Private Investment: Trends and Determinants in Thailand

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Abstract

The paper examines patterns and determinants of private investment in a view to understand the yet fully recovery of private investment in South East Asia, using Thailand as a case study. The private investment equation is estimated during the period 1960-2005, based on the extended version of neoclassical investment theory. We find that since the outbreak of Asian financial crisis in 1997, private investment in Thailand has borne the brunt of aggregate demand contraction. It was capital funds shortage rather than existing spare capacity that hinders the recovery of private investment in Thailand. The availability of capital funds should be prioritized to ensure that potential and prudential investors can access credit adequately. In the long run, private investment is mostly determined by business opportunity and investment costs. Government could play a role in promoting long-term private investment mainly through creating conducive investment climate.

Key words: investment-saving glut, investment determinants, Thailand
JEL: O11, O16, O53

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I. Issues

Private investment plays a vital role in a growth generating process in developing Asian economies. Even though investment typically represents a much smaller component of aggregate demand than does consumption, it determines the rate at which physical capital is accumulated. Hence, it plays an essential role in the expansion of the economy's production capacity and long-term economic growth. Private investment becomes even more policy relevant in the recent years as after the 1997 financial crisis, the private investment in the crisis-affected countries has not yet fully recovered. Such a slow recovery process could hinder efficiency of resource use and generate a negative signal to foreign investors (Chhibber *et al.*, 1992).

The movements of private investment in crisis-affected Asian economies also becomes policy relevant worldwide while there is a recent concern of the persistent global payment imbalances, reflecting in the growing current account deficit mainly in the US and surplus in Asian and oil-exporting economies. For Asian economies, except for China, instead of an increase in saving rate, it has been the private investment drought that induced these Asian countries run successive current account surplus.[1] Hence, examining factors hindering the recovery of private investment in these countries would also assist to redress the global imbalances problem.

The existing empirical evidence on the determinants of private investment, particularly for developing Asian economies, has been subjected to a key concern. Given the nature of data availability, research on this issue has been dominated by multi-country cross-sectional regression analysis.[2] The clear fundamental limitation of multi-country cross-sectional analysis is that it is based on the implicit assumption of 'homogeneity' in the observed relationship across countries. This is a very restrictive assumption because there are considerable differences across countries in relation to various structural features and institutional aspects, which have a direct bearing on private investment behaviour. In addition, there are also vast differences

[1] Such policy relevance is reflected in remarks by Governor Fedearal Reserve Board, Ben S. Bernanke, *The Global Saving Glut and the US Current Account Deficit,* available at http://www.fedearlreserve.gov/boarddocs/speeches/2005/

[2] See for example Sundarajan and Thakur (1980), Blejer and Khan (1984), Rama (1993), Oshikoya (1994), and Aizenman and Marion (1999). For indidual country studies, see Chhibber et al. (1992) and Pattillo (1998).

among countries with respect to the nature and quality of data, which make cross-country comparison a rather risky business. To the best of our knowledge so far, the most comprehensive single-country time series analysis is by Chhibber *et al.* (1992), which is an edited volume of seven in-depth developing-country studies covering all regions in the world. Their outcomes are dated but pointing to significant variations in the magnitude of the relationship between investment and its determinants. This suggests that data should not be pooled without caution.

This concern points to the need for undertaking in-depth time-profile analysis of private investment in individual country, by appropriately combining quantitative analysis with qualitative information on country-specific features in order to build a sound empirical foundation for informing the policy debate. Unfortunately, systematic country studies of this nature are few and far between. Therefore, this paper aims to examine patterns and determinants of private investment, using Thailand as a case study. A single equation of private investment determinant is estimated where a comprehensive set of explanatory variables are well defined and incorporated with a view to understand the yet fully recovery of private investment.

Thailand is a suitable case study for the subject at hand for three reasons. Firstly, during the past three decades, Thailand exhibited a boom and bust cycle in private investment. After the recent 1997 crisis, private investment in Thailand has not fully recovered. Its share to GDP has not only been lower than the average level of the past three decades, but also relatively low comparing with the other crisis-affected countries in the region. Hence, the analysis of patterns and determinants of private investment in Thailand would not only contribute to the ongoing debate in policy circle but also shed light for other developing countries in designing policy to promote private investment.

Secondly the incomplete recovery of private investment seems to be involved several factors such as real exchange rate depreciation, credit availability and excess capacity, some of which have theoretically ambiguous effects on investment. Their relative importance is also crucial for forming policy to speed up the investment recovery so that this requires a systematic empirical analysis.

Finally, there has not been any systematic and up-to-date study of private investment in Thailand.[3] The recent study was Mallikamas *et.al*. (2003) who estimated private investment function in Thailand but their results are subject to two serious limitations. The first limitation is they ignored a number of key variables such as public investment and uncertainty whose impacts on private investment are found to be significant in many developing countries (Chhibber *et al.* 1992). Secondly, the proposed functional form for estimation is problematic. It is based mainly on the Tobin's *q* theory which has met very limited empirical success in developing countries (Agènor, 2001). This is especially true for Thailand where total capital in the stock market was only around 7 percent of total capital stock in the country in 2001-05.

The rest of the paper is structured as follows. Section II provides an analysis of patterns of private investment in the Thai economy in order to set the stage for the empirical analysis. The analytical framework is presented in Section III. Time series properties of data and the econometric procedures are described in Section IV and V, respectively. Section VI presented and discussed regression results. The final section summarizes key inferences.

II. Patterns of Private Investment in Thailand

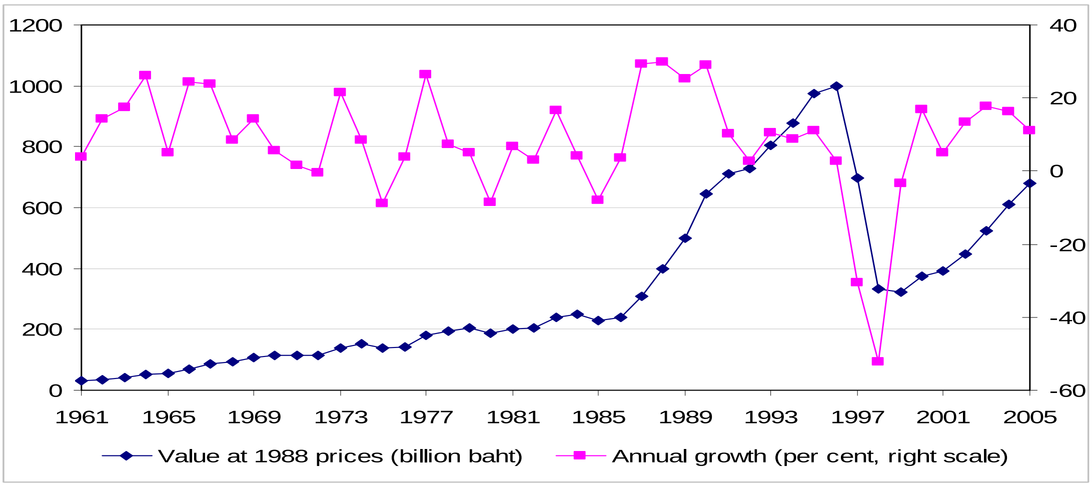
Thailand experienced a boom in private investment between 1986 and 1996 before the financial crisis starting in mid-1997 ended its boom. Before 1986, the real value of private investment was around 135 billion baht while its average annual growth was 9 per cent (Figure 1).[4] From then on, private investment took off. Its value increased to 700 billion baht in 1991 and reached the peak of 1 trillion baht in 1996. Its annual growth rate during the boom period averaged out at around 15 per cent. The Asian financial crisis starting in mid-1997 affected private investment significantly and in 1998, the real value of private investment sharply dropped to 300 billion baht and its

[3] Nidhiprabha (1994) developed investment function according to the neoclassical investment model during the period 1979-92. Nonetheless, the result was dated and subjected to the inappropriate treatment of time series property of data. The other two studies are Vines and Warr (2003) and Jongwanich (2005) whose investment function is estimated as a part of the macro-econometric model. Only in the later where private investment function is determined in line with investment function relevant for developing countries.

