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Stock Prices and Dynamics of Aggregate Investment: Evidence from Malaysia

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ABSTRACT

The paper analyzes empirically the role of stock prices in the aggregate investment function for an emerging market, Malaysia. The neoclassical investment theory that relates investment to output and lending rate and augmented with stock prices is used as an empirical basis. Applying a series of time series techniques, we document evidence suggesting favorable effects of stock market increases on aggregate investment especially in the long run. Likewise, the stock market seems to anticipate future variations in output. Reasonably, as suggested by our empirical results using vector error correction modeling, variance decompositions and impulse response functions, the aggregate investment tends to respond faster and with larger magnitude to stock price shocks than real output does. Having noted these, our analysis does not rule out adverse short run real effects of cyclical variations in stock prices.

Keywords: Aggregate Investment, Stock Market, Malaysia

INTRODUCTION

The heightened stock price fluctuations or excessive stock market volatility in especially emerging economies over the past decades has attracted wide attention especially on its relation to the macro-economy. It is well noted that stock price changes signal future economic prospects, influence the costs of capital replacement

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via the well-known Tobin's (1969) q, and have important bearings on firms and bank balance sheets. Accordingly, by affecting confidence of future economic conditions and external financing costs' of the firms, stock price changes have positive impact on aggregate investment (see Laopodis and Sawhney, 2007 and references therein for evidence). By contrast, it is also argued that increasing stock prices may impede particularly private investments. According to Weller and Helppie (2005), financial investors may pay more attention to those firms witnessing large increase in stock prices and, consequently, heighten other firms' financial constraints. At the same time, physical investments would be less attractive. In light of these views and periodic excessive stock price fluctuations in recent years, the attention given to the relation between stock prices and aggregate investment is well deserved. Indeed, understanding their interactions is particularly important for especially a developing economy since investment is considered as pressing for its progress.

In the present paper, we attempt to evaluate empirically the aggregate investment effects of stock market prices for an emerging market, Malaysia. Like any other emerging markets, the Malaysian stock market is relatively more volatile than the developed markets. Prior to the Asian crisis, Malaysia had witnessed the stock market run-up especially during the early 1990s. Its aggregate investment ratio was high by international standard and had steadily increased from 36% of GDP in 1991 to more than 43% in 1996, purporting possible positive link between stock prices and aggregate investment. The stock market however nosedived during the 1997/1998 Asian crisis. Then, post-Asian crisis, the market has again regained strength. In tandem with the stock market drop during the crisis, aggregate investment ratio declined to roughly 25% of GDP at the end of 1998. However, despite rapid economic recovery and recent stock market uptrend, the aggregate investment has only gradually increased. Indeed, unlike the pre-crisis experience, the ratio of aggregate investment to GDP has remained low since. The post-crisis experience, thus, seems to indicate no clear-cut relation between stock prices and investment. With the noted experiences, Malaysia is an interesting case study and its analysis should prove useful for other emerging markets attempting to develop through capital accumulation and, at the same time, to deal with wide market fluctuations.

In the analysis, we make use of recent time series econometric technique to establish a long run relation between aggregate investment and its determinants, which include stock prices. Then, with the presence of the long-run relation or cointegration, we apply a vector error correction modeling to analyze their short-run dynamics and adjustments toward the long-run relationship. Finally, we further analyze their causal interactions via Granger non-causality test, variance decompositions and impulse-response functions. The rest of the paper is organized as follows. In the next section, we outline the empirical model and approach. Then, section 3 details the data followed by estimation results in section 4. Finally, section 5 summarizes the main findings and provides concluding remarks.

