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A THEORETICAL EVALUATION OF THE SWEDISH CORPORATE TAX REFORM ACT OF 1994*

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This paper studies the implications of the Swedish tax reform of 1994, by explicitly modeling some unusual features of the tax code such as the Annell deduction and the tax equalization reserve (SURV). The paper is about the effects of tax policy on corporate investment and financial structure. Financial preferences are derived using pairwise comparisons, and the weighted average cost of capital is evaluated. This is done by allowing for endogenous adjustment in the firm's financial choices. This paper demonstrates how theoretical and numerical analysis can be combined to evaluate the overall effects of simultaneous changes in several tax parameters. (JEL: G30, G31, G32, G35, G39 and H25)

1. Introduction[1]

During recent years several OECD countries have experienced rather complex reforms of their corporate taxation system. The reform packages has often been very complicated and difficult to evaluate. The reason for this is the fact that a reform of the corporate taxation usually provides simultaneous changes of many different taxation parameters. Today, there exist a model that is frequently used to evaluate rather complex tax reforms. The model which was developed by King and Fullerton (1984) demonstrates how numerical and theoretical analysis can be combined to evaluate the overall effects of simultaneous changes in several tax parameters. In their model, King and Fullerton (1984) assumed that the firm's use of different financial sources were exogenously given. This was done by specifying the fractions of the investment financed by different sources of finance (debt, new share issues and retained profit). Though tax reform evaluation is possible using the framework of King and Fullerton (1984), the present paper has the advantage of allowing for endogenous adjustment in the firm's financial choices. Drawing on earlier work by Kanniainen and Södersten (1995) and Sinn (1987) this paper demonstrates the endogenous adjustments in the firm's financial choices and investment behavior, by studying

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[1] *A more detailed version of this paper, Shahnazarian (1996), available on request, provides a description of the Swedish tax systems before and after the 1994 tax reform as well as the mathematical modeling of the Annell deduction and the tax equalization reserve. Further, it also provides a mathematical appendix and a detailed description of the results obtained by the numerical analysis.*

the effects of the Swedish corporate tax reform 1993–1994[2]. The major elements of this reform were the reduction of the corporate tax rate, the introduction of a new reserve option (periodical reserve funds) and the removal of the double taxation of distributed profits.[3]

The objective of the firm in the model presented in this paper is to maximize the present value of net cash flows subject to different financial and accounting constraints.[4] Sinn (1987) and Kanniainen and Södersten (1995) suggest how corporate debt can be introduced into the model. Taxation makes borrowing attractive, but at the same time reporting conventions set different constraints on borrowing. In this paper, we will use the uniform reporting convention, as discussed by Kanniainen and Södersten (1995), because this convention is the one used in Sweden. The constraint on borrowing due to uniform reporting is not enough to prevent the firm from borrowing 100 per cent. Therefore, we introduce a credit constraint that limits the firm's borrowing to a certain proportion of net investment. This constraint has earlier been examined in Sinn (1987). More, we also model the Swedish corporate taxation in detail.

The paper is organized as follows. Chapter 2 presents the optimization, and we model several special features of corporate taxation in Sweden, including the Annell deduction and the tax equalization reserve. In addition, we account for various institutional constraints that must be taken into consideration when modeling the firm's decision making process. We close Chapter 2 by presenting the optimality conditions. The theoretical and numerical impact of taxation on the firm's financial behavior is examined in Chapter 3. In Chapter 3, we also summarize the effective tax rates and a few other parameters used in our numerical calculations. The effects on the firm's cost of capital are studied in Chapter 4.

The explicit modeling of some unusual features of the tax code such as the Annell-deduction and the SURV reserve option demonstrates that the mechanisms which determine corporate financial behavior and investment incentives are rather complicated. In this paper we find that the total cost of capital increased for 1994, even though the increase was small. Given the assumptions of the present model we show that the proportions of financing through new share issues, debt and retention depend highly on the availability of interest free tax debts arising from accelerated depreciation and various reserve options (e.g. the tax equalization reserve). By removing a reserve option, firms are forced to substitute new sources of funds for interest free tax debt. The model calculations indicate that the proportion of financing through new share issues and debt would be higher for 1994 compared to 1993, while the opposite would be true for financing through retention. The cost of issuing new shares is shown to be higher with the 1994 tax rules, while the cost of debt is the same in 1993 and 1994. On the other hand, the cost of retention is shown to fall. These changes

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[2] *From now on we will refer to this reform as »the tax reform act of 1994».*

[3] *The government's bill was based on an investigation carried out by the reform committee, published in SOU (1992:67) and SOU (1993:29). The tax reform bill of 1993 was adopted by parliament on December 16, 1993. The rate of corporate tax was reduced from 30 per cent to 28 per cent, accompanied by eliminating allocations to the tax equalization reserve, and by introducing a new reserve option (periodical reserve funds (periodiseringsfonder). According to the new reserve option law corporations were allowed to make deductions from their taxable income, at a maximum rate of 25 per cent of the fiscal year's income. The double taxation of distributed profits was also removed. At the individual level dividends on shares were tax exempted, while the Annell deduction at the firm level was removed completely. The base for capital gains taxation was reduced to half of the shareholders' capital gains, which means that the effective tax rate was set to 12.5 per cent. The interested reader is referred to SOU (1992:67), SOU (1993:29), Regeringens proposition (1993/94:50), RSV-nytt (1993:19), RSV (1993:21) and RSV-nytt (1994:6) for more details about the tax reform act of 1993. For details about the tax reform act of 1991, an interested reader is referred to Qwerin and Eriksson (1992), Ministry of finance (1991), Grosskopf and Rabe (1992), Abel (1992), Södersten (1993) and RSV (1988).*

