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The Debt-Equity Ratio of Firms and The Effectiveness of Interest Rate Policy: Analysis with a Dynamic Model of Saving, Investment, and Growth in Korea

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I. Introduction

The main purpose of the paper is to analyze empirically the impact of interest rates on the overall cost of capital, saving, investment, and growth in the Korean economy during 1963-81. The analysis takes into account the simultaneous linkages between these variables. Among the various linkages, the paper emphasizes the relationship between interest rates and the financial structure of firms, and highlights the interdependence between financing and real decisions of firms, and the consequences of this interdependence for the effectiveness of interest rate policy.

It is by now well recognized that a proper analysis of the role of interest rates requires a dynamic framework that recognizes the complex interactions between saving, investment, and growth. 1/ Single-equation analysis of saving or investment often provides a misleading and inconclusive picture of the effectiveness of interest rate policy, because such analysis focuses only on the immediate and direct effects of interest rates, and the identification of these effects is fraught with a host of theoretical and econometric complications. Only on the basis of a well-specified, simultaneous-equation framework can the dynamic effects of interest rate policies be studied, and the relative importance of the direct, as well as indirect channels through which interest rates affect growth be understood. The model developed in this paper provides an integrated framework that incorporates the effects of interest rates--both the administered rate in the banking system and the rate in the unregulated financial market (UFM)--operating through their influence on the cost of capital to investors, as well as on returns to various groups of savers. A change in the administered interest rate affects the UFM rate, the debt-equity choice by firms, the overall cost of capital, and the real interest rates, and thereby sets in motion a chain of responses influencing the desired level of the capital stock and its productivity, as well as the availability of saving and the consequent speed of adjustment of the actual capital stock to the desired level. Thus, the model incorporates various channels of effects that are emphasized in the classical and modern theories of interest rates. 2/

The Korean economy offers an interesting case study of rapid economic growth with heavy reliance on debt finance. The average debt-equity ratio--that is, the ratio of total liabilities to net worth--of firms in the industrial sector in Korea has increased from about 100 percent in the early 1960s to about 500 percent in recent years. Policymakers in Korea have in general held the view that the resultant, overleveraged financial structure restricts their macroeconomic policy

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1/ See, for example, Leff and Sato (1975), Khatkhate (1980), Sundararajan and Thakur (1980), and IMF (1983).

2/ For a discussion of alternative models of interest rate policy in developing countries, see Galbis (1982).

options and have, on various occasions, adopted measures to reduce the debt-equity ratio of firms as part of financial reform. 1/ The analytical rationale for policies to reduce the heavy reliance on debt is contained in Sundararajan (1985), where the macroeconomic consequences of the financial structure of firms in developing countries is analyzed, based on a stylized model applying to countries such as Korea.

The influence of the debt-equity ratio becomes apparent when it is recognized that the overall cost of capital to investors--which influences fixed investment, its efficiency, and profits--can be expressed as a weighted sum of the opportunity cost of bank debt and that of equity, with the weights depending upon the debt-equity ratio. 2/ Therefore, the multiplier effects of changes in the cost of bank debt on investment and growth depends, among other things, on the share of debt in investment financing, and on the induced adjustments in this share and in the cost of equity; all of these induced adjustments determine the ultimate impact of a change in the administered interest rates (the cost of bank debt) on the overall cost of capital, and, hence, on investment incentives and the productivity of capital. In addition, empirical estimates show that the cost of equity, approximated by the UFM rate, incorporates a risk premium which first falls and then rises as the debt-equity ratio rises. The resulting U-shaped, cost of capital schedule is shown to have far-reaching implications for the effectiveness of interest rate policy.

In contrast to the above findings, the well-known Modigliani-Miller (MM) theorem states that the cost of capital is independent of the financing mix (the debt-equity ratio) in a world with rational investors, perfect capital markets, no taxes, and no default or bankruptcy risks. In this framework, investment decisions are independent of financing decisions, and a unique optimal debt-ratio does not exist, with the actual ratio representing a corner solution. Since these implications are both counterfactual and counterintuitive, the MM theorem has given rise to a large body of theoretical work focusing on the determinants of the financing mix used by firms. It is by now well recognized that due to default and bankruptcy risks, due to the costs of institutional arrangements needed to protect creditors (agency costs), and due to the possibility in a growing economy that valuable investment opportunities would be forgone in the presence of large debt-service commitments, there exists an optimum debt-equity mix for firms. In other words, the cost of capital depends upon the debt-equity mix first falling and then rising as

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1/ For an historical account of developments in corporate finance and related policies, see Sakong Il (1977), Que (1979), and Virmani (1985).

2/ Throughout the paper, debt ratio (α) refers to the ratio of total liabilities to total assets, and the term debt-equity ratio (DE) refers to the ratio of total liabilities to net worth; the two terms will be used interchangeably in view of the one-to-one correspondence between the two ratios given by $DE = \alpha/1 - \alpha$.

the debt ratio rises. As a result, the financing and real decisions are no longer independent. For references to this literature and a brief survey, see Modigliani (1982). Thus, the effect of the debt ratio on the cost of capital is essentially an empirical issue.

If this effect is significant, the implied interdependence between financing and real decisions necessarily complicates the task of a model builder, who must now specify a model of financing decisions of firms in order to assess properly the impact of interest rates on the real economy. The novel feature of this paper is to address the complexity of modeling financing decisions of firms, and thereby assess the empirical significance of the interdependence of financing and real decisions for the first time in the context of a developing economy.

The different channels of influence of interest rates are first specified and estimated, and the complete model is then simulated to assess the impact of interest rate policy. Model simulations reveal that the direct effects of interest rates on saving and investment are either reinforced or offset by the substantial indirect effects arising from the optimal adjustments in the debt-equity ratios. An increase in the regulated interest rate reduces the implicit interest subsidy, and hence induces a fall in the debt-equity ratio. Given the estimated U-shaped, cost of capital schedule, when the initial debt ratio is sufficiently small, as in earlier years, the actions of firms to reduce the debt ratio raises the overall cost of capital and reinforces its normal increase due to higher interest rates. In contrast, when the debt ratio is sufficiently large, as in more recent years, the fall in the debt ratio reduces the UFM rate and the cost of capital, and offsets their normal increase. This offsetting effect is indeed substantial, producing weak or even perverse multiplier effects of interest rates on saving and growth. In other words, the effectiveness of interest rate policy has become substantially weakened in recent years owing primarily to the large corporate debt ratios that have come to prevail.

The paper is organized as follows: Section II presents the model determining saving, investment, output, the debt ratio, the real rate of interest in the UFM, and the real cost of capital to investors. Section III discusses the results for individual structural equations of the model. Section IV presents the results of simulation exercises that underscore the dynamic effects of interest rate policies and the dependence of these effects on the debt-equity ratio. Section V contains concluding remarks and highlights the policy implications.

II. The Model

The model consists of functional relationships for private fixed investment, output, household saving, corporate saving, the debt-equity ratio, the UFM rate, and several definitional identities. Public investment, the rates of taxation of household and business incomes, the

ratios of foreign saving and external debt to GDP, domestic credit, and the current and expected rate of inflation are all treated as exogenous. Considerable attention is devoted to the appropriate definition of the cost of capital to investors, which is the key variable in the model influencing investment, output-capital ratio, and corporate saving. The notation and the complete list of variables and equations constituting the model are shown on pages 19 and 20.

1. Private investment and the cost of capital

A private investment function has been derived by modifying the neoclassical theory of investment in order to incorporate the influence on the cost of capital of the dual financial system in Korea and of the substantial use of foreign currency debt by firms. 1/ The neoclassical theory suggests that private investment is positively related to the expected output level, and negatively to the expected relative price of capital--that is, the user cost of capital relative to the wage rate. Private investment also depends on the capital stock of the public sector and the investible funds available to the private sector. 2/ The novel feature of this study is an attempt to show that the user cost of capital depends not only on the administered interest rates and the international rates, which together determine the cost of debt obtained from the regulated financial system, but also on the interest rate in the UFM, which determines the cost of equity. This is because, with underdeveloped capital markets, the UFM rate serves as the relevant short-run opportunity cost of equity funds and hence determines the rate of discount for the future cash flows from investment.

The real cost of capital, defined as the minimum acceptable return on investment in equilibrium, can be derived by assuming that firms choose the level of investment in order to minimize their total cost of producing desired output, including the acquisition cost of capital, and the debt service costs. The first-order conditions for the cost-minimizing investment path simply reduce to the familiar rule stating that at each point in time, investment should be expanded until the present value of cost reductions, due to the investment minus the present value of debt service incurred in financing the investment, equals the amount of equity finance supplied by the owners (both new and old). 3/

1/ Owing to restrictions on capital flows, both the volume of foreign currency debt and external interest rates are treated as exogenous, and the effect of external interest rates on domestic rates are ignored.

2/ See Sundararajan and Thakur (1980) and Blejer and Khan (1984) for a discussion of the role of public investment in private investment decisions.

3/ For a statement of the optimal control problem used to derive the expression for the cost of capital, see Appendix I, and for a solution of the problem and the derivation of the first-order conditions, see Sundararajan (1985).

To highlight the expression for the cost of capital, this rule can be restated as follows:

$$-\partial C/\partial KP = PK\ R_c \qquad (1)$$

where $-\partial C/\partial KP$ is the reduction in nominal labor costs (C) from unit addition to private capital stock (KP), PK is the price of capital goods, and R_c is the real cost of capital given by:

$$R_c = (1 - \alpha^m)(i_u - \Pi_k + \delta) + [\alpha^{md}(i_d + a_d/i_u + a_d) + \alpha^{mf}(i_f + a_f/i_u + a_f - X)](i_u - \Pi_k + \delta) \qquad (2)$$

where i_d is the administered interest rate in the regulated financial market; i_f is the foreign interest rate; i_u is the interest rate in the UFM representing the short-run opportunity cost of equity (the rate of discount used to capitalize cash flows from investment); a_d, a_f are the amortization rates on domestic and foreign loans, respectively; δ is the rate of economic depreciation of the capital equipment; X is the expected rate of change in the nominal exchange rate, and Π_k is the expected rate of inflation for capital goods; α^{md} is the proportion of investment financed by domestic currency loans; and α^{mf} is the proportion of investment financed by foreign currency loans. The marginal debt ratio α^m is the sum of α^{md} and α^{mf}, and represents the proportion of fixed investment financed by debt. 1/ The expression in large brackets on the right side of equation (2) is the present value of debt service payments on α^{md} of domestic loans and on α^{mf} of foreign loans. Thus, the real cost of capital R_c is the weighted sum of the real opportunity cost of equity and that of debt.

Equation (1) states that capital should be acquired in the current period until the reduction in present costs, owing to a unit of additional capital, equals the current user cost of capital. The user cost of capital given in the right-hand side of equation (1) is simply the product of the price of capital goods and the real cost of capital for investors. 2/

1/ In anticipation of empirical results, it is assumed that UFM loans are not used in financing fixed investment. Fixed assets are financed by debt from the regulated financial system (bank debt and foreign currency loans) and by equity, while current assets are financed entirely by debt, including UFM debt. This is the assumption used throughout the paper and its relevance is tested in the empirical section of the paper.

2/ It is interesting to note that although the long-term rate--integral of the short-term UFM rates--is relevant for discounting future cash flows, the appropriate interest rate for defining the user cost of capital is the short-term rate. The appropriateness of the short-term rate is emphasized in Hall (1977), based on a discrete time framework.

From the first-order condition (1), an expression for the desired capital stock of the private sector can be derived using a specific cost function. If it is assumed that the production function is Cobb-Douglas:

$$QP_t = A_t(KG_t)^{\alpha_o}(KP_t)^{\alpha_1}(L_t)^{\alpha_2};\ A_t > 0,\ \alpha_o > 0,\ \alpha_1 > 0,\ \alpha_2 > 0$$

where L denotes labor input, KG denotes available infrastructure represented by government capital stock, and A the effects of shifts in the production function owing to technical change, then the variable cost function can be expressed as:

$$C_t = W_t\ L_t = W_t(QP)_t^{1/\alpha_2}(A_t)^{-1/\alpha_2}(KG_t)^{-\alpha_o/\alpha_2}(KP_t)^{-\alpha_1/\alpha_2} \qquad (3)$$

where W denotes the nominal wage rate. Differentiating this cost function with respect to KP_t and substituting in the equilibrium condition (1), we get:

$$W_t(QP_t)^{1/\alpha_2}(A_t)^{-1/\alpha_2}(KG_t)^{-\alpha_o/\alpha_2}(-\alpha_1/\beta)(KP_t)^{-(\alpha_1/\alpha_2)-1} = PK_t\ R_{ct} \qquad (4)$$

Equation (4) can be rewritten to obtain the desired level of capital stock KP_t^* that corresponds to the expected or planned output level QP_t^* and the expected rental wage ratio $(PK\ R_c/W)_t^*$:

$$KP_t^* = A_t^{-1/\bar{\alpha}}[(PK\ R_c/W)_t^*]^{-\alpha_2/\bar{\alpha}}(QP_t^*)^{1/\bar{\alpha}}(KG_t)^{-\alpha_o/\bar{\alpha}} \qquad (5)$$

where $\bar{\alpha} = \alpha_1 + \alpha_2$.

For the purposes of estimation, the following linear approximation to equation (5) is used:

$$KP_t^* = d_o - d_1(PK\ R_c/W)_t^* + d_2QP_t^* - d_3KG_t - d_4T \qquad (6)$$

The private sector's desired capital stock is a linear function of the expected rental wage ratio, the planned level of private sector output, the public sector capital stock, and a time trend (T) representing technological change. Equations (5) and (6) imply that an increase in the rental wage ratio reduces the desired capital stock owing to capital-labor substitution. However, it is the expected rental wage ratio, rather than the actual ratio, that governs investment decisions. Both public investment and technological change serve to reduce the desired capital stock of the private sector, because they generate facilities

that the private sector would have to provide for itself in their absence.

In order to derive the final form of the investment function, the process determining the planned output level and the expected rental-wage ratio, as well as the mode of adjustment of the actual capital stock to the desired capital stock need to be specified. The planned private sector output is assumed to be a function of the current and past levels of output, as well as of public sector capital stock:

$$QP_t^* = a_o + a(L)QP_t + a_1KG \qquad (7)$$

where a(L) is the lag operator. An increase in public sector capital stock raises private sector output expectations, because this increase represents potential additional demand for private sector products when these public investment projects mature. The effects of current demand for private sector output owing to current investment and production activities of the public sector is already subsumed in the private sector output variable in equation (7).

For simplicity, the expected rental wage ratio RW* is approximated by a distributed lag in the actual ratio:

$$RW^* = d(L)(PK\ R_c/W) \qquad (7a)$$

It is assumed that private capital stock adjusts only partially to its desired level. 1/

$$KP_t - KP_{t-1} = b_t(KP_t^* - KP_{t-1}) \qquad (8)$$

Equation (8) states that only a proportion of the gap between the desired capital stock and existing capital stock is closed in a given period.

