in the investment function is considered as a form of expenditure and is assumed to be quadratic in gross investment and homogenous of degree one in I_S and K_S such that:

$$G(I_s, K_s : \tau_s) = \frac{\alpha}{2}\left[\frac{I_s}{K_{s-}\ \ \tau_s}\right]^2 K_s$$

where α is an adjustment parameter indicating that the higher is the α, the higher is the adjustment cost denoted by a steeper function showing a slower rate of investment.

By using dynamic optimization model for a firm facing profit maximization problem, expectations and technology shocks are introduced to the benchmark model. Introduction of dynamic factors assumes that the firm faces adjustment costs while accumulating its capital stock. In this case, the benchmark model of the firm while considering dynamic optimization model is as follows (Chirinko, 1993):

$$\frac{I_t}{K_{t-1}} = \frac{1}{\alpha}\left(E\lceil\Lambda_t\rceil - p_t^I\right) + u_t$$

The quadratic equation is theoretically consistent as it is derived from an optimization problem of a firm where adjustment cost, as an expenditure factor, is not part of the function for simplicity, such that:

$\frac{I_t}{K_{t-1}}$ is the ratio of gross investment to lagged capital stock.

Λ_t is the unobservable shadow price of capital. It is the discounted sum of marginal revenue product over the life time of capital good evaluated at time t, i.e. it is the measure of marginal benefit of a firm α is adjustment parameter.

p_t^I is the price of capital good.

u_t is the error term including technology shock.

Chirinko (1993) shows that an empirical specification for the average Q model could be obtained using the above dynamic optimization equation. Q_t^A is the main determinant of the ratio of investment to capital stock denoted by $\frac{I_t}{K_{t-1}}$. In the above investment function, the adjustment cost of capital is considered as expenditure and is dropped out for simplicity. The specifications of Q models directly include expectation parameter in the Q investment equation and thus accounting for expectations instability if exists.

This research is concerned with the model specification of a dynamic average Q model. In that respect, the current research describes the data, presents the empirical methodology and estimates the average Q model of investment and obtains the results.

3. Econometric analysis

3.1 Model specification

Using dynamic optimization techniques, the empirical investment equation for a profit maximizing firm is (Chirinko, 1993):

$$\frac{I_t}{K_{t-1}} = \frac{1}{\alpha} Q_t + u_t$$

such that:

$$Q_t = \left(Q_t^A - 1\right) p_t^I$$

By substitution:

$$\frac{I_t}{K_{t-1}} = \frac{1}{\alpha}\left(q_t^A - 1\right) p_t^I + u_t$$

I_t denotes fixed investment and is assumed as a proportion of lagged capital stock installed in previous year, i.e. allowing for time to build which is empirically more realistic.

K_{t-1} denotes lagged capital stock and is calculated by adjusting the value of the fixed capital assets for depreciation and inflation rates available at historical costs for the available data. The calculation of capital stock uses what is known as perpetual inventory procedures which are applied for all years, starting from the earliest available data on historical fixed assets which is 1982 in this case. Calculating capital stock for each year in the time series is given by the following equation:

$$p_t^I K_t = (1-\delta) p_{t-1}^I K_{t-1} \left(\frac{p_t^I}{p_{t-1}^I} \right) + p_t^I I_t$$

such that:

p_t^I is price of investment goods, K_t is capital stock in real terms, the term $p_t^I K_t$ refers to capital in nominal terms, δ is depreciation rate, I_t is real investment, $\frac{p_t^I}{p_{t-1}^I}$ denotes inflation.

Q_t^A is average Q which is the ratio of the net added value of the firm to lagged capital stock, where the net value of a firm is taken as a proxy of its the market value. In this respect, average Q index (AQI) is used in the analysis as a measure of average Q. AQI is calculated by converting real value-added in the private sector into index numbers and then dividing the resulting series by the capital goods price index (PI), taking 1982 as the base period.

The data used in the analysis are of annual frequency covering the period 1982-2015. The investment data are obtained from bulletins of the Central Agency for Public Mobilization and Statistics (CAPMAS). The data for output and capital stock are logged and measured at 1982 constant prices, whereas all other variables are measured in percentage terms.

