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Explaining Korea's Lower Investment Levels after the Crisis

Takuji Kinkyo[*]

Summary. — This paper examines the reasons for Korea's lower investment levels after the crisis of 1997-98 through estimation of an error correction model of real investment. The econometric results suggest that the fall in investment rates resulted from a decline in the long-run equilibrium value of investment rates due to a deterioration in terms of trade. They also show that recent investment levels are neither too high nor too low relative to the long-run equilibrium value. The variation in terms of trade seems to have pronounced effects on investment through its effect on corporate profits and cash flows in Korea.

Key words — Asia, Korea, financial crisis, investment, terms of trade

1. INTRODUCTION

Korea experienced a sharp economic contraction during the financial crisis of 1997-98. The largest contributor to the fall in real gross domestic product (GDP) was gross fixed investment, which declined by more than 22 percent in 1998. Although there was a rebound in investment in subsequent periods, investment levels measured as a ratio of output remain substantially below pre-crisis levels for nearly a decade after the onset of the crisis. A similar pattern can be observed in other ex-crisis countries in East Asia, such as Indonesia, Philippines, and Thailand. The resulting large saving-investment gap in emerging Asia has been the focus of recent policy debate on global current account imbalances, particularly between the US and the rest of the world (Cline 2005; de Rato 2006; IMF 2005; Summers 2004).

Many authors consider that Korea's pre-crisis investment levels were excessive, though their explanations for the causes differ. Chang (1998) argues that the overinvestment resulted from a lack of effective investment coordination due to the

[*] Ministry of Finance, Japan. The view expressed are those of the author and do not necessarily reflect the position of the Ministry. The author is grateful to Machiko Nissanke and anonymous referees for their very useful comments on an earlier version of this paper.

dismantling of industrial policy in the early 1990s. Krugman (1998) emphasizes the role of implicit government guarantee in encouraging excessive risk-taking by entrepreneurs. Based on such views, it seems reasonable to suppose that the observed decline in the investment is in part a necessary adjustment to the previous overinvestment.

Some, however, suspect that the persistently low investment rates in emerging Asia, including Korea after the crisis are policy-induced: exchange rates are maintained undervalued and domestic demand is being repressed in order to promote export-led growth and accumulate foreign reserves as an insurance against another financial crisis. Based on this premise, many are calling for multilateral exchange rate realignments and a rebalancing of demand across countries, to achieve orderly adjustments in global imbalances (Eichengreen 2005, 2006; Mann 2005).

Notwithstanding the growing concerns over persistently low investment rates in emerging Asia, few studies have presented empirical evidence of their underlying causes or assessed whether, as some claim, the current investment levels are indeed too low.[1] This paper aims to provide such evidence for the case of Korea. More specifically, through estimation of an error correction model of real investment using quarterly data for over 20 years, we address two main questions: What are the fundamental determinants of Korea's aggregate investment and what explains the lower investment levels after the crisis? And are Korea's recent investment levels too low relative to the equilibrium value, which is derived from the long-run relation between investment and underlying fundamentals?

To test the existence of the long-run relationship between investment and fundamentals and to estimate the coefficients of the error correction model, the autoregressive distributed lag (ARDL) procedure developed by Pesaran & Shin (1999) and Pesaran et al. (2001) is applied. A set of fundamental variables in the model is identified drawing on standard neoclassical theory of investment augmented to incorporate the effects of credit constraints in the presence of imperfect financial markets.

The econometric results suggest that recent investment levels are neither too high nor too low relative to the long-run equilibrium value, although it is apparent that there was substantial overinvestment prior to the crisis. In addition, the results suggest that the persistently low investment rates since the crisis resulted from a fall in the long-run equilibrium value of investment rates due primarily to the effects of adverse terms of trade on corporate profits and cash flows. Overall, the variation in terms of trade seems to have a pronounced effect on investment, reflecting the unique characteristics of Korean industry: the concentration of exports in a fairly small number of products, and the high degree of import dependence for the supply of key production inputs.

The rest of the paper is structured as follows: Section 2 provides an overview of saving-investment relations between 1970 and 2005. Section 3 discusses the fundamental determinants of investment and sets out the theoretical framework for the subsequent empirical analysis. Section 4 describes the empirical methodology and presents the results of the estimation. Section 5 analyses the behavior of the long-run equilibrium value of investment rates. Section 6 examines the effect of particular fundamental variables on the short-run dynamics of investment rates through counterfactual simulations. Section 7 concludes.

2. AN OVERVIEW OF SAVING-INVESTMENT RELATONS

Under imperfect capital mobility, domestic saving rates and investment rates will be strongly correlated. Cross-section studies have shown that this correlation is strong even among industrial countries where capital mobility is higher (Feldstein & Horioka 1980). Although it is possible that the observed strong correlation is due to the existence of factors that affect both domestic investment and saving, domestic saving rates can act as a constraint on investment rates when there is limited access to international capital markets.

To examine saving-investment relations in Korea, public and private investment rates are plotted against domestic saving rates between 1970 and 2005 (Figure 1).[2] As can be seen from the figure, public investment rates have been stable. The standard deviation in public investment rates is only 0.8 percent for the whole period. By contrast, private investment rates and domestic saving rates have been more variable. The standard deviations in private investment rates and domestic saving rates are 6.6 percent and 4.2 percent, respectively. It is notable that private investment and domestic saving are closely correlated during the 1970s. Presumably, this is due to the presence of tight capital account controls in Korea. The correlation coefficient for that period is 0.77.

[Figure 1 about here]

Capital account liberalization began in the mid-1980s. Initially, capital outflows were liberalized in response to an increased current account surplus. The liberalization of capital inflows began as the current account deteriorated in the late 1980s. The process of capital account liberalization accelerated from the early 1990s under the Kim Young Sam government, which led to a surge in capital inflows, and particularly short-term loans, during the economic booms of the mid-1990s.[3]

Reflecting the progress of capital account liberalization, there is divergence in the behavior of private investment and domestic saving from the 1980s. Their correlation coefficient declines to 0.58 and 0.12, respectively for the 1980s and 1990s. The extremely low correlation during the 1990s seems to have reflected the irregular behavior of investment during the 1997-98 crisis. Private investment rates declined by nearly 40 percent in 1998 alone.[4] Some authors argue that severe economic contractions in the Asian economies during the crisis were caused by the credit crunch due to the adverse effects of exchange rate depreciation on bank and corporate balance sheets with large foreign-currency debts (Eichengreen 1999; Goldstein 2002; Kenen 2001). Radelet & Sachs (1998) and Furman & Stiglitz (1998), who were critics of the International Monetary Fund (IMF)-supported program, emphasize the perverse effect of monetary and fiscal tightening it demanded.