[4] *The impact of taxation on corporate financial policy and the cost of capital has been examined in the literature very carefully. Hall and Jorgenson (1967), Poterba and Summers (1985), King (1975), Bergström and Södersten (1981a), Bergström and Södersten (1981b), Sinn (1990), Atkinson and Stiglitz (1980), and Scheel and Waerness (1993) are examples of such studies. The importance of distinguishing the short-term effects from the long-term has been pointed out in much of the literature. Examples include Summers (1981), Abel (1982), Hayashi (1982), Auerbach (1986) and Osterberg (1989).*

in combination with the adjustments in the use of different sources of funds explain the slight increase in the total weighted average cost of capital.

The key impact of introducing the Annell deduction and the tax equalization reserve seems to be that the Annell deduction makes new share issues more attractive thus enhancing risk sharing and allowing corporations to attract more risky capital. What the tax equalization reserve in turn does is to mitigate the double taxation of corporate retention. However, the tax equalization reserve also effects the cost of new equity through the weight attached to the new equity cost.

2. The Theoretical Model

2.1 The Value of the Firm And Its Cash Flow Constraint

Corporate executives are assumed to choose the investment and financial plans which maximize the tax adjusted value of the firm

$$(1) \quad V(t) = \int_t^\infty [\theta\, D(u) - V^N(u)]\, e^{-r(u-t)} du$$

where $\theta = \frac{1-\tau_d}{1-\tau_c}$, $r = i\,\frac{1-\tau_p}{1-\tau_c}$. In (1) $V(t)$ is the market value of outstanding shares at time t, $V^N(u)$ is the revenue from new share issues at time u, $D(u)$ is the flow of dividends paid by the firm, τ_d is the personal tax rate on dividends, τ_c is the effective personal tax rate on accrued capital gains on shares, i is the interest rate, and τ_p is the personal tax rate on interest income. Corporate dividends (the cash flow constraint) net of profit tax, are defined from the firm's budget constraint as[5]

$$(2) \quad D = (1-\tau)[f(K) - i_B B] - h(I)(1-\varphi\tau) + \tau\delta^T C + \tau S\dot{U}RV + AN - I + V^N + \dot{B}$$

where $f(K)$ is the production function with $f_K > 0$ and $f_{KK} < 0$, K = capital, C = book capital, i_B = debt interest[6], $i_B B$ is the firm's interest costs on its debt, $\dot{B} \equiv S$ is the net flow of borrowing, and I is the investment in time u. Corporate taxation is given by τ and δ^T, the corporate income tax rate and the rate of fiscal depreciation, respectively. The fiscal depreciation rate is assumed to be higher than the economic depreciation rate ($\delta^T > \delta$). ($\tau\delta^T C$) is the tax reduction resulting from accelerated depreciation. AN is the tax reduction resulting from Annell deduction[7], while ($\tau\, S\dot{U}RV$) is the tax reduction resulting from firm's allocation to the tax equalization reserve[8]. We assume the following adjustment cost function: $h(t) = h[I(t)]$ where $h'(I) > 0$, $h''(I) > 0$ for all $I > 0$, $h'(0) \geq 0$ *and* $h(0) = 0$.[9] We introduce a variable, φ, which takes the value 0 if adjustment costs are not deductible while it takes the value 1 if adjustment costs are deductible. The after tax adjustment cost is therefore $h(I)(1-\varphi\tau)$.

2.2 Special Features of Corporate Taxation in Sweden

In this section we will present two features of the Swedish corporate taxation, namely the Annell deduction and the tax equalization reserve.

The Annell deduction: Corporate income is usually taxed twice. Corporations pay corporate tax on their net income, and in addition to this, shareholders must pay tax on dividends. An attempt to mitigate the double taxation of dividends in Sweden has been to allow corporations a deduction for dividends on newly-issued

[5] *For this, we assume that the firm pays out its cash flow except costs of production, debt service, adjustment costs, taxes, and investments. Investments are assumed to be financed both internally and externally (by issuing debt and new shares). For simplicity we also assume that the price level is unity.*

[6] *The debt interest rate is equal to the market interest rate. It is nevertheless convenient to distinguish between these in notation, since in the derived formulae often only one of the two is present. By separating the notation it becomes easier to identify the impact of one or the other.*

[7] *See Section 2.2 for a detailed explanation of the Annell deduction.*

[8] *See Section 2.2 for a detailed explanation of the tax equalization reserve.*

