OPTIMAL CORPORATE DEBT FINANCING AND REAL INVESTMENT DECISIONS UNDER CONTROLLED BANKING SYSTEMS

by

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The World Bank

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Summary

This paper develops an integrated approach towards the problem of optimal corporate real investment and finance in the context of a financial model of a developing economy characterized by a controlled banking sector and a functioning equity market. These characteristics are typical of the financial market structure of most new industrialized developing countries including, for example, Argentina, Brazil, Chile, Korea and Mexico. In most of these countries, corporations rely heavily on bank borrowing to finance their long-term investment expenditures, and as a result their debt-equity ratio is, in comparison with developed economies, very high. The implications of this high corporate leverage for the conduct of credit and monetary policy have not yet been fully appreciated.

The underlying theoretical model is based on the cost of adjustment approach to the neoclassical theory of investment, augmented to incorporate the influence of debt financing in the form of bank loans. Thus the firm's optimal rate of real investment is derived as a function of the "Tobin's q" and the financial parameters characterizing the supply of bank credit. The model's steady-state solutions are then derived and their responses to changes in the financial parameters are illustrated. The model is applied to the non-financial corporate sector of the Korean economy using annual data from 1963 to 1983. Using both capital market and balance sheet data a measure of the valuation ratio is provided and its relevance and limitation for explaining corporate real investment behaviour in the Korean economy is discussed.
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I. Introduction

The debate over the determinants of optimum corporate capital structure and its interaction with corporate real investment decisions has been in the forefront of the literature on the theory of finance at least for the past two decades. The discussion has, however, centered almost exclusively on the experience of a few industrialized countries where capital markets are assumed to be perfect and the existence of well-developed securities markets for pricing of various debt and equity claims on corporate assets are taken for granted. Within this context, one important goal of research has been to modify the implications of the original Modigliani-Miller (1958) leverage irrelevance theorem, by taking explicit account of the influences of taxes and bankruptcy cost [Baxter (1967), Scott (1976)], the agency cost [Jensen and Meckling (1976)] and the asymmetry of information [Ross (1977), Leland and Pyle (1977)] on the determination of corporate financial leverage. These studies have generally treated the corporate real investment decisions as exogenous and have focused on the financing aspects of corporate investment behaviour. In contrast, there is the important strand of research on the neo-classical theory of private investment behaviour, which either in its original context [Jorgenson (1963), Jorgenson and Hall (1971)] or in its modified cost of adjustment context [Lucas (1965), Gould (1968), Treadway (1969), Hayashi (1982)] assumes perfect capital markets and no
uncertainty.1/ In this case, it follows that the firm's real investment policy is independent of how it is financed.

Such a separation of research activity on the theory of investment and finance has often been a source of dissatisfaction and criticism [Vickers (1970), Ciccolo and Fromm (1979, 1980) and Hite (1977)] where both logic and evidence are invoked to support the argument that the firm's real and financial investment decisions are in reality linked and are made simultaneously. Thus, it is argued that the cost of capital to a firm is not determined completely exogenously but depends on its means of financing and that the timing of a firm's investment expenditures is conditional upon the availability of funds. This integrative view of the firm's real and financial investment decisions has in fact been empirically established both for the case of developed countries [Coen (1971), Artus, Muet, Palinkas and Pauly (1985)] and more strongly for developing countries [Sundararajan and Thakur (1980), Blejer and Khan (1984)]. In these studies, it is generally found that both the dynamics and the level of aggregate private investment tend to respond positively to the availability of bank credit or to the quantity of cash flows.

The aim in this paper is to develop an integrated approach towards the problem of optimal corporate real investment and finance in the context of a financial model of a developing economy characterized by credit rationing, a

1/ For an extension of the neoclassical theory of investment to include uncertainty, see Lucas and Prescott (1971).
controlled banking sector and an organized equity market. In this model, there are two financial instruments, equity and debt; equity is traded publicly in the stock market and is priced competitively, while debt is placed only with the financial institutions including both domestic and foreign banks and non-bank financial institutions. There exists no organized corporate bond market and the interest rate on bank loans is administratively set and is treated as a policy variable. It is further assumed that the banking sector imposes an upper bound to the amount of debt finance available. This upper bound is postulated to depend on the borrower's financial circumstances and its credit-worthiness. Given the condition that interest rates are administratively set, such an upper bound may be viewed as a reflection of

1/ These features are typical of the financial market structure of most new industrialized developing countries, including, for example, Argentina, Brazil, Chile, Korea, Mexico and the Philippines as well as some developed countries such as Japan. In all these countries there exists a relatively well-functioning equity market which serves to generate essential information regarding investors' attitudes and their expectations of future profitability, and provides limited amount of equity financing. Admittedly, the equity market's role in terms of providing corporate finance is still comparatively limited but it seems to be growing in almost all these countries. Between 1981 and 1985, the market value of equity shares traded in the stock markets of Brazil (Sao Paulo), Korea and Mexico, for instance, grew at an average annual rate of 36.2, 23.5 and 73.5 per cent in local currencies respectively and at rate of 45, 16.1 and 5.25 in terms of U.S. dollars. By the end of 1985 the aggregate market capitalization of the equity shares in these three countries' stock markets amounted to $89.4 billion which is about one-fourth of the size of London's equity market. See Fédération Internationale Des Bourses de valeurs for recent information and van Agtmael (1984) Wai and Patrick (1973), Sakong (1977) and Ness (1974), for a survey and analysis of stock market developments in developing countries.