The speed of adjustment b_t is assumed to vary in response to the ease with which private investment can be financed. It is specified as:

$$b_t = b_o + b_1 \frac{(S_t - IG_t)/PK_t}{KP_t^* - KP_{t-1}},\ b_1 > 0 \qquad (9)$$

The variable influencing the speed of adjustment stands for the total financing available to the private sector in real terms, (S - IG)/PK, relative to the required investment, $KP_t^* = KP_{t-1}$. 2/ The financing available to the private sector is nothing but the difference between

1/ On the optimality of the partial adjustment response, see Rothschild (1971).

2/ This technique of introducing variability in the speed of adjustment is similar to the one used by Coen (1971).

aggregate saving, (including foreign saving), and public sector investment IG; since this difference is merely gross private investment--in both fixed assets and inventories of the private sector--equation (9) also determines the allocation of private domestic investment between plant and equipment on the one hand, and inventories on the other. In addition, the resource availability variable (S - IG)/PK captures important channels through which crowding out of private investment occurs in many developing countries, including Korea.

Combining equations (6), (7), (8) and (9), and noting that private sector gross fixed investment is given by:

$$IP_t = (KP_t - KP_{t-1}) + \delta_p KP_{t-1}, \tag{10}$$

The investment function can be expressed as:

$$IP = B_o + B_1 d(L)(PK\ R_c/W)^* + B_2 a(L)QP + B_3 KG + B_4 (S - IG)/PK + B_5 KP_{-1} + B_6 T \tag{11}$$

where $B_o = b_o d_o + b_o d_2 A_o$, $B_1 = -b_o d_1$, $B_2 = b_o d_2$, $B_3 = -b_o d_3 + b_o d_2 A_1$,

$B_4 = b_1$, $B_5 = \delta_p - b_o$, and $B_6 = -b_o d_4$.

The signs of the coefficient B_2, and B_4 are expected to be positive, while the signs of B_1, B_5, and B_6 are expected to be negative. The sign of B_3, however, is indeterminate.

The influence of working capital costs can be readily incorporated in the definitions of the real cost of capital and the relative price of capital. Assuming that the cost function C(QP, KP, KG) consists of wage costs inclusive of the interest expense incurred due to advance payment to workers, and the cost of financing all current assets used in conjunction with fixed capital, a specific form of the cost function can be written as:

$$C(QP, KP, KG) = W(1 + i_d)L(QP, KP, KG) + \varepsilon KP\ PK\ i_d \tag{12}$$

where P is the general price level, L represents the employment corresponding to the level of output, infrastructure, and capital stock. The advance payment of the wage bill, W L, entails financing cost given by the W L i_d. Assuming that current assets (inventory and receivables) constitute a fixed fraction ε of the value of fixed capital stock, and that the full value of current assets are financed mainly through short-term bank loans, the finance costs of maintaining the requisite current assets is ε KP PK i_d.

As before, a new expression for the rental-wage ratio can be derived by differentiating the more general cost function (12), and applying the equilibrium condition (1). The revised expression for the rental-wage ratio is:

$$RW = \frac{PK[R_c + \varepsilon\, i_d]}{W(1 + i_d)} \qquad (13)$$

This expression which takes into account working capital costs emphasizes the possibility that the increase in the relative price of capital following a rise in the interest rate will be moderated, if the effective cost--including financing cost--of other substitute inputs (e.g., labor) rises due to the increase in interest rates, and will be accentuated if the effective cost of complementary inputs (e.g., current assets) rises.

2. Output and the productivity of capital

Private sector output is assumed to be a function of the capital stock in the private and public sectors, the rental wage ratio, and technological change represented by a time trend:

$$QP = c_0 + c_1 KP + c_2 KG + c_3 (PK\ R_c/W) + c_4 T \qquad (14)$$

Where the coefficients c_i are all positive. This equation can be derived by rewriting equation (4) and linearizing. 1/

It is important to note that while the investment function depends upon the expected value of the rental-wage ratio, the output function is related to the actual rental-wage ratio. That is, actual output corresponding to a given level of capital stock depends upon the factor intensity dictated by the current rental-wage ratio, while investment decisions are based on the long-run or the expected rental-wage ratio which serves to define the appropriate technology and product mix to be incorporated through new and replacement investments. Therefore, the joint specification of output and investment functions is consistent with the empirical observation that the possibility of substitution of capital for labor is more readily exploited through new capital equipment that has yet to be installed, while the factor intensity of the existing capital stock can be altered within a limited range in response to changes in the relative price of capital. Insofar as there exist possibilities to alter the productivity of existing capital by increasing the number of production shifts, and by varying the production mix (or sectoral composition of output), actual output would be related more to the prevailing rental-wage ratio than to the expected value of the ratio. Also, it is assumed that the labor supply is highly elastic. Thus, employment is assumed to be demand determined, a valid assumption for developing economies with surplus labor.

1/ Since the production and investment functions are both derived from the same equilibrium condition (equation (4)), there are interrelationships between the parameters of these two functions. However, these interrelations do not pose restrictions in the estimation procedure, because the investment function is based on expected values, while the production function relates to actual values.

There are a variety of channels through which interest rates influence the productivity of capital. The rental-wage ratio serves to capture the neoclassical channel by which higher interest rates raise the relative price of capital and thereby encourage more intensive use of capital and capital-labor substitution. Other mechanisms affecting the efficiency of capital include the following: first, higher real interest rates may improve bank credit rationing by reducing reliance on inefficient rationing procedures, and weeding out projects that were profitable only at a lower level of interest rates in favor of higher-yielding projects. The credit rationing effect is discussed in McKinnon (1973) and Fry (1982). Second, higher real interest rates may induce financial deepening and directly influence factor productivity, as discussed in Shaw (1973). 1/ Third, insofar as an increase in the yield on financial assets diverts saving from use in low-yielding, self-financed investments to the acquisition of financial assets, and the resulting additional financial saving is allocated by financial intermediaries to the more productive modern sector, there would be an improvement in the average efficiency of investment. (This aspect is discussed in Galbis (1977).) Finally, higher interest rates could have a negative effect on productivity in the short run, if working capital costs are raised, thereby reducing capacity utilization, as noted in van Wijnbergen (1982, 1983b).

These additional effects of interest rates on the productivity of capital can be captured by specifying a more general form for the output function:

$$QP = c_o + c_1 KP + c_2 KG + c_3 (RW) + c_4 T + c_5 (i_d - \Pi) + c_6 F \qquad (15)$$

where $i_d - \Pi$ is the real interest rate in the banking system serving to capture credit rationing and working capital effects, and F is a measure of financial deepening, which may shift the production function and induce a reallocation of credit to more productive sectors. The effect of working capital costs on the relative price of capital can be incorporated in the output function by using the more general expression for the rental-wage ratio (RW) given in equation (13). This general expression takes into account the possible adverse effect on output due to an increase in the cost of financing wage payments.

The public sector output QG is assumed to be a linear function of public sector capital stock:

$$QG_t = e_o + e_1 KG_t \qquad (16)$$

This formulation is valid for the determination of the output of the public enterprise sector; however, a more sophisticated formulation is

1/ As noted in Spellman (1976), the impact of financial deepening could be either neutral, merely shifting the production function uniformly, or factor augmenting.

required to explain the output of the general government. This complication is ignored here.

By combining equations (15) and (16), total output Q can be expressed as:

$$Q = C_o + C_1KP + C_2KG + C_3(RW) + C_4T + C_5(i_d - \Pi) + C_6F \qquad (17)$$

where RW represents a measure of the rental-wage ratio. Other variables affecting the level of output include the terms of trade, and monetary conditions. In anticipation of the empirical results, these variables are excluded in the expression for output shown in equations (15) and (17).

3. Saving

Real household saving S_H is assumed to be a function of the real interest rate on deposits in the banking system $(i_d - \Pi)$, the real yield on loans in the unregulated financial market $(i_u - \Pi)$, a distributed lag in real household disposable income YH, and excess demand for money:

$$S_H = D_o + D(L)Q_H + D_1(i_d - \Pi_c) + D_2(i_u - \Pi_c) + D_3EM \qquad (18)$$

where D(L) is the lag operator on real disposable income, and EM is a measure of the excess demand for money. 1/ The real interest rates are computed as the difference between the nominal yield on the relevant financial asset, and the rate of increase in consumer prices, Π_c. 2/

The specification of a distributed lag in output is consistent with several alternative models of saving behavior. For example, Leff and Sato (1975) have argued that savings should depend upon the first difference in permanent income. Another commonly used formulation relates saving to permanent and transitory incomes, with different marginal propensities for each type of income. All of these formulations can be captured by a general distributed lag in income; the specific model best suited for an economy has to be determined on an empirical basis, and can be inferred from the estimated lag distribution of the output variable.

Corporate saving consists of retained earnings and capital consumption allowances. Capital consumption allowances of the private sector

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1/ The excess demand for money measures the extent of disequilibrium in the money markets; this variable could influence consumption expenditure and hence saving.

2/ An alternative measure of the real interest rate given by $(i_u - \Pi_c)/(1 + \Pi_c)$, is more accurate when large changes in inflation and interest rates are involved.

(CCP) are specified as a function of the initial capital stock, in line with the assumption that the rate of depreciation is fixed. The rate of depreciation will also be significantly influenced by tax laws and accounting practices. Such shifts in the rate of depreciation can be captured by appropriate dummy variables that reflect changes in the policy regime. Therefore,

$$CCP = F_o + F_1KP_{-1} + F_2DUM2 + F_3KP_{-1}\ DUM2 \tag{19}$$

where DUM2 represents the dummy variable that assumes a value unity in the period following the revisions in policies that affect corporate saving.

Net corporate saving (NS_c) is simply retained earnings, computed as gross profits minus depreciation allowances and dividend distribution. 1/ Therefore, the factors influencing corporate profitability, both the long-run factors that influence the marginal productivity of capital as well as the short-run factors that affect capacity utilization, would influence net corporate saving, assuming that the dividend distribution policies are stable. In view of the general corporate practice in Korea of ensuring steady dividend yields on equity, no separate allowance need be made for factors affecting dividend payout.

Against this background, net corporate saving can be specified as

$$NS_c = G_o + G_1Q - G_2KP_{-1} - G_3W/P + G_4R_c - G_5EM \tag{20}$$

Real corporate saving depends upon the level of real output, excess demand for money, initial capital stock, real wages, and the real cost of capital. An increase in excess demand for money will reduce the demand for goods and thereby reduce real profitability. An increase in capital stock in relation to output implies a reduction in capacity utilization, and hence lower profits. Higher real wages also reduce profits. However, the effect of an increase in the real cost of capital is ambiguous. Insofar as the accompanying increase in the required return to capital induces more intensive use of capital and an improved use of investment funds, profits and corporate saving would be raised. To the extent, however, the associated increase in interest expenses reduces real corporate profits, corporate saving could decline. The net effect is assumed to be positive owing to the strong productivity effect observed empirically.

The appropriateness of disaggregating saving into household and corporate components has been questioned both on theoretical and empirical grounds (for example, David and Scadding (1974)). An examination of the share of gross private savings in total national income in Korea shows that in contrast to the experience of some industrial countries,

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1/ For the time being corporate taxes are ignored, but they are taken into account in empirical analysis.

this share has not shown much historical stability. The private saving ratio has shown large year-to-year fluctuations corresponding mainly to the large variations in the household saving ratio while the corporate saving ratio rose steadily until 1979 (Chart 1). Therefore, in order to identify appropriately the role of interest rates on saving, the disaggregation into household and corporate components is necessary.

4. Real interest rates in the unregulated financial markets (UFM)

The characteristics of the unregulated financial markets in Korea, and the causes of persistence of financial dualism have been discussed extensively in Cole and Park (1983). The policy of maintaining low official interest rates, 1/ the stringent credit rationing in the regulated markets, and the insufficient availability of short-term funds through the regulated banking system, which mainly provides term lending, are among the features that spurred both the demand for and supply of funds in the UFM. Although the UFM is mainly a short-term money market, the preference of large savers to accumulate the short-term, high-yielding, informal primary securities, despite the relatively high risk of default, implies that the opportunity cost of funds in the economy that governs the demand for investment in physical capital is determined in part in the UFM. 2/ Thus the UFM serves to fill many gaps in the financial system; it is a substitute for the lack of adequate institutional arrangements to meet short-term credit needs within the regulated system; it also provides risky securities to meet the needs of risk-loving investors, thus substituting for the inadequate growth of equity markets.

Although the unregulated credit sector has several submarkets, depending upon the type of intermediaries, borrowers, and lenders in each market, the interest rates in the curb market--the large-scale, informal creditbrokers' market--have served as the leading rates of the UFM, which are closely followed by other submarkets. The brokers and dealers in the curb market are reported to have an efficient system of risk assessment based on creditworthiness, established procedures, well-developed information and market-sharing arrangements. Although small firms, particularly those in need of working capital but with insufficient access to the banking system, are compelled to seek loans in the unregulated markets, the curb market segment of the UFM seems to cater mostly to the needs of large corporate firms. Large savers, who are attracted by the relatively high rate of return, are the principal suppliers of funds. The size of loans in this market is relatively large, with maturities generally not exceeding a month. The curb market interest rates are closely tied to the bank interest

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1/ Even during the high interest rate period 1965-71, real lending rates were much lower than those that prevailed in the UFM.

2/ Cole and Park (1983) note that the UFM rate closely reflected the rate of return to capital in Korea.

rate, mainly because of substitutability between bank deposits and curb market loans, and also because of operational procedures followed in the curb market. Often loans in the curb market are channelled through the regulated financial intermediaries; the lender in the curb market receives the regulated interest rate on his deposit which is earmarked for a specific borrower through a working arrangement with bank officials, and in addition collects a premium directly from the final borrower.

Against this background, a reduced-form specification for the curb market rate could be worked out under the hypothesis that these rates adjust to clear the market. 1/ It is assumed that the stock supply of curb market funds (in real terms) depends upon real income (a proxy for wealth), the real yields on various financial assets, and the perceived riskiness of loans to the curb market. The larger the perceived risk, the lower the supply of funds at any given curb market rate, and the higher the implicit risk premium demanded by the lenders. The stock demand for funds in the curb market depends upon real output, the availability of funds through external borrowing, and the portion of the excess demand for credit in the regulated financial system that spills over to the UFM. The curb market rate that equilibrates supply and demand is therefore given by:

$$i_u - \Pi = r_o + r_1 QP + r_2(i_d - \Pi) + r_3 EC - r_4 FCL - r_5 \Theta \qquad (21)$$

where FCL is the real value of foreign currency loans, EC is the excess demand for credit, and θ is a measure of the riskiness of curb market loans arising from the possibility of bankruptcy and default.