[9] *This means that the cost per unit of gross investment rises with investment. The condition $h''(I)>0$ guarantees that the adjustment cost function is convex in its (convex) domain. This means that adjustment costs will be greater, the greater the rate of investment.*

shares. Firms are allowed to deduct dividends, against current profits, at a maximum of 10 per cent per year of the value of new shares, and for a maximum period of 20 years following a new share issue. The total amount of these deductions is limited to the value of the issue. Mathematically it would be very complicated to model the rules as explained above. Therefore it is necessary to make a simplifying assumption. We assume that the firm makes the maximum available deduction in each and every period. This means that they always use 10% of the value of the new issues in the calculation of the tax base. If we assume that we have maximal exploitation then the deduction in each and every period[10] is a = 10% of the stock, k^N where k^N is equal to

$$(3) \quad k^N = \int_{g=u-b}^{u} V^N(g)\, dg$$

where b is 10 years according to the Annell deduction rule. The differential equation that corresponds to the integral (3) is

$$(4) \quad \dot{k}^N = \frac{d_k^N}{du} = V^N(u) - V^N(u-b)$$

The reason for having this equation of motion is simply due to the fact that in an optimal control problem we must be able to show how different stock variables move over time. The tax deduction obtained by the Annell deduction is therefore $AN = \tau a k^N$.

Allocation to the tax equalization reserve, SURV: Allocation to the tax equalization reserve is limited to 30 per cent of the company's equity capital, the SURV. This allocation must be accounted for in the firm's accounts under the heading of untaxed reserves and the allocated amount is reported back for taxation the year after the allocation, but as an offset to this a new allocation may be made by an amount up to the stated limit. The base for the allocation is the company's equity capital, which is defined as the total amount of the book value used for tax purposes in the annual accounts, less deductions for corporate liabilities. SURV allocations (both previous and current allocations) and Annell deductions should not be counted as a liability. In what follows, we will explain how the SURV allocation can be modeled. This can be done by looking at the change of a firm's equity capital.

The change of a firm's equity capital in each period is equal to the sum of the value of the new issue and the profit in that period less profit tax and distributed profits (dividends). The allocation to the tax equalization reserve, $\dot{SURV}$, is limited to ε of the change in equity capital in each period.[11]

$$(5) \quad \dot{SURV} = \varepsilon\{V^N + f(K) - i_B B - \delta^T C - h(I) - \tau[f(K) - i_B B - \delta^T C - \varphi h(I) - \dot{SURV} - ak^N] - D\}$$

If we substitute the expression for D, from (2), into (5) we get

$$(6) \quad \dot{SURV} = \varepsilon[\dot{C} - \dot{B}]$$

where $\dot{C} = I - \delta^T C$ is the change in the firm's tax accounting value and $\dot{B} = S$ is the net change in debt. The tax deduction obtained by making allocations to SURV is $\tau\, \dot{SURV}$.

2.3 The Constraints on the Firm's Financial Decision

Various institutional constraints must be taken into consideration when modeling the firm's decision making process. The analysis of the various constraints is carried out by a diagrammatic method suggested by Sinn (1987). The y-axis of Figure 1 represents the increase in debt, $dB/dt = S$, while x-axis represents the value of new issues of shares V^N. For this, it is necessary to assume that the capital stock, real net investment and the stock of debt are exogenously given. We are only interested in the current flow of financing and impose the different constraints on the firm's financial choice.

[10] *We assume that the firm has a history. This means that it has been issuing shares for at least 10 years.*

[11] *In this model we assume that the firm makes a maximum allocation to SURV to be able to gain maximum advantage of the deduction. This means that* $\varepsilon = 0.3$.

In our model, we will assume that firms are not allowed to re-purchase their own shares. This constraint is represented as a vertical line which coincides with the ordinate of Figure1.

(7) $V^N \geq 0$

We also assume that the gross dividend D cannot exceed the accounting profit. Södersten and Kanniainen (1995) begin by pointing out that with a uniform reporting convention the tax balance sheet of the firm must coincide with the one drawn up for the shareholders. Combining this fact with the condition that the dividends paid out must not exceed after-tax book profits leads to the following condition:

(8) $D \leq (1-\tau)[f(K)-i_B B-\delta^T C-\dot{SURV}] -(1-\varphi\tau)h(I) + \tau a k^N$

The SURV and the Annell deduction interact with corporate cash flow and hence with the financial constraints faced by firms. Substituting the expression for D, from (2), into (8) we obtain

(9) $S + V^N \leq I-\delta^T C-\dot{SURV}$

This inequality is a constraint on the use of external funds showing that the part of investment that is not covered by tax depreciation and through the current allocation to the tax equalization reserve can at most be financed by issuing new debt or new shares. This inequality is represented in Figure 1 by the upper border line. This line has a slope equal to –1.

We assume that firms are not allowed to pay negative dividends.

(10) $D \geq 0$

If we substitute the expression for D, from (2), into (10) we obtain

(11) $S + V^N \geq I-\delta^T C-\dot{SURV}-\pi_1$

where $\pi_1 = (1-\tau)[f(K)-i_B B-\delta^T C-\dot{SURV}] -h(I)(1-\varphi\tau) + \tau a k^N$. This inequality states that the sum of debt financing and new issues must at least be large enough to finance the part of investment that cannot be financed through accelerated depreciation, through allocation to the tax equalization reserve and retention. This constraint is represented by the lower border line in Figure 1. This line has a slope equal to –1.

