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CAPITAL RENTAL COST AND THE ADJUSTMENT FOR THE EFFECTS OF THE INVESMTENT FUND SYSTEM IN THE ECONOMETRIC MODEL KOSMOS

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Capital Rental Cost and the Adjustment for the Effects of the Investment Fund System in the Econometric Model ***KOSMOS***

by

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Abstract

This paper reports on a part of the work connected with the development of the National Institute's econometric model KOSMOS.

Effects of a Swedish investment stimuli program on the rental cost of capital are analysed in a neo-classical framework. The program, called the investment fund system, was designed as part of stabilization policies. It aimed at stimulating investment during periods of low economic activity and (tax-free) fund accumulation during high activity periods. The firms used the program mainly for investments in constructions but machinery was also financed using the investment fund means.

Our results indicate that investment funds reduced the rental cost of construction capital; opposite effects are, however, found for machinery on one occasion. The reason is that the program affected the effective corporate tax rate, which had two off-setting effects on the rental cost. A lower corporate tax rate on its own resulted in a lower rental cost, but at the same time it reduced the value of depreciation deductions, which led to an increase in the rental.

1. Introduction[1]

This paper reports on part of the work connected with the econometric model KOSMOS, developed at the National Institute of Economic Research, Stockholm. Investment decisions in the model are based on - among other things - the relative cost of capital. Thus, we need to measure the so called user cost (UC) of capital or capital rental. Capital rental costs are here computed using Jorgenson's neo-classical model. The effects of the investment fund system, which constituted part of the authorities' attempt to affect business investment, are modelled using two different regimes, following Bergström and Södersten [1984].

The outline of the paper is as follows. Section 2 describes the basic rental formula and the variables employed. Section 3 details the changes to the basic formula introduced in order to account for the effects of the investment fund system. A short review of the empirical results is given in Section 4. The basic rental formula is derived in the Appendix.

2. The basic formula

KOSMOS incorporates a separate rental price for machinery and construction in each of the two private sectors, Industry and Other Business. For each sector, the two rentals are later aggregated into one rental price for the composite "capital".

The rental cost formula is based on Jorgenson's neo-classical approach[2]. The rental is obtained as that price of capital services which equates the present value of the investment outlay with the present value of the future income from capital services. The derivation of the formula is given in the appendix. In terms of KOSMOS variables, the rental UC is defined as:

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[1]We are indebted to Lars-Erik Öller and Alfred Kanis for comments on an earlier version of this paper.

[2]Cf. Jorgenson [1965] and Hall and Jorgenson [1967].

$$UC = \Pi[(1-A)/(1-\tau)][\delta + \rho - \Pi^{*}],$$

where Π is the price of capital goods, A is the present value of tax deductions and cash grants per krona of capital investment, τ is the effective corporate tax rate, δ is the constant rate of physical depreciation and Π^{*} is the expected rate of increase in the price of capital goods. Each variable in the formula is, in principle, specific to one type of capital and one sector. The price of the investment good, Π, is represented by the implicit deflator for machinery and construction, respectively. The constant depreciation rates, δ, were estimated for each sector and each type of capital using the perpetual inventory formula and the benchmark values 1969:2 and 1986:2 taken from the capital stocks assessed in Hansson [1991]. The after-tax discount rate, ρ, is defined as the cost of funds to an average firm with constant proportions of debt and equity capital. The cost of debt is represented by the after-tax interest rate on 5-year government bonds, while equity capital (retained earnings rather than new issues) is assumed to require an additional risk premium of 6 percentage points[3]. The share of debt in corporate assets was set at 50 % in both sectors.

The effective tax rate, τ, in principle is the central government corporate tax rate, before[4] 1985 augmented by the local government corporate tax rate and adjusted for the deductability of the latter from the central government tax. The present value of fiscal depreciation, Ad, (which is a component of A) is based on the *straight-line* rule for construction and on the *declining-balance* rule for machinery[5]. In the case of machinery, both rules are applicable, but the latter generates larger tax deductions during the first three years after the purchase of the equipment. Thus, our choice of fiscal depreciation rule for machinery presupposes that the average age of the machinery stock is lower than four years.