EMPIRICAL APPROACH

The dynamics of aggregate investment is framed within the neoclassical investment theory. More specifically, as in Jorgensen (1971), the investment (I) is specified to be positively related to real output (Y) and negatively related to real rental cost of capital (R). For the present analysis, we augment the neoclassical function to account for possible influences of real stock prices as:

$$I_t = \beta_0 + \beta_1 Y_t + \beta_2 R_t + \beta_3 S_t + u_t \tag{1}$$

Except interest rate, all variables are in natural logarithm. As noted, the relation between real aggregate investment and real stock prices is indeterminate and, thus, requires empirical investigation. Equation (1) can be viewed as a long-run investment function, where the vector $\boldsymbol{\beta} = (\beta_0, \beta_1, \beta_2, \beta_3)$ are a vector of the long-run parameters. In the present study, we have interest in these parameters. At the same time, to better understand investment behavior, examination of aggregate investment short-run dynamics as well as its causal interactions with other variables in (1) is needed.

To this end, we adopt time-series econometric techniques to address the long-run investment behavior and the causal interactions between aggregate investment and its determinants. As an a priori analysis, we first subject each time series to ADF and PP unit root tests. Then, the cointegration test of Johansen (1988) and Johansen and Juselius (1990) is applied to verify the presence of a long-run equilibrium function for aggregate investment as stated in (1). As most macroeconomic variables are found to be non-stationary integrated of order (1), these steps are imperative to avoid "spurious" regression (Granger, 1986). Anticipating cointegration among the variables concerned, we frame the analysis in a vector error correction setting. As an illustration, the error correction modeling of the aggregate investment behavior is represented as:

$$\Delta I_t = \alpha + \lambda u_{t-1} + \delta Z_t + \sum_{i=1}^{k} \phi_i \Delta I_{t-i} + \sum_{i=1}^{k} \varphi_i \Delta Y_{t-i} + \sum_{i=1}^{k} \theta_i \Delta R_{t-i} + \sum_{i=1}^{k} \psi_i \Delta S_{t-i} + \varepsilon_t \tag{2}$$

where Δ is the first difference operator, Z is a vector of dummies including seasonal and crisis dummy variables, and u is the error term from (1). Equation (2) conveniently combines the short-run response of aggregate investment to its determinants through the first-differenced terms and its adjustment to the long-run relation as captured by the error correction term. The dynamic adjustments of other variables can be expressed in the same manner.

As a further analysis, we also assess dynamic causal interactions between real aggregate investment and real stock prices using Toda and Yamamoto's (1995) non-causality test. As an illustration, the causal influences on investment of its determinants are examined using the following equation:

$$I_t = a + bZ_t + \sum_{i=1}^{k+d\max} c_i I_{t-i} + \sum_{i=1}^{k+d\max} d_i Y_{t-i} + \sum_{i=1}^{k+d\max} e_i R_{t-i} + \sum_{i=1}^{k+d\max} f_i S_{t-i} + \omega_t \quad (3)$$

where all variables are as defined above, k is the optimal lag length and *dmax* is the maximum order of integration suspected in the system. This test is adopted due to its simplicity without the need to impose long-run parameter restrictions. Moreover, as long as *dmax* ≤ the true lag length, the test can be used even when the stability and rank conditions are not fulfilled. The test also requires no knowledge of the variables' cointegration properties and, accordingly, can add credence to the results especially when pre-test analyses are regarded skeptical.

The test for causal relations from real stock prices to real aggregate investment is based on Wald-F statistics, testing the null hypothesis of no-causality, i.e. $H_0: f_1 = f_2 = ... = f_k = 0$. The causal relations from other variables to investment can be implemented in the same manner. Needless to state, we can also test the causal influences on real output, interest rate and stock prices from other variables in the model. From the tests, four patterns of causality from a pair of the variables (say I and S) can be noted, namely, (i) they are causally independent; (ii) uni-directional causality from S to I; (iii) uni-directional causality from I to S; and (iv) bi-directional causality between I and S.

Finally, with the finding of cointegration, we estimate a level VAR model to further assess their dynamic interactions. More specifically, as a basis for inferences, we simulate variance decompositions (VDC) and impulse response functions (IRF). As the name implies, the VDC decomposes the error forecast variance of a variable of interest to its own shock and shocks in other variables. Thus, it captures the relative importance of each shock to the variations in the variable of interest. Meanwhile, the IRF traces the response of a variable concerned to a one-standard deviation shock of the variables in the model. The function, thus, indicates the direction, magnitude and persistence of the impacts of various shocks to the variable of interest, which in our case, is the aggregate investment.