2/ Here and throughout the paper, the banking sector refers to both commercial and special banks, non-bank financial institutions, and foreign banks. The important point here is that both the cost and the supply of credit from this sector is directly or indirectly controlled by the monetary authorities.
rational behavior on the part of the banking sector dictated by loan safety\textsuperscript{1} considerations. In a world characterized with uncertainty and business risk, the loan safety factor will depend on the borrower's financial leverage, and on the risk-return characteristics of its investment schedule. In the absence of uncertainty, it is then, the borrower's leverage i.e. the extent to which the firm is financed by borrowing, which bears upon the willingness of the bankers to extend new loans.

The paper is organized as follows. In Section II we develop an optimal model of corporate's real and financial investment decisions within the cost of adjustment theoretic-framework. In this sense, the model can be viewed as an extension of the cost of adjustment approach to the neoclassical theory of private investment, extended to incorporate the influence of debt financing in the form of bank loans. Thus, the firm's optimal rate of real investment is derived as a function of "Tobin's marginal $q$", i.e. the ratio between the market's valuation of an incremental unit of capital to its cost of replacement, and the financial parameters characterizing the supply of bank credit. Changes in these financial parameters are then shown to affect corporate real investment both directly through their impacts on the cost and availability of debt finance, and indirectly through their impacts on the valuation ratio. The simultaneous impact of these financial policy changes on corporate real investment are, then, evaluated by focusing on the steady-state solution of the model.

\textsuperscript{1} Even in circumstances that interest rates are free from administrative control, banks may ration credit as a rational response towards imperfect information and business risk. See, for instance, Hodgman (1960), Freimer and Gordon (1965) and Jaffer and Russell (1967) for an analysis of credit rationing along these lines.
Section III contains an application of the model to the non financial corporate sector (NFCS) of the Korean economy, using annual data from 1963 to 1983. Using both capital market and balance sheet data a measure of the valuation ratio is provided and its relevance and limitation for explaining corporate real investment behaviour in the Korean economy is discussed. This provides a new perspective on the relation between capital market development and corporate real investment, an issue which has so far been explored only in the context of industrialized countries with well-developed securities markets. 1/ Finally, a brief summary, contained in Section IV, concludes the paper.

II. Theoretical Framework

II.1 The Basic Model

To focus on the basic essentials of the relationship between corporate financial and real investment decisions, we abstract from the complexities of personal taxation of dividends and capital gains and only consider a proportional tax on corporate income with deductible interest expenses. We also assume that there exists no uncertainty and no bankruptcy cost. We assume, however, that the supply of bank credit is limited. This limitation, furthermore, is formulated to apply to the flow of debt as a function of the corporate's rate of investment and its leverage. Formally this is expressed in linear form as,

1/ See, for example, von Fustenberg (1974) and Summers (1981) for empirical applications of the q theory of investment to the U.S. data and, Poterba and Summers (1985) for an application to the British data.
\[ b(t) = hP(t) I(t) + \beta_1 P(t) K(t) - \beta_2 B(t) \]  

(1)

where \( b(t) \) is the maximum level of bank credit extended at time \( t \), \( B(t) \) is the stock of corporate debt outstanding, \( K(t) \), is the stock of real capital, \( I(t) \) is gross corporate real investment, \( P(t) \) is the price of capital goods and \( h, \beta_1 \) and \( \beta_2 \) are non-negative parameters of the underlying supply function of bank credit.

By virtue of the assumptions that interest payments are tax deductible and the cost of equity is higher than the cost of finance, the firm always has the incentive to resort to the maximum level of borrowing possible. Thus, in this model, the firm's flow demand for bank credit coincides with the maximum supply of bank credit available. This, then, implies that equation (1) can also be interpreted as expressing the equilibrium condition between the flow demand for and the supply of bank credit.

The equity market is in equilibrium when share owners are satisfied to hold the existing stock of equity. For this condition to hold, it is necessary that, the return to equity, consisting of dividends and capital gains or losses, be equal to the investor's required rate of return. Thus, this condition takes the form,

\[ \rho = \frac{E(t) + d(t)}{E(t)} \quad (2) \]
where \( E(t) \) is the stock of equity outstanding at time \( t \), \( d(t) \) is the corporate dividend payment, \( \rho \) is the investors required rate of return and the dot denotes time derivative: \( \dot{E}(t) = \frac{dE(t)}{dt} \). Furthermore, equation (2) implies

\[
\dot{E}(t) = \rho E(t) - d(t)
\] (2.a)

Solving (2.a) for \( E(t) \), yields an expression for the market value of equity, i.e.,

\[
E(t) = \int_t^\infty \exp(-\rho s) d(s) \, ds
\] (3)

which is the present value of future stream of dividend payments.