The riskiness of loans is assumed to depend upon the debt-equity ratio of firms and the rate of inflation. When initially the debt-equity ratio rises, the profitability of the firm improves due to increased use of the cheaper source of funds, thereby reducing the probability of default and hence the riskiness of loans. As the debt ratio rises beyond a critical level, the perceived riskiness of firms due to a higher debt ratio outweighs the reduction in riskiness due to gains in profitability, thereby raising the probability of default. The initial fall and the subsequent rise in the default risk of firms--the U-shaped schedule linking the risk premium with the debt ratio--can be captured by the quadratic expression:

$$\Theta = s_o - s_1 DE + s_2(DE)^2 \pm s_3 DE\ \Pi \qquad (22)$$

where DE is the debt-equity ratio. The multiplicative term DE Π which is the product of the debt-equity ratio and the rate of inflation captures the possibility that the marginal risk premium ($\partial\Theta/\partial DE$) may vary with inflation. Insofar as the level of inflation is systematically

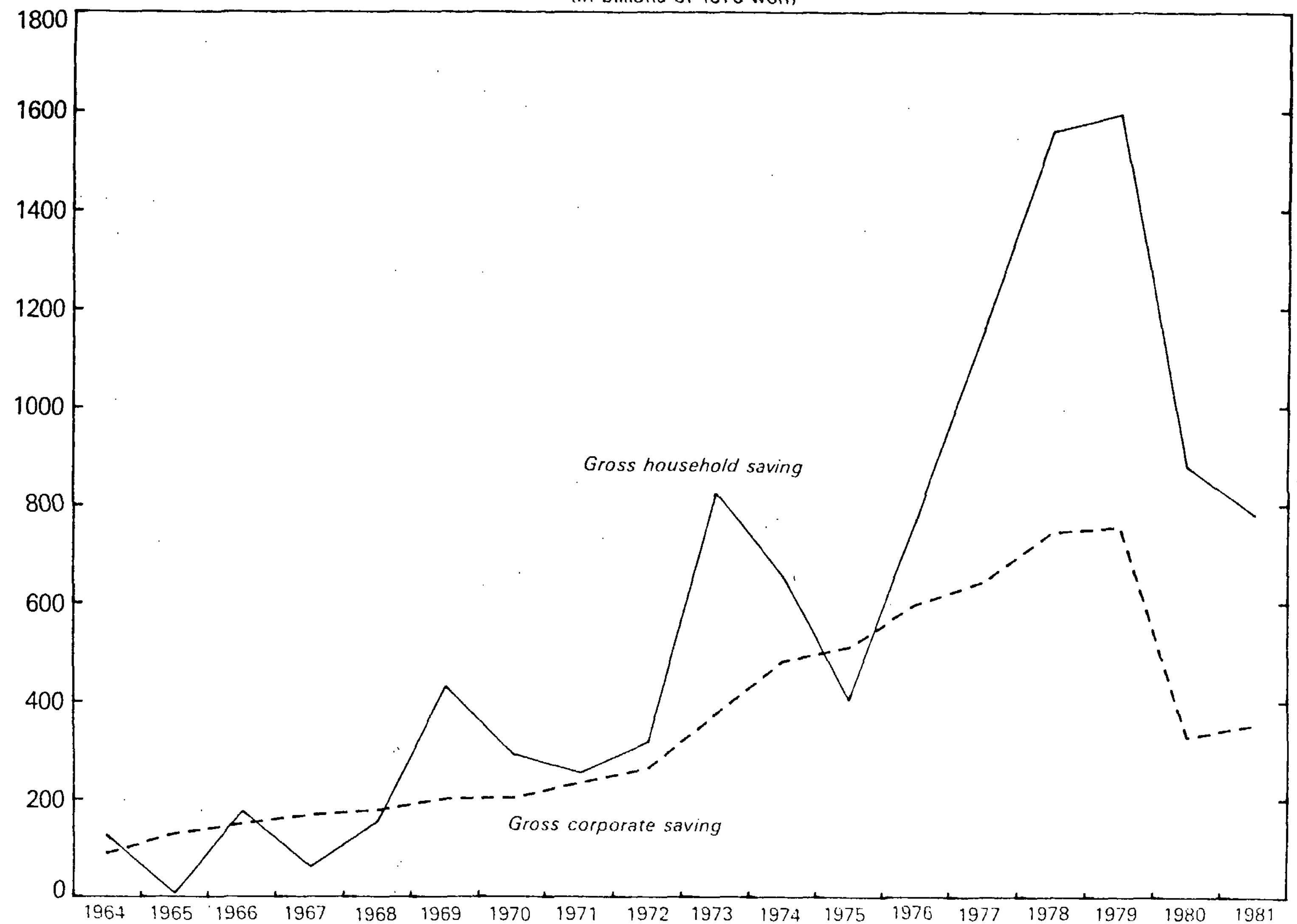
1/ For a discussion of the appropriateness of this market-clearance hypothesis, see van Wijnbergen (1982 and 1983a).

CHART 1

KOREA

PRIVATE SAVING

(In billions of 1975 won)



associated with the variability of returns to firms, the marginal risk premium may rise or fall with the level of inflation. 1/

The excess demand for credit can be expressed as:

$$EC = (DC/P)^d - (DC/P)_{-1} \tag{23}$$

where $(DC/P)^d$ is the demand for real domestic credit given by:

$$(DC/P)^d = g_o + g_1(Q) - g_2(i_d - \Pi) - g_3(i_u - \Pi) \tag{24}$$

Substituting equations (22), (23) and (24) in equation (21), and rewriting yields:

$$i_u - \Pi = U_o + U_1Q + U_2(i_d - \Pi) - U_3FCL - U_4(DC/P)_{-1}$$
$$- U_5DE + U_6(DE)^2 + U_7DE\ \Pi \tag{25}$$

where the parameters U_i are all positive and can be expressed in terms of the parameters of previous equations.

The sign of the effect of output on the real curb market rate is in principle indeterminate, depending upon whether the increased demand for curb market funds, due to a higher level of economic activity, is offset by the increased supply of funds from the larger volume of saving associated with the higher output.

The sign and size of the effect of the bank interest rate on the UFM rate also depend upon many opposing forces. An increase in the regulated interest rate would raise the UFM rate owing to the shift in the asset portfolio in favor of bank deposits, but would lower the UFM rate insofar as there is a reduction in demand for UFM loans owing to the increased availability of credit from the banking system. Thus, the effect of the regulated interest rates on the UFM rate is ambiguous if the UFM loans and bank loans are substitutes. However, there could be complementarity between the two types of loans if the mode of financing of real expenditures using the two loan markets is taken into account. In this case, the effect of an increase in bank interest rates on the demand for UFM loans would also depend upon the extent of the shift in investment in relation to saving. 2/

1/ For a discussion of the relationship between inflation and relative price variability, see Blejer (1982).

2/ See Cole and Park (1983) for a partial equilibrium analysis of the complementarity hypothesis, and Sundararajan (1985) for a more general treatment. van Wijnbergen (1983) emphasizes substitutability and assumes that at the margin expenditures are financed fully in the UFM owing to the lack of bank credit.

The effect of inflation on the interest rate in the UFM may be influenced by the debt-equity ratio of firms. 1/ This Fisher effect as well as the possible effect of inflation on the marginal risk premium (discussed earlier) are captured in the multiplicative term DE Π in equation (25).

5. Determinants of the debt-equity ratio

The computation of the cost of capital requires information on the marginal debt-ratio used in financing fixed assets, whereas for assessing the riskiness of firms and the risk premium implicit in the curb market rate, the relevant ratio is the average debt ratio in the full balance sheet of firms that includes both fixed and current assets. There is a one-to-one relationship between the average debt ratio in the full balance sheet of firms and the debt ratio used for financing fixed assets, as shown in Appendix II. The major determinants of the average debt-equity ratio DE governing all assets, both fixed and current, is discussed in this section.

The average debt-equity ratio is assumed to adjust to its desired level with a lag, and the extent of adjustment is also assumed to depend upon the availability of debt and equity funds. In general, the desired debt ratio DE* will be positively related to the implicit interest subsidy on credit from the regulated financial markets.

A precise expression for the desired average debt ratio can be derived by postulating that firms strive to obtain the debt-equity mix which minimizes the cost of capital R_c. As shown in Appendix II, the optimal debt-equity ratio can be expressed as:

$$DE^* = d^*(i_u - \bar{i}, \Pi) \qquad (26)$$ 2/

where $\bar{i} = \beta i_d + (1 - \beta)(i_f + X)$ is the weighted average of domestic and foreign interest rates (adjusted for exchange rate change), and d* is a nonlinear function of the interest subsidy $(i_u - \bar{i})$ and the rate of inflation. The larger the interest subsidy, the higher is the desired debt-equity ratio. In addition, the desired ratio will rise or fall with inflation, depending upon whether the marginal risk premium falls or rises with inflation.

Actual change in the debt ratio is assumed to be determined in part by the availability of debt finance and equity funds, and in part by the desired change in the ratio $(DE^* - DE_{-1})$, with only a fraction

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1/ The impact of inflation on the curb market rate depends upon the size of the debt-equity ratio and the response of the administered rate to inflation. This relationship is analyzed in depth in Sundararajan (1985).

2/ In deriving this relationship, it is assumed that the marginal debt ratio moves in line with the average debt ratio.

of the desired change being realized at any one time. Therefore, the equation for the change in the debt-equity ratio can be expressed as:

$$DE - DE_{-1} = a_1(DE^* - DE_{-1}) + a_o + a_2FS/Y + a_3\Delta C/Y - a_4S_c/Y \qquad (27)$$

where ΔC is the change in domestic credit from the banking system, FS is foreign saving, S_c is gross corporate saving after taxes, and Y is nominal income. The corporate saving ratio influences the availability of equity funds, while foreign saving and credit expansion, both expressed as shares of total nominal output, reflect the availability of debt finance. 1/ These variables are expressed as ratios to output in order to be conformable with the dependent variable which is also a ratio. The coefficient a_o represents the fraction of the desired change that is incorporated in current decisions. Rewriting equation (27) yields:

$$DE = a_o + a_2FS/Y + a_3\Delta C/Y - a_4S_c/Y + a_1DE^* + (1 - a_1)DE_{-1} \qquad (28)$$

Equation (28) implies that if $a_1 = 0$, the change in the debt-equity ratio is simply determined by the availability of debt and equity funds. However, if $a_1 > 0$, then the desired change in the debt-equity ratio also exerts an influence in the behavioral patterns of firms and financial institutions, and as a result, a change in the availability of debt finance or equity funds will affect the debt-equity ratio only with a lag. Also in this case, the coefficient of the lagged dependent variable is strictly related to that of the desired debt-equity ratio, with the sum of the coefficients equaling unity, a restriction which can be empirically tested. In the extreme case where the debt-equity ratio is determined entirely by the perceived optimal ratio, the coefficients a_2, a_3, and a_4 will all be zero, so that one obtains the expression:

$$DE = a_o + a_1DE^* + (1 - a_1)DE_{-1}$$

Thus, the expression (28) could be used to test whether the debt-equity ratio is supply or demand determined, or whether both factors play a role. Both factors could play a role because, for example, the increased availability of bank credit need not by itself lead to a higher debt ratio for individual firms, if banks and firms finance additional projects on the basis of a chosen debt-equity norm (based on historical practices as well as optimality considerations), and firms then obtain the needed equity finance from internal sources. In situations of severe financial repression, however, the debt-equity ratio is likely to be determined mainly by the supply of credit and the flow of equity funds.

1/ The availability of debt finance should properly be measured by including the UFM debt which is a substitute for bank debt in the financing of current assets. However, the requisite data are not available and hence the specification includes only bank credit.

6. The complete model

The complete model is presented in Table 1. The list of endogenous and exogenous variables appearing in the model is also presented in the table for ready reference. The model incorporates features from both the neoclassical, as well as modern theories of interest rates. In addition, the financing decisions of firms and their influence on real decisions are explicitly modeled. The dynamics of the model derive primarily from the capital stock identity as well as from the lagged dependent variables in the system. The model does not treat the monetary sector in detail. While the analysis takes into account the effect of the excess demand for money on expenditures and saving and the effect of the supply of bank credit on the UFM interest rate, the feedback effects of interest rates on money, credit, and inflation are ignored for simplicity. The extension of the model to endogenize the rate of inflation and monetary and credit aggregates is beyond the scope of the present paper.

The role of interest rates in the model can be illustrated by considering the various channels through which the impact of interest rate policy is transmitted. An increase in the administered interest rate would raise the interest rate in the unregulated markets, and in general also the real cost of capital. The resulting increase in the rental-wage ratio would depress the desired level of capital stock and investment, but would raise the productivity of capital and hence output.

The availability of saving would increase due to the higher level of output; saving would also be affected by the increased returns to household savers, and by the increased cost of capital which would have a particular impact on the marginal productivity of capital and hence business saving. The increase in the availability of saving, as well as the larger level of output would alter investment activity, thereby more or less offsetting the reduction in investment due to the substitution effect of the increased relative price of capital. The net effect on saving and investment would thus depend upon the strength of the direct effect of interest rates, and the real cost of capital relative to the indirect effects emanating from higher output. This indirect effect, through changes in output for any given capital stock, derives mainly from the neoclassical feature of the model that links output to the relative price of capital. The relative price of capital would also be influenced by working capital costs, insofar as the increase in interest costs also affects the cost of financing other factor inputs such as labor and current assets.

In addition, the real cost of capital and the real sector decisions based on it are influenced by the financing decisions of firms. An increase in the administered interest rate reduces the implicit interest subsidy, and hence lowers the debt-equity ratio used by businesses. Such actions by firms to minimize the overall cost of capital tends to

Table 1. A Model of Saving, Investment, and Growth

Gross fixed investment

$$IP = B_o - B_1 d(L)RW + B_2 a(L)QP + B_3 KG$$
$$+ B_4(S - IG)/PK + B_5 KP_{-1} + B_6 T$$

Output

$$Q = C_o + C_1 KP + C_2 KG + C_3 RW + C_4 T + C_5(i_d - \Pi) + C_6 F$$

Household saving

$$S_H = D_o + D(L)Q_H \pm D_1(i_d - \Pi_c) \pm D_2(i_u - \Pi_c) + D_3 EM$$

Net corporate saving

$$NS_c = G_o + G_1 Q - G_2 KP_{-1} - G_3 W/P + G_4 R_c - G_5 EM$$

Private sector capital consumption

$$CCP = F_o + F_1 KP_{-1} + F_2 DUM_2 + F_3 DUM_2\ KP_{-1}$$

Real interest rate in the unregulated financial market

$$i_d - \Pi = U_o + U_1 Q + U_2(i_d - \Pi) - U_3 FCL - U_4(DC/P)_{-1}$$
$$- U_5 DE + U_6 DE^2 + U_7 DE - \Pi$$

Debt-equity ratio

$$DE = a_o + a_1 DE^* + a_2(FS/Y) + a_3(\Delta C/Y) - a_4(SC/y) + (1 - a_1)DE_{-1}$$

Real cost of capital

$$R_c = (1 - \alpha)(i_u - \Pi_K + \delta) + [\alpha\beta(i_d + a_d/i_u + a_d)$$
$$+ \alpha(1 - \beta)(i_f + a_f/i_u + a_f - X)](i_u - \Pi_K + \delta)$$

Desired debt-equity ratio

$$DE^* = d^*[i_u - (\beta i_d + (1 - \beta)i_f), \Pi]$$

Some definitional identities:

Capital stock: $KP = KP_{-1} + IP - CCP$

Real gross saving: $S/P = S_H + NS_c + CCP + SG + FS$

Household disposable income: $Q_H = (\eta_h - t_h)Y/PC$, where $Y = Q\ P$

Debt to fixed assets ratio: $\alpha = (DE/1 + DE)$ 1/

Rental wage ratio: $RW = (PK\ R_c/W)$,
if working capital costs are excluded

$RW = PK[R_c + \varepsilon\ i_d]/[W(1 + i_d)]$,
if working capital costs are included

(Continued)

1/ A modified formula is used in empirical work, as noted in Section III, and Appendix II.