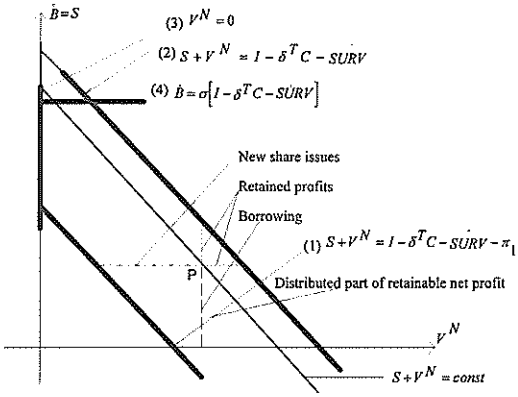

Figure 1: The financial constraints of the firm.

Finally, we also assume that firms face some degree of credit constraint, in accordance to Sinn (1987) but re-modified to capture the allocation to the tax equalization reserve. We require therefore that the net change in debt is no grater than the fraction σ of the change in equity capital

(12) $\dot{B} \leq \sigma[I-\delta^T C-\dot{SURV}]$

where σ indicates the maximum marginal debt-asset ratio, that is the maximum proportion of investment net of accelerated depreciation and allocation to the tax equalization reserve that the firm is allowed to finance through new loans raised in the credit market.[12] . This is represented as the upper horizontal border line in Figure 1. σ is treated as an exogenous variable in the model.

Between the upper and the lower border lines, in Figure 1, there are an infinite number of parallels on which $S + V^N$ is constant. Each of these lines characterizes given levels of re-

[12] *Sinn discusses how the maximum marginal debt-asset ratio can be derived; See Sinn (1987) pp. 76–77 and 108–116 for further details. See also Shahnazarian (1996) for a discussion about the derivation of the inequality (12).*

tention and dividends (because investment is treated as a given quantity). If we start from point P, the magnitudes of all three forms of finance as well as the level of distributions can be established. Retained profits are represented as the distance between the upper border line and the point P. The distributed part of retainable net profit is represented as the distance between the lower border line and the point P. With the help of Figure 1, we can find the optimal point in a well specified solution space. This point specifies the overall financial optimum and the size of distributions.

2.4 The Firm's Objective and the Optimality Conditions

The state variables of the optimization problem are the capital stock (K), the firm's book capital (C), and the stock of debt (B). The firm will choose the net increase in debt ($\dot{B}= S$), new issues of shares V^N, and net investment (I) so that the value of the firm is maximized. Formally the firm's objective is then to maximize (1) subject to $\dot{K} = I-\delta K$, $\dot{C} = I-\delta^T C$, $\dot{B} = S$, (2), (4), (7), (9), (11), (12) and the initial conditions $K(t) = K_0$, $C(t) = C_0$, $B(t) = B_0 < K_0$, $k^N(t) = k_0^N$, and $SURV(t) = SURV_0$. The current-value Hamiltonian for this problem is:

$$
\begin{aligned}
F = {} & \theta\{(1-\tau)[f(K)-i_B B]-h(I)(1-\varphi\tau)+\tau\delta^T C \\
& +\tau\varepsilon(I-\delta^T C-S)+\tau a k^N-I+V^N+S\}-V^N \\
& +\mu_K(I-\delta K)+\mu_c(I-\delta^T C)+\mu_B S+\mu_k N[V^N(u) \\
& -V^N(u-b)]+n_1[I-\delta^T C-\varepsilon(I-\delta^T C-S)-S-V^N] \\
& +n_2\{S+V^N-I+\tau[ak^N+\delta^T C+\varepsilon(I-\delta^T C-S)] \\
& -(1-\tau)[f(K)-i_B B]-h(I)(1-\varphi\tau)\} \\
& +n_3\{\sigma[I-\delta^T C-\varepsilon(I-\delta^T C-S)]-S\}
\end{aligned}
$$

where μ_K, μ_C and μ_B are the shadow prices or co-state variables of the capital stock, the stock of book capital and the stock of debt, respectively, while n_1, n_2 and n_3 are the Kuhn–Tucker shadow-price of constraints (9), (11) and (12). $\mu_k N$ is the co-state variable for firm's Annell deductions. The first-order necessary conditions are:

(13) I: $[\tau\varepsilon-1-h'(I)(1-\varphi\tau)][\theta + n_2] + \mu_K + \mu_c + n_1(1-\varepsilon) + n_3\sigma(1-\varepsilon) = 0$

(14) S: $[1-\tau\varepsilon][\theta + n_2] + \mu_B - n_1(1-\varepsilon) - n_3(1-\sigma\varepsilon) = 0$

(15) V^N: $\theta-1 + \mu_k N(t)-\mu_k N(t + b) + n_2-n_1 \le 0$, $V^N \ge 0$, $V^N \dfrac{\delta F}{\delta V^N} = 0$

(16) K: $\dot{\mu}_K = (r + \delta)\mu_K-(1-\tau)f_K(\theta + n_2)$

(17) C: $\dot{\mu}_C = (r + \delta^T)\mu_c + \delta^T(1-\varepsilon)[n_1-\tau n_2 + \sigma n_3-\theta\tau]$

(18) B: $\dot{\mu}_B = r\mu_B + (1-\tau)i_B(\theta + n_2)$

(19) K^N: $\dot{\mu}_k N = r\mu_k N-\tau a(\theta + n_2)$

(20) n_1: $I-\delta^T C-\varepsilon(I-\delta^T C-S)-S-V^N \ge 0$, $n_1 \ge 0$, $n_1 \dfrac{\delta F}{\delta n_1} = 0$