The objective of the firm is to maximize the market value of its equity as given by (3), subject to a set of constraints. The first constraint is that dividends cannot be negative, that is,

\[
d(t) \geq 0 \text{ all time.}
\] (4)

The second constraint refers to the equality between the use and sources of funds. Given the assumption that there is no issue of new equity, the sources of funds consist basically of two items: (a) after-tax operating profits, net of interest payments and (b) net borrowing. On the use side, there are also two main items: (a) payments of dividends, and (b) expenditures on new capital goods, including costs of installation and adjustment. Under these conditions, dividends can be derived as operating profit plus new borrowing minus investment expenditures. Therefore
\[ d(t) = (1-\tau) \left[ \pi(K(t)) - r B(t) \right] + b(t) - a B(t) - P(t) I(t) (1 + c(I(t), K(t))) \]  

where \( \pi(.) = \) before tax profit, taken to be an increasing and concave function of \( K \), i.e. \( \frac{\partial \pi}{\partial K} > 0, \frac{\partial^2 \pi}{\partial K^2} \leq 0 \), \( r = \) interest rate, \( a = \) amortization rate on debt, \( I = \) gross corporate real investment, \( \tau = \) the corporate profit tax rate, and \( c(.) = \) adjustment-cost function per unit of investment.

The cash flow constraint (5) is straightforward, although two features require comment. First, it is noted that interest payments are treated as tax deductible. This conforms to the prevailing tax regulation in many countries including Korea, where tax allowances are made for corporate interest payments. This, in effect, lowers the cost of borrowing and thus induces firms to substitute debt for equity financing. The limit to this process of substitution is determined either by some legal and institutional restraints on the debt finance available, or through consideration of bankruptcy cost associated with increasing corporate leverage.  

Second, we have included a unit cost of adjustment item, \( c(I, K) \) in equation (5) to capture the additional installation expenses associated with the process of investment. The rationale is based on the models of Lucas (1967), Gould (1968) and Treadway (1969), where the cost of adjustment was introduced in the

---

1/ See Miller (1977) for consideration of taxes, Scott (1976) for consideration of bankruptcy costs, and Auerbach (1985) for an empirical investigation of corporate leverage in the U.S.
neoclassical theory of investment to obtain an explicit solution for the firm's optimal rate of investment. Furthermore, following Hayashi (1982) and Summers (1981), this cost function is assumed to depend positively on \( \frac{I}{K} \) and specifically to take the form \(^1/\)

\[
c(I,K) = \frac{a}{2} \cdot \frac{I}{K}
\]  

(6)

where \( a \geq 0 \) is a constant parameter.

Two other constraints are the evolution of the firm's stocks of capital and debt as given by

\[
K(t) = I(t) - \delta K(t)
\]  

(7)

\[
B(t) = b(t) - a B(t)
\]  

(8)

where \( \delta \) is the rate of depreciation of physical capital.

Equation (7) describes the familiar perpetual method of capital accumulation, wherein real capital increases at the rate of gross investment less depreciation due to obsolescence and wear and tear. The rate of depreciation is further taken as a constant fraction of existing capital stock. In equation (8) net flow of loans from the banking sector is defined as the difference between new loans contracted and the amortization payment on

\(^1/\) This specification of the cost of adjustment is the same as the one adopted by Bruno and Sachs (1985).
The existing loans where the rate of amortization is assumed to remain unchanged over time.

The maximization problem facing the firm, stated formally, is to choose \( b(t) \), \( I(t) \) and \( d(t) \) to maximize the present value of its market equity, \( E(t) \), subject to the constraints (1), (4), (5), (7) and (8) and given initial conditions, \( B(o) \) and \( K(o) \). This problem can be solved by means of standard control techniques. Thus, we treat \( b(t) \), \( I(t) \) and \( d(t) \) as control variables and \( B(t) \) and \( K(t) \) as state variables and formulate the current-value Hamiltonian, \( H \), as,

\[
H = d + \lambda (I - \delta K) + \mu (b - a B) \tag{9}
\]

where \( \lambda \) and \( \mu \) are the associated shadow prices of capital and debt respectively.

Taking into account the constraints (1), (4), and (5) we define the Lagrangian \( L \) as

\[
L = H + \theta \left\{ (1-\tau) [\tau(K) - rB] - aB + b - PI \left( 1 + \frac{a}{2} \left( \frac{I}{K} \right) \right) - d \right\}
\]

\[
+ \psi_1 (hPI + \beta_1 PK - \beta_2 B - b) + \psi_2 (d - \xi^2) \tag{10}
\]

where \( \theta \), \( \psi_1 \) and \( \psi_2 \) are the Lagrangian multipliers associated with constraints (5), (1) and (4) respectively and \( \xi \) is a slack variable, introduced to convert the inequality constraint (4) into equality. The necessary conditions for an optimal solution are the following:
\[ \lambda = (\rho + \delta) \lambda - \theta \left[ (1-\tau) \frac{3\pi}{3K} + \alpha \right] P \left( \frac{I}{K} \right)^2 - \psi_1 \beta_1 P \]  
(10.a)

\[ \dot{\mu} = (\rho + a) \mu + \theta \left[ (a + (1-\tau) r) \right] + \beta_2 \psi_1 \]  
(10.b)

\[ \frac{\partial L}{\partial \beta} = \theta + \mu - \psi_1 = 0 \]  
(10.c)

\[ \frac{\partial L}{\partial I} = - \theta p \left( 1 + \alpha \frac{I}{K} \right) + \lambda + \psi_1 h p = 0 \]  
(10.d)

\[ \frac{\partial L}{\partial d} = 1 - \theta + \psi_2 = 0 \]  
(10.e)

\[ \psi_1 > 0 \]  
(10.f)

\[ \psi_2 \xi = 0 \]  
(10.g)

and the transversality conditions are:

\[ \lim_{t \to \infty} \exp(-\rho t) \lambda(t) K(t) = 0 \]  
(10.h)

\[ \lim_{t \to \infty} \exp(-\rho t) \mu(t) B(t) = 0 \]  
(10.i)