Table 1 (Concluded). A Model of Saving, Investment, and Growth

List of endogenous variables

IP = Real gross fixed investment in the private sector;
Q = Real GDP;
Y = Nominal GDP;
S_H = Real household saving;
Q_H = Real disposable income of households;
SC = Net corporate saving in constant prices;
CCP = Capital consumption allowances in constant prices;
i_u = Interest rate in the unregulated market;
DE* = Desired debt-equity ratio;
DE = Actual debt equity ratio;
α = Ratio of debt to capital
R_c = Real cost of capital to investors in physical capital;

List of exogenous variables

SG = Public sector saving;
KG = Public sector capital stock;
IG = Gross investment by the public sector;
T = Time trend;
i_d = Bank deposit rate;
i_f = Interest rate on foreign currency loans;
F = Measure of financial deepening;
EM = Measure of excess demand for money;
DUM2 = Dummy variable representing a shift in financial policies
FCL = Stock of foreign currency loans in domestic currency units at constant prices;
DC/P = Real domestic credit for the banking system;
ΔC = Change in domestic credit;
P = GDP deflator;
PK = Investment deflator;
PC = Consumption deflator;
Π = Rate of change in GDP deflator, with subscripts K, and C representing the capital goods and consumer goods components;
β = Share of foreign currency loans in total corporate debt;
X = Percentage change in the nominal exchange rate expressed in domestic currency units per unit of foreign currency;
a_d, a_f = Rate of amortization of domestic and foreign currency units;
δ = Rate of depreciation
η_h = Share of household income in total GDP;
t_h = Share of taxes paid by households net of transfers per unit of GDP;
ε = Ratio of current assets to fixed assets

dampen (accentuate) the impact of interest rate policy on the overall cost of capital when the debt ratios are sufficiently large (small). This is the feature of the U-shaped schedule linking the cost of capital with the debt ratio. That is, depending upon whether the initial debt ratio is above or below the optimal level, the magnitude of the response of the cost of capital to interest rates would be altered, thereby changing the ultimate impact of interest rate policy on saving, investment, and growth. The empirical evidence on the various channels of influence of interest rates is presented in the next section.

III. Empirical Results

1. Data

Data on investment, saving, output, prices, wages, domesticly regulated interest rates, and interest rate on foreign loans are all obtained from various issues of the Economic Statistics Yearbook published by the Bank of Korea; wage data are for the industrial sector. The interest rate on one-year bank deposits, calculated as a period average, is used as the representative interest rate in the regulated segment of the financial markets. The interest rate on foreign loans and the rate of amortization of these loans were obtained by dividing respectively the interest and amortization payments on long-term external debt by the average of beginning and end-of-period stock of such debt. The UFM interest rates are approximated by the curb market rate compiled by the Bank of Korea, based on quarterly business financial surveys. The rate of amortization of domestic currency loans was simply assumed to be equal to the calculated rate of depreciation of fixed assets based on actual data on capital consumption in the private sector. Data on debt-equity ratio, current asset to fixed asset ratio, and the foreign currency loan to fixed asset ratio, all needed to compute the weighted average cost of capital, are taken from various issues of Financial Statement Analysis published by the Bank of Korea. Annual data on these ratios for various subsectors are averaged, using as weights, the share of each sector in industrial GNP in each year, thereby obtaining the average ratios for the industrial sector.

The data on capital stock in the private and public sectors are constructed by cumulatively adding the time series on real net fixed investment to the estimates of the initial capital stock based on figures reported in Hong (1976). 1/

The expected depreciation of the exchange rate as well as the expected rate of change in the price of capital goods were approximated by the annual average rate of change in the corresponding actual values over the preceding three years.

1/ Since linear investment functions are used, the error in estimating the initial capital stock can be readily absorbed into the intercept term.

2. Model adaptations

The model specification was slightly altered in order to reflect the lack of data on certain variables, and the strong multicollinearity between some time series. Because of the lack of separate GDP series for the private and public sectors, total GDP is used as an explanatory variable in the private investment function instead of private sector GDP. This modification does not constitute a specification error because the public sector output is assumed to be a function of public sector capital stock, and, therefore, the coefficient of public sector capital stock in the private investment function reflects the implicit subtraction of public sector output from total output. As a result, only the interpretation of the coefficient is affected, and no specification bias is involved. This coefficient reflects not only the effects of public sector capital stock on private costs and private output expectations but also the negative effect owing to the implicit subtraction of public sector output. Therefore, the coefficient of public sector capital stock would be smaller than it would have been if private sector output, instead of total output, had been used as an explanatory variable in the private investment function.

Also, since separate production functions for the private and public sector output could not be estimated, the estimated function relates total GDP to public and private capital stocks and other variables. However, the strong correlation between the time series on public and private capital stock rendered their coefficient estimates unreliable when entered separately in the production function. Therefore, total capital stock was used in the production function, thereby ignoring the possible differentials in the productivity of the private and public sector capital. 1/

In order to apply the weighted average formula for the cost of capital (R_c) shown in equation (2) of Chapter II (and also in Table 1), information is required on the marginal shares of debt and equity in the financing of fixed assets, whereas the available data relates to the average shares of debt and equity in total assets, both fixed and current. In order to estimate the shares of debt and equity in fixed capital purchases, it was assumed that all current assets were financed by bank debt and curb market loans, and that the share of current assets to fixed assets, ε, is exogenous. Under these assumptions, the average ratio of debt to fixed assets is given by:

$$\alpha^a = (1 + \varepsilon)(DE/1 + DE) - \varepsilon \, . \qquad (29)$$

1/ These productivity differentials are crucial in the analysis of crowding out by public investment, as shown in Sundararajan and Thakur (1980). For the purposes of this paper, productivity differentials may be ignored.

This is a modified version of the simpler formula presented in Table 1, and the modification reflects the fact that the published debt-equity ratio DE refers to the debt-equity mix corresponding to all assets in the balance sheet of firms, and hence may not reflect the debt-equity mix used in financing fixed assets alone. Although the financing mix for fixed investment can be represented by the debt-equity ratio corresponding to all assets, such a representation was rejected based on its comparatively poorer performance in empirical work. Therefore, the alternative assumption that all current assets are financed by debt (including UFM loans) was chosen. For simplicity, the average debt to fixed assets ratio, derived from this assumption (equation (29)), was assumed to be equal to the marginal debt ratio needed in the cost of capital calculations. The specification error due to this assumption is not likely to be substantial, insofar as the marginal debt ratio is systematically and positively related to the average ratio. 1/

3. Discussion of the estimates

All behavioral equations were estimated by two-stage least squares using annual data for the period 1963-81. For each equation, the most general specification was first estimated, and then by dropping insignificant variables, and by imposing a priori restrictions based on theory and initial results so as to break multicollinearity, the equation that yielded the lowest standard error was chosen for simulation.

In all equations two dummy variables were included and the significant ones retained. The variable DUM 1 assumes a value of unity in 1980 and 1981 and zero in other periods, and represents the political and economic uncertainties that dominated those years following the second oil shock and a change in political leadership. The variable DUM 2 assumes the value of unity from 1973 onward and zero in all previous years, and reflects the shift in investment strategy to favor more capital-intensive sectors, and the 1972 Presidential Decree that initiated substantive changes in financial sector policies. 2/

a. Output

Real GDP is determined primarily by capital stock, the rental-wage ratio, and technological change represented by a time trend. This finding is illustrated in Table 2 which presents a set of output equations estimated using different measures of the rental-wage ratio. The coefficients of determination of the estimated equations are high, and the explanatory variables, particularly several measures of the rental-wage ratio, are statistically significant and have the expected signs. Alternative specifications, not reported here, using lagged capital stock, using real wages alone instead of rental wage ratio, or including other

1/ See Sundararajan (1985) for an analysis of the relationship between marginal and average debt ratios.

2/ For a description of the measures, see Bank of Korea (1973).

Table 2. Korea: Selected Output Equations

1. Without allowance for working capital costs

(1) $$Q = -5{,}717.33 + 0.2383(KP + KG) + 14.0736(PK\,R_c/W)$$
(-2.86) (5.47) (2.63)

$$+ 482.287T - 2{,}186.47\ DUM\ 1 + 232.31\ DUM\ 2$$
(4.14) (-7.78) (-1.04)

Adj R^2 = .9977 SEE = 192.9 DW = 1.82

(2) $$Q = -5{,}010.47 + 0.2595(KP + KG) + 13.9957[PK(i_u - \Pi_k + \delta)]/W$$
(-2.84) (6.95) (2.59)

$$+ 428.394T - 2{,}216.88\ DUM\ 1 + 451.055\ DUM\ 2$$
(4.34) (-8.02) (-2.34)

Adj R^2 = 0.9978 SEE = 192.0 DW = 1.672

(3) $$Q = -633.33 + 0.3330(KP + KG) + 4.7581[PK(i_d - \Pi_k + \delta)]/W$$
(-.905) (11.71) (1.02)

$$+ 193.55T - 2{,}395.41\ DUM\ 1 + 680.55\ DUM\ 2$$
(3.99) (-7.57) (-2.53)

Adj R^2 = 0.9968 SEE = 228.63 DW = 1.63

2. With allowance for working capital costs

(4) 1/ $$Q = -7{,}702.60 + 0.2031(KP + KG) + 22.5048[PK\,RC/W(1 + i_d)]$$
(-5.63) (5.42) (4.37)

$$+ 592.759T - 2{,}096.85\ DUM\ 1$$
(6.79) (-8.01)

Adj R^2 = 0.9981 SEE = 176.0 DW = 2.099

(5) $$Q = -7{,}024.71 + 0.2240(KP + KG) + 23.9789[PK(i_u - \Pi_k + \delta)/w(1 + i_d)]$$
(-3.79) (6.00) (3.55)

$$+ 537.37T - 2{,}088.66\ DUM\ 1 + 336.935\ DUM\ 2$$
(5.24) (-8.38) (-1.93)

Adj R^2 = 0.9983 SEE 167.4 DW = 1.87

(6) $$Q = -4{,}579.21 + 0.2678(KP + KG)$$
(-2.28) (6.47)

$$+ 10.4114\{PK[R_c + \varepsilon\, i_d]/W(1 + i_d)\}$$
(2.04)

$$+ 406.345T - 2{,}312.43\ DUMMY\ 1 + 288.45\ DUMMY\ 2$$
(3.62) (-7.95) (-1.22)

Adj R^2 = 0.9974 SEE 207.4 DW 1.76

1/ Equation chosen for model simulation.

relevant variables that might affect output such as terms of trade, real balances and real interest rate in the banking system, all yielded much larger standard error of the estimates.

In order to identify the most appropriate measure of the rental-wage ratio, alternative definitions of this ratio were included in the production and investment functions. The definitions used differed depending upon the particular measure of the real cost of capital used, and on whether working capital costs were taken into account or not. The following possible measures of the real cost of capital were considered: the real interest rate in the banking system ($i_d - \Pi_k + \delta$), the real interest rate in the UFM ($i_U - \Pi_K + \delta$), and the weighted average cost of capital (R_c). Different definitions of R_c were also considered by altering the measure of the debt ratio, and of the rate of amortization of domestic bank loans. It was found that the share of debt in fixed assets computed on the assumption that all current assets are financed by debt--given by equation (29)--performed better than the shares based on the alternative assumption that the overall debt ratio applies to fixed assets as well. The assumption that the rate of amortization on domestic loans equals the rate of depreciation of fixed assets provided better results than other arbitrarily chosen amortization rates, although the sensitivity of the standard error of the output function, and of the time path of the real cost of capital to changes in the rate of amortization was not significant.

The output equations in Table 2 illustrate the strong positive impact of the rental-wage ratio on the productivity of capital. The significant coefficient for several measures of the rental-wage ratio can be interpreted as supporting the hypothesis that an increase in the cost of capital--and hence the relative price of capital--increases the overall efficiency of capital by permitting a shift of resources to more productive sectors, and by encouraging more productive use of capital within each sector. 1/ In fact, the rental wage ratio remained high during 1963-72, particularly after the 1965 interest rate reform, and has generally declined since the late sixties, contributing to an increase in the capital-output ratio over time.

Table 2 illustrates the importance of proper identification of the cost of capital in judging the effectiveness of interest rate policy. The use of administered interest rate alone in measuring the relative

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1/ The significance of the rental-wage ratio could simply reflect the effect of variations in the real wage rate, insofar as short-run output decisions depend mainly on the cost of the variable factor, namely labor. The output functions estimated by replacing the rental-wage ratio by real wages alone yielded significantly inferior results with much larger standard errors. Thus, the relevance of the rental-wage ratio for explaining annual variations in output is strongly confirmed. It is, however, possible that for shorter-term variations in output (monthly or quarterly), the real wage rate could be the more important determinant than the rental-wage ratio.

cost of capital resulted in an insignificant coefficient for the rental-wage ratio, as seen from equation (3). In contrast, substantially lower standard errors and significantly positive coefficients are obtained if the UFM rate or the weighted average cost of capital is used. It is interesting to note that, in terms of the standard error of the output equation, the UFM rate performs almost as well as the weighted average cost of capital.

The significance of working capital costs in defining the rental-wage ratio is tested in Table 2 which presents three equations--(4), (5), and (6)--in which the computed rental-wage ratio takes into account the cost of financing wage payments. The last equation allows also for the cost of financing the complementary requirements of current assets. The standard errors of these three equations are generally lower than the first three equations of Table 2, which exclude working capital costs. This suggests that the impact of interest rates on the relative price of capital can be best approximated in empirical analysis by incorporating working capital costs.

Among the equations that allow for working capital costs, equation (4), based on the weighted average cost of capital formula, is chosen for model simulation even though it has a slightly larger standard error than equation (5) based on the UFM rate alone. This choice is justified because the difference in the standard errors is not significant, the weighted average formula has a stronger theoretical rationale, and the specification shown in equation (4) economizes on the number of explanatory variables, with one of the dummy variables becoming insignificant.

b. Investment

Two of the estimated equations for real gross fixed capital formation in the private sector are shown in Table 3.

These equations reveal that private investment is primarily determined by the supply of investible funds available to the private sector, as seen from the highly significant coefficient for the resource-availability variable (S - IG/P), which influences the speed with which actual investment adjusts to the desired level. The desired investment, however, is mainly influenced by the expected output level best proxied by the current output, by technological change represented by a time trend, and by the lagged capital stock; the rental-wage ratio plays an insignificant role in influencing investment demand, as seen from equation (2) of Table 3, although the variable enters with the correct negative sign. 1/

1/ While van Wijnbergen (1982) finds that the real UFM rate has a strong negative effect on investment, other studies--Norton and Rhee (1981), Sundararajan and Thakur (1980), and Yusuf and Peters (1985)--do not find a significant interest rate effect. However, van Wijnbergen uses only financial variables in the investment function and ignores real output. None of these studies focuses on the appropriate measure of the cost of capital for investment and production decisions.

