

Financial Factors and Business Fixed Investment in Korea: An Aggregate Analysis*

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This paper attempts to empirically reexamine the effects of financial factors on business fixed investment in Korea. In order to model the investment process, we first apply the cointegration technique of Johansen to determine whether there exists a long-run investment relationship. For the short-run investment dynamics we estimate an error correction model represented by the cointegrating relationship. Our empirical results provide some evidence on the effects of financial variables on business fixed investment. The real interest rate was found to have a long-run relationship with investment. Both real interest rate and the availability of financing turned out to affect the short-run investment dynamics. However, our short-run empirical models suggest that financial variables played only limited roles in the recent investment decline. (JEL Classification: E22).

I. Introduction

In recent years Korea experienced a pronounced slowdown in the pace of real business fixed investment. The growth rates of business fixed investment (producers' durable equipment and nonresidential structures) declined from a very high 16.7% in 1990 to 11.1% in 1991 and then plummeted to a mere 0.5% in 1992. This was the lowest growth since the early 1980s. Business fixed investment continued to be sluggish in 1993 with a growth rate of less than 2%. This marked decline in business fixed investment is worrisome as business fixed investment

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plays a crucial role in the determination of future supply capacity and productive efficiency.

There are apparently two contrasting views on the causes of the recent investment decline. The first view emphasizes the role of financial factors in business fixed investment. High interest rates and tight monetary or credit conditions are held responsible. Proponents of the first view tend to urge the government authority to pursue more expansionary monetary or credit policies in order to stimulate investment. The second view points out that the investment decline is primarily attributable to weakening real fundamentals. Proponents of the second view tend to argue that expansionary monetary or credit policies are more likely to add to already high inflationary pressure rather than to stimulate investment. It needs to be mentioned that debates on the relative importance of financial and non-financial factors in investment had recurred whenever there was a pronounced investment decline.

Empirical studies have also produced conflicting results on the effects of financial factors on business fixed investment in Korea. Most previous studies have estimated conventional structural equations or vector autoregression systems. But the problems with conventional empirical models are by now well known. Therefore, many of previous empirical results are not very convincing.

The object of this paper is to empirically reexamine the effects of financial factors on business fixed investment in Korea. In order to model the fixed investment process, we first apply the cointegration technique of Johansen (1988) to determine whether there exists a long-run investment relationship. For the short-run investment dynamics we estimate an error correction model represented by the cointegrating relationship. By utilizing a new technique, our study is expected to shed new light on the role of financial factors in business fixed investment and to have some implications for the causes of the recent investment decline in Korea.

The remainder of this paper is organized as follows. Section II briefly reviews recent literature on the role of financial factors in business fixed investment and considers their significance in the specific context of Korea's financial market and policy environments. In section III we begin with an analytical framework of long-run investment relationship. Then we perform tests for cointegration employing Johansen's technique and estimate an error correction model derived from the cointegrating relationship. Section IV concludes the paper by summarizing the main empirical results.

II. Financial Factors in Business Fixed Investment

Most of traditional macroeconomic theories assumed implicitly or explicitly that financial markets functioned perfectly. Therefore, the market interest rate was envisaged as the only link between financial markets and investment (and other real economic activities), to the neglect of other financial factors.

This neglect of financial factors other than the interest rate was provided with a solid microeconomic justification in the Modigliani-Miller theorem. In the perfect capital market with perfect information and no default risk, firms are able to finance whatever amount they want at the prevailing market interest rate. Suppose that banks decide to curtail credit and hold more safe securities. Because bank and nonbank sources of finance are perfect substitutes for firms in the perfect capital market, firms denied bank credit can resort to the equity or bond market and raise funds at the same interest rate.

Recent developments in the economics of imperfect information in the credit market reconsider the role of financial factors in investment and other real economic activities.¹ Stiglitz and Weiss (1981) have shown that credit rationing may emerge because of moral hazard or adverse selection problems stemming from information asymmetries between lenders and borrowers.

If firms are credit rationed, it may be the availability of financing, both internal and external, rather than the interest rate that has more impacts on the investment decisions of firms. The possibility of credit rationing sheds new light on the monetary transmission mechanism. The monetary policy affects investment by changing the availability of credit even without changing the interest rate. However, credit rationing may not act as a financing constraint to firms if they can directly raise funds by issuing new equities or bonds. Myers and Majluf (1984) and Greenwald, et al. (1984) show that imperfect information problems may make the costs of issuing equities or bonds prohibitively high and therefore give rise to equity rationing. Especially new or small firms, about which informations are not well publicized, are more likely to have difficulties in raising funds in the equity or bond market and have to depend on banks. When these bank dependent firms are denied credit by banks, they have to curtail their investment expenditures.