3.2 Empirical methodology and results

This section presents the empirical procedures and results of studying the average Q model. It includes testing for unit root in the time series and cointegration analysis for a vector error correction model (VECM). The estimation results are based on innovations analysis using impulse responses and variance decompositions.

The time series properties of the data are examined by unit root test using both types of specifications: augmented Dickey–Fuller (ADF) test and Phillips–Perron (PP) test to avoid spurious regressions (Hamilton, 1994). Regarding the (PP) unit root test, it is a non-parametric method of statistics which accounts for heteroskedasticity and potential serial correlation in the error terms for the time series under investigation. It is specified by the Newey–West using Bartlett Kernel spectral estimation method. The test regression for the variables is done with intercept only. Table I shows both unit root tests for the average Q model.

The Dickey – Fuller unit root test is based on the regression shown as:

$$y_t = \kappa + \beta y_{t-1} + \epsilon_t$$

The augmented ADF test regression with a constant term and a trend can be written as:

$$\Delta y_t = \kappa + (\beta - 1) y_{t-1} + \sum_{i=1}^{s} \delta_i \Delta y_{t-s} + \gamma t + \epsilon_t$$

where Δ is the differencing operator.

The null hypothesis is the presence of unit root, i.e. anon-stationary series indicating that the ADF test statistics corresponds to *H*0: $\beta = 1$.Schwartz criterion is used to suggest the lag structure for the test equation. All variables are examined in the log level form for simplicity except the constant depreciation rate. To ensure consistency and avoid serial correlation, the lag length of the autoregressive process is determined by the general to specific technique

Variable	Lag length	ADF test results *t*-statistics	PP test results *t*-staistics
IR	0	−2.513	−2.496
AQI	0	−2.168	−2.168
PI	0	−2.615	−1.958
IF	0	−1.511	−1.533
XF	0	−2.418	−2.410
First (log) differences			
ΔIR	0	−9.232	−8.987
ΔAQI	0	−5.525	−5.659
ΔPI	0	−5.230	−5.384
ΔIF	0	−6.640	−6.565
ΔXF	0	−5.499	−5.499
Critical values for test statistics			
1%		−3.663	−3.663
5%		−2.960	−2.960
10%		−2.619	−2.619

Table I.
Unit root test

(Schwartz, 1978; Perron, 1988). This method starts by examining the t-statistic while moving from longer lag length, getting down to the smaller one where the lowest lag length is assumed to be asymptotically or approximately normal. ADF test equation is re-estimated for a number of times until the significant lag length is found and indicated by the least value of Schwarz criteria. The null hypothesis *H0* of the unit root test is rejected if the absolute value of a test statistic of a variable exceeds the critical value in absolute terms. Zero lag length in the ADF test is equivalent to Dickey–Fuller test autoregression, i.e. only one lag interval is used in estimation. In the present case, test regression is done only with intercept or constant term.

Table I shows autoregression estimation of the variables included in the Average Q model of investment. Both ADF and PP t-statistics are estimated with constant term only as the data do not show a time trend, i.e. without time trend. The null hypothesis is not rejected for all variables using the log level form. The list of variables includes:

Investment rate (IR) measured as the ratio of gross fixed investment to lagged capital stock.

Average Q Index (AQI) used in the test equation as the measure of average Q (AQ).

Capital goods price index (PI) presenting the price developments for machinery and equipment. This variable partly accounts for business uncertainty from conditions in the foreign exchange market as most of the capital goods are imported and financed through the banking system. The investor bears exchange risk related to indebtedness to the banks in foreign currency.

Cash flow to lagged capital stock (IF) a proxy for internal finance IF, where cash flow is calculated as net income plus depreciation.

Capital gearing (XF) a proxy for external finance and calculated as the ratio of outstanding long-term debt to lagged capital stock; it accounts for uncertainty in financial markets associated with asymmetric information.

From Table I, the results of ADF test and PP test reinforce each other as shown. The null hypothesis is not rejected using both methods of estimation for all shown variables in their log level form as the test statistics do not exceed the critical values at all levels of significance.