Table 3. Korea: Selected Investment Equations

(1) 1/

$$IP = \underset{(1.07)}{392.362} + \underset{(3.25)}{0.3802Q} - \underset{(-2.69)}{93.121T} + \underset{(2.74)}{1{,}128.24\ DUM\ 1}$$

$$- \underset{(1.73)}{214.933\ DUM\ 2} - \underset{(-2.34)}{0.1436KP(-1)} + \underset{(9.00)}{0.8066[(S - IG)/P]}$$

Adj. $R^2 = 0.9937$ SEE = 110.45 DW = 2.74

(2)

$$IP = \underset{(0.279)}{565.84} + \underset{(2.17}{0.3917Q} - \underset{(-0.73)}{105.196T} + \underset{(2.56)}{1{,}136.95\ DUM\ 1}$$

$$- \underset{(1.49)}{210.324\ DUM\ 2} - \underset{(-2.22)}{0.1431KP(-1)} + \underset{(7.66)}{0.8026[(S - IG)/P]}$$

$$- \underset{(-0.087)}{0.5533[(PK\ R_c)/(WC(1 + i_d)]}$$

Adj. $R^2 = 0.9930$ SEE 116.0 DW = 2.72

1/ Equation used in simulation.

The strong statistical significance of the variable measuring the resources available to the private sector shows that public sector investment may crowd out private investment in the very short run. The existence of this net crowding-out effect cannot be determined on the basis of this coefficient alone, since public investment also has a positive effect on output, output expectations, and saving, and these effects may offset the immediate crowding-out effect operating through the influence of public investment on resource availability. 1/

Alternative specifications of investment demand that included additional explanatory variables--such as government capital stock, a distributed lag in the rental-wage ratio and in output so as to capture expectation formation, a measure of the excess demand for money to reflect monetary and credit conditions--all resulted in insignificant coefficients for these variables, and larger standard error of equations than those reported in Table 3. The lack of significance of the government capital stock--although its effect was positive--probably reflects the implicit subtraction of public sector output discussed earlier, whose effect offsets any positive effect of government capital stock on private investment and output expectations. The negative coefficient for DUM 2 captures the policy-induced shifts in the level and the rate of depreciation after 1972, discussed in the next section.

The rental-wage ratio has only a negligible negative effect on investment, although it exerts a strong positive effect on output. There are theoretical grounds to believe that the rental-wage ratio can have a significant effect on output without having an immediate direct effect on the level of investment. These results imply that an increase in interest rates and hence the rental-wage ratio--increases the overall efficiency of capital and hence output and this positive effect on output stimulates investment demand, more than offsetting any negative substitution effect on investment. Thus, an increase in interest rates can stimulate investment even within the strictly neoclassical framework adopted here.

c. Private saving

The estimated equations for the gross domestic saving of the household sector are presented in Table 4. The equations provide a good fit of actual data, and indicate that real returns to financial assets and a

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1/ Therefore, a complete analysis of the effect of public sector investment on private investment requires the computation of the impact and dynamic multipliers of public sector investment based on model simulation. See Sundararajan and Thakur (1980) for such simulation exercises.

distributed lag in real disposable income are the major determinants of household saving. 1/

The financial dualism in Korea is reflected in the household saving behavior summarized in equations (1), (2), and (3) of Table 4. The specification (equation (1)), which includes both the real interest rate in the banking system and the real return in the UFM, performs significantly better than the specifications which include only one of the interest rate variables. Moreover, when both interest rates are included, the real interest rate in the banking system has a significant negative effect on household saving, while the real UFM interest rate has a larger and statistically significant positive effect. This rather surprising result suggests that savers who normally utilize the banking system probably constitute a separate group, distinct from savers who typically utilize the UFM as an outlet for their saving. Such segmentation of household savers would probably explain why the balance between income and substitution effects is different for different interest rates. The empirical results show that the income effect of higher interest rate dominates the substitution effect for the unsophisticated savers who typically use the banking system, while the opposite is true for savers utilizing the UFM.

When the real interest rate in the banking system alone is used in the saving function (equation (2), Table 4), it is statistically insignificant, but becomes highly significant (with a negative sign) when it is entered together with the real UFM rate. 2/ The economic rationale for this result is that when the bank interest rate alone is used, its coefficient captures not only its own direct effect on saving, but also the indirect effect of the excluded variable, namely the UFM rate which is influenced in the same direction by the bank interest rate. Since these two effects work in opposite directions, they offset each other resulting in an insignificant coefficient for the bank interest rate. Therefore, the exclusion of the real UFM rate in the saving function can seriously misspecify and underestimate the scope and effectiveness of interest rate policy. Most of the published work on Korean saving behavior uses the bank interest rate, and the often conflicting and inconclusive evidence from these studies on the interest sensitivity

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1/ The addition of other variables such as a measure of the excess demand for money, or the use of alternative measures of the real interest rate--obtained by measuring the expected inflation in terms of an average inflation rate over the preceding three years, or by measuring the real rate as $(i - \Pi^e)/1 + \Pi^e$ instead of $i - \Pi^e$--all yielded much higher standard errors than the one reported for equation (1) of Table 4.

2/ These results are not spurious, simply reflecting a strong collinearity between bank interest rate and the UFM rate. Although bank interest rate is one among many variables affecting the UFM rate, as shown in subsection III.3.d., the direct correlation coefficient between the two variables is only about 0.5 during 1963-81.

Table 4. Korea: Private Saving Equations, 1963-81

(Figures in parentheses are t-statistics)

1. Gross domestic saving of households

(1) 1/ $S_H = -1{,}086.91 + 0.6433Q_H - 0.1510Q_H(-1)$
(-6.5) (10.60) (-2.95)

$- 0.3688\ Q_H(-2) + 11.1655(i_u - \Pi_c)$
(-6.79) (5.04)

$- 8.0521(i_d - \Pi_c) + 492.079\ DUM\ 1 + 82.278\ DUM\ 2$
(-3.44) (3.62) (-1.32)

Adj. $R^2 = 0.9869$ SEE = 55.66 DW = 2.2

(2) $S_H = -428.276 + 0.6527Q_H - 0.1313Q_H(-1) - 0.4434Q_H(-2)$
(2.30) (5.99) (-1.43) (-4.73)

$- 2.3537(i_d - \Pi_c) + 603.893\ DUM\ 1 + 25.1438\ DUM\ 2$
(-0.64) (2.5) (-0.23)

Adj. $R^2 = 0.9577$ SEE = 99.89 DW = 0.96

(3) $S_H = -836.45 + 0.5545Q_H - 0.0827Q_H(-1) - 0.3549Q_H(-2)$
(-3.96) (7.17) (-1.24) (-4.66)

$+ 7.4834(i_u - \Pi_c) + 407.906\ DUM\ 1 + 130.462\ DUM\ 2$
(2.74) (2.16) (-1.53)

Adj. $R^2 = 0.9739$ SEE = 78.45 DW = 1.405

2. Net corporate saving before taxes

(4) 1/ $S_c = -154.36 + 0.1133Q - 0.0111KP(-1) - 3.6438(W/P)$
(-3.96) (9.46) (-1.42) (-3.79)

$+ 1.4049[R_c + \varepsilon\ i_d] - 0.00794EM - 38.394\ DUM\ 1$
(4.54) (-2.38) (-7.27)

Adj. $R^2 = 0.9944$ SEE = 16.16 DW = 2.731

(5) $S_c = -141.09 + 0.1157Q - 0.1462KP(-1) - 3.3909(W/P)$
(-3.11) (8.00) (-1.57) (-3.03)

$+ 1.5917R_c - 0.00694EM - 35.120\ DUM\ 1$
(3.48) (-1.79) (-5.57)

Adj. $R^2 = 0.9924$ SEE = 18.92 DW = 2.160

3. Capital consumption allowances

(6) 1/ $79.662 + 0.0899KP(-1) - 0.0310[KP(-1)DUM\ 2)$
(0.98) (11.04) (2.65)

$+ 404.59DUM\ 2 - 275.38DUM\ 1$
(-3.63) (-4.00)

Adj. $R^2 = 0.9871$ SEE = 47.02 DW = 1.86

1/ Equations used in simulation.

of saving in part reflect the consequence of omitting the real UFM rate in the specification. 1/

An examination of the lag distribution of disposable income in equation (1), Table 4 shows that household saving is strongly related to permanent income as well as transitory income. The lag distribution of income has a positive coefficient for current income and negative coefficients for one-period and two-period lagged incomes. Moreover, the sum of the coefficients is positive. This form of lag distribution is consistent with the hypothesis that saving is related to permanent income Q_H^P and transitory income Q_H^T with different marginal propensities to save out of the two types of income. Defining permanent income as a weighted sum of current and past incomes:

$$Q_H^P = \eta_1 Q_H + \eta_2 Q_H(-1) + \eta_3 Q_H(-2)$$

$$\Sigma \eta_i = 1, \quad \eta_i > 0, \quad i = 1,2,3$$

and transitory income as the deviation of current income from permanent income:

$$Q_H^T = Q_H - Q_H^P$$

and assuming that the marginal propensity to save from permanent income is μ_1, and from transitory income is μ_2, we can obtain the following lag distribution for the income variable:

Income variable	Q_H	$Q_H(-1)$	$Q_H(-2)$
Coefficients	$\mu_1\eta_1 + \mu_2(1 - \eta_1)$	$(\mu_1 - \mu_2)\eta_2$	$(\mu_1 - \mu_2)\eta_3$

The sum of the coefficients is μ_1, the marginal propensity to save out of permanent income, which is estimated at 0.12. 2/ The marginal

1/ For studies on Korean saving behavior, see Brown (1973), Frank et al (1975), Kwang Suk Kim (1977), Mahn Je Kim and Yung Chul Park (1977), Williamson (1979), van Wijnbergen (1982), Sundararajan and Thakur (1980), and Yusuf and Peters (1984). While van Wijnbergen reports the results using only the UFM rate, others use only the time deposit rate; there are substantial differences in the size and significance of interest elasticity reported in these studies. With the exception of Frank et al, who report separate equations for household consumption and corporate saving, all other studies use gross domestic or national saving.

2/ The lag distribution was estimated using a second-degree polynomial without any end point restrictions. The sum of the coefficients (0.12) is significant at 95 percent probability level.

propensity to save out of transitory income, although not identifiable, is much larger ($\mu_2 > \mu_1$), consistent with the large negative coefficients for the lagged income variables.

The corporate saving behavior is summarized in equations (4) and (5) of Table 4, which explain the retained earnings of corporations before taxes, and in equation (6) which explains capital consumption allowances.

Net corporate saving is primarily determined by the factors affecting profitability, namely the level of output, capacity output, monetary conditions, the cost of capital, and the real wage rate. In line with a priori expectations, corporate profitability and saving improve when output increases, and decline when the real wage rate or capital stock increases; the impact of capital stock, however, is not highly significant, although this variable serves to reduce the standard error of the equation substantially. Monetary conditions also have a strong impact on corporate saving, as seen from the significant negative coefficient for the variable measuring the excess demand for money. An increase in the excess demand for money, ceteris paribus, lowers expenditures and sharply reduces corporate profits. 1/

In addition, the weighted average cost of capital, including the cost of financing the complementary requirements of current assets, $R_c + \varepsilon\, i_d$, has a strong positive effect on corporate profitability, and performs much better than alternative measures of cost of capital. 2/ The strong positive effect of the cost of capital on corporate saving (given the real wages) reflects the improved marginal productivity of capital in response to increased capital cost, consistent with the positive efficiency effects on output discussed earlier. Also, when the cost of capital that excludes the cost of financing current assets (R_c) is used in the corporate saving function (as in equation (5)), the standard error of the equation increases significantly. Thus, the inclusion of current asset financing costs seems to be important in determining retained profits, although, as noted earlier, the rental-wage ratio, which influences the productivity of capital, is best approximated by excluding these costs. This is probably because larger outlays on current asset financing primarily induces a reduction in dividend payments, thereby raising retained profits.

1/ The excess demand for money was estimated by the expression $(M/P)^d - (M/P)_{-1}$, where $(M/P)^d$ = desired demand for real broad money and $(M/P)_{-1}$ is the initial value of the same variable. $(M/P)^d$ was computed from the formula:

$$\ln(M/P)^d = -1.62 - 0.045 i_u + 0.151 i_d - 5.40 \Delta P/P + 1.17 \ln(Q) - 0.98\ \text{DUM 1}$$

where the coefficients were derived from an estimated money demand function that assumes partial adjustment of the log of actual balances to the log of the desired balances.

2/ A positive effect of nominal interest rates on corporate saving in Korea is noted in Frank et al (1975).

The major component of gross corporate saving, however, is the provision for capital consumption which depends mainly on the size of capital stock, and the shifts in policy regime, as shown in equation (6) of Table 4. The shift in policy regime since 1973--represented by the variable DUM 2--led to a larger level of depreciation allowances (as seen from the positive coefficient for DUM 2), but resulted in a smaller rate of depreciation (as seen from the negative coefficient for the multiplicative variable KP(-1) DUM 2). These results, together with the highly significant coefficient for the lagged capital stock, show that the rate of depreciation fell from about 9 percent in earlier years to about 6 percent since 1973, when more capital-intensive projects were sought. 1/

d. The UFM rate and the debt-equity ratio

The determinants of the UFM rate and the debt-equity ratio, and the close interrelationship between these two variables are illustrated in Table 5.

The equations for the real interest rate in the curb market show that real output, the real interest rate in the banking system, and the real value of domestic credit and foreign currency loans are its major determinants. While output and the bank interest rate have a strong positive influence on the curb market rate, the supply of funds from the regulated financial system--both the lagged real value of bank credit and the current real value of foreign currency loans--has a strong negative effect.

In addition, the debt-equity ratio seems to have a strong effect on the risk-premium implicit in the curb market rate; in line with a priori expectation, the risk premium first falls and then rises as the debt-equity ratio rises, as seen from the negative coefficient for DE and a positive coefficient for DE^2, both highly significant in the UFM rate equation. However, the interaction between DE and Π, represented by the multiplicative term DE Π, is statistically insignificant (as seen from equation (2), Table 5), suggesting that the marginal risk premium is not influenced by the level of inflation.

The change in the debt-equity ratio is determined not only by the corporate saving ratio and the foreign saving ratio, but also by the desired (optimal) value of the average debt-equity ratio. A rise in the corporate saving ratio raises the share of equity funds available to firms and hence reduces the debt-equity ratio. 2/ In contrast, a rise in the foreign saving ratio increases the debt-equity ratio,

1/ Apparently, the increase in the legal depreciation rates of major industries from 30 percent to between 40 and 80 percent following the 1972 Presidential Decree has had only a temporary effect.

2/ Schmidt (1976) discusses the role of corporate profits in the determination of debt-equity ratios in Germany.