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[3]To represent the yield required by the shareholders to secure the capital gains needed in order to justify retaining profits rather than distributing them in the form of dividends. The cost of equity capital, being not deductible, is not adjusted for corporate tax.

[4]Local government corporate tax was abolished in 1985.

[5]Cf. the Appendix.

The present value of fiscal depreciation deductions per invested krona equals for machinery:

$$ADm = \tau \; [\, \delta \,/\, (\delta + \rho)],$$

and for buildings:

$$ADb = \tau \; [1/\Gamma * PVA(\rho, 0.9*\Gamma\text{-}1) +$$
$$0.02* PVA(\rho,4) + .02 + 1/\Gamma \,]$$

$$PVA\,(r,k) = [1/r - 1/(r(1+r)^k],$$

where PVA(r,k) denotes the present value of an annuity over k periods at the discount rate r and Γ is the economic lifetime of the investment.

The ADb formula, derived in Södersten & Lindberg [1983], accounts for the accelerated fiscal depreciation during the first five years (abolished in 1990) and the fact that the first depreciation deduction is already made the same year the investment outlay takes place.

The variable A includes, besides the present value of fiscal depreciation deductions (AD), various investment deductions and investment grants introduced occasionally in order to stimulate investment[6] (denoted G in the appendix).

The definition of expected rate of price growth, Π^*, requires special attention. Our rental cost has been derived from a model of an optimizing firm with static expectations, where in particular the interest rate and the price inflation for capital are expected to be constant. The expected price inflation is a steady-state rate, and it is not clear how it is connected to the observed rate of aggregate capital price inflation. Since the observed rate of inflation actually is the most volatile component of the rental formula, any expectation formation mechanism that closely follows the actual rate, results in a rental

[6]The data were generously supplied by Alfred Kanis.

cost dominated by the inflation rate variation. In practice, this means an immediate dip in the rental cost each time the inflation rate accelerates.

The expected steady-state inflation rate, required by the model, was approximated using the adaptive expectations formula with a very small weight (0.05) for observed inflation. The expected interest rate was computed using the same scheme but with a larger weight (0.3) for the observed interest rate.

3. Effects of investment funds

The present value of fiscal depreciation and the effective tax rate were adjusted in the period 1970-90 to account for the effects of the now defunct investment fund system. This system aimed at stimulating investment during periods of low business activity and at stimulating fund appropriations for later investment during periods of high activity. Firms were allowed to transfer, free of tax, a given percentage of their book profits to an investment fund. These untaxed funds were available for investment purposes during periods of investment fund release, announced by the government.

No depreciation deductions from taxable income were allowed for the productive capital financed from the investment fund. The fund was considered as an item on the firm's balance sheet and, consequently, the money allocated to it was available to the firm for any short-term use. However, a given percentage of the means transferred to the investment fund had to be deposited interest-free with the Central Bank. This constituted *de facto* a form of taxation, but as long as the share of the required deposit with the Central Bank was lower then the corporate tax rate itself, it was profitable for a firm to transfer money to the investment fund.

Södersten [1989] outlines a model of an optimizing firm under the investment fund system and distinguishes six possible regimes, depending on the availability of means from investment funds and on the availability of means for transfer to investment funds (i.e the choice between retained earnings and dividend).

Following Bergström and Södersten [1984], here we employ Södersten's regime 2 to model the period 1970-74 and regime 3 to model the period 1975-90. The main difference between the two regimes is that under the former, firms expect to finance their *marginal* investment with the investment fund means (thus assuming the fund is inexhaustible), while under the latter, firms expect the money appropriated for transfer to the investment fund to be used almost immediately for investment. Consequently, the latter regime implies that investment funds were not large enough to finance marginal investment but that they do finance some intra-marginal investment.

Empirical evidence on which regime is the best description of reality at an aggregate level is hardly available. Bergström and Södersten [1984] point out, that in the second half of the seventies, when investment fund releases were more or less continuous, only 20 % of investment was actually financed from the system. This seems to indicate that the latter regime of the two mentioned above was relevant, rather than the former one.