[4] Caution is needed when considering the average annual growth during this period 1961-1985 because the annual growth rates in the 1960s can be affected by the low absolute value of investment.

growth rate registered at -52 per cent. This was the largest contraction of private investment over the past four decades. Even though private investment has resumed its positive growth rate since 2000, its real value was still far lower than that during the boom period, e.g. private investment for 2054 was 680 billion baht, around half of that in 1996.

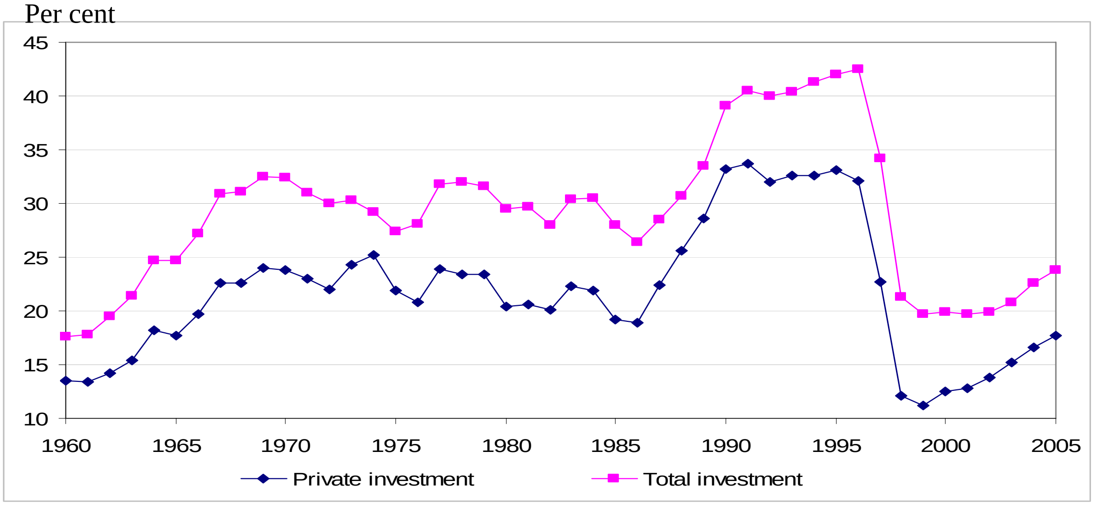
Figure 1
Value and (Per cent) Annual Growth of Private Investment in Thailand 1961-2005



Source: The National Economic and Social Development Board

Figure 2 illustrates private and total investments as a percentage of GDP during the period 1960–2005. The gap between private and total investments indicates the percentage share of public investment. Over the past four decades, private investment accounted for the bulk of total investment, 74 per cent on average, while public investment was more or less constant. This figure reveals that private investment as a share of GDP has not been fully recovered since the financial crisis in 1997. Its share of GDP remained at around 18 per cent in 2005, which was lower than the average level during the period 1960-1986, pre-boom period. The public investment, which has mostly concentrated on infrastructure, was used as an instrument to counter business cycles as observed by the decreased and increased shares of public investment during the period 1988–89 and 1999–2002.

Figure 2
The Share of Gross Fixed Capital Formation to GDP in Thailand, 1960-2005



Source: The National Economic and Social Development Board.

The investment slowdown tended to occur in all production sectors. In Table 1, a share of total investment to GDP was disaggregated into nine sectors, namely agriculture, mining and quarrying, manufacturing, construction, ownership and dwellings, transportations and communications, wholesale and retail trade, banking, and other services. All of them significantly declined during the recent financial crisis and have showed a slow pace of their recovery afterwards. The slow recovery of all private investment sectors rather than a specific sector implies that they could have some common factors hindering such recovery.

Table 1: The Share of Disaggregated Private Investment, 1986-2005

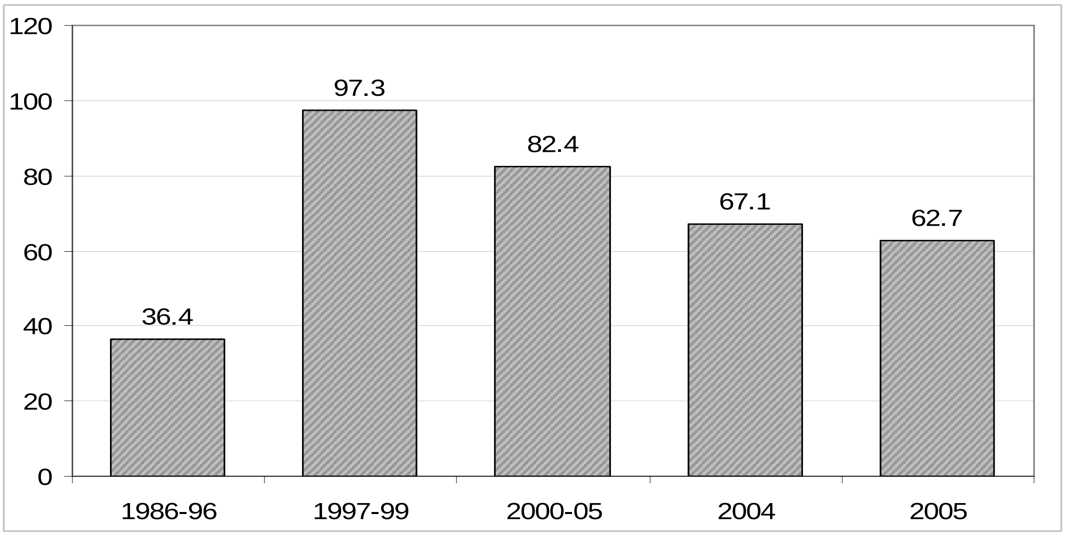
	Total	Agriculture	Mining and Quarrying	Manufacturing	Construction	Ownership of Dwellings	Transportation and Communication	Wholesale and Retail Trade	Banking, Insurance and Real Estate	Services
1986-96	29.5	1.2	0.5	6.9	1.3	8.0	4.4	3.6	0.6	3.0
1997-99	15.3	1.1	0.2	3.9	0.4	2.6	3.4	1.7	0.4	1.6
2000-05	14.8	0.8	0.2	3.5	0.6	3.0	2.8	1.8	0.3	1.6
2001	12.8	0.7	0.2	3.2	0.5	2.5	2.5	1.5	0.3	1.5
2002	13.8	0.9	0.2	3.3	0.4	3.0	2.7	1.5	0.3	1.5
2003	15.2	0.9	0.2	3.7	0.6	3.2	2.9	1.7	0.3	1.6
2004	16.6	0.9	0.3	4.0	0.8	3.6	3.0	2.0	0.3	1.7
2005	17.7	1.1	0.3	4.3	0.8	3.7	3.3	2.1	0.4	1.7

Source: The National Economic and Social Development Board.

Over and above the relatively low level of private investment in all sectors, its decomposition into new and replacement investments has raised more concern on economic growth sustainability. According to the perpetual inventory method, i.e. changes in net private capital stock plus depreciation are total investment, most of investment flows undertaken in the post-crisis period has been so far for replacement rather than the new investment. The latter is likely to be more beneficial to long-term economic growth as it would expand a country's production capacity. Figure 3 shows the percentage share of replacement investment measured by depreciation allowance between three periods, namely boom, crisis and crisis aftermath. The percentage share of replacement investment to total private investment in the crisis aftermath period was to some extent close to that in the crisis period but far higher than that in the boom period.

Figure 3
The Percentage Share of Replacement Investment to total Private Investment during 1986–2004

Per cent



Source: The National Economic and Social Development Board.