Table 5. The UFM Rate and the Debt-Equity Ratio

The curb market

1. 1/

$$i_u - \Pi_c = \underset{(11.75)}{58.7193} + \underset{(8.65)}{0.4666}(i_d - \Pi_c) + \underset{(6.41)}{0.003967}Q$$

$$- \underset{(-2.62)}{10.6092}\ DE + \underset{(2.93)}{2.3695}\ DE^2 - \underset{(-2.14)}{0.5877}\ FCL$$

$$- \underset{(-6.15)}{1.4163}(DC/P)_{-1} + \underset{(1.01)}{4.7465}\ DUM\ 1$$

Adj. $R^2 = 0.9942$ SEE = 1.144 DW = 2.288

2.

$$i_u - \Pi_c = \underset{(27.23)}{63.1895} + \underset{(7.71)}{0.5083}(i_d - \Pi_c) + \underset{(9.07)}{0.003456}Q$$

$$- \underset{(-8.60)}{14.3036}\ DE + \underset{(7.06)}{3.0776}\ DE^2 + \underset{(0.20)}{0.00645}\ (DE * \Pi_c)$$

$$- \underset{(-1.74)}{0.4134}\ FCL - \underset{(-5.11)}{1.4134}\ (DC/P)_{-1}$$

Adj. $R^2 = 0.9933$ SEE = 1.233 DW = 2.052

Debt-equity ratio

3. 1/

$$DE = \underset{(2.830)}{2.0624} + \underset{(1.992)}{4.5230}\ FS/Y - \underset{(-3.286)}{22.6468}\ S_c/Q$$

$$+ \underset{(2.748)}{0.3810}\ DE^* + \underset{(7.807}{0.6537}\ DE_{-1} - \underset{(-3.625)}{0.9749}\ DUMMY\ 2$$

Adj. $R^2 = 0.9574$ SEE = 0.2512 DW = 1.990

Desired debt-equity ratio

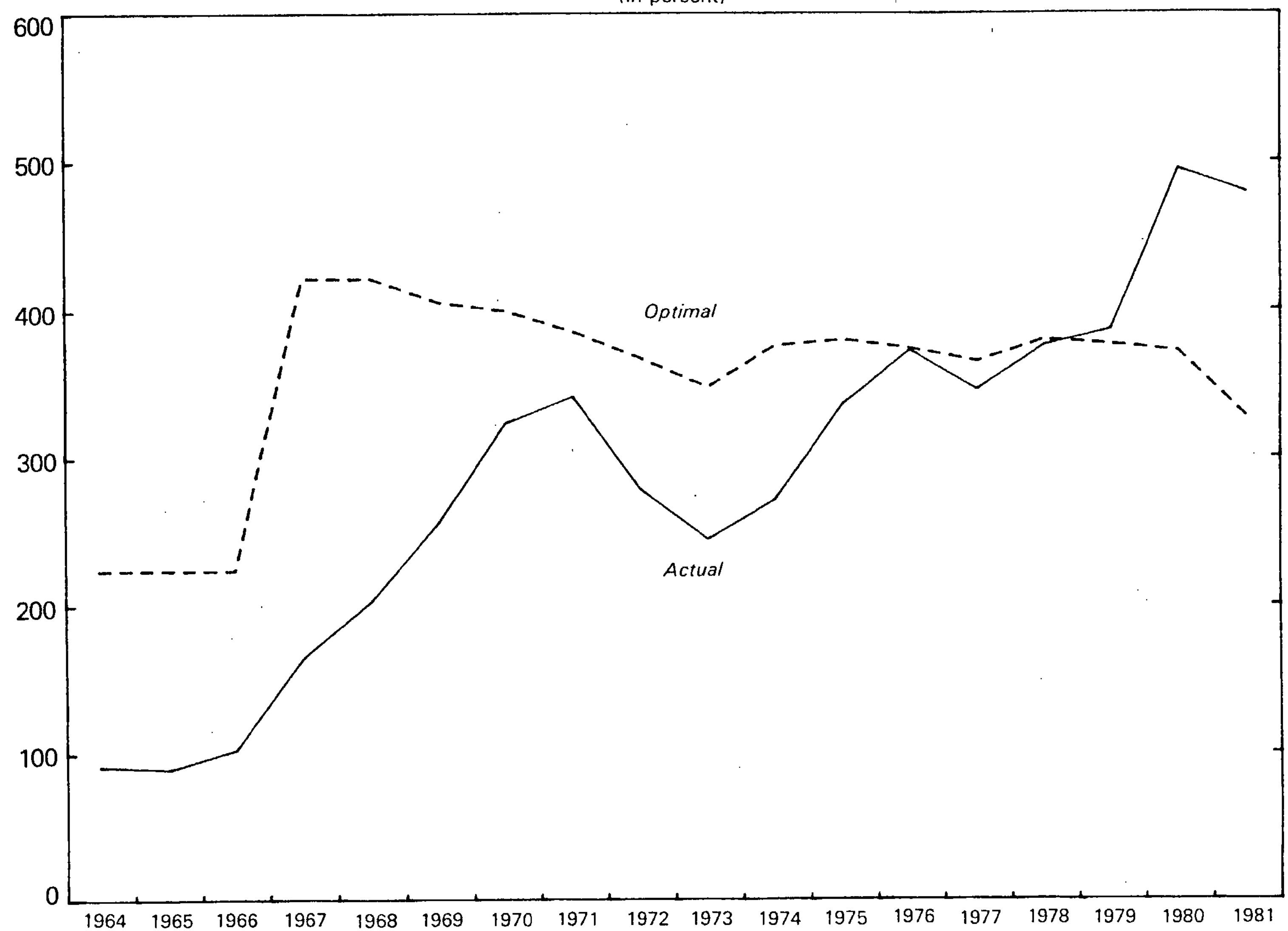
4. 1/

$$DE^* = (8.17 + \sqrt{66.75 + 25.15 * C})/12.58$$

where $C = 14.46 + \{i_u - [\beta i_d + (1 - \beta)(i_f + x)]\}$

1/ Equations used in simulation.

CHART 2
KOREA
ACTUAL AND OPTIMAL DEBT-EQUITY RATIO
(In percent)



reflecting the negligible share of equity investment by nonresidents. Interestingly, the share of bank credit expansion to total GDP was found to be insignificant in the debt-equity ratio equation (not reported here). 1/ In addition, the sum of the coefficients of the desired debt-equity ratio and the lagged debt-equity ratio is close to, and not significantly different from one. As noted in Section II.5, this finding confirms the hypothesis that a fraction of the gap between the desired and lagged debt-equity ratio is reflected in the actual change in the ratio, and this fraction is estimated at about 0.38. 2/

The significant influence of the optimal debt ratio on the actual ratio indicates that developments in the supply of debt and equity funds alone cannot properly account for the observed rise in the debt-equity ratio. The observed value of the ratio is compared with the computed optimal value in Chart 2. It is evident that the sharp increase in the observed debt-equity ratio should be attributed in part to the large interest subsidy and the resulting incentives for firms to strive for a larger ratio of debt to equity.

The formula used to compute the optimal debt-equity ratio as a function of the implicit interest subsidy is presented as equation (4), Table 5. The interest subsidy is given by the difference between the curb market rate and the weighted average of domestic interest rate and the foreign interest rate adjusted for exchange rate changes. The numerical coefficients in the expression for the desired debt-equity ratio are related to the regression coefficients of DE and DE^2 in the curb market rate equation. Since the curb market rate and the cost of capital are nonlinear functions of the debt-equity ratio, the process of minimization of the expression for the cost of capital leads to the particular formula for optimal debt ratio shown in Table 5 (see Appendix II for the algebraic derivation of the formula).

IV. Model Simulations: Dynamic Effects of Interest Rate Policy

Static simulations, based on historical values of the lagged variables showed that the goodness of fit of the model as a whole is very good. 3/ The model was also dynamically simulated (i.e., lagged variables are those generated by the model itself); the actual and dynamically simulated values of private investment, GDP, private saving,

1/ This result probably reflects the possibility that, insofar as bank credit reduces the use of curb market loans, the overall debt ratio that includes both bank debt and the UFM debt would not change much.

2/ The measured debt-equity ratio would also be influenced by the timing of the revaluation of assets, which is regulated by the 1965 Assets Revaluation Law. These effects can be absorbed in the random disturbance term.

3/ The full model used for simulations consisted of the behavioral equations chosen in Chapter III, and a set of definitional identities to link various variables as shown in Table 1.

the UFM rate, the debt-equity ratio, and the cost of capital are shown in Chart 3. Dynamic simulations indicate that the model is stable; and the goodness of fit even in dynamic simulations where errors can cumulate is indicative of the robustness of the model. These dynamic simulation results also provide a basis for deriving the dynamic effects of interest rate policy.

To derive these effects, the model is dynamically simulated by raising the bank interest rate by two percentage points over its historical levels from 1967 onward. The results of this counterfactual experiment are compared with the original dynamic simulations, and the implied impact and long-run multipliers--the absolute difference in the two simulated values of the endogenous variable, as well as the percentage change in the level variables--are shown in Table 6 and plotted as the solid line marked DE in Chart 4.

In order to identify the consequences of the endogenous response of the debt-equity ratios of firms for interest rate policy, the interest rate multipliers are also computed by ignoring the induced variations in the debt-equity ratio. For these computations, the model is dynamically simulated by excluding the equations for the actual and desired debt-equity ratio, and by comparing the results with the dynamic simulation results of a two percentage point rise in the interest rate (from 1967 onward) applied to the truncated model. 1/ The implied multipliers are shown in Table 7 and are plotted as the dotted line DX in Chart 4.

The nonlinearities in the model imply that the multiplier effects are not independent of the size of the shock in the exogenous variable, or of the initial year in which the shock is applied. In other words, the multipliers are not stationary. However, since the nonlinearity arises only because of the linkages between the debt-equity ratio and the cost of equity (the UFM rate), the direction of change in the interest rate multipliers over time can be interpreted and analyzed.

1. Interest rate and the cost of capital

The variations in the absolute and relative cost of capital constitute a crucial channel through which interest rates influence saving, investment, and growth; therefore, the impact of interest rate policy on the UFM rate and on the cost of capital will be analyzed first for the complete model with endogenous debt-equity ratio.

In this model the impact on the UFM rate following an increase in bank interest rate varies with the initial size of the debt ratio; the

1/ Using as performance criterion the mean squared error in the simulated values of saving, investment, and output, the complete model with endogenous adjustment in the debt-equity ratio performs about as well as the truncated model.

CHART 3

KOREA

DYNAMIC SIMULATIONS, 1964-81

(In billions of won)

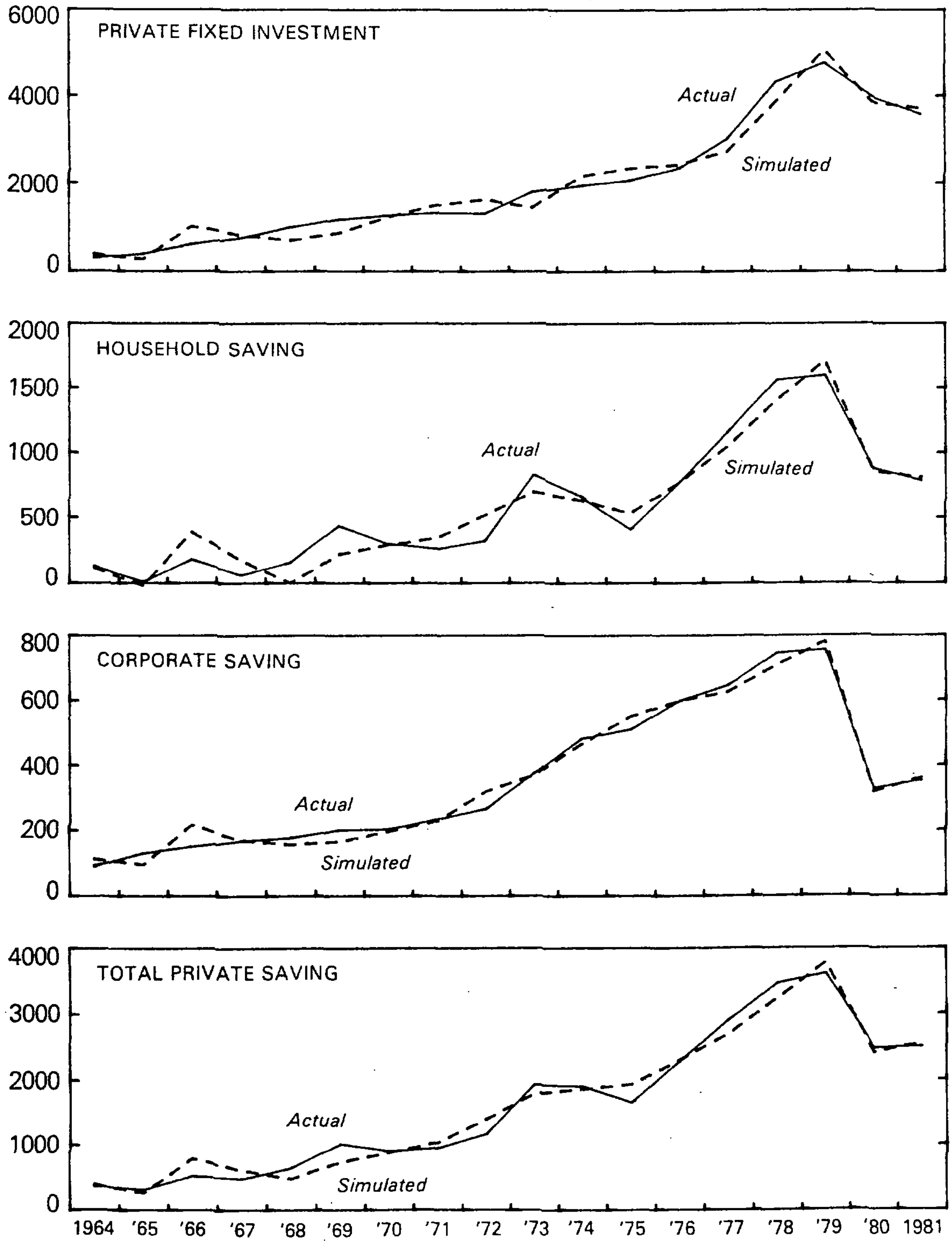


CHART 3 (continued)