This view is further supported by the report of the Committee on Reformed Business Taxation[7] which claims that approximately half of the industry's construction and around 20% of its machinery investment were financed from the investment funds during the period 1979-86. Our own assessment[8] for the whole business sector indicates that an average of 10% of all investments in 1976-86 was financed with the investment fund means, with a maximum of 25% in 1986 and a minimum of 5% in 1984. If we assume that investment funds were only employed to finance construction, a maximum of 65% (in 1986) could have been financed by the fund system. The corresponding number for machinery would have been 35% in 1986.

In 1985[9], the share of the investment fund appropriations which had to be deposited with the Central Bank was raised above the corporate tax rate. Consequently, it was no longer

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[7]Cf. SOU 1989:34.

[8]The investment fund means employed were computed using the data for withdrawals from the special accounts for investment at the Central Bank and the corresponding required share of deposit with the Central Bank.

[9]Actually, beginning with the 1984 balance statement.

unconditionally profitable for a firm, which had funds available after dividend distribution, to transfer them to the investment fund. Still, the latter of the two regimes above prevailed for firms expecting an investment fund release. These firms could transfer funds to the investment fund and expect to reclaim them in the immediate future, thus financing part (but not necessarily all) of their investments. The main difference was that in the new situation fund appropriations were determined by the firm's investment plans and no longer by the maximal share of book profits allowed for transfer. In our computations, the share of profits transferred to the investment fund, λ, was set to zero, beginning in 1985. Up to 1984, this share is assumed to be equal to the maximum allowed by the authorities.

For the period 1970-74, the effective corporate tax rate equals the share deposited with the Central Bank for funds transferred to the investment fund and the nominal corporate tax rate for the remaining profits, i.e.:

$$\tau = (1-\lambda)^*\tau_c + \lambda^*\tau_{if},$$

where τ_c is the statutory corporate tax rate, λ is the proportion of profits allocated to the investment fund and τ_{if} is the share of the allocated means which had to be deposited with the Central Bank.

In the same period, *during investment fund releases* the present value of the depreciation deductions per invested krona is equal to the proportion of investment fund means deposited with the Central Bank (τ_{if}). This is so because, although no actual depreciation deductions could be made when investment fund means were employed, firms were allowed to withdraw the relative part of their Central Bank deposits. The net cost of real assets is also affected by the special investment deduction granted those enjoying the benefits of a general release[10].

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[10]There were general and selective investment fund releases. Selective releases were less attractive to firms than the general ones. The use of investment fund means was in that case limited to 75% of the fund and 75% of the investment cost. Furthermore, the deduction from taxable income of 10% of the investment cost, granted in connection with general releases, was not allowed. Cf. A. Markowski [1976].

According to our assumptions, after 1974, marginal investments are no longer financed from the investment funds. The value of fiscal depreciation (of the marginal investment) is then not affected by the investment fund releases, nor is the special investment deduction applicable. On the other hand, since the means transferred to investment funds are expected to be immediately employed for investment, the effective tax on this part of profits equals the present value of fiscal deductions which cannot be made when investment is financed by the investment fund system. The effective tax on the remaining profits equals the nominal corporate tax rate. Thus, the effective corporate tax rate under investment fund releases during the period 1975-90 is computed as:

$$\tau = (1-\lambda) * \tau_c + \lambda * \text{Ad}.$$

With no investment fund release, the effective corporate tax rate is defined as for the period 1970-74 above.

4. Empirical Results

The computed rental cost series are depicted in diagram 1. The corresponding curves for industry and other business are almost parallel with the rental for other business being slightly higher. In the discussion below, we are therefore going to refer to the curves for industry only. As can be seen from the diagram, both series exhibit a clear upward trend. This is due to the behavior of the investment goods prices during the period under study. The trend exhibited by the real rental costs, depicted in Diagram 2, is much less pronounced. The latter trend is due to the development of the real discount rate (cf. Diagram 2), which crucially depends on the way inflation and interest rate expectations are formed in our model.

The humps in the machinery rental in 1973-75 and 1980 are due to the temporal abolishment of the investment deductions, which were not connected with the investment fund system. Since 1974 and 1980 were economic activity peak years[11], this illustrates the counter-cyclical character of the economic policy of the period.