(21) n_2: $S+V^N-I+\tau[ak^N+\delta^T C+\varepsilon(I-\delta^T C-S)] + (1-\tau)[f(K)-i_B B]-h(I)(1-\varphi\tau) \ge 0$, $n_2 \ge 0$, $n_2 \dfrac{\delta F}{\delta n_2} = 0$

(22) n_3: $\sigma[I-\delta^T C-\varepsilon(I-\delta^T C-S)]-S \ge 0$, $n_3 \ge 0$, $n_3 \dfrac{\delta F}{\delta n_3} = 0$

3. The Financial Decisions

Preference relations that are obtained by comparing any two financial instruments hold everywhere in the solution space.[13]

[13] *It is worth mentioning that financial preferences should not be mixed up with preferences in the sense of utility levels, because such preferences are not important according to Fisher's separation theorem.*

The comparison between new share issues and retained profit: To be able to find out whether the firm chooses new issues of shares or retained profit to finance investment, we use the first order condition with regard to V^N, (15). Assume now that I and S are exogenously-given values, and that the firm makes positive new issues. Assume that the firm distributes an amount that is both positive and less than the accounting profit ($n_1 = 0$ and $n_2 = 0$). It can be shown that (15) becomes:

$$(23)\quad \frac{\delta F}{\delta V^N} = \theta - 1 + A \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \Leftrightarrow NI \begin{Bmatrix} > \\ \sim \\ < \end{Bmatrix} RP$$

where $A = \dfrac{\theta \tau a}{r}[1 - e^{-rb}]$ is the tax reduction that results from the Annell deduction, NI stands for new issues of shares, and RP denotes retained profits. Expression (23) measures the marginal advantage of substituting new share issues for retention. The substitution does not affect the market value of the firm, because it only creates gross advantages and disadvantages for the shareholders.

Expression (23) can be interpreted in another way. For this purpose we multiply both sides of (23) by $\dfrac{i(1-\tau_c)}{(1-\tau_d)(1-\tau)}$. This implies the following

$$(23')\quad \frac{i(1-\tau_p)}{(1-\tau_c)(1-\tau)} \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} \frac{i(1-\tau_p)}{(1-\tau_d)(1-\tau)}[1-A] \Leftrightarrow NI \begin{Bmatrix} > \\ \sim \\ < \end{Bmatrix} RP$$

The left-hand side of equation (23') is the cost of retention. This is the cost that the firm save when it substitutes new share issues for retention. The right-hand side is the cost of new share issues. For instance, if the cost of retention that the firm saves because of the substitution exceed the cost of new share issues then it will prefer to substitute new issues of shares for retain profits. In Figure 1, $NI > RP$ means a horizontal movement to the right, with $NI < RP$ a horizontal movement to the left is preferable, and with $NI \sim RP$ the firm is indifferent between new issues of shares and retention.

The comparison between debt and retained profit: For this comparison, we use the first-order condition with respect to S, (14), and assume that I and V^N are exogenous. Assume now that the credit restriction is not binding ($n_3 = 0$) and that the firm distributes an amount that is both positive and less than the accounting profit ($n_1 = 0$, $n_2 = 0$). It can be shown that, by taking the assumptions in this section into account, (14) becomes:

$$(24)\quad \frac{\delta F}{\delta S} = \theta[1-\tau\varepsilon] - \theta \frac{(1-\tau) i_B}{r} \begin{Bmatrix} > \\ = \end{Bmatrix} 0 \Leftrightarrow DF \begin{Bmatrix} > \\ \sim \end{Bmatrix} RP$$

where DF stands for debt financing. Thus (24) measures the marginal advantage of substituting debt financing for retention.[14]

Equation (24) can also be interpreted in another way. For this purpose we rewrite equation (24) as follows

$$(24')\quad \frac{(1-\tau_p)}{(1-\tau_c)(1-\tau)} i(1-\tau\varepsilon) \begin{Bmatrix} < \\ = \end{Bmatrix} i \Leftrightarrow DF \begin{Bmatrix} > \\ \sim \end{Bmatrix} RP$$

The right-hand side of equation (24') is the cost of debt financing. On the left-hand side, $\dfrac{(1-\tau_p)}{(1-\tau_c)(1-\tau)} i$ is the cost of retain profit. This is the cost that the firm saves when it substitutes debt for retention. However, a substitution between debt and retention makes the base for the allocation to the tax equalization reserve smaller. This means that the firm loses

[14] *Note that we do not consider the policy,* $\dfrac{\delta F}{\delta S} < 0 \Leftrightarrow DF < RP$, *because we would then get a solution at the lower boundary of the solution space. This solution is characterized by* $D = 0$, *which also means that the market value would be zero (If* $V^N > 0$ *then the market value will become negative). The interested reader is referred to Sinn (1987), p. 82.*

the tax reduction resulting from such allocation. $\frac{(1-\tau_p)}{(1-\tau_c)(1-\tau)} i\tau\varepsilon$ is therefore the disadvantage of the substitution. If the cost of financing through retention exceed the cost of debt financing then the firm will prefer to substitute between these two financial instruments. In Figure1, $DF \succ RE$ means a vertical movement upward, whilst with $DF \sim RE$ the firm is indifferent between debt financing and retention