It should be noted, however, that investment contractions during the crisis were not a temporary phenomenon. Investment rates remained substantially below their pre-crisis levels for nearly a decade after the onset of the crisis despite a modest decline in domestic saving rates. There seem to have been some fundamental determinants of Korea's domestic investment other than domestic saving rates and the specific causes for the sharp investment contraction during the crisis

3. DETERMINANTS OF INVESTMENT

Neoclassical investment theory focuses on real capital costs as a key determinant of investment (Jorgenson 1963; Hall & Jorgenson 1967).[5] Solving the optimization problem of a perfectly competitive firm facing no adjustment costs and with constant return Cobb-Douglas technology, it can be shown that the ratio of desirable capital stock to output is inversely related to real capital costs. If for reasons of simplicity, we ignore tax considerations and depreciation, the real capital cost is defined as the real price of capital goods multiplied by the real interest rate. Furthermore, assuming that the steady-state growth rate of capital stock is constant, as predicted by the Solow's (1956) growth model, long-run investment can be expressed as a constant fraction of desirable capital stock. Then it can be shown that the ratio of long-run investment to output is inversely related to real capital costs.

Neoclassical theory assumes that a firm can borrow whatever amounts of funds are necessary to finance investment. However, in the presence of imperfect financial markets due to asymmetric information and agency problems, there may be limits on the firm's access to external financing (Stiglitz & Weiss 1981). This credit rationing can prevent the firm from undertaking potentially profitable investment. When faced with credit constraints, the firm may need to rely on internal funds to finance investment. Under these circumstances, internally generated cash flows and current profits can be important determinants of investment. Following the seminal work of Fazzari et al. (1988), a large body of empirical work has provided evidence suggesting that the investment of credit-constrained firms is more sensitive to internal cash flows (see Hubbard's (1998) survey).

A firm's current profits can be significantly affected by variations in productivity and terms of trade (i.e., the ratio of unit value of exports to unit value of imports). For example, a rise in labor productivity may improve current profits by reducing labor costs. Likewise, an improvement in terms of trade may have a positive effect on profits by increasing the relative prices between exported products and imported production inputs. Terms-of-trade effects seem particularly important for the Korean economy where exports are concentrated in a fairly small number of products, such as semiconductors and information and communication equipment, and the degree of import dependence for the supply of key production inputs, including fuels, materials, and components is high.[6]

A firm's access to external financing may vary inversely with its net worth, i.e., the difference between assets and liabilities (Mishkin 2001). A firm with a high net worth is less likely to default on its debt repayments. Moreover, net worth can perform a similar role to collateral: if a firm with a high net worth defaults, the lender can recover a substantial part of the losses from the sale of the assets. Also, a high net worth means that a firm has a lot to lose from bankruptcy, reducing the likelihood of the firm undertaking risky investment. Thus, a higher net worth may improve a firm's access to external financing.

Importantly, the pro-cyclical nature of net worth can give rise to a 'financial accelerator' effect (Bernanke & Gertler 1989; Bernanke et al. 1996; Greenwald & Stiglitz 1993; Kiyotaki & Moore 1997). A rise in asset prices and cash flows during economic booms will increase a firm's net worth, improving its access to external financing. This may in turn enable the firm to undertake more investment, leading to further economic expansions. Conversely, a decline in asset prices and cash flows during recessions may exacerbate the economic downturn by reducing a firm's net worth and thus its ability to finance investment. Thus, relatively small shocks in economic activities may be magnified by the variation in a firm's credit availability.

Based on the above discussions, we assume that Korea's aggregate real investment is determined in the long run by the following set of variables:

$$IY = f\,(KC, PRO, TOT, DERATIO) \qquad (1)$$

where *IY* denotes the real investment rate as defined as the ratio of real gross fixed investment to real GDP. *CK* denotes the real capital cost as discussed above, which is anticipated to be negatively related to *IY*. *PRO* and *TOT* respectively denote the labor productivity and the terms of trade. These last two variables are expected to be positively related to current profits and thus *IY*. The debt to equity ratio is denoted by *DERATIO* which captures the financial accelerator effect. This variable is expected to be negatively related to *IY* through the effect on a firm's access to external financing. The definition of the variables in Equation (1) is described in detail in the appendix.

The short-run dynamics of *IY* are specified by the estimated error correction model (ECM) associated with the long-run relation between *IY* and the fundamental variables. It is assumed that the long-run equilibrium value of *IY* derived from the underlying long-run relation with the fundamental variables will serve as an anchor: any deviations from long-run equilibrium will be corrected through changes in *IY* or the underlying fundamentals, either through market forces or policy interventions over time. The speed of correction will be inversely related to the capital stock adjustment costs.

4. ECONOMETRIC METHODOLOGY AND RESULTS

The ECM of real investment is estimated using quarterly data for the period 1981 quarter 2 to 2004 quarter 4.[7] The econometric method used to test for the existence of the long-run relationship and to estimate the coefficients of the ECM is the ARDL procedure developed by Pesaran & Shin (1999) and Pesaran et al. (2001). The ARDL procedure was chosen because it can be applied irrespective of whether the underlying regressors are integrated in the order of zero (*I(0)*) or 1 (*I(1)*).[8] Accordingly, it can circumvent the pre-testing problems associated with standard cointegration analysis which requires the classification of the variables into *I(0)* and *I(1)*.[9]

The ARDL procedure involves two stages. In the first stage, the existence of the long-run relation between the variables is tested by computing the F-statistic for testing the significance of the lagged levels of the variables in the error correction form of the underlying ARDL model. As shown in Table 1, when *IY* (real investment rate) is the dependent variable, the F-statistic exceeds the upper bound of the critical value band and thus the null of no long-run relation between the variables can be rejected at the 95 percent level. However, the null of no relationship between the variables cannot be rejected when *KC* (real capital cost), *PRO* (labor productivity), *TOT* (terms of trade), and *DERATIO* (debt-equity ratio) are treated as dependent variables. The results suggest that these fundamental variables can be interpreted as long-run forcing variables explaining *IY*.

[Table 1 about here]

The second stage of the ARDL procedure is to estimate the long-run coefficients and the associated ECM. First, the ARDL model is estimated using the ordinary least square (OLS) method for all possible orders of lags.[10] Then, using the Schwarts Bayesian criterion (SBC), the ARDL (1,3,0,0) is selected. The residual diagnostic statistics suggest that there is no serial correlation or heteroskedasticity (see Table 2). Thus, the selected model satisfies the white noise assumption. In order to test for the stability of regression coefficients, the Chow (1960) test is applied over two sub periods: the pre-crisis period (1981 quarter 2 to 1997 quarter 3) and the rest of the sample period (1997 quarter 4 to 2004 quarter 4). The test statistics are not significant at the conventional significance level and thus the null hypothesis that the coefficients are the same in the two periods cannot be rejected (see Table 2).