The sustained increase in the machinery rental beginning in 1984-85 is partly due to the removal of the investment allowances (not connected with the investment fund system). It was also a result of the increase of the required investment fund deposits with the Central Bank, which affected the effective corporate tax rate.

The downturn in 1991 is a result of the lower corporate tax rate - introduced in connection with the tax system reform - and the lower investment goods price inflation rate.

Diagram 1 also includes rental costs computed without allowing for the investment fund system. The effect of the system can be seen there as the difference between the corresponding dashed and solid lines. These effects are crucially dependent on the assumptions of the model. A direct effect of the investment fund system on the marginal cost of capital can only be seen in the construction series between 1972:2 and 1974:2. After this period, the system results only in a reduced effective corporate tax rate and its sole effect is thus a general subsidy to (part of) the business sector.

We can note that in 1981 this subsidy was, according to our results, negative for machinery investment. This was due to a temporary change in the balance of the two off-setting effects of a change in the corporate tax rate. A lower effective tax rate on its own results in a lower rental, but at the same time it reduces the value of depreciation (and other) deductions, which leads to an increase in the rental.

Generally, the effects of the investment fund system in our model can be seen to be rather substantial for construction during 1972-74, where the rental was reduced by approximately 25% of the corresponding rental cost without investment funds. For the

[11]See Sundberg [1992b].

rest of the period, the effect was 5-10% for construction and up to 5% for machinery. The negative effect for the machinery rental in 1981 amounted to 2% in both sectors.

Appendix: Derivation of the basic rental cost formula

The approach adopted here follows Jorgenson[12] [1965]. In his neo-classical model, a firm is assumed to maximize its net worth, ie. the discounted value of future net revenue. Net revenue, R(t), is for any t defined as:

$$R(t) = p\,Q(t) - s\,L(t) - q\,I(t) - T(t), \qquad (X.1)$$

where Q(t) is the amount of the produced good, L(t) is the amount of hours worked and I(t) is the volume of gross investments, all three being continuous functions of time, t. The parameters p,s and q denote their respective prices, assumed to be given functions of time. There are no stocks of finished goods.

T(t) is the tax function defined as:

$$T(t) = u[pQ - sL - q(v\delta + wr - xq_t/q)K] \qquad (X.2)$$

where u is the corporate income tax rate, r is the interest rate, δ the factor of physical depreciation per krona of capital and subscripts denote partial derivatives, such that $q_t = \partial q/\partial t$. The parameters v and w denote the proportions of depreciation cost (δqK) and interest cost (rqK), respectively, which are tax deductible and x the proportion of capital gains (q_tK) which is tax liable.

The firm's maximisation problem is:

$$\text{Max } W = \int e^{-rt} R(t)dt, \qquad t \in [0,\infty], \qquad (X.3)$$

subject to

$$I(t) = K_t(t) + \delta K(t), \qquad (X.4)$$

$$Q(t) = F(K(t),L(t)). \qquad (X.5)$$

[12]See Wallis [1973] for a very pedagogical exposition.

Equation (X.4) defines investment as the sum of net investment and replacement of depreciation. Investment is a continuous variable so there is no "lumpiness" in the investment scheme. No capacity restriction is assumed. The accumulated capital is homogenous with no vintage-specific characteristics. Equation (X.5) defines a production function of the neo-classical type, which means that it is continuous, twice differentiable and that the marginal product of at least one input is positive[13].

The Lagrangean is:

$$\mathcal{L} = \int\{e^{-rt}R(t) + \lambda_0(t)[Q(t)-F(K(t),L(t))] + \lambda_1(t)[K_t(t)-I(t)+\delta K(t)]\}dt, \quad t\in(0,\infty).$$

The Lagrange multipliers, $\lambda_{i(i=1,2)}$, are functions of time, implying that the corresponding restrictions must hold in every time period.