The comparison between debt and new issues of shares: We begin our analysis by differentiating the Hamiltonian function with respect to V^N, given I and the constraint $V^N + S = const.$ Using (23) and (24) we obtain, after few simplifications, the following expression for the firm's financial preference

$$(25) \quad \left.\frac{\delta F}{\delta V^N}\right|_{V^N+S=cons.}$$

$$= \theta\tau\varepsilon(1-\tau_p) + A(1-\tau_p) + (1-\tau)(1-\tau_d)$$

$$\left\{\begin{matrix}=\\<\end{matrix}\right\}(1-\tau_p) \Leftrightarrow DF \left\{\begin{matrix}>\\\sim\end{matrix}\right\} RP$$

(25) measures the marginal advantage of substituting new share issues for debt financing.

Emphasizing the firm's point of view (25) can be expressed as follows.

$$(25') \quad i\left\{\begin{matrix}=\\<\end{matrix}\right\}\frac{(1-\tau_p)^i}{(1-\tau_d)(1-\tau)}(1-\tau\varepsilon-A)$$

$$\Leftrightarrow NI\left\{\begin{matrix}-\\<\end{matrix}\right\}DF$$

On the right-hand side of (25') $\frac{(1-\tau_p)^i}{(1-\tau_d)(1-\tau)}$ is the cost of new share issues. However substituting debt for new share issues means that the firm lose the tax reduction from Annell deduction. Further, substitution reduces the equity capital base for the allocation to the tax equalization reserve. This means that the firm will also lose the tax reduction resulting from SURV allocations. i is the cost of debt. If the net cost of new share issues exceeds the cost of debt financing , then the firm will prefer debt to new share issues.

A numerical calculation of the financial choice: A tax system is a combination of different tax rates and deduction rules. To find out the firm's overall financial optimum we must have knowledge of the tax system. Depending on the tax rules, we will get different solutions in the solution space. Depending on the prevailing tax rules, expressions (23), (24) and (25) fulfill different conditions, so that six different preference patterns for possible movements in the solution space of Figure 1 can be shown to exist. Each of these constellations implies a typical preference pattern for possible movements in the solution space. We will use numerical examples to determine the firm's overall financial choice. For this reason it is necessary to use numerical values for different tax parameters. The numerical values used in this model are summarized in Table 1.[15]

In this section we will insert the parameter values presented in Table 1, and an interest rate of 5%, into (23), (24), and (25) to find numerical values for these conditions. For maximum exploitation of the Annell deduction $\left.\frac{\delta F}{\delta V^N}\right|_{93}$ = 0.104898 and $\left.\frac{\delta F}{\delta V^N}\right|_{94}$ = 0.0135276. This

[15] *For an exposition of how the parameter values are calculated the interested reader is referred to King and Fullerton (1984) chapter 4, or Södersten and Lindberg (1983) pp. 44–71. The parameter values presented here are obtained by Södersten (1994). The effective corporate tax rate, taking into account the periodical reserve fund, can be calculated from following equation* $\tau = \tau_{stat}(0.75 + 0.25\, e^{-5i(1-\tau_{stat})})$. *An example will clarify the working of periodical reserve fund. Assume that the interest rate* i *is equal to 0.05. We know that* $\tau_{stat} = 0.28$, *so that* $\tau = 0.268469$. *If* $i = 0.1$ *then* $\tau = 0.258837$. *We can therefore conclude that the effective corporate tax rate becomes lower than the statutory corporate tax rate, if we take into account the periodical reserve fund. For the mathematical modeling of the periodical reserve fund, the reader is referred to Shahnazarian (1996), p. 26–27.*

Table 1. Effective tax rates and depreciation rates for tax purposes, 1993 and 1994

Year	1993	1994
Corporate income tax rate (τ)	30%	See below
Tax rate on interest income (τ_p)	17.9%	15.5%
Dividend tax rate (τ_d)	17.9%	2.6%
Capital gains tax rate (τ_c)	7.7%	3.9%
Depreciation rate for tax purposes (machinery), δ_m^T	30%	30%
Depreciation rate for tax purposes (buildings), δ_b^T	4.9%	4.9%
Actual depreciation rate (machinery), δ_m	12.5%	12.5%
Actual depreciation rate (buildings), δ_b	3.3%	3.3%
SURV allocation	30%[b]	0%
Annell deduction	10%[c]	0%

Source: Södersten (1994); The tax rates (τ_p, τ_d, τ_c) reflect the taxation of three categories of savers, i. e. households, insurance companies and tax exempt institutions.

[a] The corporate tax rate for 1994 must be adjusted for the periodical reserve fund.

[b] We assume maximum exploitation of the tax equalization reserve. The rules for the SURV allocation are explained in Section 1.2.