DATA PRELIMINARIES

The data are quarterly from 1991.Q1 to 2007.Q2, the span of which is dictated by data availability. In the analysis, we use gross fixed capital information deflated by the consumer price index to represent real gross investment. Real output is measured by real gross domestic products. Meanwhile, the average lending rate less realized annual inflation rate is used as a measure of real lending rate. Finally, the real share prices are the Kuala Lumpur Composite index deflated by the consumer price index. The main sources of the data are *the International Financial Statistics* (CD-ROM) by the IMF and *Monthly Statistical Bulletin* (various issues) published by Bank Negara Malaysia.

Figure 1 provides the time-series plots of these variables. Three aspects of the plots are notable. First, real aggregate investment tends to move in tandem with real GDP and stock prices. The simple correlation between investment and GDP is 0.36. Meanwhile, the correlation between investment and share prices is 0.58. However, its relation to real interest rate is not clear cut. Second, all variables declined substantially during the time of crisis in mid-1997 and 1998. Finally, as should be expected, the real GDP data exhibit seasonal patterns. On the first point, the plots are indicative of positive relations between investment on one hand and real output and share prices on the other hand. This motivates a formal analysis such that the observed relation is not spurious. In light of the second and third observations, we incorporate both crisis and seasonal dummies in our analysis of their long run relations and short run dynamic interactions.

As is imperative in any time series analysis, we first implement ADF and PP unit root and Johansen-Juselius cointegration tests to examine the variables' temporal stochastic properties. The results of unit root tests and cointegration test are given in Table 1 and Table 2 respectively. As may be noted from Table 1, all variables are integrated of order 1, or I(1). That is, they are non-stationary in level form but

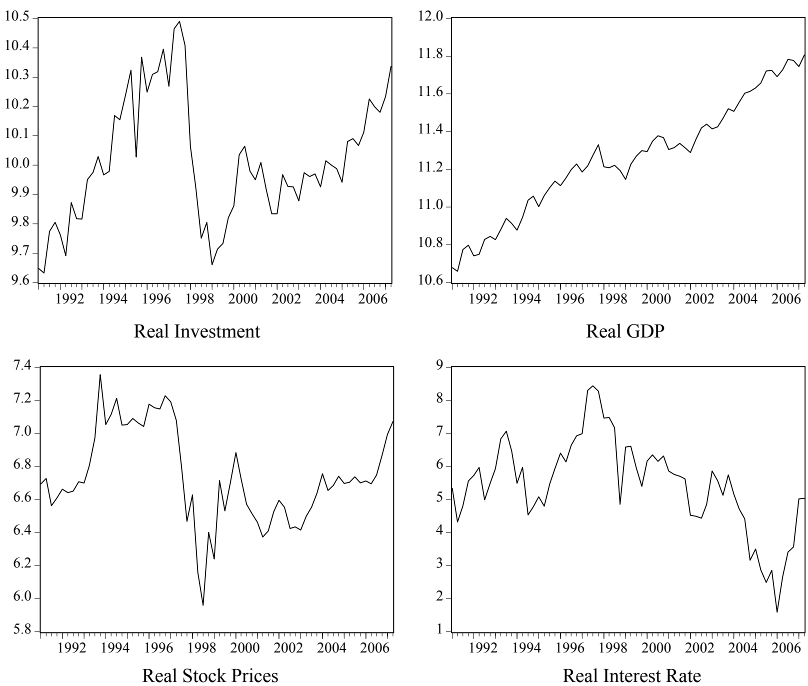

Figure 1 Time-Series Plots of the Variables

Table 1 Unit Root Tests

	ADF		PP	
Variables	***X***	**Δ*X***	***X***	**Δ*X***
I	-2.259	-9.406*	-2.223	-9.348*
Y	-1.862	-3.899**	-2.902	-10.67*
S	-2.785	-4.257*	-2.291	-9.152*
R	-2.771	-9.070*	-2.564	-9.026*

Note: The test equations include drift and trend terms. The lag order of the ADF test is based on the AIC. * and ** denote significance at 5% and 1% respectively.