There are, a priori, two possible optimal paths or regimes corresponding to whether the firm maintains a positive stream of dividend payments or not. These two paths correspond to whether \( \psi_2 = 0 \) or \( \psi_2 > 0 \). We will assume here that the firm maintains a positive stream of dividend payments and resorts to the maximum level of borrowing possible. Under these circumstances, we have \( \psi_2 = 0 \) which from equation (10.e) implies that
θ = 1. To derive formally the firm's optimal investment rule and its financing, we use this value of θ to solve equations (10.b) and (10.c) for μ and ψ₁, and substitute the results into equations (10.a) and (10.d) to obtain,

\[ P \left[ 1 + \alpha / \frac{I}{K} \right] - h \left( \frac{\rho - (1 - \tau) r}{\rho + a + \beta_2} \right) = \lambda \quad (11.a) \]

\[ \dot{\lambda} = (\rho + \delta) \lambda - \left[ (1 - \tau) \frac{3 \pi}{\partial K} + \alpha / \frac{I}{K} \right] \left( \frac{I}{K} \right)^2 + \beta_1 \frac{\rho - (1 - \tau) r}{\rho + a + \beta_2} \right) \quad (11.b) \]

Equation (11.a) describes the equilibrium condition for the firm's optimum level of real investment. It states that, an optimizing firm will continue to invest until the marginal cost of an additional unit of investment is equal to the marginal value of that investment. The marginal cost of investment, as shown in equation (11.a), is composed of two factors; (i) the marginal cost of acquisition and installation associated with investment, and (ii) a term that reflects the impact of firm's substitution of debt for equity. The latter term depends on the cost of debt relative to equity financing and on the institutional restraint on the availability of debt finance. Clearly, to the extent that debt financing is cheaper than equity financing, i.e.

\((1 - \tau) r < \rho\), firms are in a position to decrease the marginal cost of their investment through substitution of debt for equity. The limit to this substitution is set, in our model, by the credit ceiling imposed by the banking sector.

In equation (11.b), the evolution of \( \lambda \), the marginal value of investment, is described to depend on three main factors; (i) the marginal
profitability of capital, \( \frac{\partial \pi}{\partial K} \), (ii) the extent to which an increase in \( K \) reduces the installation cost, i.e. \( a \left( \frac{I}{K} \right)^2 \), and (iii) the extent to which an increase in \( K \) shifts outward the supply of bank credit, i.e. \( \beta \left( \frac{\rho - (1-\tau)\tau}{\rho + a + \beta^2} \right) \). Note that, the two first terms depend on the firm's underlying production function and its output market characteristics, while the last term depends on its financial policy and the underlying financial market characteristics. Thus in this model, the marginal value of a unit of investment depends not only on the underlying market and technological factors which govern the profitability of that investment but also on its mode of financing. This interaction between finance and investment is, in fact, an important distinctive feature of our model. To highlight this aspect of the model, let us solve equation (11.a) for the firm's optimal rate of real investment, \( I \), and obtain

\[
I = \frac{1}{a} \left[ q - 1 + h \frac{\rho - (1-\tau)\tau}{\rho + a + \beta^2} \right] K
\]

(12)

where \( q = \frac{\lambda}{\rho} \) is the familiar "Tobin's marginal q" defined as the ratio of the market value of an additional unit of capital to its replacement cost.

Equation (12) offers some important insights into the relationship between the firm's real investment decisions and its financial policy. Thus, it is readily seen that, \( \frac{\partial I}{\partial h} > 0, \frac{\partial I}{\partial \tau} < 0, \frac{\partial I}{\partial \beta^2} < 0 \). But since \( q \) depends also on these financial parameters, the results just indicated can only provide a partial view of the relationship between investment and finance. To derive at a more general view, we rewrite equation (11.b) in terms of \( q \) and note that the resultant equation in conjunction with equation (12), describe a system of two first-order differential equations in \( K \) and \( q \), namely,
\[
\dot{K} = \frac{1}{a} \left[ q - 1 + h \frac{\rho - (1 - \tau) r}{\rho + a + \beta_2} - \alpha \delta \right] K \tag{13.a}
\]
\[
\dot{q} = (\rho + \delta - \hat{p}) q - \left[ (1 - \tau) \frac{\pi_K}{p} + a/2 \left( \frac{\tau}{K} \right)^2 + \beta_1 \frac{\rho - (1 - \tau) r}{\rho + a + \beta_2} \right] \tag{13.b}
\]

where \( \hat{p} = \frac{\dot{p}}{p} \) denotes rate of inflation in capital goods prices, and
\[
\pi_K = \frac{3\pi}{8K}.
\]

The system of equations (13.a) and (13.b) describes the joint determination of the optimal time path of \( K \) and \( q \) and provides the basis for our analysis of the short and long-term implications of various exogenous changes in the underlying financial market conditions.