[Table 2 about here]

The ECM is obtained by rewriting the selected ARDL model in terms of the lagged levels and the first difference of the variables as shown in Equation (2). The standard errors are reported in parentheses. All the long-run coefficients are correctly signed and statistically significant. The coefficient of the error correction term (*EC*) has the correct sign and suggests that the deviation from long-run equilibrium will be reduced by about 15 percent within one quarter. With the exception of ΔPRO_t and ΔTOT_t, the remaining coefficients, which relate to the short-run dynamics of the model's convergence with equilibrium, are significant at the conventional significance level.

$$\Delta IY_t = \underset{(0.026)}{0.086} - \underset{(0.031)}{0.067}\,\Delta KC_t + \underset{(0.006)}{0.009}\,\Delta PRO_t - \underset{(0.026)}{0.015}\,\Delta TOT_t - \underset{(0.029)}{0.058}\,\Delta TOT_{t-1}$$

$$- \underset{(0.028)}{0.077}\,\Delta TOT_{t\text{-}2} - \underset{(0.001)}{0.003}\,\Delta DERATIO_t - \underset{(0.035)}{0.152}\,EC_{t\text{-}1}$$

where

$$EC_{t\text{-}1} = IY_{t\text{-}1} - \underset{(0.084)}{0.565} + \underset{(0.211)}{0.439}\,KC_{t\text{-}1} - \underset{(0.032)}{0.060}\,PRO_{t\text{-}1} - \underset{(0.066)}{0.467}\,TOT_{t\text{-}1} + \underset{(0.010)}{0.019}\,DERATIO_{t\text{-}1}$$

$$R^2 = 0.37 \quad \overline{R}^2 = 0.31 \quad DW = 2.21 \qquad (2)$$

Based on the estimates of the long-run coefficients, the long-run equilibrium value of *IY* (*LRIY*) can be expressed as a function of the fundamental variables:

$$LRIY_t = 0.565 - 0.439KC_t + 0.060PRO_t + 0.467TOT_t - 0.019DERATIO_t \qquad (3)$$

The level of the fitted values and *LRIY*, which are obtained by inserting the actual value of the fundamental variables into Equation (2) and (3) respectively, are plotted against the actual investment rate in Figure 2.

[Figure 2 about here]

5. LONG-RUN EQUILIBRIUM VALUE OF REAL INVESTMENT RATES

As can be seen from Figure 2, *LRIY* exhibits a sustained rise in the second half of the 1980s and is relatively stable during the first half of the 1990s. There is a sharp decline in *LRIY* from 1996, reaching its lowest point in the first quarter of 1998. However, it bounces back and from the end of 1999 stabilizes at a similar level to the early 1980s.

As suggested by the figure, the adjustment in actual investment rates tends to lag behind changes in long-run equilibrium values presumably due to the adjustment costs of capital stock. Consequently, there are large and persistent gaps between actual investment rates and *LRIY* following a major shift in the *LRIY* trend.

The gap, measured as a percentage of *LRIY*, is depicted in Figure 3. Actual investment rates in the second half of the 1980s are substantially below *LRIY* (i.e., underinvestment), contrasting with the six quarters prior to the crisis (1996 quarter 2−1997 quarter 3) when they are well above *LRIY* (i.e., overinvestment). The gap widens after the onset of the crisis due to a sharp decline in *LRIY* relative to actual investment rates but narrows rapidly and almost disappears by the third quarter of 1998. From the end of 1999, there is neither substantial and persistent overinvestment nor underinvestment.

[Figure 3 about here]

What then caused these large variations in *LRIY*? Table 3 presents the contribution ratio of each fundamental variable to changes in *LRIY* over four sub periods: the second half of the 1980s (1985 quarter 4−1989 quarter 3), the pre-crisis period (1995 quarter 4−1997 quarter 3), the crisis-peak period (1997 quarter 4−1998 quarter1), and the early recovery period (1998 quarter 2−1998 quarter 4).[11] The contribution ratio is obtained by decomposing changes in *LRIY* into parts explained by changes in the fundamental variables, the weights being the long-run coefficients in Equation (3).

[Table 3 about here]

For the second half of the 1980s, when *LRIY* shows a rising trend, improved *TOT* (terms of trade) is the largest contributing factor, accounting for more than 80 percent of the rise. A decline in *DERATIO* (debt-equity ratio) is the second major contributor, accounting for a quarter of the increase in *LRIY*. The improvement in terms of trade was mainly due to a decline in oil prices. Low oil prices, along with low world interest rates and the low US dollar were the major driving forces of Korea's economic boom between 1986 and 1988. As a result of strong export-led growth, the current account surplus increased rapidly, reaching about 8 percent of GDP.

In the pre-crisis period, when *LRIY* declines by one-third, deteriorating *TOT* is responsible for more than 90 percent of the decline. This deterioration in terms of trade was primarily due to a cyclical decline in the prices of semiconductor products – Korea's biggest export items. The unfavorable terms of trade contributed to the worsening in the current account position. In addition, the current account deficit was financed mostly by short-term foreign debt, which made the Korean economy vulnerable to a sudden reversal in capital inflows.[12]

LRIY continues to decline during the crisis-peak period with more than half of the decline due to a rise in *KC* (real capital cost) while the contribution ratio from *TOT* is less than 30 percent. In the subsequent early recovery period, a decline in *KC* is responsible for more than half of the sharp rebound in *LRIY*.

The rise and fall in the real capital cost reflect increases and decreases in its two major components: the real price of capital goods and the real interest rate. In response to the crisis, the nominal interest rate was raised sharply to stabilize exchange rates. Accordingly, the real interest rate increased. The nominal interest rate was allowed to fall, however, as the exchange rate began to stabilize following the successful agreement with foreign creditors about short-term debt rescheduling in early 1998. In addition, a rise in inflation expectations following the steep exchange rate depreciation seems also to have contributed to a decline in real interest rates.

The real price of capital goods rose sharply following the sharp exchange rate depreciation after the collapse of the fixed exchange rate regime in December 1997. This is largely due to Korea's heavy reliance on imports for the supply of capital goods and intermediate inputs. The real price of capital goods, however, began to fall in the second quarter of 1998 following the exchange rate appreciation. While the won-dollar rate was lower than its pre-crisis level even after the appreciation, the real price of capital goods continued to decline long after the crisis was over. This was presumably due to a fall in the foreign-currency price of imported capital goods.