¹ For good reviews, see Gertler (1988) and Stiglitz (1988). Kashyap, et al. (1993) is a recent empirical examination of financial factors in business fixed investment using U.S. aggregate data.

In the specific context of Korea's financial market and policy environments, we make contrasting considerations on the significance of financing constraints. Korea's relatively less developed financial markets are likely to make financing constraints more severe. The equity and bond markets represent only a small portion of sources of financing. Firms are heavily dependent on bank loans but there still exist various financial regulations, such as interest rate ceilings on bank loans and the imposition of credit limits on firms. As a result, credit rationing may be more widespread.

However, the Korean government may have accommodated the demand for investment financing to maximize economic growth by the selective credit policy. It may be that firms were relatively free to raise investment funds, while constrained in non-investment activities. Therefore, it is hard to determine *a priori* whether the availability of financing has been a more important determinant of investment decisions in Korea than in developed countries.

III. Long-run and Short-run Investment Processes

A. Long-run Investment Relationship

Most previous studies on the effects of financial factors on business fixed investment in Korea have estimated conventional structural equations or vector autoregression systems. But it is by now well known that the presence of unit roots in the time series and the possibility of cointegration among the series make the estimation and interpretation of conventional empirical models difficult (for a survey, see Campbell and Perron, 1991). For example, many of the macroeconomic time series that enter investment equations are nonstationary and tend to produce spurious regressions. But simple first differencing of the time series can be misleading if they are cointegrated.

In this section we employ the cointegration analysis and the error correction framework in order to model the investment process. We first apply the cointegration technique of Johansen (1988) to determine whether there exists a long-run investment relationship. For the short-run investment dynamics we estimate an error correction model represented by the cointegrating relationship. The error correction model is considered as a method of overcoming problems associated with conventional empirical models.

This section begins with a structural model of investment to determine the long-run investment relationship. The model is based on

Bean's (1981) version of the neoclassical model of investment. We employ Bean's model mainly because it permits a direct analysis of investment without a measure of the capital stock on which reliable data, especially on quarterly basis, are not available in Korea.² Assuming a constant returns to scale, constant elasticity of substitution production function, the optimal capital stock is derived by equating the marginal productivity of capital with the real user cost of capital:

$$(1) \quad K^* = AY^e(1 + 1/\epsilon)^\sigma / C^\sigma$$

where K^* is the desired capital stock, Y^e the expected output, ϵ the elasticity of demand in the product market, σ the elasticity of substitution, and C the real user cost of capital.

Net investment is usually modeled as a distributed lag on changes in the desired capital stock, but modeling gross investment requires a measure of the capital stock, on which reliable data are not readily available. To circumvent this difficulty, Bean introduces further simplifying assumptions. Assuming that output grows at a constant rate g which is small relative to the rate of depreciation, δ , then

$$(2) \quad \log(K_t/Y_t) = \log[I_t/(\delta + g) Y_t]^3 \\ \approx \log(I_t/Y_t) - \log\delta - g/\delta$$

By substituting (2) into (1), we obtain the long-run equilibrium relationship:

$$(3) \quad \log I = a + \log Y - \sigma \log C$$

where a is some constant.

It is hypothesized that the short-run dynamics of actual investment follows an error correction process. The error correction framework is appealing when it comes to modeling rational decision-making under uncertainty, particularly those on irreversible, long-lived capital assets. To incorporate the availability of financing into this framework, we

² Han (1993) and Shafik (1992) are previous applications of the error correction framework based on Bean's model to business fixed investment in Korea and Egypt, respectively. But they employ the Engle and Granger two-step procedure, which yields an inefficient and asymptotically biased estimate.

³ This can be easily proved from the equation for the evolution of the capital stock ($\Delta K = (I/Y)Y - \delta K$) and the long-run equilibrium relationship that the growth rates of capital and output are equal.

assume, following the suggestion of Eisner (1978), that the availability of financing may affect the short-run dynamics of investment, but not the long-run equilibrium level of investment.

B. Tests for Cointegration

The existence of long-run relationship underpinning the investment equation is tested by the cointegration technique. According to the idea of the cointegration analysis, a set of variables are cointegrated if they are each individually integrated of the same order and there exists one or more linear combinations (cointegrating vectors) of these variables that are integrated of order zero. If there exists a cointegrating vector, that linear combination can be interpreted to reflect a long-run equilibrium relationship. In order to test for cointegration we use the technique proposed by Johansen (1988). The sample period is 1974:-1992:4. All of the quantity variables are adjusted for seasonality with the X-11 ARIMA method.