III. The Analytical Framework and the Model

The determinants of private investment in this study are based on the framework of the neoclassical model (Jorgenson, 1967 and 1971) with modification, in which relevant structural features of developing countries are taken into consideration. The basic premise of the neoclassical investment model is that firms' maximize utility of a consumption stream subject to a production function relating the flow of output to the flows of labour and capital services (Jorgenson, 1967: p.136). The firm supplies capital services to itself through the acquisition of investment goods. The demand for capital is therefore a derived demand. Under the Cobb-Douglas production function, the desired capital stock could be derived to positively relate to the planned output level (Y^e) and negatively relate to the expected rental cost of capital (C) as follows:

$$K_t^* = \alpha Y_t^e C_t^{-1} \tag{1}$$

where α is the distribution parameter

Cost of capital is composed of three components as expressed in equation (2). The first component is the opportunity cost which is measured by the interest that the firm would receive if it sold the capital goods and invested the proceeds. This cost is rPk_t where Pk_t and r denote the price level of capital goods and the nominal bank lending rate, respectively. The second component is depreciation of the capital goods, measured by δPk_t where δ is the rate of capital depreciation. The last component captures the capital gain/loss resulting from expected changes in price of capital goods, $\Delta Pk_t = \pi_t^e Pk_t$ where π_t^e is the rate of expected changes in price of capital goods. All of them are deflated by the general price (P) into real terms.

$$C_t = Pk_t \frac{\left(r + \delta - \pi^e{}_t\right)}{P} \tag{2}$$

Gross private investment (I) is defined as in equation (3);

$$I_{i,t} = \Delta K_{i,t} + \delta K_{i,t-1} \tag{3}$$

That is, gross private investment is composed of net and replacement components. The former is equal to changes in capital stock whilst the latter is taken to be proportional to the capital stock available at the previous period. It is noteworthy that in the short run where the actual stock of capital cannot reach the desired capital stock level, the private investment in equation (3) is a function of lagged investment and adjustment coefficient as expressed in equation (4);

$$I_{i,t} = \left[1-(1-\delta)L\right]\beta K^{*}_{i,t} + (1-\beta)I_{i,t-1} \qquad (4)^{5}$$

where β denotes the adjustment coefficient, and L is lag operator, (e.g. $LK^{*}_{i,t} = K^{*}_{i,t-1}$).

In the long run where firms invest in order to reach the desired capital stock, the desired investment can be determined by a distributed lag of the changes in desired capital stock as follows:

$$I_t = \sum_{j=0}^{J} \beta_j \Delta K^{*}_{t-j} \qquad (5)$$

Substitute the desired capital stock from equation (1) to equation (5), private investment is a function of output, cost of capital, and adjustment coefficient;

$$I_t = \sum_{j=0}^{J} \beta_j \Delta\left(\alpha Y^{e}_{t-j} C^{-1}_{t-j}\right) \qquad (6)$$

According to the literature survey in the previous section, β_j is usually a function of economic factors that influence the ability of private investors to achieve the desired level of investment. In the context of developing countries, the response of private investors is hypothesized as depending on several factors as follows;

(1) Availability of Financing (PDC),

According to McKinnon (1973), Shaw (1973), Sundararajan and Thakur (1980), Blejer and Khan (1984), and Athukorala and Sen (2002), the availability of financing would be a key factor influencing investment behaviour independently of the cost of capital. Available bank credit to the private sector would perhaps tend to be quantitatively the most important variable in determining the amount of actual investment (Gertler, 1988; and Hubbard, 1998) because equity markets have not been well developed and excess demand for credit typically exists. Thus, firms highly depend on bank credit for both their working capital needs and longer-term financing

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[5] For the details of this derivation see also Blejer and Khan (1984).

of capital accumulation. An increase in available credit to the private sector will in general encourage real private investment.

This view points out that the inclusion of credit constraint (PDC) as an explanatory variable in determining the adjustment of β_j is needed. This is especially relevant in Thailand where the presence of credit crunch and its effect has been in the policy circle since the beginning of the crisis (Siamwalla, 2004). Nonetheless whether it really constraints recovery of private investment has not been studied systematically.

(2) Public Investment (GI),

It is a well-accepted proposition that in developing countries (desirable) private and public investments are related (Sundararajan and Thakur, 1980; Blejer and Khan, 1984; and Athukorala and Sen, 2002). Nonetheless, its relationship can be either positive or negative, depending on the nature of public investment. When the public sector invests dominantly in infrastructure, public and private investment can complement each other. Hence, the relationship between public and private investments would be positive. In addition, if there is some slack in the economy (e.g. the onset of the crisis), an increase in public investment can encourage domestic demand expansion that induces an expansion of private investment. On the other hand, with limited physical and financial resources, an increase in public investment can 'crowd out' private investment thereby inducing a negative relationship.

(3) Economic Uncertainty (UC),

Economic uncertainty (UC) can also have an effect on the desired investment (Pindyck and Solimano, 1993; and Price, 1995; and Athukorala and Sen, 2002). An investment decision contains the property of irreversibility. Investment costs of setting up plants and installing equipment can be considered as sunk costs if capital, once installed, is industry specific and cannot be put to productive use in a different activity or if secondary markets are not efficient. The presence of a high degree of economic uncertainty can lead to an increase in opportunity costs —the cost of postponing or waiting for new information before deciding to invest— resulting in a reduction of (desirable) private investment. According to the previous studies, UC in developing countries can be measured in terms of the volatility of output growth (UC_O), inflation (UC_{Infla}), real exchange rate (UC_{RER}), and terms of trade (UC_{TOT}).

(4) Output Gap (*OUTG*),

Output gap (*OUTG*), the difference between actual output and potential output, is used as an indicator of demand conditions in good markets. It can have a pervasive effect on private investment (Sundararajan and Thakur, 1980; and Blejer and Khan, 1984). Its impact on investment is expected to be positive. When actual output is approaching its potential, this would indicate growing demand and encourage firms to expand their capacity in order to capture the increased demand. By contrast, when a country has excess capacity, i.e. there is a wider gap between actual and potential output, firms postpone their investment projects.

(5) Real Exchange Rate (*RER*).

The real exchange rate level (*RER*) could also influence the desired investment level. Its impact can either promote or retard private investment. Depreciation could lower the real income and wealth of the private sector, thereby lowering aggregate demand. A fall in domestic demand could induce firms to revise their expectations of future demand and postpone their investment plan. In addition, RER depreciation could raise the real cost of imported capital goods and then adversely affect private investment. However, RER depreciation raises the price of tradable goods relative to the price of nontradable ones. Hence this would help to stimulate investment in the tradable sector and if the positive impacts on this sector overwhelm the negative impact that could emerge in nontradable sector, total investment could increases (Agènor, 2001).