II.2 Steady-state equilibrium

The system attains its steady-state equilibrium when \( K = \dot{q} = 0 \). The phase diagram corresponding to this system is shown in Figure 1. In the figure, the \( K = 0 \) line is based on equation (13.a) and depicts the locus for which the rate of change of the capital stock is zero. The downward sloping curve \( \dot{q} = 0 \) is based on equation (13.b) and describes the locus for which the marginal value of investment is zero. By virtue of the assumption that the profit function is concave, the steady-state equilibrium of the system denoted by \( K^*, q^* \), is unique, and lies on the saddle-point path of the system as indicated by the dark line in the figure.

Consider now the consequences of an increase in \( h \) brought about, for instance, as a result of an expansionary credit policy. An increase in \( h \) lowers the \( K = 0 \) locus and leaves the \( \dot{q} = 0 \) locus unaffected. The new intersection will involve a higher level of capital stock and a lower \( q \), as shown in figure 2. Thus an increase in marginal debt-capital ratio has
Figure 1. Phase Diagram of the System of Equations (13.a) and (13.b)
Figure 2. Response to an Increase in the Supply of Bank Credit

\[ q \]

\[ k = 0 \]

\[ q = 0 \]
Figure 3. Response to a Decrease in the Rate of Interest
favourable impacts on the firm's optimal capital stock and on its rate of investment, but has adverse effect on its marginal valuation;

\[
\frac{3K}{3h} > 0, \frac{3I}{3h} > 0, \frac{3q}{3h} < 0.
\]

Next consider a decrease in the rate of interest. From equations (13.a) and (13.b) it can be inferred that a decrease in the rate of interest shifts both loci; the \( K = 0 \) locus shifts upward because the lower interest rate tends to induce the substitution of debt for equity and thus lowers the marginal cost of investment. The \( q = 0 \) schedule shifts to the right because of positive impact of higher availability of debt financing on the firm's marginal values of capital. Formally, the responses in the firm's optimum level of capital stock, its rate of investment and the valuation ratio are as follows:

\[
\frac{3q}{3r} < 0, \quad \frac{3I}{3r} < 0, \quad \frac{3K}{3r} < 0
\]

III. Empirical Results

III.1 Specification of Corporate Investment Function

In this section, we use evidence from the corporate sector of the Korean economy to gain some quantitative insight into the relationship between corporate real investment behavior and financial policy as elaborated in the previous section. It was shown, in the previous section, that changes in financial policy operating via changes in the rate of interest and/or changes in the supply of bank credit could have important effects on the firm's
optimal rate of investment. The main objective in this section is to establish the quantitative dimension of these relationships. The starting point is the modification of equations (1) and (13.a) into some suitable empirical forms that can be estimated. We extend equation (1) to account for any short-term variation in bank credit which may stem from cyclical fluctuations in the overall level of economic activity. Thus, the basic equations to be estimated, expressed in discrete time, are:

$$I_t = \frac{1}{a} \left( q_t - 1 + h \left( \frac{r_t}{\rho_t + a + \beta_2} \right) \right) + \varepsilon_{1t}$$

(14.a)

$$b_t = b_0 + h p_t I_t + \beta_1 p_t K_t - \beta_2 B_{t-1} + \beta_3 y_t + \varepsilon_{2t}$$

(14.b)

where $y_t$ in equation (14.b) is the deviation of real GDP from its long-term trend included as a measure of business cycle, and $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are disturbance terms assumed to be normally distributed with definite variance-covariance matrix and zero means.

Before turning to the estimation of equations (14.a) and (14.b) one obstacle remains. As emphasized originally by Tobin and Brainard (1977), and subsequently by Hayashi (1982) and Summers (1981), $q$ in equation (14.a) is not directly observable and so this equation is not empirically operational. What is, in principle, observable and which, under certain conditions can serve as an appropriate proxy for $q$, is the "average $q" to be denoted by $Q$ and defined as the ratio of the market value of existing capital to its replacement cost. The market value of existing capital can be inferred from the market's valuation of various security claims over total corporate assets. This includes the market value of equity as well as the market value of debt if
debt is publicly issued. If on the other hand there exist no organized corporate bond market and if debt is mostly financed by bank loans or loans from other financial institutions, then there is no meaningful empirical counterpart to the market value of debt. In this case one possible approach would be to measure debt at its book value by referring directly to the liability side of corporate balance sheet. This measure of corporate debt has the advantage of being free from estimation error. But it suffers from one major drawback, namely, it reduces the informational content of the "q" ratio as a determinant of corporate investment. The loss in the informational content of "q" and thus in its predictive power is proportional to the ratio of debt to equity in the firm's capital structure.