Table 2 Cointegration Test

Test	**Null Hypothesis**			
Statistics	***r = 0***	***r* £ *1***	***r* £ *2***	***r* £ *3***
Trace	56.345	13.993	4.249	0.013
Max	42.352	9.744	4.236	0.013
Critical Values (5%)				
Trace	47.856	29.797	15.495	3.841
Max	27.584	21.132	14.265	3.841

Note: The VAR includes crisis and seasonal dummies and its lag order is 1.

stationary in first difference. This allows us to proceed to cointegration test. In specifying the vector error correction model for the Johansen-Juselius test, we place the requirement of non-correlated errors in all equations. The lag order is set to 1, which we find sufficient to render the error terms uncorrelated. From table 2, we uncover evidence supporting a unique cointegrating vector among the variables. It is pleased to note that over-fitting the VECM by increasing the lag order to 2 does not affect the results. Likewise, adjusting both trace and maximal eigenvalue statistics for small sample bias as suggested by Reinsel and Ahn (1992) does not overturn the presence of cointegration among them. Thus, aggregate investment shares a long-run relation with its determinants, namely, real output, real interest rate and real share prices.

ESTIMATION RESULTS

This section reports estimation results. We first discuss the long-run and short-run dynamics of aggregate investment based on a vector error correction modeling.

Further analyses based on Granger non-causality test, variance decompositions and impulse-response functions are then presented.

Vector Error Correction Modeling

Given the presence of a long run relationship between aggregate investment and its determinants, we extract the following cointegrating equation from the Johansen-Juselius procedure (the number in parentheses are t-ratios):

$$I_t = 1.594 + \underset{(5.362)}{0.315Y_t} + \underset{(0.084)}{0.0013R_t} + \underset{(13.09)}{0.722S_t} \tag{4}$$

From the equation, we may note positive and significant long-run relationships between investment and real output and real share prices. The real interest rate coefficient, however, is not statistically significant. Relevant to our focus, the results suggest favorable effect of real stock prices on aggregate investment in the long-run, lending support to the presence of balance sheet and/or external financial cost effects. Note that the estimated long-run coefficient of real stock prices is higher. Using the static OLS or ARDL approach to obtain the long-run coefficients yields similar results. However, in the case of static OLS, the interest rate coefficient is significant.

Table 3 presents the VECM estimation results. As can be noted from the table, both real aggregate investment and real output bear the burden of making adjustments once the investment deviates from its long-run value. In other words, shocks in the included variables leading to deviations from their long-run path are corrected by changes in investment and output. The adjustment of aggregate investment seems to be fast, namely, 54.5% of the disequilibrium is corrected by aggregate investment changes next period. Real output also seems to adjust downward, perhaps in anticipation of aggregate investment decline. Note that the error correction coefficient for the investment equation is higher as compared to that of the output equation, which is reasonable given the relatively high volatility of investment. The error correction coefficients for real interest rate and stock prices are not significant at even 10% significance level, suggesting weak exogeneity of these variables in the system.

Several notable results emerge from the short-run coefficients, i.e. the coefficients of lagged first-differenced terms. First, the coefficients of lagged changes in stock prices are significant in both real investment and output equations, underlying the significant role of the stock market in real activity for Malaysia even in the short run. However, they are signed negatively. Since changes in stock prices are essentially cyclical variations in the stock market, they capture short run stock market fluctuations or volatility. In other words, in the short run, stock market fluctuations can have adverse effect on the economy. Meanwhile, the long run