On the basis of the argument discussed above, the adjustment coefficient β_j in equation (6) can be expressed as:

$$\beta_j = b_0 + \frac{1}{\left(\Delta K_{t-j}\right)}\begin{bmatrix} b_1 PDC + b_2 GI + b_3 UC_O + b_4 UC_{\text{Infla}} + b_5 UC_{RER} + b_6 UC_{TOT} \\ + b_6 (Y / \overline{Y}) + b_7 RER \end{bmatrix} \quad (7)$$

For estimation purposes, the desired capital stock is approximated by the linear combination of the planned output and the real rental cost of capital, which is based on extrapolations of past value. With this assumption, substitute equation (7) into equation (6), the desired investment can be rewritten as

$$I_t^* = b_0 + \sum_{j=0}^{J} \theta_{1,j} g_{t-j}^{y} + \sum_{j=0}^{J} \theta_{2,j} g_{t-j}^{c} + \sum_{j=0}^{J} \theta_{3,j} PDC + \sum_{j=0}^{J} \theta_{4,j} GI + \sum_{j=0}^{J} \theta_{5,j} UC_O + \sum_{j=0}^{J} \theta_{6,j} UC_{\text{infla}}$$

$$+ \sum_{j=0}^{J} \theta_{7,j} UC_{TOT} + \sum_{j=0}^{J} \theta_{8,j} UC_{RER} + \sum_{j=0}^{J} \theta_{9,j} OUTG + \sum_{j=0}^{J} \theta_{10,j} RER \quad (8)$$

By and large, the discussion so far implies the empirical model of private investment is as follows;

$$I = f\left(g^{y},\ g^{c},\ PDC,\ GI,\ UC_O,\ UC_{\text{infla}},\ UC_{TOT}, UC_{RER}, OUTG,\ RER\right) \quad (9)$$

where *I* is the real private investment. The independent variables (with the expected signs are given in parentheses) are listed as follows,

g^{y} (+)	=	output growth
g^{c} (-)	=	growth of real cost of capital
PDC (+)	=	availability of financing
GI (?)	=	public investment
UC_o (-)	=	output growth uncertainty
UC_{infla}(-)	=	inflation uncertainty
UC_{TOT} (-)	=	terms of trade uncertainty
UC_{RER} (-)	=	real exchange rate uncertainty
OUTG (+)	=	output gap
RER (?)	=	real exchange rate

IV. Data and Variable Construction

Data series of investment, capital stock, and output were compiled from various issues of *National Income Account*, (National Economics and Social Development Board, Thailand). The data are annual data during the period 1960–2005 (the latest annual data available) at the constant price. Data related to private domestic credit, interest rate, world price, nominal exchange rate and terms of trade are compiled from *International Financial Statistics* (CD-ROM) (International Monetary Fund). In the selection and transformation of most of the data series, we have simply followed established practice in the field of research.

Total investment is measured by gross fixed capital formation (GFCF), which is further decomposed into private and public sector investment. The former covers both local and foreign owned enterprises whereas the later is defined as GFCF, net of public investment.

Regard to cost of capital, price of capital goods is proxied by the implicit price deflator of private investment. We cannot construct the price of capital from capital stock data because of the data limitation. Nevertheless, this would not create any major difference in our analysis because these two price deflators are highly correlated during the period 1960-2005. The general price level is proxied by GDP deflator instead of consumer price index (CPI) to measure the prices of all goods and services produced in the country. The latter measures the price of only the goods and services bought by the consumer which are dominated by food items. This would be appropriate to reflect the cost of living. Depreciation rate (δ) is constructed by dividing baht value of depreciation to that of capital stock.

Availability of financing (*PDC*) is measured by the ratio of private domestic credit to (nominal) GDP. Domestic lending rate is proxied by MLR rate. Economic uncertainty is represented by three-year moving average standard deviations of the change in macroeconomic variable in our interest, i.e. output, inflation, terms of trade and real exchange rate.

The real exchange rate is generally defined as the ratio between world prices adjusted by exchange rate and the domestic prices. The world prices are the weighted average of wholesale price index of major exporting countries for Thailand, using the export share during the period 2000-05 whereas the domestic price is represented by consumer price index. Export share is used on the basis of the superiority in representing the country's competitiveness than other possible weights such as total trade share or import shares (Warr, 1986). This is the commonly used measures of real exchange rate.

The output gap is measured by the ratio of actual (*Y*) to potential output ($\bar{Y}$). In this study, $\bar{Y}$ is generated according to the Hodrick-Prescott (HP) filter method (Hodrick and Prescott, 1997). While output gap can be generated by using the linear time trend method, the time series properties are not taken into account under this methodology. If output is non-stationary, and exhibits a stochastic trend, then the residual from removing a linear trend is still non-stationary. This would violate the usual assumption that the output gap is a mean-reverting variable. In contrast, using HP filter approach renders the output gap stationary over a wide range of smoothing value and it allows the trend to change over time. Hence, the HP filter is our preferable choice.

V. Econometric procedures

In line with the standard practice in time-series econometrics, the time series property of data was tested at the outset using the Augmented Dickey-Fuller (ADF) test. Test results are reported in Table 2. According to the test results, the variables under consideration do not have the same order of integration; the output growth (g^y), the growth of cost of capital (g^c), uncertainty of real exchange rate (UC_{RER}), uncertainty of inflation rate (UC_{Infla}), uncertainty of output growth (UC_O) and output gap (*OUTG*) are stationary (*I*(0)) while other variables are non-stationary (*I*(1)).

The fashionable cointegration econometric procedures, such as the two-step residual-based procedure adopted by Engle-Granger (1987), and the system-based reduced rank regression approach due to Johansen (1991, 1995), that are appropriate for the variables in the system being of equal order of integration are not applicable in our case. We opted to use the 'general to specific' (unrestricted dynamic) modelling procedure (Hendry *et al.*, 1984). The main advantage of this method is not only to be able to apply for the mixture of stationary and nonstationary data but also to be able to apply it for a small sample size study. In addition, recent Monte Carlo studies revealed that in the case of finite sample, this method gives precise estimates and valid *t*-statistics, even in the presence of endogenous explanatory variables (Inder, 1993; Hendry, 1995; Pesaran *et al*., 2001).

Table 2
Augmented Dickey-Fuller Test for Unit Roots, 1960–2005

Variables	*t*-statistics for level Without time trend[A]	*t*-statistics for level With time trend[B]	*t*-statistics for first difference[A]
I	-1.76 (2)	-2.79 (1)	-4.24 (1)*
g^y	-3.61 (0)*	-3.79 (0)*	-6.56 (1)*
g^c	-7.39 (1)*	-7.29 (1)*	-5.10 (5)*
PDC	-1.12 (1)	-2.11 (1)	-4.26 (0)*
UC_{RER}	-4.08 (0)*	-4.83 (0)*	-8.48 (0)*
UC_{TOT}	-2.39 (0)	-2.71 (0)	-6.80 (0)*
UC_O	-3.54 (3)*	-3.53 (3)*	-7.14 (0)*
UC_{Infla}	-2.94(1)*	-3.49(1)**	-5.51(3)*
$OUTG$	-3.71 (1)*	-3.64 (1)*	-4.55 (1)*
RER	-0.73 (4)	-4.14 (3)*	-4.39 (3)*
GI	-1.91 (1)	-4.15 (5)*	-4.23 (0)*

Note: The t-statistic reported is the *t*-ratio on γ_1 in the below auxiliary regression, in which * and ** denote the rejection of the null hypothesis at 5 and 10 per cent level respectively.

A: $$\Delta X_t = \gamma_0 + \gamma_1 X_{t-1} + \sum_{i=1}^{p} \beta \Delta X_{t-i} + \mu_t \qquad \text{(Without time trend)}$$

B: $$\Delta X_t = \gamma_0 + \gamma_1 X_{t-1} + \sum_{i=1}^{p} \beta \Delta X_{t-i} + \gamma_3 T + \mu_t \qquad \text{(With time trend)}$$

where X is the variable under consideration, T is a time trend and μ is the disturbance term. The lag length (*p*) are determined by the Akaike Information Criterion (AIC) to ensure the residual whiteness. Figures in parentheses indicate the order of augmentation selected on the basis of AIC. All variables are in logarithm formula. ΔY, ΔC, and *PDC* is measured in terms of ln(1+x).

The general to specific (GSM) procedure is to embed the relationship being investigated within a sufficiently complex dynamic specification, including lagged dependent and independent variables so that a parsimonious specification of the model can be uncovered. Under this procedure, estimation begins with an autoregressive distribution lag (ARDL) specification of an appropriate lag order:

$$Y_t = \alpha + \sum_{i=1}^{m} A_i Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{m} B_{ij} X_{j,t-i} + \mu_t \qquad (10)$$

where α is a constant, Y_t is the endogenous variable, $X_{j,t}$ is the j^{th} explanatory variable and A_i and B_{ij} are the parameters.