With these considerations in mind, we proceed to measure the "average q" in the non-financial private corporate sector of the Korean economy as the ratio of market value of equity plus book value of debt to the replacement cost of capital. With the exception of data on the book value of corporate debt which is directly available from the Flow of Fund tables published by the Bank of Korea, other variables had to be estimated. In the process, we relied on both national income accounts and balance sheet data to generate the necessary information. The detailed methodological issues including data coverage, sources and problems are discussed in appendix A. In brief, here, our estimates of both market value of equity and replacement cost of capital follows conventional approaches; the market value of equity was estimated by capitalizing corporate dividend payments, using annual average yield on equity as the discount rate; and the replacement cost of capital was calculated by

1/ See, for instance, Taggart (1985) and Holland and Myers (1979).
perpetual inventory method, using an average depreciation rate of 8 percent per annum. These estimates are reported in Table A.1 in the appendix A.

Table 1 provides estimates of the average "Tobin's q" as well as the ratio of the book value of debt to the total book value of debt plus the market value of equity in the non-financial private corporate sector of the Korean economy for the 1963-1983 period. The latter ratio represents a measure of corporate financial leverage and as expected is relatively very high. For the decade of 1970s, for instance, the corporate leverage in Korea averaged at 0.787 which, in a rough comparison, is close to a level of 0.722 observed for Japan\(^1\) and is significantly higher than a level of 0.315 observed for the U.S.\(^2\) over the same period. This high level of debt-to-capital ratio observed in Korea is indicative of the dominant role of debt financing in the corporate capital structure and has significant potential implications for the implementation and management of financial policy.\(^3\) A high debt-to-capital ratio renders the corporate sector very vulnerable to effects of contractionary changes in credit and monetary policy and thus may limit the ability of policy makers to pursue stabilization policies.

Two features of the estimates of the "average q" shown in the second column of Table 1 are worth noting. First, the estimates appear quite reasonable despite the fact that the denominator and the numerator of q were estimated independently of each other. The estimates for the period 1963-

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1/ This is based on T. Wakasuy et. al. (1984).

2/ Based on Taggart (1985).

3/ See Sundararajan (1985) for a theoretical analysis of the macroeconomic effects of high corporate leverage in developing countries.
Table 1.

Tobin's Average Q Ratio and the Ratio of Debt to Total Capital:

Korean Non-financial Private Corporate Sector, 1963-1983

<table>
<thead>
<tr>
<th>Year</th>
<th>Debt-Capital Ratio</th>
<th>Average Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>0.68202</td>
<td>1.26043</td>
</tr>
<tr>
<td>1964</td>
<td>0.67577</td>
<td>0.95609</td>
</tr>
<tr>
<td>1965</td>
<td>0.72764</td>
<td>0.90510</td>
</tr>
<tr>
<td>1966</td>
<td>0.73304</td>
<td>0.95336</td>
</tr>
<tr>
<td>1967</td>
<td>0.78920</td>
<td>1.08706</td>
</tr>
<tr>
<td>1968</td>
<td>0.82243</td>
<td>1.20301</td>
</tr>
<tr>
<td>1969</td>
<td>0.80738</td>
<td>1.36209</td>
</tr>
<tr>
<td>1970</td>
<td>0.84807</td>
<td>1.20548</td>
</tr>
<tr>
<td>1971</td>
<td>0.87823</td>
<td>1.21239</td>
</tr>
<tr>
<td>1972</td>
<td>0.85599</td>
<td>1.25568</td>
</tr>
<tr>
<td>1973</td>
<td>0.71789</td>
<td>1.40181</td>
</tr>
<tr>
<td>1974</td>
<td>0.71604</td>
<td>1.28329</td>
</tr>
<tr>
<td>1975</td>
<td>0.75634</td>
<td>1.43888</td>
</tr>
<tr>
<td>1976</td>
<td>0.71588</td>
<td>1.52710</td>
</tr>
<tr>
<td>1977</td>
<td>0.73914</td>
<td>1.46433</td>
</tr>
<tr>
<td>1978</td>
<td>0.77921</td>
<td>1.32340</td>
</tr>
<tr>
<td>1979</td>
<td>0.87506</td>
<td>1.07677</td>
</tr>
<tr>
<td>1980</td>
<td>0.86517</td>
<td>0.97482</td>
</tr>
<tr>
<td>1981</td>
<td>0.86590</td>
<td>1.02734</td>
</tr>
<tr>
<td>1982</td>
<td>0.87417</td>
<td>1.02012</td>
</tr>
<tr>
<td>1983</td>
<td>0.84197</td>
<td>1.09519</td>
</tr>
</tbody>
</table>

Note:  
(1) = Ratio of book value of debt to total market value of equity plus book value of debt.  
(2) = Ratio of book value of debt plus market value of equity to Replacement Cost of Capital.  

Sources: See Table Al in appendix A.
1983, are generally greater than one, which reflect the market's optimistic expectation of the pattern of corporate profitability during that period. Second, the broad movements in "Q" seem to have been closely paralleled by the pattern of corporate real investment expenditures. These movements have followed a cyclical pattern, characterized by a phase of upward movement from 1976 until 1980, and a phase of downward movement since 1981.