6. COUNTERFACTUAL SIMULATIONS

It is interesting to examine what would have happened to the path of *IY* (real investment rate) if the underlying fundamental variables, particularly *TOT* (terms of trade) and *KC* (real capital cost) had maintained their pre-crisis values. To illustrate the effects of particular variables on the dynamics of *IY*, a simple counterfactual simulation is performed using the estimated ARDL model underlying Equation (2):[13]

$$IY_t = 0.086 + 0.848 IY_{t-1} - 0.067 KC_t + 0.009 PRO_t - 0.015 TOT_t + 0.027 TOT_{t-1}$$
$$- 0.019 TOT_{t-2} + 0.077 TOT_{t-3} - 0.003 DERATIO_t$$
$$R^2 = 0.97 \quad \bar{R}^2 = 0.97 \quad DW = 2.21 \tag{4}$$

Using Equation (4), the value of simulated *IY* is computed recursively with one of the fundamental variables being held constant at its pre-crisis value. The other fundamental variables are set to the actual values on the assumption that fundamental variables are independent of each other and that fixing the value of a particular variable will not affect the values of the others.

The deviation rate of the simulated *IY*, measured as a percentage of the actual investment rate, is depicted in Figure 4. The simulation is performed for the period 1995 quarter 4 to 2004 quarter 4, with one of the fundamental variables being fixed at its 1995 quarter 4 value. 1995 quarter 4 was chosen as the benchmark because the actual investment rate was close to *LRIY* (the long-run equilibrium value of *IY*) at that time.

[Figure 4 about here]

As predicted from the results of the earlier analysis, the largest effect is from changes in *TOT*. When *TOT* is held constant, the deviation rate exhibits a rising trend over almost the entire period, with the exception of a temporary decline during the recovery period. The deviation rate is about 60 percent in the first quarter of 1998 and more than 80 percent by the end of 2002. The result is consistent with the explanation that the observed decline in investment rates in the second half of the 1990s can be explained to a large extent by the worsening terms of trade.

The large and increasing deviations reflect a sustained decline in the actual terms of trade, which seems to have had an adverse effect on corporate profits and thus investment. The decline in terms of trade was primarily due both to a decline in prices of leading export products, such as semiconductors and information and communication equipment, and a rise in the import prices of fuels, minerals, and metals (see Figure 5a and 5b). As the terms of trade deteriorated, there was a significant decline in the profitability of some of the key electric and electronics industries (see Figure 6).

[Figure 5a and 5b about here]

[Figure 6 about here]

When *KC* is held constant, the deviation rate shows a rise during the crisis period, reaching about 17 percent in the first quarter of 1998. This reflects a temporary but sharp rise in the actual real capital cost in the wake of the crisis. It should be noted, however, that the deviation rate becomes negative in the subsequent recovery period, reflecting a decline in the actual real capital cost as economic stability is recovered. This suggests that the adverse effects on the investment of a rise in real capital costs during the crisis period was not only temporary, but also partly offset by the positive effect of a decline in real capital costs in subsequent periods.

When *DERATIO* (debt-equity ratio) is held constant, the deviation rate increases towards the crisis period, reaching about 10 percent in the first quarter of 1998. This reflects a rise in the actual debt-equity ratio resulting primarily from a surge in foreign borrowing. However, the overall effect on investment of changes in *DERATIO* is less significant than changes in *TOT* and *KC*.

When *PRO* (labor productivity) is held constant, the deviation rate decreases monotonically. This is due to a rising trend in the actual labor productivity. The overall effect on investment of changes in *PRO* is much less significant than the others.

To examine more deeply the effect on investment of changes in the underlying fundamentals during the crisis period, a second counterfactual simulation is performed with one of the variables held constant at its pre-crisis, 1997 quarter 3 value. The results are shown in Figure 7.

[Figure 7 about here]

Three points are significant. Firstly, the deviation rate during the crisis period is positive and greater when *KC* is held constant than when *TOT* is fixed. This suggests that a rise in real capital costs had a more adverse effect on investment during the crisis period than the deterioration in terms of trade.

Secondly, the deviation rate during the crisis period is positive when either *PRO* or *DERATIO* is held constant. This suggests that a temporary decline in labor productivity and a rise in the debt-equity ratio both contributed to the further decline in investment. A rise in the debt-equity ratio seems to reflect the adverse effect of exchange rate depreciation on corporate balance sheets which involved currency mismatches.

Thirdly, regardless of which variable is held constant the deviation rate becomes negative in the recovery periods, reflecting the reversal in the direction of changes in the actual fundamental variables. This suggests that the adverse effects on investment of changes in the underlying fundamentals during the crisis period were not only temporary, but were also partly offset by the positive effects of their subsequent changes, such as the decline in real capital costs. It is noticeable that the deviation rate decreases almost monotonically after the crisis when *DERATIO* is held constant. This seems to reflect a substantial reduction in the debt-equity ratio due to the progress of corporate restructuring particularly by the *Chaebol*, the conglomerate of Korean firms.

7. CONCLUSIONS

This paper has investigated the causes of Korea's persistently low investment levels after the crisis and examined whether recent investment levels are too low relative to the long-run equilibrium value consistent with the underlying fundamentals. An error correction model of real investment was estimated using the testing and estimation procedure developed by Pesaran & Shin (1999) and Pesaran et al. (2001). The underlying theoretical framework was derived from a standard neoclassical theory of investment augmented to incorporate the effects of credit constraints under imperfect financial markets. The main findings of the analysis can be summarized as follows.

Firstly, there seems to have been a sizeable overinvestment during the period preceding the crisis in the sense that the investment rate is higher than the long-run equilibrium level. The magnitude of overinvestment was much greater (in absolute terms) than that of the underinvestment that emerged in the second half of the 1980s. The overinvestment seems to have resulted from a steep decline in the long-run equilibrium value of investment rates due to a deterioration in terms of trade. The worsening of the terms of trade was provoked by a cyclical decline in the prices of semiconductor products which were Korea's biggest export items.

Secondly, the magnitude of overinvestment even increased during the crisis period due to a further decline in the long-run equilibrium value of investment rates. This decline was due mainly to a sharp rise in real capital costs. The real capital cost rose as the exchange rate depreciated and nominal interest rates rose in the wake of the crisis. However, it seems that the adverse effect of the rise in real capital costs was both temporary and partly offset by the positive effect of the decline in real capital costs in the subsequent recovery period.

Most importantly, there is neither substantial underinvestment nor overinvestment in recent periods. The long-run equilibrium value of investment rates remain substantially lower than its pre-crisis level due largely to a continuous decline in terms of trade provoked by a decrease in the prices of export products, such as electronics and a rise in the import prices of production inputs.

Overall, the variation in terms of trade seems to have a pronounced effect on Korea's investment through its effect on corporate profits due largely to the unique characteristics of Korean industry: the concentration of exports in a fairly small number of products such as semiconductors and information and communication equipment, and high import dependence for the supply of key production inputs, including fuels, materials, and components. Thus, the investment of credit-constrained firms appears to be sensitive to the effect of terms-of-trade shocks on their current profits and cash flows.

In terms of policy implications, enhancing the stability of the Korean economy might be achieved by broadening of the range of products competitive in world markets. More diversification in export products could mitigate the effects on aggregate investment and net exports of adverse terms-of-trade shocks to particular industries. To this end, the Korean government should encourage firms to enter new industries by introducing measures to enhance the mobility of human and capital resources across industries.