Equation (10) can be rearranged by subtracting Y_{t-1} on both sides and turns the set of explanatory variables in terms of differences representing the short-run dynamics. The lagged levels of both dependent and explanatory variables are still left in the rearranged functional form on the right-hand-side in order to capture the long-run multiplier of the system.

$$\Delta Y_t = \alpha + \sum_{i=1}^{m-1} A_i^* \Delta Y_{t-1} + \sum_{j=1}^{k}\sum_{i=0}^{m-1} B_{ij}^* \Delta X_{j,t-1} + C_0 Y_{t-m} + \sum_{j=1}^{k} C_1 X_{j,t-m} + \mu_t \qquad (11)$$

where $A_i^* = -\left[I - \sum_{i=1}^{m-1} A_i\right], B_{ij}^* = \left[\sum_{i=0}^{m-1} B_{ij}\right], C_0 = -\left[I - \sum_{i=1}^{m} A_i\right], \ C_1 = \left[\sum_{i=0}^{m} B_{ij}\right]$, and the long-run multiplier of the system is given by $C_0^{-1} C_1$.

Equation (11) is known as the error correction mechanism (ECM) representation of the model. This is the particular formulation generally used as the 'maintained hypothesis' of the specification search. The estimation procedure involves first estimating the unrestricted equation (11), and then progressively simplifying it by restricting statistically insignificant coefficients to zero and reformulating the lag patterns where appropriate in terms of levels and differences to achieve orthogonality. As part of the specification search, it is necessary to check rigorously at every stage even the more general of models for possible misspecification. Such checks will involve both a visual examination of the residual from the fitted version of the model and the use of tests for serial correlation, heteroskedasticity and normality in the residual, and the appropriateness of the particular functional form used. In particular, any suggestion of autocorrelation in the residual should lead to a rethink about the form of the general model. Furthermore, the structural stability test is conducted by employing the cumulative sum of recursive residuals (CUSUM), the cumulative sum of squares of recursive residual (CUSUMSQ), and recursive coefficients and residuals. Above all, theoretical consistency must be born in mind throughout the testing down procedure.

VI. Results

The final parsimonious estimate of the model, together with a set of commonly used diagnostic statistics, and long-run elasticities computed from the steady-state solutions to the estimated equation are reported in Table 3. The estimated private investment is statistically significant at the one-percent level in terms of the standard *F*-test and it performs well in terms of standard diagnostic tests for serial correlation (LM), functional form specification (RESET), normality (JBN), heteroskedasticity (ARCH), and whiteness of the regression residuals (DF). The Wu-Hausman test suggests no evidence of simultaneity for any of these variables. The cumulative sum of recursive residuals (CUSUM), the cumulative sum of squares of recursive residual (CUSUMSQ), and recursive coefficients and residuals suggest the stability of estimates.

Private investment tends to positively respond to output growth (g^y) in both the short and long run. In the short run, an increase in output growth by one percentage point (e.g. 7 to 8 per cent) leads to an increase in private investment by 1.2 per cent in the first period and 1.0 per cent in the following period.[6] In the long run, the impact of a percentage point increase in output growth promotes a growth rate of private investment by 12 per cent. The relatively large impact of output growth on private investment is consistent with findings in previous studies, which are based on other developing countries (e.g. Sundarajan and Thakur (1980) on Korean and Indian experience, Athukorala and Sen (2002) on India experience and Blejer and Khan (1984) on developing countries experience).

In the short run, it was found that both estimated coefficients corresponding to private domestic credit (*PDC*) and output gap (*OUTG*) are significantly different from zero with theoretical suggested signs. An insignificance of real rental cost of capital (g^c) in the short run would be due to the impact of credit availability that is likely to overshadow the short-run effect of cost of capital thereby preventing the role of the

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[6] $g^y = (\ln Y_t - \ln Y_{t-1}) = \ln\left(Y_t / Y_{t-1}\right) = \ln(1+g^y) \approx g^y_t$ so $\partial \ln I_t / \partial \Delta Y_t = \dfrac{\left(\Delta I_t / I_t\right)}{\Delta g^y_t} = 12$. When the output grows from 4 to 5 per cent, $\Delta g_t = 0.05 - 0.04 = 0.01$.

interest rate channel in determining the private investment. However, in the long run, real rental cost of capital is statistically significant and a one percentage point increase in this variable leads to a 1.6 per cent reduction in private investment.

Table 3
Determinants of Private Investment in Thailand: Regression Results

$$\Delta I = -0.97 + 1.18\Delta g^{y} + 0.99\Delta g^{y}(-1) + 0.46\Delta PDC - 0.02\Delta UC_{RER} - 0.01\Delta UC_{\text{Infla}} + 1.39\Delta OUTG$$
$$(-1.78)^{**}\,(1.60)^{**}\quad (2.74)^{*}\qquad (3.78)^{*}\qquad (-2.42)^{*}\qquad (-1.40)^{***}\qquad (2.10)^{*}$$
$$-0.16I(-1) + 1.89g^{y}(-1) - 0.17g^{c}(-1) + 0.38RER(-1) - 0.02UC_{\text{Infla}} + 0.11GI(-1)$$
$$(-4.59)^{*}\qquad (2.08)^{*}\qquad (-1.67)^{**}\qquad (3.33)^{*}\qquad (-1.54)^{***}\qquad (2.87)^{*}$$

Long-run response of the investment rate with respect to explanatory variables[2]

Output growth (g^y)	11.68 (2.26)*
Growth of real cost of capital (g^c)	-1.08 (-1.49)***
Real exchange rate (*RER*)	2.38 (3.19)*
Inflation uncertainty (UC_{infla})	-0.14 (-1.42)**
Public investment (*GI*)	0.70 (5.20)*

Adjusted R^2=0.94	$F(15,27)$ = 47.01*	*RESET*, $F(1,26)$=0.46 (p=0.50)
LM1,$F(1,26)$=0.25 (p=0.62)	*LM2*,$F(2,25)$= 0.48 (p=0.62)	*JBN*, $\chi^2(2)$=0.68 (p=0.71)
ARCH, $F(1,26)$=0.28 (p=0.60)	*DF*=-7.00*	*Chow*, $F(7,20)$=1.77 (p=0.15)

Notes: [1] The level of statistical significance denoted as: * = 5% , ** = 10%, and *** = 15%. All variables are measured in natural logarithms.

[2] Computed from the long-run (steady-state) solutions to the estimated model.

LM = Breusch-Godfrey serial correlation LM test
RESET = Ramsey test for functional form mis-specification
JBN = Jarque-Bera test of the normality of residuals
ARCH = Engle's autoregressive conditional heteroscedasticity test
DF = Dickey-Fuller test for residual stationarity (augmentation was not needed in terms of both the Akaike Information criterion and the Schwarz Bayesian criterion)
Chow = Chow test for predictive failure (the out-of-sample forecasting ability) conducted to test the ability of the equation estimated for the 1960-98 period (including dummy variables) to forecast the dependent variable for the post crisis period (1999-2005)

[3] Two dummy variables (i.e. D7879 and D9798) are included to capture effects of the second oil price shock and recent financial crisis causing unusual changes in private investment.

As postulated by the theory, an investment decision contains the property of irreversibility. The presence of a high degree of economic uncertainty can have negative impacts on private investment. There is no consensus as to what economic uncertainty variables are taken into consideration by private investors. They could vary from country to country. Hence, we undertake the sensitivity analysis seeking for the statistical significance of four alternatives of economic uncertainty. The findings suggest that only the coefficients corresponding to the uncertainty of real exchange rate (UC_{RER}) and inflation (UC_{Infla}) are found to be statistically significant.[7] The output and terms of trade uncertainty variables are not statistically significant in the case of Thailand. In the short run, the uncertainty of the real exchange rate and inflation can lead to a reduction in private investment. A one per cent increase in the real exchange rate and inflation uncertainties discourages private investment by 0.02 and 0.01 per cent, respectively. In the long run, the uncertainty of inflation (UC_{Infla}) still has an impact on private investment. An increase in this uncertainty by one per cent reduces the long-run private investment by 0.14 per cent.