KOREA

DYNAMIC SIMULATIONS, 1964-81

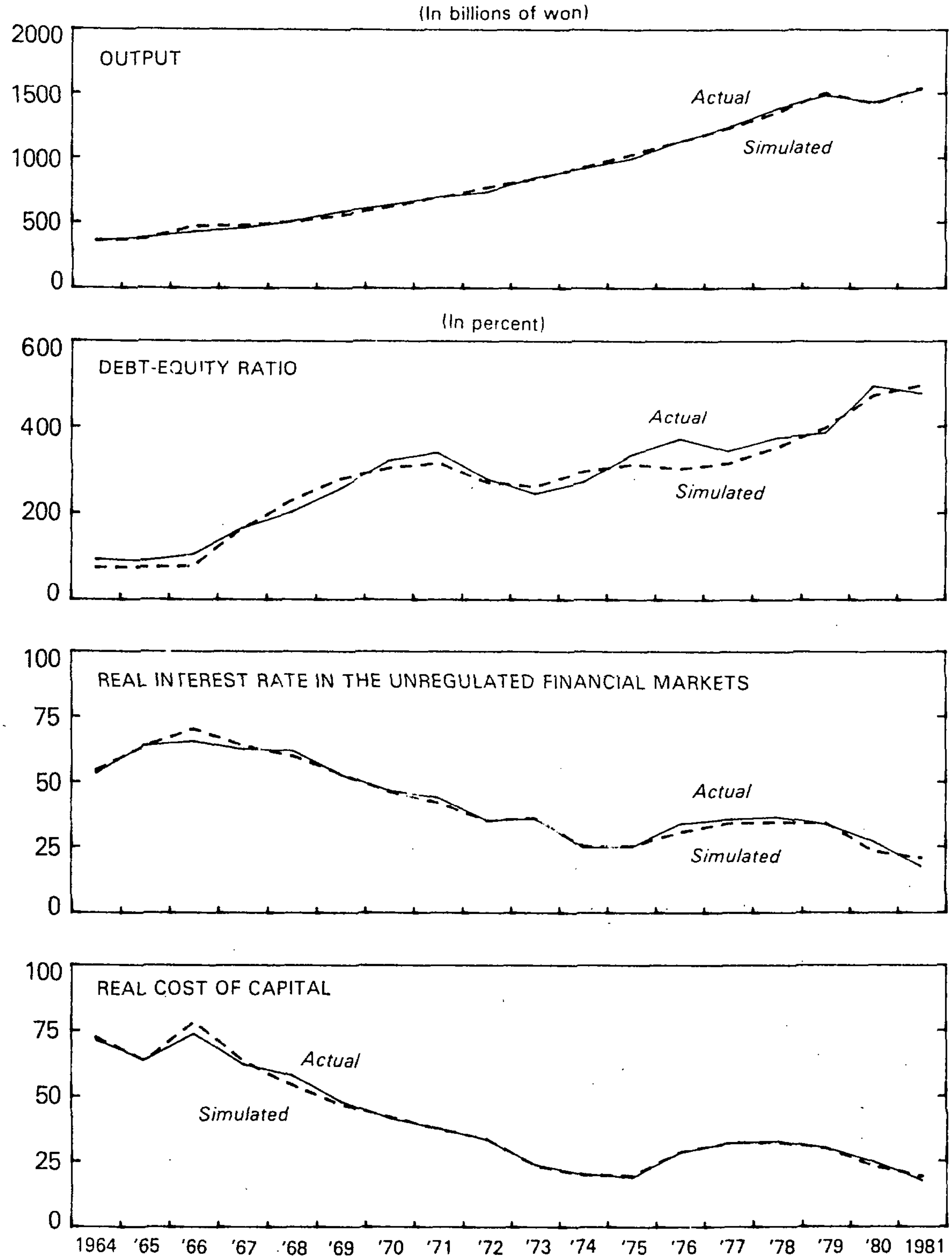


CHART 4

KOREA

DYNAMIC MULTIPLIERS OF INCREASE OF 2 PERCENTAGE POINTS IN THE BANK'S INTEREST RATE DURING 1967-71[1]

(In billions of 1975 won)

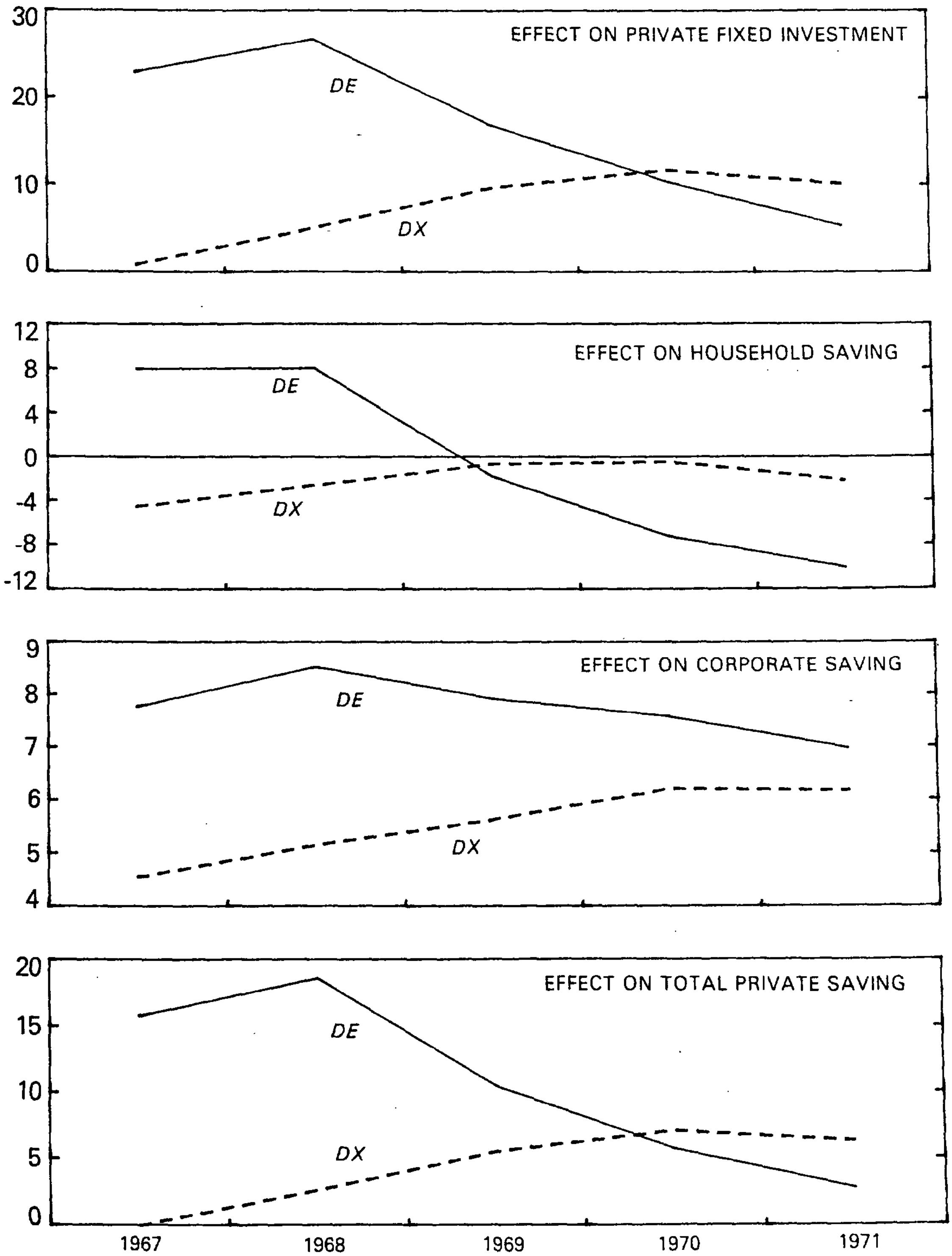
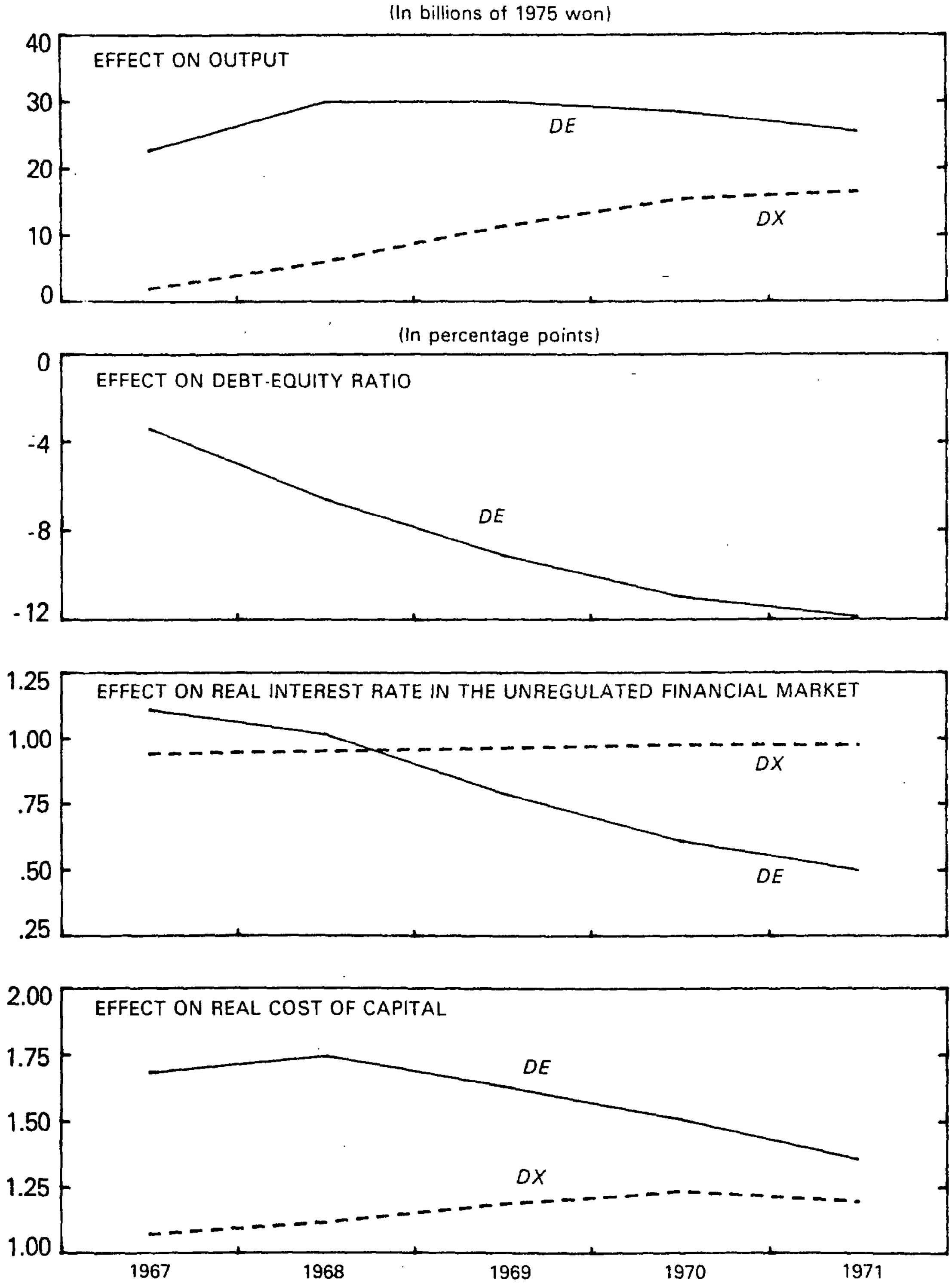


CHART 4 (continued)

KOREA

DYNAMIC MULTIPLIERS OF INCREASE OF 2 PERCENTAGE POINTS IN THE BANK'S INTEREST RATE DURING 1961-71[1]



[1] DE denotes multipliers based on the complete model with endogenous debt-equity ratio; DX is based on the truncated model with exogenous debt-equity ratio.

Table 6. Korea: Dynamic Multiplier Effects of a Permanent Two Percentage Point Increase in Bank Interest Rate, Beginning 1967 with Endogenous Debt-Equity Ratio

(In billions of 1975 won or percentage points)

	Household Saving	Net Corporate Saving	Total Private Saving 1/	Private Fixed Investment	Real GDP	Debt-Equity Ratio	The UFM Rate	Real Cost of Capital
Effects in the first five years								
1967	8.00	7.76	15.76	22.97	22.76	-3.5	1.11	1.68
	(4.7)	(4.6)	(2.6)	(2.8)	(0.48)			
1968	8.05	8.52	18.63	26.67	30.04	-6.6	1.01	1.74
	(0.0)	(5.4)	(3.9)	(3.9)	(0.6)			
1969	-1.80	7.91	10.39	16.88	30.05	-9.2	0.80	1.63
	(-0.8)	(4.8)	(1.4)	(2.0)	(0.5)			
1970	-7.27	7.57	5.71	10.38	28.52	-11.9	0.61	1.51
	(-2.5)	(3.9)	(0.1)	(0.9)	(0.46)			
1971	-10.08	6.97	2.75	5.31	25.44	-11.8	0.50	1.35
	(-2.9)	(3.0)	(--)	(0.40)	(0.37)			
Long-run								
1979	-13.68	5.89	-3.75	-5.06	16.92	-8.8	0.26	1.00
	(-0.8)	(0.75)	(--)	(-0.1)	(0.1)			
1980	-20.37	5.00	-11.86	-13.93	10.49	-9.5	-0.15	0.56
	(-2.4)	(1.58)	(-0.5)	(-0.4)	(0.1)			
1981	-23.10	3.88	-16.74	-18.94	5.80	-10.1	-0.33	0.48
	(-2.9)	(1.1)	(-0.6)	(-0.5)	(0.04)			

1/ Includes capital consumption allowances.

Note: Figures in parentheses are percentage change in the variable attributable to the two percentage point increase in bank interest rate.

Table 7. Korea: Dynamic Multiplier Effects of a Permanent Two Percentage Point Increase in Bank Interest Rate, Beginning 1967 with Exogenous Debt-Equity Ratio

(In billions of 1975 won or percentage points)

	Household Saving	Net Corporate Saving	Total Private Saving 1/	Private Fixed Investment	Real GDP	Debt-Equity Ratio 2/	The UFM Rate	Real Cost of Capital
Effects in the first five years								
1967	-4.58 (-2.6)	4.54 (2.8)	-0.04 (0.11)	0.86 (--)	2.00	0.0	0.94	1.07
1968	-2.61 (-4.2)	5.15 (3.1)	2.62 (1.1)	5.06 (0.6)	6.02 (0.1)	0.0	0.95	1.11
1969	-0.68 (-0.3)	5.63 (3.3)	5.48 (0.7)	9.57 (1.1)	11.35 (0.2)	0.0	0.96	1.20
1970	-0.47 (-0.2)	6.20 (3.2)	7.07 (0.8)	11.63 (1.0)	15.43 (0.2)	0.0	0.98	1.24
1971	-2.17 (-0.6)	6.16 (2.7)	6.25 (0.6)	10.05 (0.7)	16.40 (0.2)	0.0	0.97	1.19
Long-run								
1979	-2.95 (-0.2)	6.59 (0.8)	7.58 (0.2)	7.85 (0.2)	20.88 (0.1)	0.0	0.99	1.17
1980	-2.71 (-0.3)	6.96 (2.1)	8.42 (0.3)	8.48 (0.2)	22.39 (0.2)	0.0	0.98	1.08
1981	-2.83	6.38	7.97	7.60	23.71	0.0	0.98	1.07

1/ Included capital consumption allowances.
2/ No change in the debt-equity ratio due to the assumed exogeneity of this variable.

Note: Figures in parentheses are percentage changes in the relevant variable attributable to the two percentage point increase in bank interest rate.

larger the initial debt ratio, the smaller the increase in the UFM rate. This is seen from columns (6) and (7) of Table 6. A two percentage point increase in the bank interest rate from 1967 onward leads to about one percentage point increase in the UFM rate in the first two years following the policy change (1967 and 1968), but the effect on the UFM rate gradually falls in subsequent years and becomes even negative by 1980 and 1981. This is because although the direct effect of an increase in the bank interest rate on the UFM rate is positive, there are indirect effects owing to adjustments in the debt-equity ratio. These indirect effects can be either positive or negative depending upon the initial size of the debt ratio. Following the increase in the bank interest rate, the fall in interest subsidy and the increase in corporate saving together lead to a reduction in the debt-equity ratio of about nine to ten percentage points below its historical level in the long run (column 6). This reduction serves to push up the UFM rate, when the initial debt-equity ratio is relatively small (i.e., below the desired level), as in 1967 and 1968, but reduces the UFM rate in later years when the debt ratio is very large, as in 1980 and 1981. 1/ This shift in the direction of change in the UFM rate is in line with the U-shaped relationship linking the UFM rate and the debt ratio.