NOTES

1. A notable exception is IMF (2005).
2. The investment and saving rates are measured by nominal gross investment and saving as percentages of nominal GDP. To remove price effects, which can be substantial, particularly for investment in the electronics sector, the real value should be used; however, breakdowns between the private and public sectors are not available for real investment and saving.
3. For a review of the process of financial liberalization in Korea, see Chang et al. (1998) and IMF (2002).
4. Even excluding 1997 and 1998 data, the correlation coefficient is still only 0.59 during the 1990s.
5. An alternative approach to modeling investment behavior is Tobin's (1969) and Brainard & Tobin's (1968) *q*-theory. They argue that investment depends on whether the ratio of the market value to the replacement cost of capital, which is known as Tobin's *q*, is greater or less than 1. Hayashi (1982) shows that under certain conditions the neoclassical model yields a *q*-model.
6. The share of electric and electronic products in Korea's exports between 1999 and 2004 was, on average, more than 30 % (Bank of Korea *Economic Statistic System*). According to Baek & Jones (2006, p.9), Korea's dependence ratio on foreign materials and components is about 70% for DVD players, 50% for mobile phones, and 91% for liquid crystal displays.
7. The sample period starts from 1981 quarter 2 because prior to that date the data on corporate bond rates are not available.
8. If a variable must be differenced *d* times before it becomes stationary, then it is said to be integrated of order *d*, or *I(d)*. *I(0)* is stationary in levels, while *I(1)* becomes stationary after differencing once.
9. See, for example, Enders (2004, ch.6) for the account of cointegration analysis.
10. An order of 4 was chosen as the maximum lag since the observations are quarterly.
11. The beginning and the end of each period corresponds to the point where the deviation rate is the local minimum.
12. See Chang (1998) for an analysis of the Korean crisis.
13. It is assumed that the estimated parameters are immune from Lucas Critique (Lucas 1976) and thus invariant in the presence of policy changes.

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Table 1. *F-statistics for testing the existence of long-run relationships*

Dependent Variables	F-statistics	Upper bound of critical value band [a]
△IY	3.959	3.805
△KC	2.279	3.805
△PRO	0.732	3.805
△TOT	1.384	3.805
△DERATIO	2.221	3.805

a. The critical value bound at 95 percent level for the case with five regressors, an intercept, and no trend. A set of critical value bounds for various cases are presented in Pesaran & Pesaran (1997)

Table 2. *Diagnostic tests*

	Lagrange multiplier (LM) statistics	F-statistics (modified LM)
Serial correlation [a]	3.237 [0.519] [c]	0.718 [0.582]
Heteroskedasticity [b]	0.011 [0.917]	0.011 [0.918]
Chow test	10.102 [0.342]	1.122 [0.358]

a. LM test of residual serial correlation

b. Based on the regression of squared residuals on squared fitted values

c. P-values in brackets.

Table 3. *Contribution ratios to changes in LRIY* (%)

Periods		*KC*	*PRO*	*TOT*	*DERATIO*
2nd. half of '80s	85Q4-89Q3	-11.0	4.9	81.7	24.4
Pre-crisis	95Q4-97Q3	3.4	-4.8	91.5	9.9
Crisis-peak	97Q4-98Q1	54.4	2.5	28.5	14.5
Early recovery	98Q2-98Q4	51.0	5.3	35.9	7.8

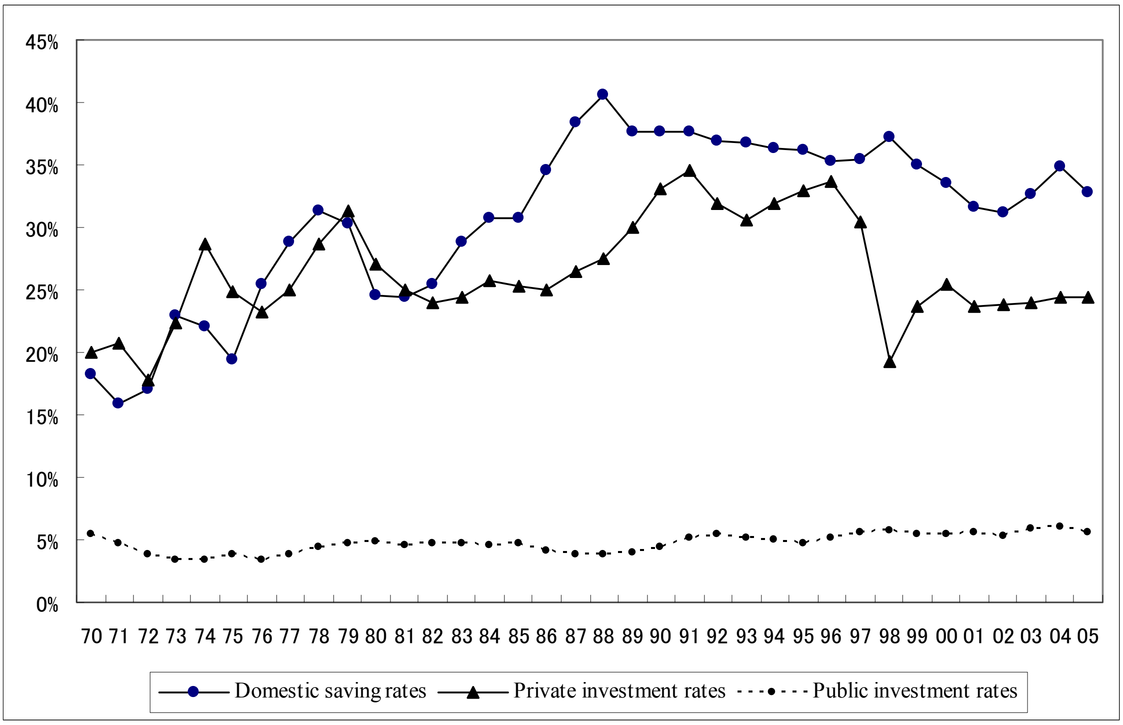

Figure 1. Saving-investment relations
Sources: Bank of Korea, Economic Statistic System