[c] We assume maximum exploitation of the Annell deduction. The rules for an Annell deduction are explained in Section 1.2.

means that $NI \succ RP$ for both 1993 and 1994, which indicates a horizontal movement to the right in Figure 1. Intuitively, this means that the cost of retention exceed the cost of new shares, which in its turn means that the firm preferred to substitute new issues of shares for retain profits. But a comparison shows that new issues of shares was more strongly preferred to retention during 1993. The reason that $NI \succ RP$ in 1993 is the Annell deduction, which decreases the cost of new share issues. However, the sensitivity analysis of the Annell deduction indicates that these results depend highly on the maximum deduction allowed. Further, the reason for $NI \succ RP$ in 1994 was the tax structure in this year. The double taxation of distributed profits was removed which reduced the cost of new shares.

For maximum exploitation of SURV allocations $\left.\frac{\delta F}{\delta S}\right|_{93} = 0.109437$, indicating that debt financing is preferred to retention ($DF \succ RP$ means a vertical movement upward in Figure 1) for 1993. This is also the case for 1994 (when $\varepsilon = 0$), because $\left.\frac{\delta F}{\delta S}\right|_{94} = 0.170319$. But a comparison shows that debt financing is more strongly preferred to retention during 1994.

When we have maximum exploitation of the Annell deduction ($a = 0.1$) and SURV ($\varepsilon = 0.3$), then $\left.\frac{\delta F}{\delta V^N}\right|_{V^N+S}^{(93)} = -0.0045383$ and

$\left.\frac{\delta F}{\delta V^N}\right|_{V^N+S}^{(94)} = -0.156791$, indicating that $NI \prec DF$ (meaning a movement upward along an inclined parallel) for both 1993 and 1994 (when $\varepsilon = a = 0$). These results indicate that the cost of new share issues exceed the cost of debt financing. However, a comparison shows that debt-financing is more strongly preferred to new share issues, during 1994. Mathematically, these results means that $n_1 > 0$, $n_2 = 0$, $n_3 > 0$ and $V^N > 0$. Intuitively, the numerical results indicate that the overall financial optimum is found where the dividend constraint in (9) and the constraint on borrowing in (12) bind simultaneously.

4. *The Cost of Capital*

An interesting question to be answered is how taxation affects the optimal employment of capital. We may now derive the equation characterizing the firm's optimal policy for the case where $n_1 > 0$, $n_2 = 0$, $n_3 > 0$ and $V^N > 0$. Using (13)–(22), we find after some rearrangement that the firm's cost of capital will be given by the optimum condition

$$(26)\quad f_K-\delta=(r+\delta)\frac{1-\varphi\tau}{1-\tau}\,h'(I)$$

$$+\frac{(1-\tau_p)i(1-A)}{(1-\tau_d)(1-\tau)}\,\frac{(1-\sigma)(1-\varepsilon)}{1-\sigma\varepsilon}$$

$$\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]+i_B\frac{\sigma(1-\varepsilon)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$$

$$+\frac{(1-\tau_p)i}{(1-\tau_c)(1-\tau)}\{1-\frac{1-\varepsilon}{1-\sigma\varepsilon}\,\frac{r+\delta}{r+\delta^T}$$

$$-\tau\frac{\delta^T-\delta}{r+\delta^T}-\tau\frac{\varepsilon(1-\sigma)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]\}$$

$$+0\cdot\tau\frac{\delta^T-\delta}{r+\delta^T}+0\cdot\tau\frac{\varepsilon(1-\sigma)}{1-\sigma\varepsilon}$$

$$\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$$

The cost of capital represents the minimum required rate of return on marginal investment by corporation. It consists of cost of depreciation, cost of adjustment, and the cost of various sources of finance where the latter are sensitive to the tax effects. With accelerated depreciation ($\delta^T > \delta$) it can be shown that the average (in present-value terms) proportion of debt finance for the marginal investment project is $\frac{\sigma(1-\varepsilon)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$, while the share of new share issues is $\frac{(1-\sigma)(1-\varepsilon)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$.

The share of investment financed by retention then becomes

$$\{1-\frac{(1-\sigma)(1-\varepsilon)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$$

$$-\frac{\sigma(1-\varepsilon)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$$

$$-\tau\frac{\delta^T-\delta}{r+\delta^T}-\tau\frac{\varepsilon(1-\sigma)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]\}.$$

By accelerated depreciation the firm can use tax debt (which rises because of accelerated depreciation) as a source of finance for it's investment. The proportion of investment that is financed through tax debt is thus equal to $\tau\frac{\delta^T-\delta}{r+\delta^T}$. The cost of this source of finance is equal to zero. We also have another source of finance that can also be categorized as a tax debt. This tax debt arises through allocation to the SURV, so that the proportion that can be financed through this kind of tax debt is equal to $\tau\frac{\varepsilon(1-\sigma)}{1-\sigma\varepsilon}\left[1-\frac{\delta^T-\delta}{r+\delta^T}\right]$. The cost of this source of finance is also equal to zero. The first term in equation (26), is the increase in the cost of capital due to the impact of additional investment on adjustment cost. The second, third and fourth terms characterize the cost of capital for the proportion of investment that is financed through new share issues, debt and retention, respectively. The corresponding expression for the cost of capital 1994, can be found by setting, $a = 0$ *and* $\varepsilon = 0$ in equation (26).[16]