Dropping all time indices for convenience, denoting the expression in curly brackets in the Lagrangean by f and differentiating with respect to K, Q, L, I, λ_0 and λ_1 yields the first order conditions:

$$\partial f/\partial K - d\{\partial f/\partial K_t\}/dt =$$

$$-\lambda_0\, \partial F/\partial K + \lambda_1\delta + q(v\delta + wr - xq_t/q) - d\lambda_1(t)/dt = 0, \qquad (X.6)$$

$$\partial f/\partial Q = e^{-rt}\,(1-u)p + \lambda_0 = 0, \qquad (X.7)$$

$$\partial f/\partial L = -e^{-rt}\,(1-u)s - \lambda_0 \partial F/\partial L = 0, \qquad (X.8)$$

$$\partial f/\partial I = -e^{-rt}\, q - \lambda_1 = 0, \qquad (X.9)$$

$$\partial f/\partial \lambda_0 = Q - F(K,L) = 0, \qquad (X.10)$$

$$\partial f/\partial \lambda_1 = K_t - I + \delta K = 0, \qquad (X.11)$$

The non-standard form[14] of (X.6) is due to the presence of the time derivative of K in the investment identity (X.4).

[13] A complete list of assumptions is given in Gravelle & Rees [1981], p 163-165.

[14] See Elgerd [1967].

Using (X.7), (X.8) and (X.10), we obtain the marginal condition for labor:

$$\partial Q/\partial L = s/p. \qquad (X.12)$$

The time derivative of $\lambda_1(t)$ in (X.9) is (recalling that q is a function of time):

$$d\lambda_1(t)/dt = rqe^{-rt} - q_t e^{-rt}$$

which, substituted into (X.6), results in:

$$-\lambda_0\, \partial F/\partial K + \lambda_1\delta + q(v\delta + wr - xq_t/q) - rqe^{-rt} + q_t e^{-rt} = 0. \qquad (X.14)$$

Using λ_0 from (X.7) and Q = F(K,L), we obtain:

$$\partial Q/\partial K =$$
$$[q\{r(1-uw)/(1-u) + \delta(1-uv)/(1-u)\} - q_t(1-ux)/(1-u)]/p = c/p, \qquad (X.15)$$

which is the marginal productivity condition for capital. The numerator, denoted by c, is the implicit rental value of capital services and should be viewed as an ownership cost. The rental cost is inversely related to the degree of tax deductibility of the interest and depreciation cost (w and v). Assuming full tax deductibility, w=v=1, and also x=1, we obtain the well-known basic formula:

$$c = q\,(\,r + \delta - q_t/q). \qquad (X.16)$$

According to (X.16), the real cost of capital services (c/p), derived from one krona of capital stock, includes three components: interest, depreciation and capital gains/losses. The last term in X.16, i.e. the relative change in the price of capital good, q_t/q, was originally assumed away by Jorgenson[15] as transitory. The terms r and $-q_t/q$ are sometimes coupled together into a specific "real rate of interest".

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[15]Cf. Jorgenson [1963].

The same result as above can be obtained upon computing the rental which equates the present value of the investment cost with the present value of the flow of future rental costs pertaining to the same investment[16].

The cost of one unit of investment at time s is q(s) and its present value is $e^{-rs}q(s)$. The cost of capital services supplied over the time interval dt, starting at t, by a unit investment acquired at time s is $c(t)e^{-\delta(t-s)}dt$, where c(t) is the price of capital services at t. The present value of the cost of services is:

$$e^{-rt}\, c(t)\, e^{-\delta(t-s)}\, dt.$$

Setting the present value of the cost of investment equal to the present value of the flow of costs of investment services, gives:

$$e^{-rs}\, q(s) = \int [e^{-rt}\, c(t)\, e^{-\delta(t-s)}]\, dt, \qquad t \in [s,\infty]. \qquad \text{(X.17)}$$

Differentiating (X.17) with respect to time of acquisition, s, yields:

$$c(s) = q(s)[\, r(s) + \delta] - q_t, \qquad \text{(X.18)}$$

which is identical to equation X.16.