III.2 Estimation Method and Results

Turning to the estimation of the system of equations (14.a) and (14.b), we substitute \( Q_t \) for \( q_t \) in equation (14.a) and after slight modification obtain,

\[
\frac{I_t}{K_t} = \frac{1}{\alpha} (Q_t - 1) + \frac{h}{\alpha} X_t (\beta_2) \tag{15}
\]

where \( X_t (\beta_2) = \frac{\rho_t - (1 - \tau_t) r_t}{\rho_t + \bar{a} + \beta_2} \), and \( \bar{a} \) is a given value of the rate of amortization taken to be 10 percent per year. Note that, for a given value of \( \beta_2 \), \( X_t \) is empirically observable and thus can be used as part of the data set.

To obtain consistent and efficient estimates of the parameters \( \alpha, h, \beta_0, \beta_1 \) and \( \beta_3 \), we performed an iterative grid search over \( \beta_2 \) and chose the value that maximized the log likelihood function corresponding to the system of equations (14.b) and (14.c). The grid search was conducted over the interval \( \{\hat{\beta}_2 \pm k \hat{\sigma} \mid k = 0, 1, 2, 3, 4\} \) where \( \hat{\beta}_2 \) and \( \hat{\sigma} \) are respectively the OLS estimates of \( \beta_2 \) and its standard error obtained from the regression of equation (14.b) using annual data for years 1963-1983. The regression results of this equation are,
\[ b_t = 176.2 + 0.76 \ p_t \ I_t + 0.2 \ p_t \ K_t \]
\[ (71.07) \ (0.114) \ (0.044) \]

\[-0.337 B_{t-1} + 383.12 \ y_t \]
\[ (0.049) \ (171.76) \]

\[ R^2 = 0.98 \]

The final results of the maximum-likelihood estimates of equations (14.b) and (15) are reported in Table 2. The table also shows the corresponding asymptomatic standard error of the estimates. These estimates correspond to the value of \( \beta_2 = 0.287 \); which led to the maximum value of the log likelihood function. Considering our estimation results, they seem quite satisfactory as all have the right sign and all, with the exception of coefficient of cyclical fluctuation of real output, are significantly different from zero at the 5 percent level. The estimated value for \( h \) is 0.88 which is consistent with the high leverage characteristic of Korean corporate sector. The implied value for the coefficient of cost of adjustment is \( \alpha/2 = 1.19 \), which suggests an unusually high cost of adjustment per unit of investment.

We are now in a position to provide a quantitative measure of the extent to which government policy over the past two decades has yielded positive investment incentives to the private corporate sector. Let us then formally introduce the concept of "investment incentive space," to be denoted by \( S \) and defined as,

\[ S = \{ Q_t \geq q_t^* \mid t = 1963, - - - - - - , 1983 \} \]
Table 2

Maximum-Likelihood Estimates of the Parameters of Equation (14.b) and (15)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Estimates</th>
<th>Standard-Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_0$</td>
<td>143.250</td>
<td>63.980</td>
</tr>
<tr>
<td>$h$</td>
<td>0.880</td>
<td>0.092</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>0.212</td>
<td>0.012</td>
</tr>
<tr>
<td>$\beta_3$</td>
<td>116.000</td>
<td>146.300</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>2.380</td>
<td>0.408</td>
</tr>
</tbody>
</table>
where \( q_t^* \) is the steady-state value of \( q_t \) given by

\[
q_t^* = 1 - h \frac{\rho_t - (1 - \tau_t) r_t}{\beta_2 + a + \rho_t}
\]  (17)

Thus, when \( Q_t > q_t^* \), firms have an incentive to expand real investment, and the larger the distance between \( Q_t \) and \( q_t^* \), the greater the incentive for investment.

Figure 4 shows the plots of \( Q_t \) and \( q_t^* \) for the Korean non-financial corporate sector over the 1963-1983 period. The shaded area between \( Q_t \) and \( q_t^* \), as shown in the figure, represents a measure of incentive accorded to the corporate private sector during this period. As can be seen, these incentives were greatest from mid-1960s to late 1970s, which, interestingly, corresponded to the vigorous expansion of corporate investment during that period.

IV. Concluding Remarks

In many developing countries, corporations rely heavily on bank borrowing to finance their long-term investment expenditures. This has reflected partly the effects of past governmental policy to encourage debt financing through a variety of measures, including low interest rates, generous tax allowances for interest payments, and a tacit commitment against bankruptcy and business failures. Thus, the resultant comparative advantage in favour of debt financing has generally led to high corporate leverages with adverse potential implications for the conduct of credit and monetary policy. To gain an understanding of how corporate investment may respond to various policy-induced changes in corporate financial environment, this paper
FIGURE 4: TOBIN'S AVERAGE Q AND INVESTMENT INCENTIVE SPACE: KOREAN NON-FINANCIAL CORPORATE SECTOR

RATIO

1.6
1.4
1.2
1
0.8
0.6
0.4

YEAR


Q

investment incentive space

q∗
has developed a dynamic optimization model of the firm's investment and financial behavior. The model was estimated for the non-financial corporate sector of the Korean economy, using annual data from 1963-1983. On the basis of the estimates obtained we constructed a quantitative measure of the extent to which governmental initiatives led to encourage corporate investment through liberal interest rate and tax policies. It was shown that the private corporate sector in Korea benefited from some investment incentives from mid-1960s to early 1980s.
REFERENCES


Sundararajan, V. (1985), Debt-Equity Ratios of Firms and Interest Rate Policy, IMF Staff Papers, No. 3, September, pp. 430-473.