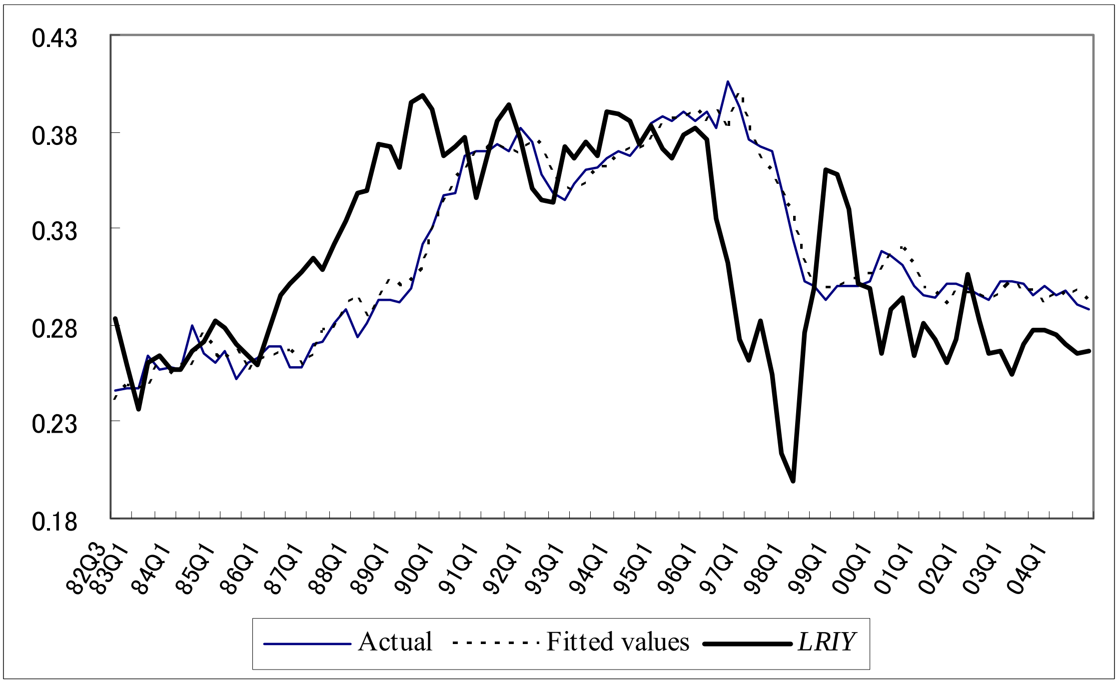

Figure 2. Actual investment rates, fitted values, and LRIY

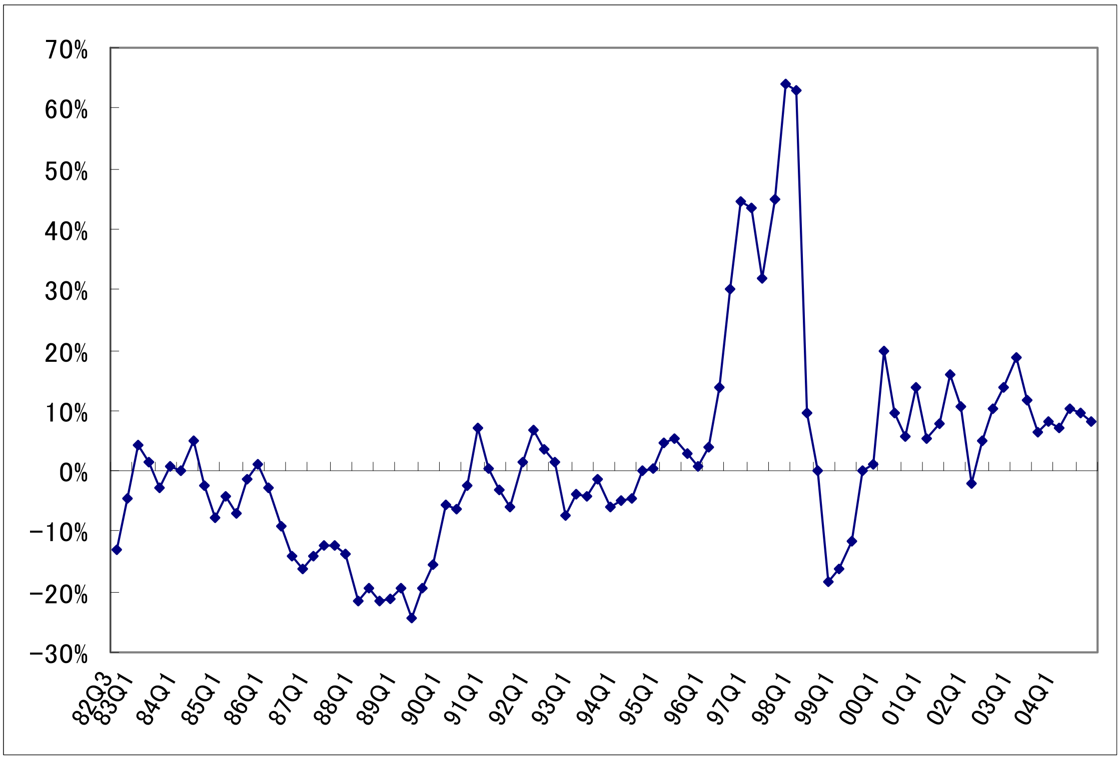

Figure 3. Sizes of investment gaps (as a percentage of LRIY)

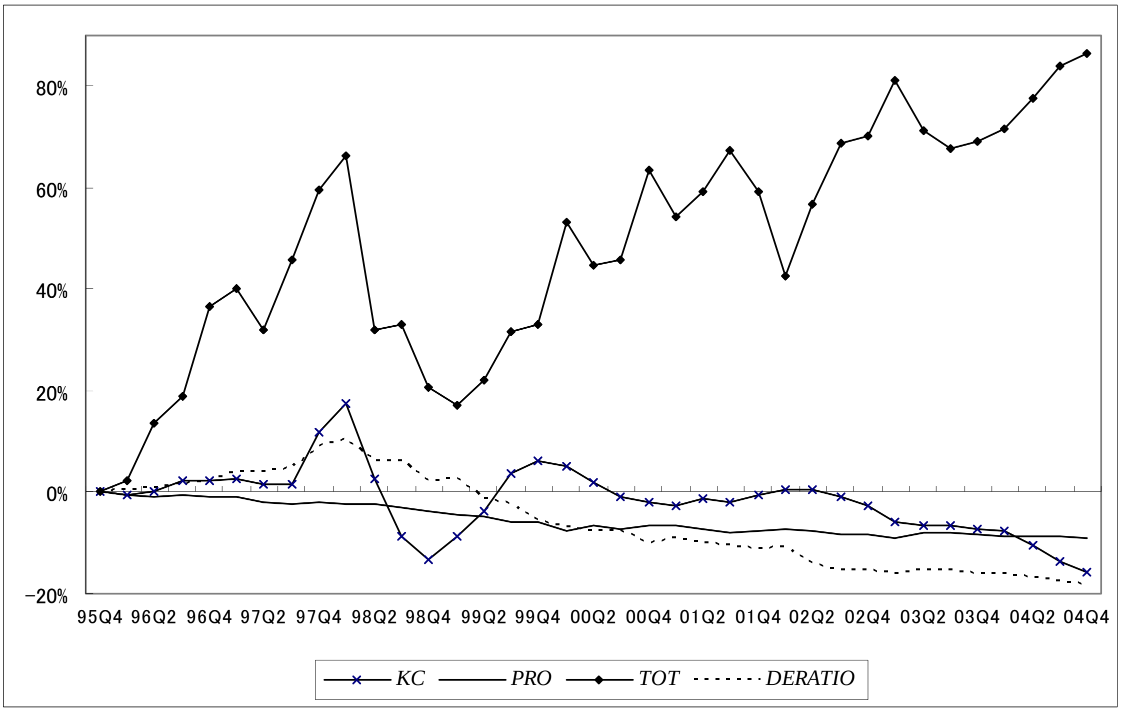

Figure 4. Deviation rates of simulated IY (fixed at 1995Q4 values)