Introducing corporate taxation and tax deductible depreciation allowances, we obtain in an analogous way our final formula for the rental cost of capital[17].

$$c = [(1\text{-}A)/(1\text{-}\tau)]\, [q\, (\, r + \delta - q_t/q\,)], \qquad \text{(X.19)}$$

where τ is the (effective) corporate tax rate faced by the firm and A is the present value of all the tax deductions and cash grants per invested krona. Thus, 1-A is the net cost to

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[16]See Jorgenson [1965] for a discussion of the equivalence of the two approaches.

[17]Cf. Hall and Jorgenson [1967]. Here we follow the equivalent formulation of Bergström and Södersten [1984].

the firm of acquiring an asset of unit value[18]. Equation X.19 is more general than the definition of c implied by equation X.15, which was based on specific assumptions regarding tax deductibility.

Two commonly used fiscal depreciation schemes are the *straight-line* scheme and the *declining-balance* scheme. The straight-line rule stipulates that a constant share of the original investment cost be deducted from income each year during the life time of the investment. The present value of the straight-line depreciation flow per invested krona is then:

$$ADb = \tau/\omega \int e^{-rt}\, dt \qquad t \in [0,\omega] \qquad (X.20)$$

$$= \tau/\omega\ [1/r - 1/(r(1+r)^{\omega})],$$

where ω is the life time of the investment. The expression in the square bracket is the present value of a flow of one krona over ω periods at the discount rate r.

The declining-balance rule stipulates that a constant fraction γ of the remaining value of the investment be deducted each year over an infinite time horizon. The present value of the infinite tax deduction series is:

$$ADm = \tau\gamma \int e^{-(\gamma+r)t}\, dt \qquad t \in [0,\infty] \qquad (X.21)$$

$$= \tau\gamma/(\gamma+r).$$

Denoting by G the fraction of the original investment cost which is directly reimbursed through a cash grant or a special tax deduction, we obtain:

$$A_i = AD_i + G, \qquad i = b,m.$$

[18]Cf. Bergström & Södersten [1984].

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Svensk Sammanfattning

Denna uppsats redovisar resultat från ett delprojekt i utvecklingen av Konjunkturinstitutets ekonometriska modell KOSMOS.

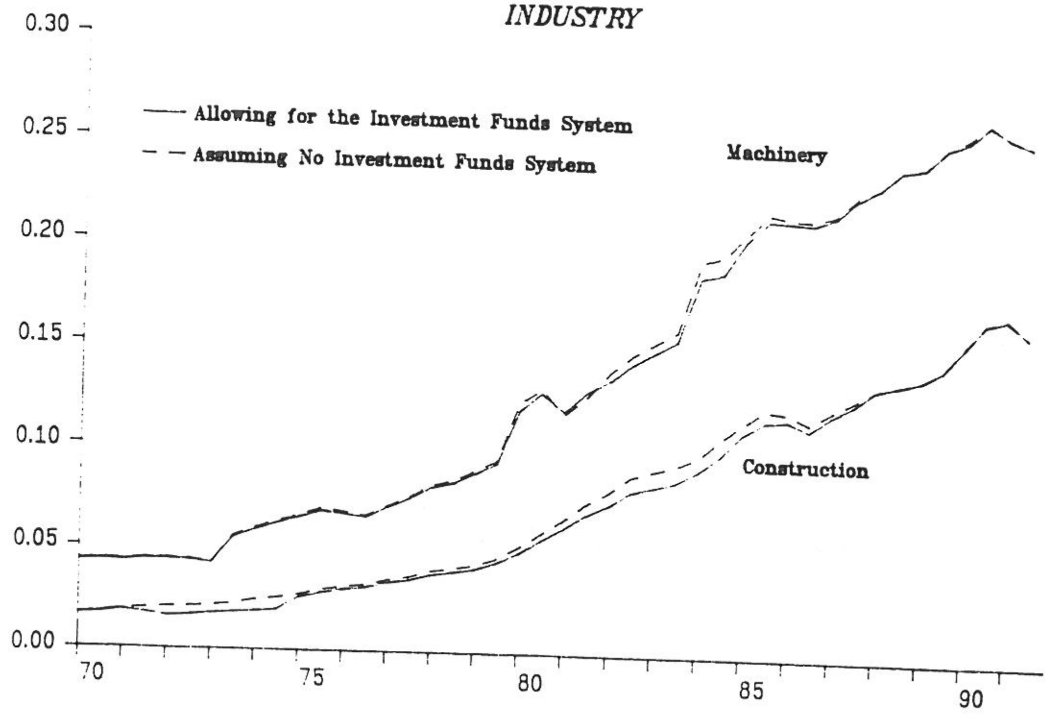
De svenska investeringsfondernas effekt på kostnaden för kapitaltjänster analyseras inom ramen för en neoklassisk modell. Investeringsfonderna var en del av den svenska stabiliseringspolitiken. Deras syfte var att stimulera investeringar i lågkonjunktur och (skattefri) kapitalackumulation i högkonjunktur. Företagen har utnyttjat fonderna för i huvudsak byggnadsinvesteringar men även maskininvesteringar har varit aktuella.