APPENDIX A

DEFINITION AND DATA SOURCES

The primary source for most of the data used in this study is, Economic Statistics Yearbook (ESYB), Bank of Korea, various issues. Two set of flow of funds tables i.e., the Integrated Accounts of National Income and Financial Transactions, and Financial Assets and Liabilities, contained in this publication, were utilized to generate the necessary balance sheet data for total nonfinancial private corporate sector for the years 1963-1983. These data were supplemented, when necessary, by drawing on two other sources, which are, IMF, IFS, and Major Statistics of Korean Economy (MSKE), Economic Planning Board, various issues.

The definition of variables are as follows:

1) PI = fixed capital formation (in current prices), ESYB.
2) P = price deflator for fixed capital formation constructed as a weighted arithmetic average of whole sale price indices of construction materials and capital goods, (MSKE).
3) I = real fixed capital formation, (1) deflated by (2).
4) b = gross borrowing consisting of special and commercial bank loans, insurance and trust loans and net foreign loans, ESYB.
5) B = total corporate debt consisting of total bank debt, foreign debt and debt owned to insurance and trust companies, ESYB.
6) d = dividends, from National Income Accounts, ESYB.
7) \( p = \) \text{annual average yield on stocks traded in the Korea Stock Exchange, ESYB.}

8) \( r = \) \text{interest rate on commercial bank loans for machine, industry and promotion, MSKE.}

9) \( \tau = \) \text{corporate income tax rate constructed from data obtained from ESYB.}

10) \( K = \) \text{capital stock, constructed by means of the perpetual inventory method,}

\[
K_t = I_t + (1 - \delta) K_{t-1}
\]

where the average depreciation \( \delta \) is estimated to be 8 percent per annum using straight line depreciation rule based on an average life time of 35 years for structures and 15 years for machinery and equipment.

11) \( y = \) \text{cyclical fluctuation of real aggregate output constructed as the deviation of real GDP from its long-term trend.}
Table A.1
Market Value of Equity, Book Value of Debt
and Replacement Cost of Capital:
Korea non-financial Private Corporate Sector, 1963-1983

(Billion won)

<table>
<thead>
<tr>
<th>Year</th>
<th>Market Value of Equity</th>
<th>Debt</th>
<th>Capital Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1963</td>
<td>17.30</td>
<td>37.11</td>
<td>43.17</td>
</tr>
<tr>
<td>1964</td>
<td>23.33</td>
<td>48.63</td>
<td>75.26</td>
</tr>
<tr>
<td>1965</td>
<td>27.28</td>
<td>72.90</td>
<td>110.69</td>
</tr>
<tr>
<td>1966</td>
<td>50.67</td>
<td>139.14</td>
<td>199.11</td>
</tr>
<tr>
<td>1967</td>
<td>67.41</td>
<td>252.37</td>
<td>299.69</td>
</tr>
<tr>
<td>1968</td>
<td>105.47</td>
<td>488.52</td>
<td>493.76</td>
</tr>
<tr>
<td>1969</td>
<td>183.41</td>
<td>768.79</td>
<td>699.07</td>
</tr>
<tr>
<td>1970</td>
<td>184.41</td>
<td>1029.38</td>
<td>1006.89</td>
</tr>
<tr>
<td>1971</td>
<td>180.48</td>
<td>1301.67</td>
<td>1222.51</td>
</tr>
<tr>
<td>1972</td>
<td>262.17</td>
<td>1558.32</td>
<td>1449.81</td>
</tr>
<tr>
<td>1973</td>
<td>806.22</td>
<td>2051.61</td>
<td>2038.67</td>
</tr>
<tr>
<td>1974</td>
<td>1164.77</td>
<td>2937.14</td>
<td>3196.41</td>
</tr>
<tr>
<td>1975</td>
<td>1557.05</td>
<td>4833.34</td>
<td>4441.23</td>
</tr>
<tr>
<td>1976</td>
<td>2418.48</td>
<td>6093.79</td>
<td>5574.14</td>
</tr>
<tr>
<td>1977</td>
<td>2726.74</td>
<td>7726.19</td>
<td>7131.39</td>
</tr>
<tr>
<td>1978</td>
<td>2839.92</td>
<td>10022.89</td>
<td>9719.55</td>
</tr>
<tr>
<td>1979</td>
<td>1984.55</td>
<td>13898.99</td>
<td>14751.13</td>
</tr>
<tr>
<td>1980</td>
<td>2891.89</td>
<td>18556.19</td>
<td>22022.11</td>
</tr>
<tr>
<td>1981</td>
<td>3687.00</td>
<td>23807.59</td>
<td>26762.91</td>
</tr>
<tr>
<td>1982</td>
<td>3944.14</td>
<td>27399.99</td>
<td>30725.79</td>
</tr>
<tr>
<td>1983</td>
<td>5960.67</td>
<td>31758.09</td>
<td>34440.35</td>
</tr>
</tbody>
</table>

Source: See previous section on Definition and Source of Data.
Some Recent DRD Discussion Papers


197. Import Compression and Export Performance in Developing Countries, by M. Khan and M. Knight, October 1986.