Table 3 VECM Estimation Results

Ind. variables	Equations ΔI	ΔY	ΔR	ΔS
ECT_{t-1}	-0.545*	-0.117*	1.481	0.222
	(5.636)	(3.889)	(1.634)	(1.184)
ΔI_{t-1}	-0.051	0.069***	1.072	-0.186
	(0.428)	(1.876)	(0.970)	(0.817)
ΔY_{t-1}	-0.480	-0.138	-0.422	0.425
	(1.095)	(1.014)	(0.103)	(0.500)
ΔR_{t-1}	0.039*	0.002	-0.140	0.056**
	(2.806)	(0.504)	(1.072)	(2.088)
ΔS_{t-1}	-0.179**	-0.047***	0.326	-0.167
	(2.273)	(1.919)	(0.440)	(1.094)
Constant	-0.029	-0.033*	0.114	0.043
	(1.435)	(5.175)	(0.596)	(1.088)
Crisis	0.003	0.006	-0.952**	-0.265*
	(0.063)	(0.407)	(2.163)	(2.914)
Q2	0.059***	0.066*	0.202	-0.024
	(1.747)	(6.286)	(0.635)	(0.365)
Q3	0.052***	0.088*	-0.194	-0.064
	(1.846)	(9.938)	(0.730)	(1.169)
Q4	0.086*	0.054*	-0.082	0.020
	(2.595)	(5.242)	(0.263)	(0.317)
Adjusted-R^2	0.5461	0.7135	0.0465	0.1755

Note: numbers in parentheses are absolute values of t ratios. *, **, and *** indicate significance at 1%, 5% and 10% respectively.

trending behavior seems to be directly related to investment and output. Second, we may also note positive and significant coefficients of changes in the lending rate in the investment and stock price equations, which contradicts the conventional wisdom. Finally, in the short-run, private investment exerts positive influences on real output. Thus, real investment seems to serve as a channel through which the stock market affects real activity.

It should be noted that the above interpretation should be taken with caution. It is well noted that the VECM or VAR coefficients are difficult to interpret since the variables are interacting dynamically with feedback effects. The VECM short-run coefficients, however, only represent the impact effects, holding other right-hand-side variables constant. Thus, they do not fully reflect dynamic interactions among the variables. As a further analysis, we now turn to dynamic causal interactions among the variables using Granger non-causality test, variance decompositions and impulse-response functions.

Further Analyses

To further analyze dynamic causal interactions among the variables, we first implement the Toda-Yamamoto's (1995) Granger non-causality test. Then, we estimate a level VAR model and simulate variance decompositions and impulse-response functions. In simulating VDC and IRF, the variables are placed in the following order: Y, I, R and S. This stems from our contention that output is most exogenous affected by other variables with lags while stock prices are the most endogenous. Still, it is pleased to note that alternative orderings of the variables do not materially affect our main findings. Table 4 reports the Granger non-causality test results. Meanwhile, Table 5 presents the variance decompositions and Figure 2 plots the impulse response functions. In the estimation, the optimal lag order is set to 3, which we find sufficient to render the error terms uncorrelated.

Table 4 Toda-Yamamoto Granger Non-Causality Test

Dependent Variables	Lagged right-hand-side variables			
	I	***Y***	***S***	***R***
I	—	0.996 [0.404]	10.16 [0.000]	0.997 [0.404]
Y	1.711 [0.180]	—	6.156 [0.002]	2.928 [0.045]
S	0.226 [0.878]	1.391 [0.259]	—	2.904 [0.046]
R	5.224 [0.004]	1.827 [0.157]	3.928 [0.015]	—

Note: numbers in squared brackets are p-values. The optimal lag order for the VAR is 3.