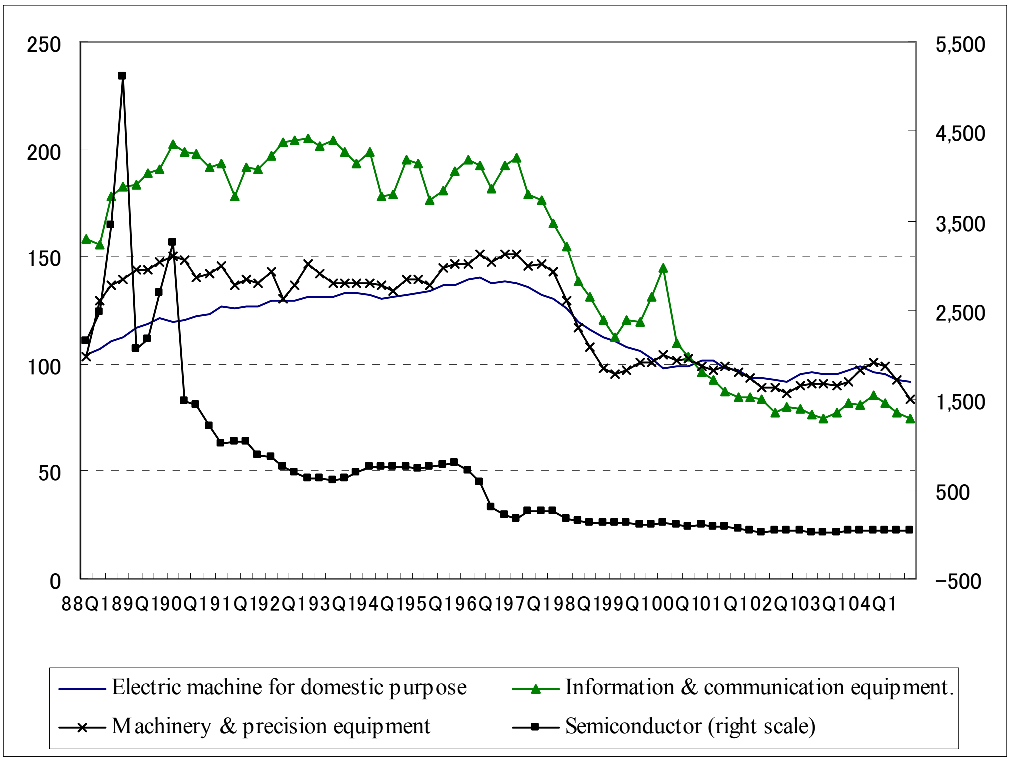

Figure 5a. Unit value of exports (indexes 2000 =100)
Sources: Bank of Korea, Economic Statistic System

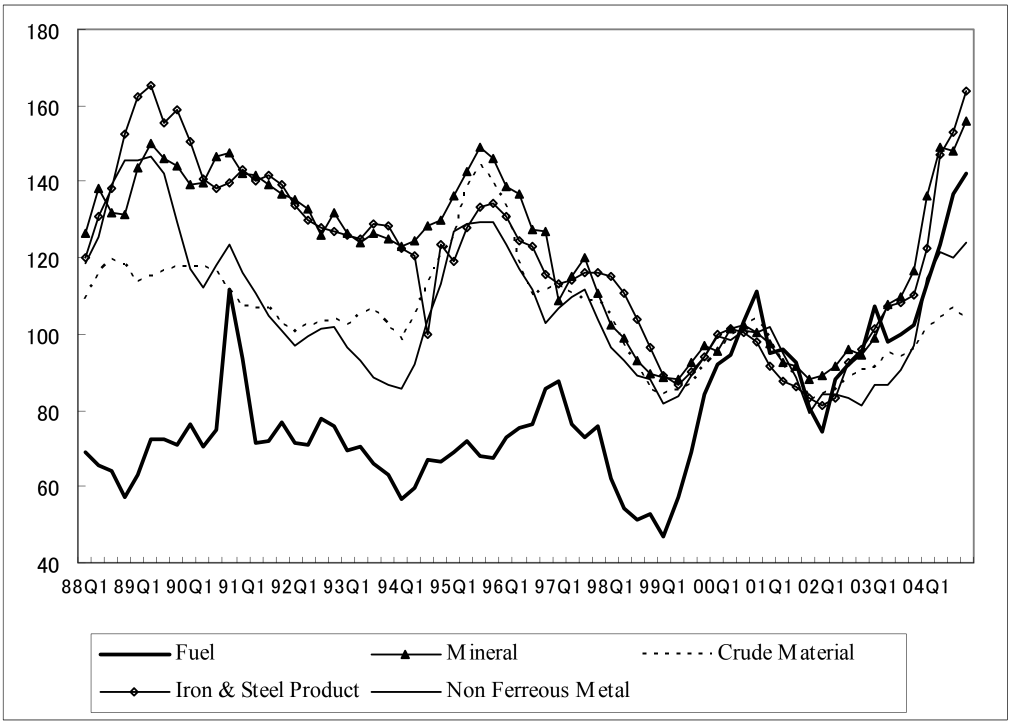

Figure 5b. Unit value of imports (indexes 2000 =100)
Sources: Bank of Korea, Economic Statistic System