Data constraints prevent us from constructing a theoretically correct measure of the real user cost of capital. Instead, we adopt two separate proxies. The first is the relative price of capital goods (P), which is represented by the ratio of the implicit price deflator for investment goods to the implicit GNP deflator. The second is the cost of financing, represented by real interest rate (R) which is nominal interest rate minus expected inflation rate.⁴ Selecting a proper measure of nominal interest rate is also important. Official bank lending rate does not represent an adequate measure in the case of Korea since various regulations on bank lending rate are associated with such widespread financial practices as requiring compensating balances. The secondary market rate on corporate bonds is considered as reflecting most adequately financial market conditions and hence effective borrowing costs. It is used as our measure of nominal interest rate. The expected inflation rate is the simple average of the current and three lagged values of the growth rates of the implicit GNP deflator.⁵ We include real interest rate and the relative price of capital goods separately rather than merge them into a single

⁴ The real user cost of capital is defined, in the simplest form which abstracts from taxes, investment credits, and depreciation allowances, as $(\text{price of investment goods}/\text{price of output}) \times (\text{depreciation rate} + \text{real interest rate})$. For details, see Gordon and Veitch (1986) or Chirinko (1993).

⁵ Experimentations with predicted values computed from a couple of other arbitrary methods, an ARIMA equation and a two-variable vector autoregression system containing inflation and money supply, little altered the estimation results.

price of capital variable because we want to isolate the effect of real interest rate as a financial variable.

In order to implement Johansen's test for cointegration, the orders of integration of the time series entering the model need to be identified. We performed the augmented Dickey-Fuller tests for the presence of unit roots in the time series. Each regression for the series in level included a constant and a time trend term. For the first differences of the series, only constant terms were included. Various lags were experimented with. Each of the log of real nonresidential fixed investment ($\log I$), the log of real output (real GNP, $\log Y$), real interest rate (R), and the log of the relative price of capital goods ($\log P$) is judged to be integrated of order one. These results are consistent with many previous studies (for example, Choi, 1993) and thus need not be reported.

Because all variables are integrated of order one, the Johansen technique is directly applied to test for cointegration among the variables. We employ the approach that allows for possible deterministic trends in the data (see Johansen and Juselius, 1990). To minimize arbitrariness in selecting lag lengths, we followed a usual practice of selecting four lag length specification.

In Table 1 we present the maximal eigenvalue and trace test statistics. These statistics reject the hypothesis of no cointegration, which indicates that there is at least one long-run equilibrium relationship among the variables. We find up to two cointegrating vectors. But the cointegrating vector which corresponds to the larger eigenvalue is in-

Table 1
JOHANSEN'S COINTEGRATION TESTS

r	λ_{\max}	trace	5% critical values	
			λ_{\max}	trace
r = 3	0.37	0.37	8.08	8.08
r = 2	13.38	13.75	14.59	17.84
r = 1	21.36	35.11	21.28	31.26
r = 0	28.83	63.93	27.34	48.42

Notes: r denotes the number of cointegrating vectors. The 5% critical values of the maximal eigenvalue (λ_{\max}) and trace test statistics are taken from table A2 of Johansen and Juselius (1990). Results are based on four lag length specification.

consistent with the predictions of the economic model. Specifically, the coefficients on real interest rate and the relative price of capital goods are not appropriately signed. The long-run relationship implied by the cointegrating vector which corresponds to the smaller eigenvalue is given by:

$$(4) \quad \log I_t = 0.98 \log Y_t - 2.36 R_t - 2.22 \log P_t + ECT_t$$

where ECT is the error correction term.⁶

The next step is to perform Johansen's likelihood ratio tests for exclusion restrictions on real output, real interest rate, and the relative price of capital goods in the cointegrating vector. The chi-square statistics on the exclusion restrictions on real output, real interest rate, and the relative price of capital goods are 6.01, 13.63, and 7.58, respectively, which exceed the critical value with two degrees of freedom at the 5% level of significance. These results indicate that each of three variables has a long-run relationship with business fixed investment.

C. Error Correction Model

To model the short-run investment dynamics, we estimate an error correction model using the long-run equilibrium relationship reported in (4). As mentioned above, we incorporate the availability of financing into the error correction framework. For the measures of the availability of financing, two financial aggregates, real M2 supply (M) and real bank credit to the private sector (B), are adopted. Although real money supply has been used most frequently in empirical studies on investment in Korea, real bank credit seems to be a measure more directly relevant to investment. These financial quantity variables enter the error correction model in second log-differences as the dependent variable is the growth rate of investment rather than the level of investment.