We find the positive relationship between private and public investment (*GI*) in the long run reflecting the complementary nature of public and private investments in Thailand. An increase in *GI* by one per cent leads to an increase in private investment by 0.7 per cent. The positive relationship between *RER* and private investment is also found in the long run. A one per cent depreciation of *RER* (i.e. an increase in *RER*) leads to an increase in private investment by 2.4 per cent. The positive and significant coefficient corresponding to *RER* would simply reflect the nature of export-led growth economy in Thailand. The positive impact of *RER* depreciation on tradable sector tends to overwhelm the negative impacts that could emerge in the nontradable sector and the overall economy.

Note that value of lagged dependent variable (*I*(-1)) indicates the speed of adjustment of private investment to exogenous shock. The coefficient corresponding to *I*(-1) is quite low (i.e. 0.16). This implies that it will take a long time to dissipate the shock without any policy responses. According to the calculation, in Thailand, it takes approximately more than 20 years for private investment to fully adjust itself to

[7] See the sensitivity analysis in Appendix 2.

a given shock.[8] The slow recovery reflects the irreversibility nature of investment. The slow process is also found in Jongwanich (2005) where the Thai macro-econometric model is constructed. In particular, in Jongwanich (2005), private investment registers the lowest speed of adjustment, compared to other key macroeconomic variables such as consumption, exports, imports, etc. Such a slow recovery points to the demand for policy responses to promote private investment.

In order to examine the key factor hindering private investment recovery, the time patterns of all estimated variables are examined together with their estimated coefficients. After the 1997-98 crisis, the availability of capital funds tends to be a key factor that hinders the recovery of private investment as only *PDC* has showed a downward trend after the crisis. Movements of other variables seemed to support private investment recovery, i.e. there was an upward trend of economic growth and output gap while real cost of capital, real exchange rate and inflation uncertainty were kept at the relatively competitive level. In particular, the upward trend of *OUTG* with its value that exceed one pointed out that production capacity tended to be fully utilised during 2000-05 so that concerns about the presence of excess capacity that would hinder the private investment recovery is limited.[9]

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[8] The number of years to clear *X* percent of an exogenous shock through "automatic adjustment" alone can be computed from the formula $(1-X)=(1-|\hat{A}|)^T$, where $\hat{A}$ is the estimated coefficient of I_{t-1}, and *T* is the required number of years.

[9] Note that the generated *OUTG* variable in this study is consistent with the time pattern of the capacity utilization index constructed by Bank of Thailand (Figure 5). To compare these two series, we normalize these two series by their historical peak levels, i.e. we normalized the capacity utilization index of the bank of Thailand by its 1995 level and the output gap by its 1996 level. The normalized figures of both indices show the low level of spare production capacity during the period 2000-05, i.e. 88 and 94 per cent of their peak level for capacity utilization index and output gap, respectively.

Figure 5: Comparison between Capacity Utilization of the Bank of Thailand and Generated Output Gap, 1995-2005

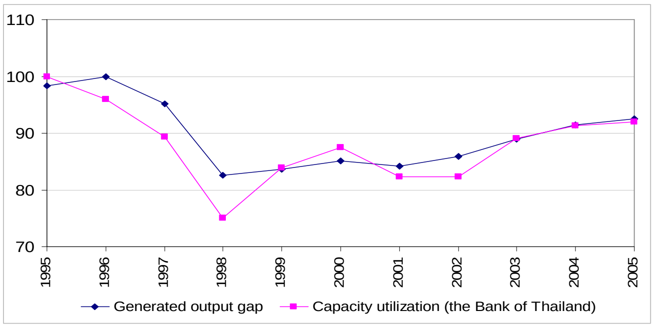
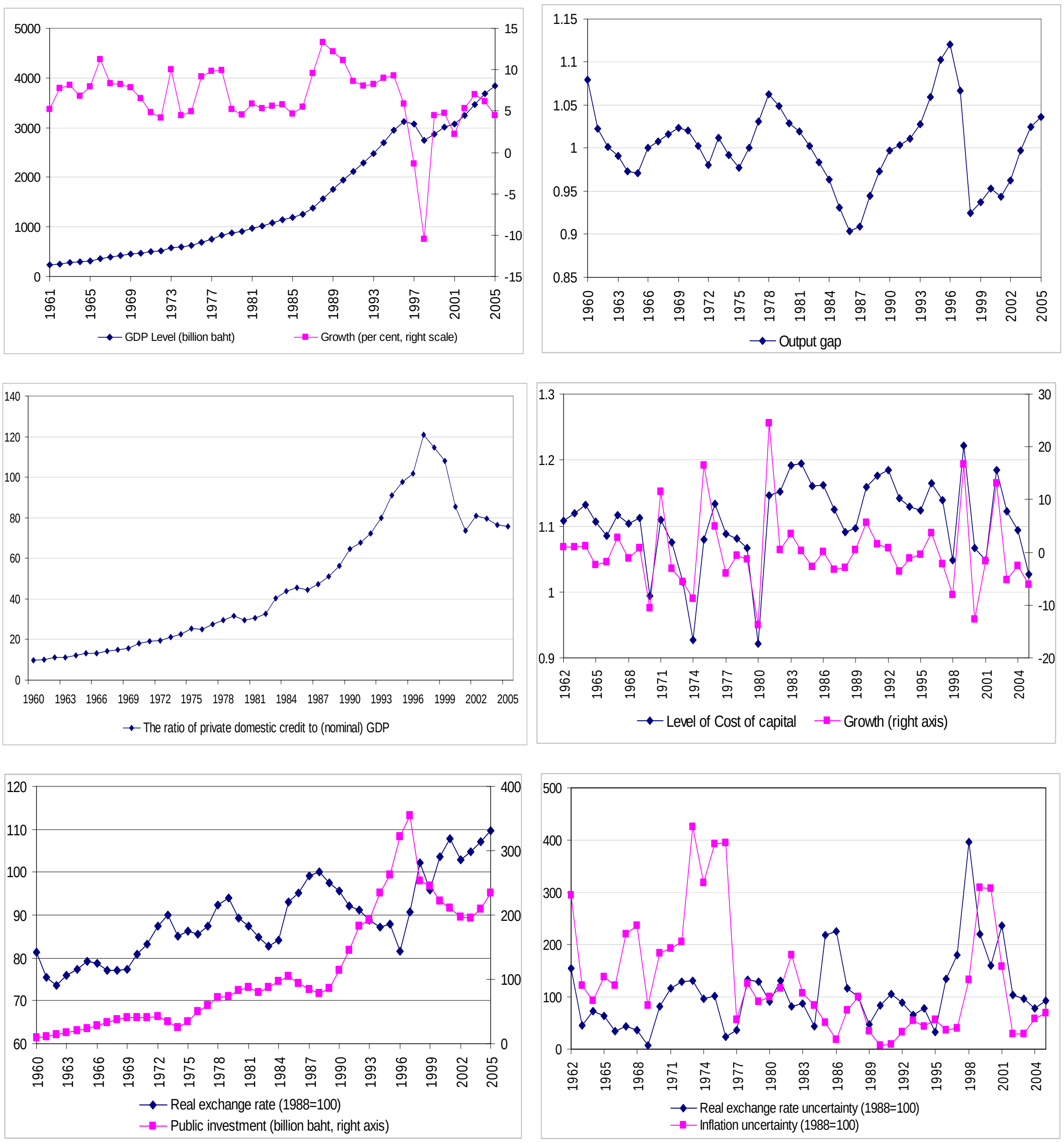


Figure 4: Time Patterns of Variables in Estimated Equation, 1960-2005



Sources: The National Economic and Social Development Board, International Financial Statistics (IFS, CD ROM), IMF and author's calculation.