Våra resultat antyder att investeringsfonderna har sänkt kapitalkostnaden för byggnadsinvesteringar men vid åtminstone ett tillfälle gäller det omvända för maskininvesteringar. Orsaken är att fonderna påverkade företagens effektiva skattesats och detta hade i sin tur två effekter på kapitalkostnaden vilka verkade i olika riktningar. En lägre företagsskatt, allt annat lika, resulterar givetvis i en lägre kapitalkostnad men den lägre skattesatsen minskar samtidigt värdet av avskrivningarna vilket höjer kapitalkostnaden. I vissa fall kan den kostnadshöjande effekten vara starkare vilket leder till icke helt intuitiva resultat.

Diagram 1

CAPITAL RENTAL COST

INDUSTRY



OTHER BUSINESS

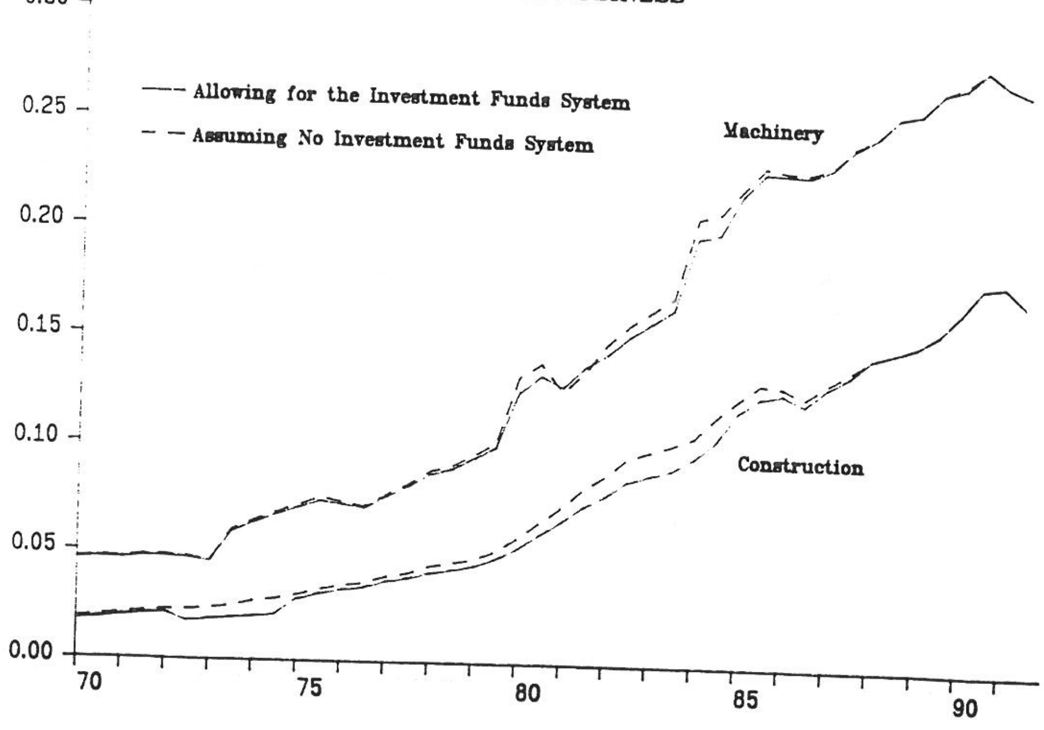
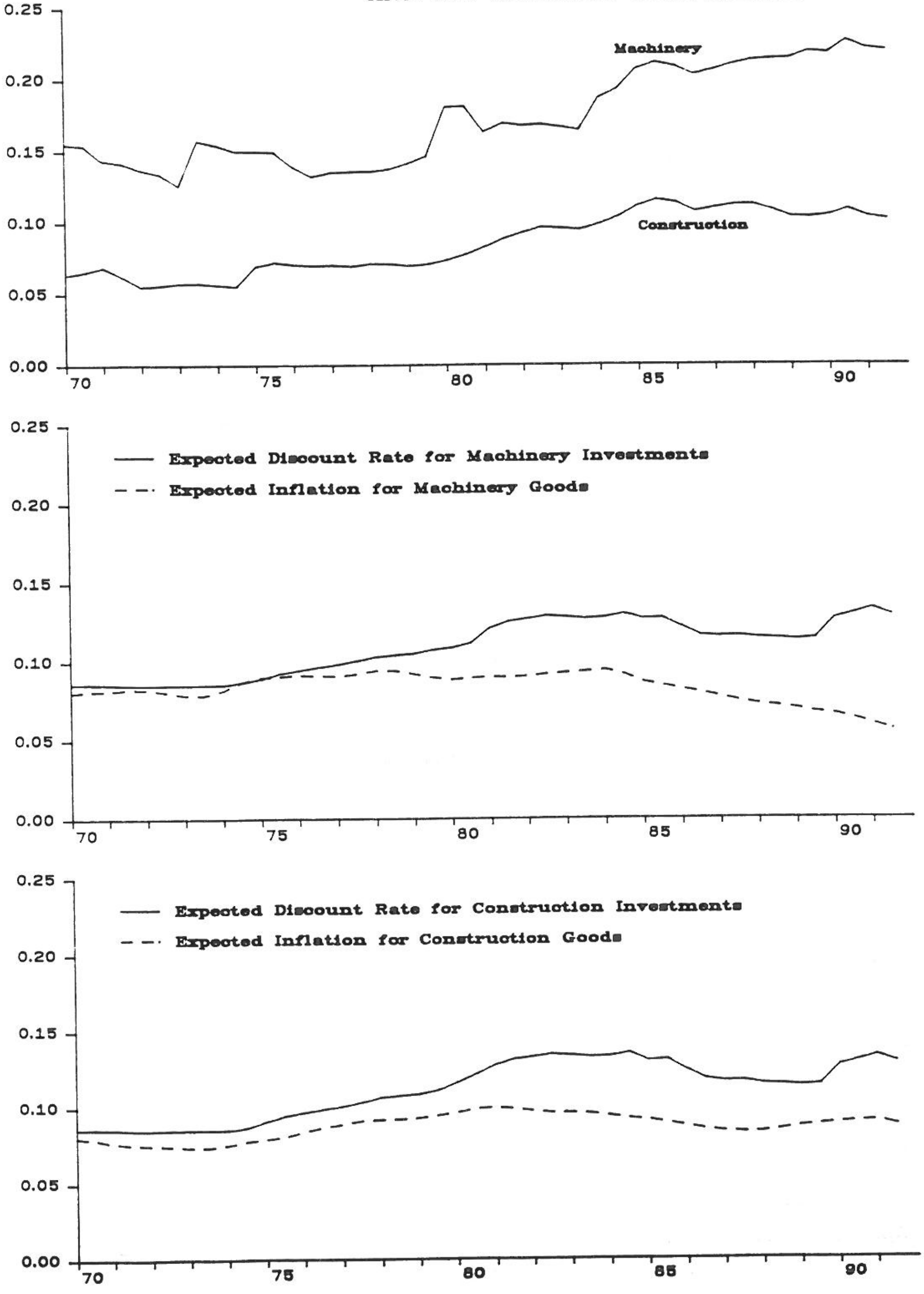


Diagram 2 *REAL CAPITAL RENTAL COST FOR INDUSTRY AND ITS SELECTED COMPONENTS*



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