Following the familiar general-to-specific modeling strategy, we initially estimate the following general model:

$$(5) \quad \Delta \log I_t = \alpha + \beta ECT_{t-1} + \sum_{i=1}^4 \gamma_i \Delta \log I_{t-i} + \sum_{i=0}^4 \eta_i \Delta \log Y_{t-i} \\ + \sum_{i=0}^4 \theta_i \Delta R_{t-i} + \sum_{i=0}^4 \lambda_i \Delta \Delta \log B_{t-i} \text{ (or } \Delta \Delta \log M_{t-i} \text{)}$$

⁶ To check the sensitivity of the cointegration test results to the selection of lag lengths, we experimented with six and eight lag lengths. In each case we find two cointegrating vectors one of which is consistent with the economic model.

$$+ \sum_{i=0} p_i \Delta \log P_{t-i} + e_t$$

where ECT is from equation (4) and e is a disturbance term. We then sequentially impose statistically insignificant restrictions, arriving at the final parsimonious specification.

The estimation results are presented in Table 2. In both cases, the coefficients on the error correction term, ECT_{t-1} are very small and insignificant. This result is rather surprising in view of the presence of cointegration and the theoretical appeal of an error correction framework in the investment process. It may simply reflect ample difficulties in modeling the investment process without necessarily denying the appropriateness of an error correction framework. The effects of financial variables are substantially different depending upon the measures of the availability of financing.⁷ When real bank credit is used as a measure, both real interest rate and real bank credit are found to affect the short-run investment behaviors. By contrast, when real money supply is used as a measure, both financial variables turn out to be insignificant.

Finally, we briefly examine the implications of our short-run empirical models for the investment collapse of 1992. First, the growth rate of real bank credit (or real money supply) did not experience a discernible decline during the period of 1991:3-1992:4. Second, about 2 percentage point increase in real interest rate during the same period is not of such magnitude as to bring about an investment collapse according to the estimates of our empirical models. Indeed our empirical models leave too large (negative) residuals for 1992. Of course, our measure of real interest rate and our use of money supply and bank credit as proxies for the availability of financing are less than satisfying, which may account for limited roles of financial variables in the investment collapse of 1992.

IV. Summary and Conclusions

There have been recurrent debates on the relative importance of financial and non-financial factors in business fixed investment in Korea. These debates were rekindled when there was a marked investment decline in recent years. A rather popular opinion, which held high

⁷ The simple correlation coefficient of $\Delta \log M$ and $\Delta \log B$ is 0.78 for the sample period.

Table 2
RESULTS FOR ERROR CORRECTION MODEL

Variables	Bank Credit	Money Supply
Constant	-0.04 (-0.76)	-0.07 (-1.52)
ECT _{t-1}	-0.03 (-0.50)	-0.08 (-1.49)
ΔlogI _{t-1}	-0.38 (-3.55)	-0.33 (-3.06)
ΔlogY _t		0.54 (1.74)
ΔlogY _{t-2}	0.58 (1.95)	
ΔlogY _{t-3}	0.65 (2.22)	
ΔlogY _{t-4}	0.79 (2.80)	0.81 (2.84)
ΔR _{t-1}	-0.69 (-2.75)	
ΔΔlogB _{t-1}	0.63 (1.98)	
ΔlogP _t	-0.74 (-7.25)	-0.75 (-7.64)
ΔlogP _{t-1}	-0.40 (-3.34)	-0.30 (-2.53)
ΔlogP _{t-2}	-0.45 (-4.88)	-0.43 (-4.89)
ΔlogP _{t-3}	-0.42 (-4.88)	-0.40 (-4.51)
R ²	0.57	0.53
Ljung-Box Q(19)	13.35	10.87

Notes: Numbers in parentheses are t statistics.

interest rates and tight monetary or credit conditions responsible for the investment decline, seemed to gather considerable theoretical support from recent theories of financing constraints in business fixed investment.

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fixed investment process, we first applied the cointegration technique of Johansen to determine whether there exists a long-run investment relationship. For the short-run investment dynamics we estimated an error correction model represented by the cointegrating relationship.

The empirical findings presented in this paper provide some evidence on the direct effects of financial variables on business fixed investment. The real interest rate was found to have a long-run relationship with investment. When we used real bank credit as a measure of the availability of financing, which we suppose is more directly relevant to investment, both real interest rate and the availability of financing turned out to affect the short-run investment dynamics. However, our short-run empirical models suggest only limited roles of financial variables in the recent investment decline. Further research is needed.

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