The concern on availability of capital funds seems to be more pronounced as loans tended to be allocated more for personal consumption as opposed to investment projects. Table 4 shows that allocation of loans from financial institutions to personal consumption significantly increased, particularly from financial companies. The proportion of personal consumption credits to total credits in financial companies increased dramatically from 30 per cent in 1990-96 to 86 per cent in 2005. Such

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Sources: The National Economic and Social Development Board, the Bank of Thailand and author's calculation.

increases were contributed by reductions of loans allocated to all investment components, particularly construction and manufacturing. For commercial banks, the ratio of personal consumption loans to total loans increased to almost 20 per cent in 2005, from 12 per cent before the crisis period. Even though the decline in loans allocated to construction and trade contributed significantly to the higher ratio of consumption loans, the declining trend of credits allocated to manufacturing raised concerns on future exports and growth sustainability.

Table 4: The Proportion of Loans from Commercial Banks and Financial Company Classified by Type of Businesses (per cent of total loans)

	1990-96	1997-99	2000	2001	2002	2003	2004	2005	2006Q3
Commercial Banks									
Agriculture	5.3	2.7	2.6	2.4	2.3	2.1	2.1	2.0	1.9
Mining	0.5	0.6	0.5	0.4	0.5	0.3	0.5	0.3	0.3
Manufacturing (production)	25.0	30.5	28.7	26.8	26.1	25.5	27.3	26.5	26.4
Construction	14.9	13.8	10.9	8.9	8.5	9.9	10.5	10.5	10.6
Trade	26.3	23.1	20.1	18.3	19.1	17.8	17.4	16.6	16.7
Personal consumption	12.0	11.1	11.1	11.5	12.3	15.4	16.0	18.4	20.2
Financial companies									
Agriculture	0.6	0.8	0.6	0.6	0.5	0.2	0.2	0.0	0.0
Mining	0.4	0.3	0.5	0.1	0.2	0.1	0.0	0.1	0.2
Manufacturing (production)	15.2	20.4	16.5	13.8	10.4	7.5	6.0	3.0	4.2
Construction	27.1	26.8	22.4	16.2	14.1	11.0	11.9	3.6	6.8
Trade	10.3	10.3	8.7	6.6	4.7	3.7	2.9	1.5	2.7
Personal consumption	30.4	19.8	28.3	35.5	50.9	63.3	66.7	86.0	74.4

Source: The Bank of Thailand

After the crisis, capital markets have increased their importance as an alternative source of funds; however, the use of them remained low and concentrated. The share of equity market capitalization to GDP increased from 53 per cent in 1996 to 72 per cent in 2005 while debt security to GDP also rose from 23 per cent to 46 per cent during the same period. In relation to the banking sector, the importance of capital markets remained low. The ratio of bank assets to GDP, although declining, remained higher than 100 per cent in 2005. Compared to the well-developed financial market countries, the ratio of both market capitalization and debt securities to GDP in Thailand was still low (Table 4). In addition, only large corporations could make use of capital markets. For example, more than 70 per cent of total bond and long-term debt securities during 1999-2005 were issued by corporations whose assets exceed 50 billion baht while corporations whose assets are lower than 10 million baht account for only 6 per cent. Thus, capital markets still play a limited role to be an alternative source of funds, especially for small and medium enterprises.

Table 5: Structure of Financial Market in Thailand in 1996 and 2005
(per cent of GDP)

	1996			2005		
	Market capitalization	Debt securities	Bank assets	Market capitalization	Debt securities	Bank assets
Thailand	53	23	156	72	46	116
Hong Kong	282	32	165	592	37	166
Japan	71	103	149	107	156	160
Singapore	165	20	114	220	59	120
USA	106	143	59	136	165	73

Table 4.1: Net Proceed of Bond and Long-term Debt Securities during 1999-2005

	> 50,000	10,000-50,000	1,000-10,000	500-1,000	<500
No. of issuers	20	33	68	4	3
Financing amount					
- Value (billion baht)	835	243	62	1	3
- per cent of total	73.0	21.3	5.4	0.1	0.3

Source: Suthiwart-narueput and Kritsophon (2006)

VII. Conclusion and Policy Inferences

The paper examines patterns and determinants of private investment in Thailand in a view to understand factors that hinder its recovery in the post-crisis period. The private investment equation is estimated during the period 1960-2005. The functional form of the private investment is based on the extended version of neoclassical investment theory, in which output growth, cost of capital, availability of capital funds, economic uncertainty, real exchange rate and public investment are incorporated. The time series property of data was tested at the outset to guard against spurious regression. As there is a mix between stationary and non-stationary variables, we opted to use the 'general to specific' (unrestricted dynamic) modelling procedure to obtain short-run and long-run determinants of private investment.

The key finding is that private investment in Thailand has borne the brunt of aggregate demand contraction since the outbreak of Asian financial crisis in 1997. Most of the investment undertaken in the post-crisis period has been so far for replacement rather than expanding production capacity. This would raise more concern on economic growth sustainability.

In the short run, output growth, real private credit, and the existence of spare capacity are the key determinants of private investment. Over and above these three variables, economic uncertainty in terms of both inflation and real exchange rate is apparent in the scene of the private sector in their decision to invest in Thailand. In the long run, private investment is mostly determined by business opportunity (output growth and RER) and investment costs. The positive and significant coefficient corresponding to RER would simply reflect the nature of export-led growth phenomenon in Thailand. The positive impacts of RER depreciation on the tradable sector tend to overwhelm the negative impacts that could emerge in the nontradable sector and the overall economy. Government investment could promote long-term private investment but its impact is relatively limited.

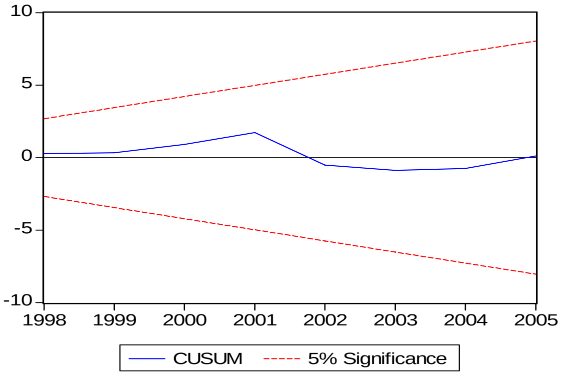
The regression analysis also suggests that without any policy response, private investment would take a long time to dissipate any shocks mainly because of the irreversible nature of investment. The estimated coefficients and time patterns of all estimated variables suggest that the shortage of available capital funds for private investment seems to be a key factor hindering the recovery of private investment in Thailand.

Two policy inferences can be drawn from this study. Firstly, the need for a long period of time to dissipate shocks on private investment points to a room for policy makers to compensate for any negative shocks and therefore speed up the recovery process. Among the short run policy-induced determinants, the availability of prudential capital funds should be prioritized in order to ensure that potential and prudential investors could access credit adequately. Capital markets should be further developed as an alternative source of funds to investors.[10] Secondly, policy makers should promote conducive investment climate, especially in terms of both prudential investment projects and low level of economic uncertainty, inflation and real exchange rate in particular. Even though changes in the latter two variables could reflect market forces acting on them, leaning against the wind of these changes could generate positive spillover to promote conducive investment climate and support the recovery of private investment.