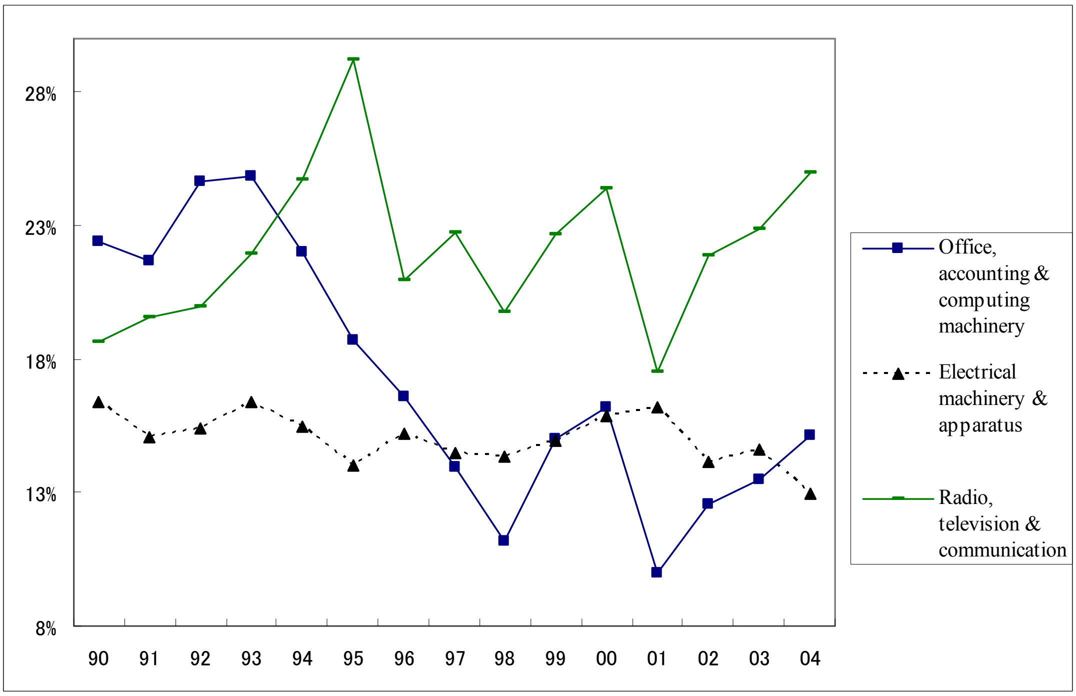

Figure 6. Operation profits/sales ratio
Sources: Bank of Korea, Economic Statistic System

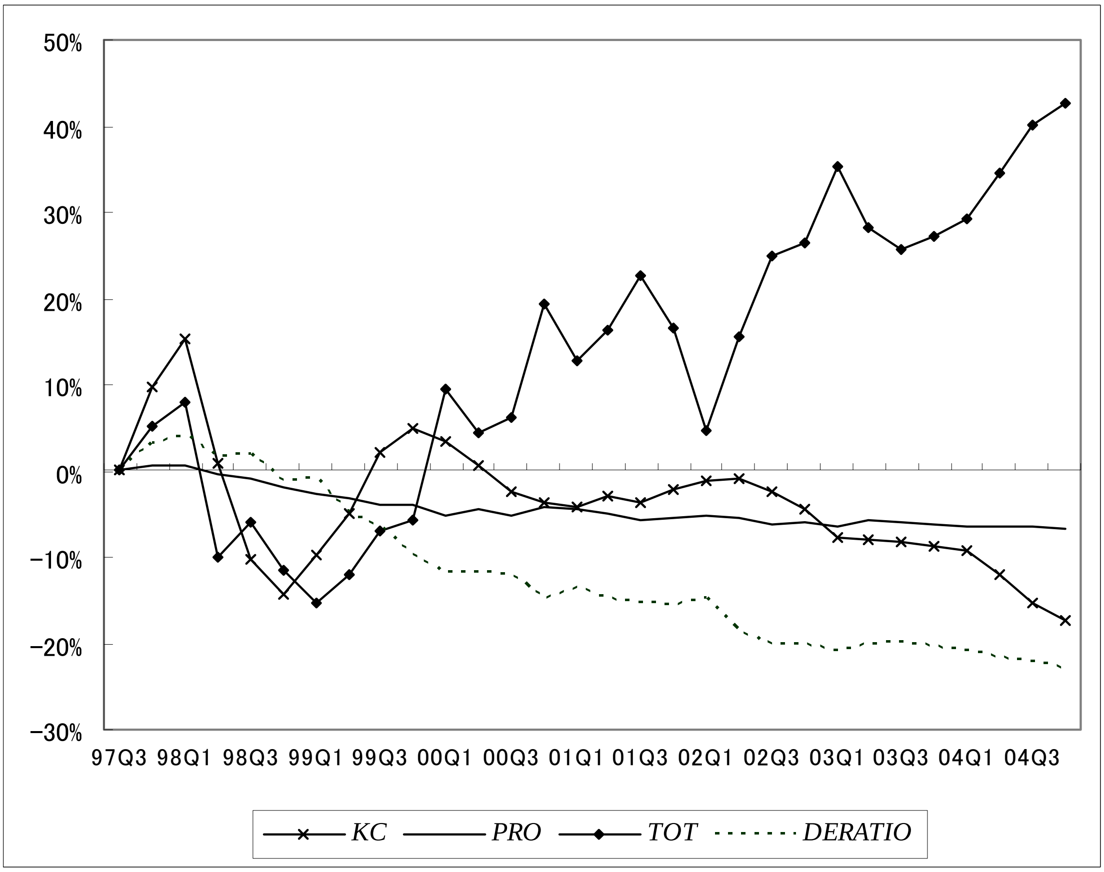

Figure 7. Deviation rates of simulated IY (fixed at 1997Q3 values).

APPENDIX. DEFINITIONS OF VARIABLES AND DATA SOURCES

***IY* (real investment rate)**: This variable is defined as the ratio of the seasonally adjusted real gross fixed capital formation to the seasonally adjusted real gross domestic product. As we have no breakdown for the private and public sectors, gross fixed capital formation is used as a proxy for private investment given that public investment rates were relatively stable over the period studied.

[Source] Bank of Korea *Economic Statistic System*

***KC* (real capital cost)**: This variable is defined as the real price of capital goods multiplied by the real interest rate divided by 100. The real price of capital goods is measured by the price index for capital equipment divided by the producer price index. The real interest rate is measured by the corporate bond rate less the fourth order moving-average of inflation rates computed using the producer price index.

[Source] IMF *International Financial Statistics*; Bank of Korea *Economic Statistic System*

***PRO* (labour productivity)**: This variable is defined as the log of the seasonally adjusted industrial production index less the log of the manufacturing employment index, relative to the trade-weighted average of the equivalent for the major trading partners. The following fixed weights are used for the period: the United States: 0.45, Japan: 0.35, EU: 0.2. These weights are computed by dividing each region's trade share by the sum of these trade shares using 1993 trade data. The trade share of the Western Hemisphere is added to that of the United States since most of developing countries in this region pegged their currencies to the dollar and still tend to focus on the dollar in exchange rate management.

[Source] IMF *International Financial Statistics, Direction of Trade Statistics*; Bank of Korea *Economic Statistic System*

***TOT* (terms of trade)**: This variable is defined as the log of the unit value of exports less the log of the unit value of imports.

[Source] IMF *International Financial Statistics*

***DERATIO* (debt-equity ratio)**: This variable is defined as the ratio between the outstanding liabilities of debt and equity in the business sector, as measured by the flow of funds accounts. The debt includes loans from financial institutions and borrowing from securities markets, such as commercial papers and corporate bonds.

[Source] Bank of Korea *Economic Statistic System*