The ultimate impact on the overall cost of capital is the net result of changes in the bank interest rate, and the induced changes in the UFM rate and the debt ratio. The fall in the debt ratio by itself reduces the share of the cheaper source of finance and always contributes to an increase in the overall cost of capital. However, the ultimate effect on the cost of capital depends also upon the reaction of the UFM rate. A strong increase in the cost of capital--about 1.7 percentage points--is recorded in the initial years of the policy change when the UFM rate rose substantially, but the multiplier effect on the cost of capital falls gradually to about 0.5 percentage point in 1980 and 1981, in line with the smaller increases or even declines induced in the UFM rate in more recent years.

This fall in the long-run response of the cost of capital, despite a permanent increase in bank interest rate, implies that the impact or the immediate effect of interest rate policy on the cost of capital (DR_c/di_d) has progressively declined in more recent years of high corporate debt. 2/ Thus, the policy of attempting to raise the cost

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1/ While the reduction in the debt ratio in response to a fall in the desired ratio (a function of interest subsidy) is appropriate when the initial ratio is already above its optimum level, such a reduction may seem counterintuitive if the initial ratio is below the optimum level. However, this is the result of the partial adjustment specification. Simulation results would be clearly modified if a differential adjustment mechanism is specified.

2/ Since the long-run multiplier is approximately the sum of the impact and lagged multipliers, a decline in the long-run effect implies that the impact and lagged multipliers are declining, possibly becoming negative.

of capital to firms by raising bank interest rates works well only in situations of moderate debt, but produces weak effects, or could even induce effects in the opposite direction in situations of high debt.

The importance of endogenous adjustments in the debt-equity ratio is further illustrated in Table 7, which presents the multiplier effects for the case where such endogenous adjustments are ignored. In this case, the UFM rate increases by about one percentage point and the overall cost of capital by slightly more than one percentage point, both in the short run and in the long run, in contrast to the sharp and progressive weakening of the impact of interest rate policy observed for the case of endogenous debt ratios.

2. The effect on saving, investment, and output

The multiplier effects based on the complete model with endogenous adjustments in the debt ratio will be discussed first. The computed multipliers suggest two important observations. First, the indirect effects of interest rates on saving and investment arising from the induced effects on output and on the debt-equity ratio can dominate the direct effects observed in the individual equations for saving and investment. Second, the impact multipliers vary over time, and the lag structure of the dynamic multipliers can be very complex, particularly when the debt-equity structure of firms varies in response to interest rate policy. 1/ These two points are illustrated in the discussion below.

In the first two years following the policy change, household saving rises substantially (column 1, Table 6), because the direct negative effect of the increase in the bank interest rate is more than offset by the positive saving effect of the induced increase in the UFM rate (and in total output). 2/ In subsequent years, however, household saving declines because in line with the progressive weakening of the induced increases in the UFM rate discussed earlier, the direct negative effect dominates.

However, due to the increase in the cost of capital, net corporate saving rises substantially, particularly in the first few years. Total private saving, including capital consumption allowances, also rises significantly in the first few years, but the effect on total saving becomes progressively weaker, and the long-run effect becomes negative,

1/ The complexity of the distributed lag effects of interest rates on saving and investment is noted in Molho (1986), in a different context.

2/ As explained in subsection III.3.c, the income effect of higher interest rate dominates the substitution effect for the savers utilizing the banking system, thereby resulting in a direct negative effect of bank interest rate on household saving. The opposite is true for savers using the UFM.

owing primarily to the reductions in household saving. Thus, the interest semi-elasticity of private saving shifts from a high of 1.3 and 2.0 in 1967 and 1968, respectively, to negative values in later years.

Private fixed investment expands strongly in the first two years following the policy change, mainly because of improvements in the availability of saving, and the increased demand for investment following the rise in output. However, the investment response becomes progressively smaller, and even negative in later years, owing primarily to reductions over time in the availability of saving.

The increase in interest rates and the cost of capital raises the rental wage ratio and stimulates real GDP, which increases substantially in the initial years with an interest semielasticity of about 0.2 to 0.3, but in the long run, the response of output, although positive, becomes negligible in line with the sharply reduced impact on the cost of capital in later years.

The observed reductions over time in the response of private saving, investment, and output, despite a permanent increase in bank interest rate from 1967 onward, shows that the effectiveness of interest rate policy measured by the impact multiplier (dY_t/di_{dt}) must have declined and become negative in later years, in contrast to the positive effects observed in the initial years. For example, computation of the interest rate multipliers by initiating the policy change in a later year, such as 1975, produces much smaller dynamic effects on saving, investment, and growth than those recorded in Table 6.

A comparison of the results shown in Tables 6 and 7 again underscore the critical role played by the size and responses of the debt-equity ratios of firms. In the initial years, the response of real investment, output, and saving in the case of the exogenous debt ratio is much smaller than in the case of the endogenous debt ratio; but the opposite is true in the long run. Thus, the responsiveness of the debt ratio to interest rate policy improves the effectiveness of the policy when the debt ratio is relatively small (as in the earlier years), but weakens it in later years when the debt ratio is large.

V. Summary and Policy Implications

A structural model of saving, investment, and growth is specified and estimated. The model specifies various channels through which interest rates influence growth, and, in the process, highlights the effect of changes in the regulated interest rates on the UFM rate, on the debt-equity ratios of nonfinancial firms, and on the overall cost of capital. The overall cost of capital is computed as the weighted sum of the real opportunity cost of equity (measured by the real UFM rate) and the real opportunity cost of debt (based on the present value of debt service payments), with the weights depending upon the debt-equity ratio.

It is found that the direct effects of interest rates on household saving and private fixed investment are weak, but the direct effects on corporate saving and output are strong. The rental wage ratio--the relative cost of capital to labor, inclusive of working capital costs--has a strong positive effect on the productivity of capital, and hence output. Consistent with this productivity effect, corporate saving is also positively and strongly linked to the cost of capital. The overall direct effect of interest rates on household saving is, however, weak, because the significantly positive response of household saving to the UFM rate is partly offset by a strong negative response to bank interest rate. This difference in the sign and size of interest rate effects suggests that there exists considerable segmentation of the financial markets and household savers. The direct effect of interest rates on private fixed investment is negligible, because investment is mainly determined by the availability of saving and the level of expected output.

Model simulations reveal that indirect effects of interest rates on saving and investment--arising from the influence of the rental-wage ratio on output, and from the influence of adjustments in the debt-equity ratio on the overall cost of capital--can be substantial and can dominate the direct effects. Reflecting these indirect channels of influence, the multiplier effects of a permanent increase in bank interest rate on saving and investment are strongly positive in the initial years following the policy change, but the effects become progressively weaker over time, and even negative in later years.

This progressive weakening in the effectiveness of interest rate policy is primarily explained by the initial size of the debt-equity ratio, and the endogenous adjustments in the ratio in response to interest rate policy. The reduction in subsidy following an increase in the bank interest rate induces a fall in the debt-equity ratio. However, the debt-equity ratio is shown to have a strong nonlinear effect on the UFM rate, with the UFM rate initially falling and then rising as the debt-equity ratio increases. This results in a U-shaped cost of capital schedule. Therefore, when the debt ratio is relatively small, as in earlier years, the induced fall in the debt ratio raises the cost of capital, and reinforces the normal increase in the cost of capital due to higher interest rates in the banking system. In contrast, when the debt ratio is relatively large, as in more recent years, the induced fall in the debt ratio reduces the cost of capital and partly offsets the normal increase in the cost of capital due to higher interest rates. This offsetting effect can indeed be substantial, as demonstrated in the model simulations. In other words, the observed, U-shaped cost of capital schedule together with the optimizing behavior of economic agents are shown to have far-reaching implications for the effectiveness of interest rate policy.

The policy implications of these findings include the following: first, in order to improve the effectiveness of interest rate policy,

the debt-equity ratios of firms should be reduced. For this purpose, a reliance merely on reducing interest subsidy would not suffice. This is because, owing to adjustment lags, the changes in the debt-equity ratio induced by changes in interest subsidy are not sufficiently large--though significant--to bring about the needed reductions in the ratio. Other policies such as measures to promote equity markets, raise corporate saving, and further encourage direct foreign investment are needed. Such measures may have to be complemented by enforcing appropriate debt-equity norms for project finance. Reforms to integrate the financial markets, and thereby encourage savers to shift to the regulated financial system, are also important to improve the effectiveness of interest rate policy. Such reforms would ensure that returns to various groups of savers and the cost of capital respond fully to interest rate policy, and thereby raise the interest elasticity of saving and growth.

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APPENDIX I

The Optimal Control Framework to Derive the Expression for the Cost of Capital

The real cost of capital is derived by assuming the firms choose the investment path that minimizes their total cost of producing desired output (QP*), including the acquisition cost of capital and the debt service costs.

The cost of production C is a function not only of the planned output level QP*, but also of the plant size represented by private capital stock KP, and of the available infrastructure represented by government capital stock KG. The acquisition cost of capital is primarily the value of net investment and replacement investment at current prices; 1/ hence it is nothing but the value of gross fixed investment. The debt service costs include the interest and amortization payments on domestic and external debt. Therefore, the present value of total costs (TC) is given by:

$$TC \equiv \int_0^\infty \exp\left(-\int_0^t i_u(s)ds\right)[C(QP_t^*, KP_t, KG_t) + (1 - \alpha^m)I_t PK_t + (i_d + a_d)G_t + (i_f + a_f)F_t E_t]dt \tag{30}$$

where $i_u(s)$ is the interest rate in the UFM representing the short-run opportunity cost of equity. $\int_0^t i_u(s)ds$ denotes the long-term discount rate defined as the integral of the short-term UFM rates. I is real gross investment, PK is the price of capital goods; α^m is the proportion of investment financed by debt (that is, the marginal debt ratio); G is total domestic-currency debt outstanding. F is total external (foreign currency) debt outstanding; E is the exchange rate, measured in number of domestic-currency units per unit of foreign currency; i_d is the administered interest rate in the regulated financial market; i_f is the foreign interest rate; and a_d, a_f are the amortization rates on domestic and foreign loans, respectively. At each point in time, total cost--cash outflows from the point of view of the owners of the firm--consists of labor and other variable costs C(QP*, KP, KG), funds supplied by the owners to acquire new plant and equipment $(1-\alpha^m)I\ PK$, and the debt service payments on domestic and external debt, $(i_d + a_d)G$ and $(i_f + a_f)F\ E$, respectively.

1/ The acquisition cost includes other costs such as the costs of installation which are ignored for simplicity.

The present value of cash outflows is obtained by applying the rate of discount computed as the integral of the UFM rate. This procedure is based on the implicit assumption that the opportunity cost of equity funds is given by the present and prospective yields on loans in the unregulated financial markets, a reasonable assumption in the Korean context. With underdeveloped capital markets, the major alternative to risky investments in physical capital is likely to be the placement of funds in the UFM. The validity of this assumption is underscored by the finding that a significant share of UFM loans were made by the owners, major stockholders or executives of the borrowing firms. 1/ In line with this assumption, and insofar as firms use UFM loans in financing fixed investment, such loans are treated as equity finance, and should be excluded from the computation of the marginal debt ratio α^m.

The task is to minimize the total cost--the present value of cash outflows given by equation (30)--with respect to the control variable I, subject to the constraints:

$$\dot{KP} = I - \delta\ KP \qquad (31)$$

$$\dot{G} = \alpha^{md}\ I\ PK - a_d G \qquad (32)$$

$$\dot{F} = \alpha^{mf}\ I\ PK/E - a_f F \qquad (33)$$

where δ is the rate of economic depreciation of the capital equipment, α^{md} is the proportion of investment financed by domestic currency loans, and α^{mf} is the proportion of investment financed by foreign currency loans. The marginal debt ratio α^m is the sum of α^{md} and α^{mf}. The dot above a variable denotes the time derivative.

Equation (31) states that the change in capital stock, $\dot{KP}$, equals gross investment I minus depreciation. The rate of economic depreciation, stated as a proportion δ of existing capital, is assumed to remain unchanged over time. 2/

Equations (32) and (33) describe the time path of loans outstanding, both domestic and external. They state that the change in debt outstanding--the net inflow of loans--equals total new loans minus the amortization of existing loans. Equation (33) refers to foreign loans measured in foreign currency units. Thus, the investor's external debt obligations are all denominated in foreign currency units, and the investor bears the full exchange risk. This is the typical situation in Korea. The amortization payments on both domestic and external loans are assumed to be proportional to the stock of loans outstanding,

1/ See Cole and Park (1983).

2/ The shifts in the rate of depreciation over time due to policy changes are taken into account in the empirical work.

whereas new loans are obtained only for financing fixed investment. Loans to finance working capital requirements can be readily incorporated, but such loans are ignored for simplicity for the time being (as is borrowing for the purposes of dividend distribution and the maintenance of cash reserves).

The problem of minimizing total cost (equation (30)) subject to the constraints (31), (32) and (33), is a well-defined control problem that can be solved to characterize the path of optimal capital accumulation. The first-order conditions for the optimal investment path yield the expression for the cost of capital used in the text.

APPENDIX II

The Derivation of the Expression for the Optimal Debt-Equity Ratio

Assuming for simplicity that in the computation of the optimal debt ratio firms regard the marginal and average debt ratios to be identical, the weighted average cost of capital can be written as,

$$R_c = (1 - \alpha)[i_u - \Pi_k + \delta] + \alpha[\overline{i} - \Pi_k + \delta]$$

where α = the common value of the average and marginal debt ratio ($\alpha^m = \alpha^a \equiv \alpha$), and

$$i_u = \overline{U} - U_5 DE + U_6(DE)^2 + U_7(DE\ \Pi), \quad (34)$$

with $\overline{U}$ denoting other factors that influence i_u shown in equation (25) of the text.

First, the expression for R_c will be rewritten in terms of the debt-equity ratio DE.

For this purpose, the following considerations are relevant. The average and marginal debt ratio α refers only to the financing of fixed assets, whereas the debt-equity ratio DE reflects the financing mix governing both fixed and current assets. While α is relevant in defining the cost of capital for fixed capital formation, the overall debt-equity ratio is relevant in assessing the riskiness of firms and the cost of equity i_u. By assumption, fixed assets are financed by debt from the regulated financial markets as well as equity, while current assets are financed entirely by debt including the UFM debt. Assuming, in addition, that the ratio of current assets to fixed assets is exogenous to the model, the following relationship between α and DE can be verified:

$$\alpha = DE(1 + \varepsilon)/(1 + DE) - \varepsilon \quad (35)$$

Thus, there is a unique one-to-one relationship between α and DE. Substituting equation (35) into the expression for R_c and simplifying yields:

$$R_c = (1 + \varepsilon)(i_u + DE\ \overline{i})/(1 + DE) + \overline{R}$$

where $\overline{R}$ denotes other factors which are independent of the debt-equity ratio.

Differentiating the above expression with respect to DE, and equating the derivative to zero yields the first-order condition which can be simplified to:

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