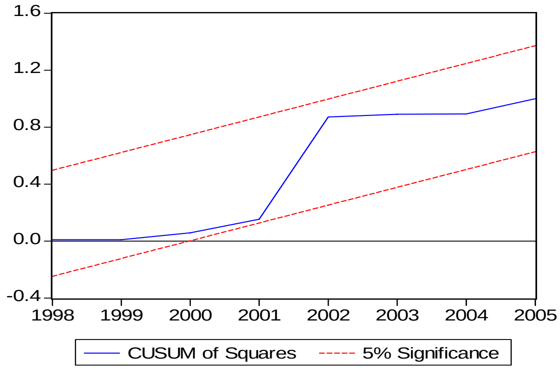
[10] To provide detailed policy recommendation, a systematic analysis examining the linkage between private investment and a financial system is needed. Unfortunately, it is far beyond the scope of the current study.

Appendix 1
The Structural Stability Tests

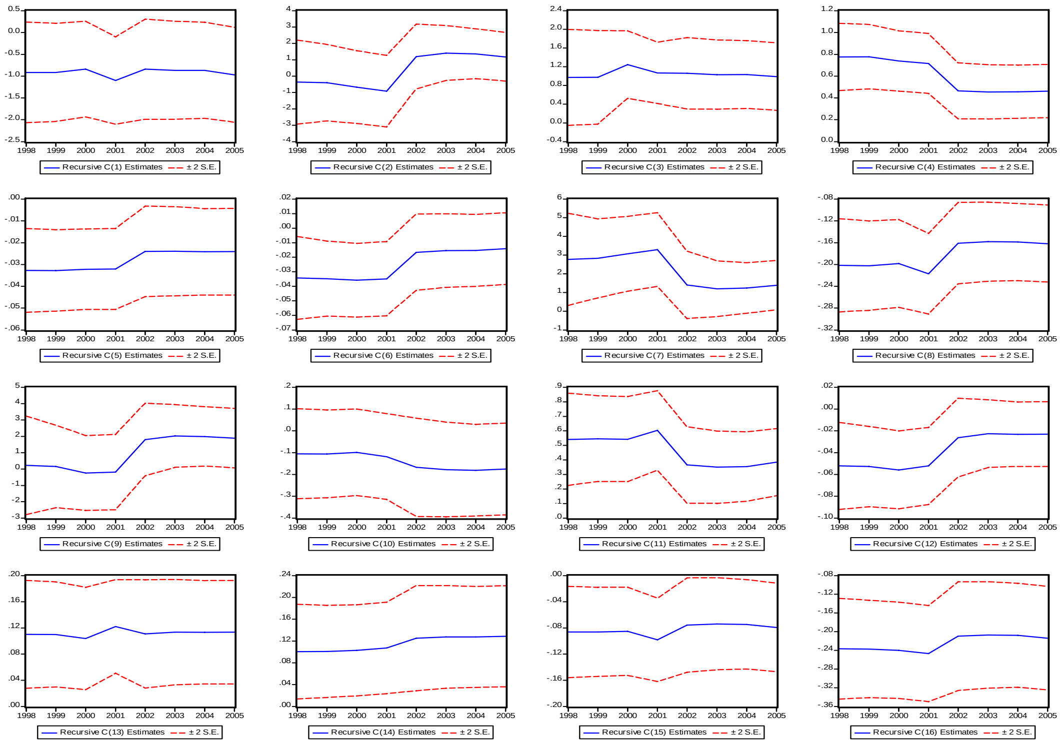
A. The cumulative sum of recursive residuals (CUSUM)



B. The cumulative sum of squares of recursive residual (CUSUMSQ)



C. Recursive coefficients



Appendix 2
Sensitivity Analysis of Economic Uncertainty Variables on Determinants of Private Investment in Thailand: (Dependent variable = Δ*I*)

Variable	Parameter (*t*-ratio)			
Constant	**-0.32** (-0.49)	**-0.93** (-1.63)***	**-0.97** (-1.75)**	**-0.93** (-1.65)***
Δg^y	**0.94** (1.20)	**1.19** (1.54)***	**1.18** (1.56)***	**1.19** (1.57)***
Δg^y (-1)	**0.77** (1.98)**	**0.97** (2.57)*	**0.99** (2.70)*	**0.97** (2.63)*
ΔPDC	**0.55** (3.18)*	**0.44** (3.33)*	**0.46** (3.71)*	**0.44** (3.41)*
ΔUC_{RER}	**-0.016** (-1.00)	**-0.02** (-2.26)*	**-0.02** (-2.26)*	**-0.02** (-2.43)*
ΔUC_{INFLA}	**-0.02** (-1.50)***	**-0.01** (-1.50)***	**-0.01** (-1.42)***	**-0.01** (-1.41)***
ΔUC_{OUTPUT}	**0.007** (0.59)	**-0.00069** (-0.09)	**-0.001** (-0.15)	
ΔUC_{TOT}	**0.009** (0.60)	**-0.005** (-0.46)		**-0.005** (-0.48)
$\Delta OUTG$	**1.65** (2.06)*	**1.39** (2.03)*	**1.39** (2.06)*	**1.39** (2.07)*
I(-1)	**-0.19** (-4.88)*	**-0.16** (-4.46)*	**-0.16** (-4.50)*	**-0.16** (-4.55)*
g^y (-1)	**2.09** (2.24)*	**1.92** (2.04)*	**1.88** (2.04)*	**1.92** (2.09)*
g^c (-1)	**-0.16** (-1.28)	**-0.19** (-1.61)***	**-0.17** (-1.57)***	**-0.19** (-1.71)**
RER(-1)	**0.16** (1.00)	**0.38** (3.07)*	**0.39** (3.27)*	**0.37** (3.14)*

(cont.)

Appendix 2 (cont.)

$UC_{INFLA}(-1)$	**-0.04** (-2.07)*	**-0.02** (-1.48)***	**-0.02** (-1.53)***	**-0.02** (-1.50)***
UC_{RER} (-1)	**0.02** (1.00)			
UC_{OUTPUT} (-1)	**0.02** (1.07)			
UC_{TOT} (-1)	**0.01** (1.01)			
GI (-1)	**0.16** (3.30)*	**0.11** (2.80)*	**0.11** (2.81)*	**0.12** (2.87)*
D7879	**-0.08** (-2.23)*	**-0.08** (-2.31)*	**-0.08** (-2.30)*	**-0.08** (-2.36)*
D9798	**-0.29** (-3.32)*	**-0.21** (-3.69)*	**-0.21** (-3.74)*	**-0.21** (-3.80)*
N	43	43	43	43
$\overline{R}^2$	0.94	0.94	0.94	0.94
F-test	34.32*	38.77*	42.48*	42.83*
LM1, F-test	F (1, 21)=0.41 (p= 0.53)	F (1, 24) = 0.43 (p= 0.52)	F (1, 25) = 0.26 (p= 0.62)	F (1, 25) = 0.43 (p= 0.52)
RESET,	F (1, 21)= 0.00 (p= 0.95)	F (1, 25)= 0.31 (p= 0.58)	F (1, 25)= 0.46 (p= 0.51)	F (1, 25)= 0.32 (p= 0.58)
JBN, χ^2 (2)	0.28 (p= 0.87)	0.58 (p= 0.75)	0.78 (p= 0.68)	0.52 (p= 0.77)
ARCH,	F (1,21) = 0.00 (p= 0.99)	F (1, 24) = 0.24 (p= 0.63)	F (1, 25) = 0.28 (p= 0.60)	F (1, 25) = 0.25 (p= 0.62)
DF	-7.36*	-7.86*	-7.86*	-7.35*

Notes: [1] The level of statistical significance denoted as: * = 5% , ** = 10%, and *** = 15%. All variables are measured in natural logarithms.
[2] Computed from the long-run (steady-state) solutions to the estimated model.

Test Statistics
LM = Breusch-Godfrey serial correlation LM test
RESET = Ramsey test for functional form mis-specification
JBN = Jarque-Bera test of the normality of residuals
ARCH = Engle's autoregressive conditional heteroscedasticity test
DF = Dickey-Fuller test for residual stationarity (augmentation was not needed in terms of both the Akaike Information criterion and the Schwarz Bayesian criterion)

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