These further analyses unequivocally suggest the significant causal role of the stock market to real economic activities. From Table 4, the null hypothesis of Granger non-causality from the stock prices to real investment and to real output is rejected at even 1% significant level. The results also suggest bi-directional causality between stock prices and lending rate. Then, in Table 5, after 12-quarter horizon, innovations in stock prices account for roughly 63% and 31% of the variations in respectively real investment and real output. These results are in line with the previously noted finding that the real investment tends to respond more strongly to the stock market disturbances than real output does. As may be observed from Figure 2, in response to a one-standard deviation shock in real stock prices, both real investment and output increase significantly after 3 quarters. Their significant responses last to 2-years horizon. Again, reaffirming the relatively high fluctuations of real investment, the magnitude of its response to stock price shocks is higher. Note that the bi-directional causality between real stock prices and lending rate is further reflected in the variance decompositions, where interest rate shock tends to explain variations in stock prices at short-horizon while stock price shocks affect lending rate at longer horizon. This causal pattern is, however, not captured

Table 5 Variance Decompositions

Period	S.E.	*I*	*Y*	*S*	*R*
(i) *Variance Decompositions of I*					
1	0.080	87.174	12.826	0.000	0.000
3	0.098	66.795	12.017	13.356	7.831
6	0.143	33.483	7.823	51.032	7.662
12	0.193	20.476	11.429	63.172	4.923
24	0.293	14.042	16.236	66.788	2.934
(ii) *Variance Decomposition of Y*					
1	0.022	0.000	100.00	0.000	0.000
3	0.037	1.566	76.428	14.789	7.221
6	0.056	6.868	47.986	29.951	15.194
12	0.077	11.291	47.534	31.902	9.273
24	0.104	13.245	51.531	29.164	6.060
(iii) *Variance Decomposition of S*					
1	0.147	4.687	0.0029	83.473	11.838
3	0.179	3.782	1.9970	84.542	9.680
6	0.213	3.746	2.776	85.729	7.748
12	0.265	7.028	8.026	78.282	6.663
24	0.395	10.222	12.044	73.780	3.954
(iv) *Variance Decomposition of R*					
1	0.344	0.058	0.199	0.000	99.743
3	0.743	5.937	8.476	0.246	85.341
6	0.896	18.320	12.269	1.186	68.225
12	1.094	21.732	9.154	23.182	45.931
24	1.604	22.321	8.137	46.381	23.161

Note: the lag order of VAR is 3. The variables' ordering: Y, I, R and S.

in the impulse response function. More specifically, we observe only negative impact response of stock prices to interest rate shocks.

From Figure 2, there seems to be a bi-directional causality between investment and lending rate as suggested by Granger non-causality test in Table 4. The variance decompositions in Table 5 also suggest the significant explanatory power of investment innovations to variations in lending rate, which is further reaffirmed by the impulse response functions (Figure 2). Apart from real stock prices, variations in output explain quite substantially the forecast error variances of real private investment. Namely, more than 10% of the variations in aggregate investment is attributable to shocks in real output at almost all horizons reported (Table 5). Likewise, innovations in investment account for sizable portion of the variations in output, reaching 13% after 24-quarter horizon. It should be noted that this pattern of causation is not reflected in the impulse-response function except the immediate response of investment to output shocks (Figure 2).

In sum, while uncovering several other interesting results, these further analyses further reaffirm the important role of the stock market to Malaysia's investment and output. The preponderance of the evidence tends to indicate positive influences of