One the other hand, the first difference of the above stated variables are estimated using the intercept term only (i.e. without a time trend) and in the log form for simplicity. Both tests, ADF and PP, reject the null hypothesis of unit root for all variables since the computed t-statistic exceeds the critical values in absolute terms at 5 per cent significance level as shown in Table I.

The next step in the estimation of a dynamic time-series model in which all variables are assumed endogenous is to carry out a multivariate analysis. This starts with formulating a vector autoregressive (VAR) system that captures short run dynamics. A VAR process of order p can be specified as:

$$y_t = m + \sum_{i=1}^{p} A_i y_{t-i} + \epsilon_t$$

where y is a vector representing the endogenous variables in the model, m is a vector of constants, A_i are matrices of coefficients and ϵ_t is a vector white-noise process. The lag structure identified for the VAR model of the case in hand is found to be 1 using Schwartz criteria. In other words, a VAR(1) specification describes the short run dynamics of the present model.

As discussed under the univariate case, it is found that all the variables are integrated of order 1, i.e. all the variables are I(1).As a result, the model is tested for the presence of a long-run relationship. Johansen (1991, 1995) cointegration test shows that there is a long run relationship among the variables. Thus, the cointegrating relation may be represented as:

$$\Delta y_t = m - \pi y_{t-1} + \epsilon_t$$

where, in this multi-equation system, y is a vector representing the five variables in the model, m is a vector of constant terms and the matrix $\pi = \alpha \beta'$ is the product of a column vector α that denotes speed of adjustment and a row vector β' that denotes parameters of the cointegrating equation.

In the present model, Johansen (1991, 1995) cointegration test indicates that there is a long run relationship among the variables. Based on economic theory, the cointegrating equation may be specified as:

$$\Delta IR_t = \mu + \alpha(\beta_1 IR_{t-1} - \beta_2 AQI_{t-1} + \beta_3 PI_{t-1} + \beta_4 IF_{t-1} + \beta_5 XF_{t-1}) + \epsilon_t$$

where in this single equation, μ is a constant term, α is a coefficient representing the speed of adjustment to long-run equilibrium and βs represent the cointegrating vector of parameters. The stated order of variable sin the equation is based on economic theory.

Thus, a full dynamic specification for studying investment spending could take the form of VECM:

$$\Delta y_t = m + A\ \Delta y_{t-1} - \pi y_{t-1} + \epsilon_t$$

where the notation is as defined before.

In the present five-variable model, the full dynamic estimation of investment rate (IR) equation under VECM could be specified in standard notation as:

$$\Delta y_t = m + A\Delta y_{t-1} - 0.574(IR_{t-1} - 12.44 - 13.62\,AQI_{t-1} + 0.01\,PI_{t-1} - 0.24\,IF_{t-1} - 0.1XF_{t-1}) + \epsilon_t$$

The previous equation shows that the speed of the system to adjust to long run equilibrium is α = –0.574. It reveals a fairly high speed of adjustment to long run equilibrium where about 60 per cent of the error term will be corrected per unit time.

It is important to analyze the dynamic behavior of the model through studying impulse response and variance decomposition in VECM. For the impulse response, Figure 1 shows a combined graph of the impact of standard deviation shocks to the determinants of investment on investment rate (IR) over five periods.

As the analysis focuses on the impact of stochastic shocks to the determinants of investment on the investment rate (IR), it can be seen from Figure 1 that there is an initial decrease in investment rate due to a shock in investment itself reaching the lowest rate in the second period. This is followed by a significant increase in IR before the effects of the shock dampen out. Also, the impulse responses show that a one standard deviation shock to the value of the firm had a positive impact on investment rate reaching its highest response at the third period. Stochastic shocks to both internal finance and external finance had slightly positive impact on the investment rate. However, a stochastic shock to prices of capital goods had a negative impact on the investment rate.

Regarding the tabular representation of variance decomposition to one standard deviation shock in each variable over five periods is shown in Table II.