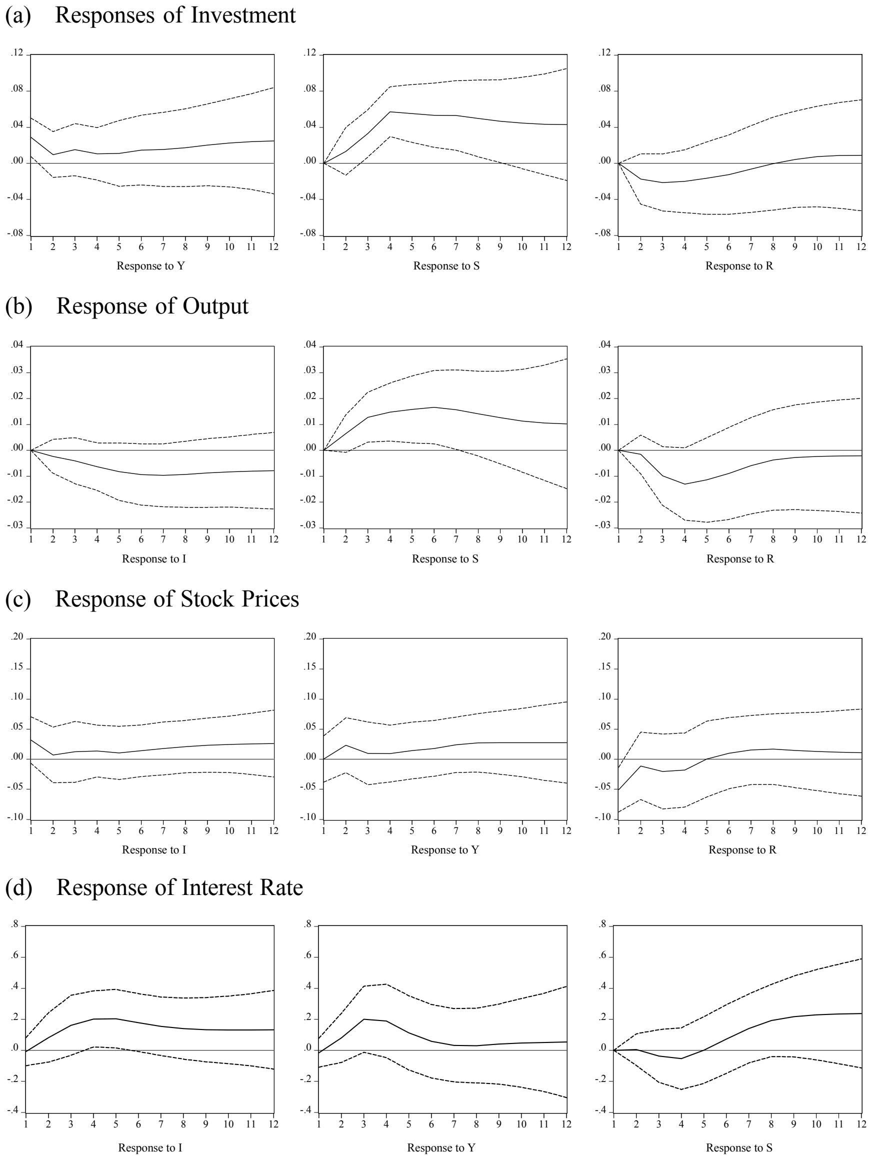

Figure 2 Impulse-Response Functions

the stock market on the two variables especially over the longer horizons. These are in line with the VECM results noted earlier. However, taken together, our results do not rule out adverse real consequences of cyclical variations or volatility in the stock market.

CONCLUSION

The high stock price fluctuations following market liberalization of many emerging economies has created great concern over its impact on the economy. While it is argued that the long term trend in the share prices may anticipate or even lead future real activities, whether their fluctuations have favorable or adverse consequences on real output and investment have not yet been settled. In this paper, we model aggregate investment behavior for Malaysia along the line of the neoclassical investment theory and incorporate stock prices in the analysis to examine potential role played by stock price movements. In the paper, we make use of various time series techniques to uncover the long-run investment function as well as to look at dynamic causal interactions between aggregate investment and its determinants. These include cointegration analysis, vector error correction modeling, Toda and Yamamoto's non-causality test, and simulated variance decompositions and impulse-response functions.

The evidence we obtained suggest strongly the significant role of stock prices to aggregate investment as well as real output. More specifically, real stock prices enter positively in the long-run investment equation. Then, once there are shocks that throw the variables out of their long-run path, both real aggregate investments and real output bear the burden of making adjustments, which indicate the long-run causality from stock prices to both investment and output. The significant role played by the stock market is further reaffirmed by the non-causality test, variance decompositions and impulse response functions. Namely, they all suggest the causal role of stock prices in influencing aggregate investment. Apart from these results, we also note that cyclical variations or volatility of stock prices can have adverse real consequences. In short, the stock market does exert favorable influences on real activities especially over the long run, highlighting the importance to further develop the market in emerging economies. However, their short run fluctuations and volatility require moderation. This necessitates further research to understand stock market development and volatility.

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