Focusing on investment rate, the table shows variance decomposition for investment rate. The first column indicates five periods for the short run analysis. The second column shows the standard error for the corresponding period. The standard error increases from 9.2 in the first period to 9.9 in the second period till it reaches 12.8 in the fifth period. This increase in each period is attributed to the effects of uncertainty over the forecasts in previous periods of other variables in the model. The third column shows the percentage of investment rate variance that is attributed to shocks in investment rate only. The fourth column shows the percentage of investment rate variance that is attributed to shocks in

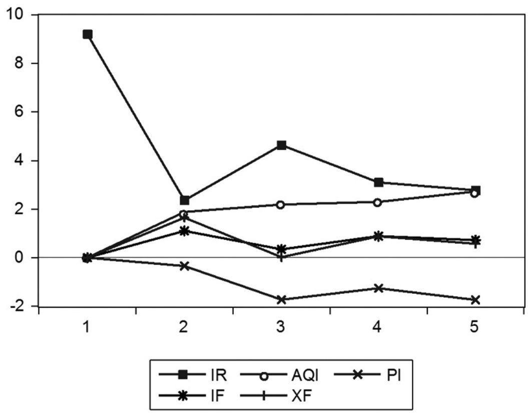

Figure 1.
Impulse response combined graph in VECM

Table II.
Variance decomposition in VECM

			Variance decomposition of IR			
Period	S.E.	IR	AQI	PI	IF	XF
1	9.199978	100.0000	0.000000	0.000000	0.000000	0.000000
2	9.890987	92.22624	3.615245	0.118892	1.252100	2.787521
3	11.27876	87.80707	6.548290	2.445629	1.054998	2.144010
4	12.05118	83.51721	9.383058	3.228707	1.460281	2.410742
5	12.81583	78.54289	12.82318	4.691902	1.613906	2.328118

average Q only. The fifth column shows the percentage of investment rate variance that is attributed to shocks in prices of capital goods. The sixth column shows the percentage of investment rate variance that is attributed to shocks in internal finance.

The last column shows the percentage of investment rate variance that is attributed to shocks in external finance.

In case that the model used a five period forecast of investment rate, 78.5 per cent of the forecast variance is attributed to shocks in investment rate itself, 12.8 per cent is attributed to shocks in average Q or the value of the firm, 4.7 per cent is attributed to shocks in the prices of capital goods, 1.61 per cent is attributed to shocks in internal finance, 2.33 per cent is attributed to shocks in external finance. This shows that the largest variance in forecasting investment rate is attributed to shocks in investment rate itself as can be expected. Also, the greater the forecast horizon, the larger the proportion of forecast variance that will be attributed to variables other than investment rate.

4. Conclusion

Stochastic shocks to the determinants of private investment in Egypt have their impact on investment rate. The representation of impulse response in VECM shows that a one standard deviation shock to the value of the firm has a positive impact on investment rate. Stochastic shocks to both internal finance and external finance have slightly positive response from investment rate. Also, a stochastic shock to investment rate has a positive yet declining response from itself. However, a stochastic shock to prices of capital goods has a negative impact on investment rate.

The representation of variance decomposition in VECM shows that investment rate is positively affected yet at a declining rate by a one standard deviation shock in both internal and external finance during the period 1982-2015. Also, a stochastic shock in the value of the firm or in the prices of capital goods has a slightly positive impact on investment rate.

With regard to policy implications, the estimated results of the empirical model show that changes in the prices of capital goods in Egypt are significant factors that have negative impact on investment rate. *This is related to the fact that prices of imported goods denominated in local currency are affected by foreign exchange market conditions in the form of significant changes in the pound exchange rate. With imports of capital goods being mainly financed through the banking system, investors bear exchange risk in repaying their foreign currency debt.* Thus, foreign exchange market reforms as adopted recently in the Egyptian economy and improvements in the trade balance are important steps to improve the investment climate.

Regarding the source of finance, the estimated results show that changes in both internal and external finance have a positive impact on investment rate. This is related to the role of asymmetric information, in financial markets, on the cost of capital and hence investment decisions of the firm. In this case, it is the firm's decision to choose the method of financing its investment depending on factors such as its market value, institutional size and capacity, and the opportunity cost of the funds used in financing the required investment.

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