A numerical calculation of the cost of capital will simplify the understanding of (26). By sensitivity analysis we are able to see the impact of the Annell deduction, the SURV allocation, the credit constraint and the interest rate. In a numerical calculation of the cost of capital, it is important to look at both the cost of the different sources of finance, as well as the proportion of different financing sources used for an investment. If we concentrate our attention entirely on the cost of the different sources of finance, we will not gain a fair picture of the situation. The reason for this is very simple. As can be seen in (26), the deduction and allocation rules affect only the proportions of the different financing sources.[17]

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[16] *Note that the tax parameters for 1994 is different from those for 1993, while* δ^T *and* δ *are the same for both 1993 and 1994.*

[17] *In equation (26), there are two parameters that require a more-detailed description, namely the rate of fiscal depreciation and the rate of economic depreciation,* (δ^T *and* δ *respectively). As mentioned in Section 3 we use numerical values for the parameters, provided by Södersten.*

Table 2. Numerical values of the different terms in (26) and the total cost of capital for 1993 and 1994. Maximum exploitation of tax allowances assumed, and $\sigma = 0.5$.

i	0.05		0.1	
Year	1993	1994	1993	1994
CN*	0.0560423	0.0592973	0.117608	0.117053
CR*	0.0635351	0.0600995	0.12707	0.118637
CD*	0.05	0.05	0.1	0.1
PAD*	0.097773	0.088088	0.0854648	0.0746722
PS*	0.0356871	0	0.0378592	0
PN*	0.277566	0.335944	0.29446	0.355755
PD*	0.277566	0.335944	0.29446	0.355755
PR*	0.311407	0.240024	0.287756	0.213819
TCC*	0.049219	0.0511431	0.100642	0.102585

* CN-Cost of new share issues, CR-Cost of retention, CD-Cost of debt, PAD-Proportion of tax debt (arising from accelerated depreciation), PS- Proportion of tax debt (arising from allocations to SURV), PN- Proportion of new share issues, PD- Proportion of debt, PR- Proportion of retained earnings, TCC- total cost of capital

In Table 2 we show the cost of the sources of finance, the proportion of these sources used for an investment and the total cost of capital, for 1993 and 1994. we assume that $h'(I) = 0$, which means that there are no adjustment costs.

The main conclusion from Table 2 is that the total cost of capital is higher for 1994 than for 1993 (even though the difference was very small). This is true for both i = 0.05 and I = 0.1.

The cost of issuing new shares is higher for 1994 than for 1993, for interest rates lower than 10%, while for $i \geq 0.1$ the opposite is true (notice that the changes are very small). The cost of retention is higher for 1993 than for 1994. The cost of debt is the same for both 1993 and 1994.

The proportion of tax debt from accelerated depreciation is higher during 1993 compared to 1994 regardless of the interest rate. The proportion of tax debt from SURV allocations rises with the interest rate for 1993. This allocation possibility was removed for 1994. The proportion of financing through new share issues is higher for 1994 compared to 1993, regardless of *i*. The proportion of debt is higher for 1994 compared to 1993, regardless of *i*. Finally, retained earnings are used in a higher proportion during 1993 compared to 1994, regardless of the prevailing interest rate.

Even though the cost of issuing new shares is almost identical in 1993 and 1994, and even though the cost of debt is identical in 1993 and 1994, the firm uses more of both of the source of funds. The reason for this is that, in 1994, the firm is not allowed to make SURV allocations. At the same time, the tax rules make the value of the tax debt (arising from accelerated depreciation) less valuable, so that the proportion of the investment that can be financed through tax debt decreases. The firm must therefore compensate for the new financing restrictions with other financing sources. Therefore it chooses to increase its financing through new share issues and debt. At the same time, the prevailing tax rules make retention less favorable to the firm. This can also be one of the contributory causes as to why the firm increased it's use of new share issues and debt. The numerical calculations indicate that 1994 tax reform makes firms adjust their financial structure to the existing tax system, without changing their investment behavior radically.

Sensitivity analysis of the Annell deduction: A sensitivity analysis of the Annell deduction can be undertaken by varying the parameter *a*. The results of such an analysis are shown in Table 3. The only thing that happens, when the maximum allowed Annell deduction is reduced, is that the cost of new share issues increases, which means that the total cost of capital increases. By comparing the situation during 1993 with the situation during 1994 (compare Table 2 (year 1994 and $i = 0.05$) with Table 3), we find that the cost of new share issues becomes higher for 1993 than for 1994, when $a < 0.1$. Furthermore, the total cost of capital for

The parameters accounted for in Section 3 were: $\delta_M = 0.125$, $\delta_b = 0.033$, $\delta_M^T = 0.3$ and $\delta_b^T = 0.049$. In my calculations we will use an average value for δ^T and δ. These values are obtained by using the following numerical values for the proportions of inventories and buildings within the firm: Proportion inventories = 0.67, Proportion buildings = 0.33 (these numerical values were provided by Södersten(1994)). The following equations show the method used in my calculations

$$\frac{\delta^T}{\delta^T + r} = 0.67\frac{\delta_M^T}{\delta_M^T + r} + 0.33\frac{\delta_b^T}{\delta_b^T + r}$$

$$\frac{\delta}{\delta + r} = 0.67\frac{\delta_M}{\delta_M + r} + 0.33\frac{\delta_b}{\delta_b + r}$$

Table 3. Numerical values of different terms in (26) and the total cost of capital for $i = 0.05$, $\varepsilon = 0.3$, $\sigma = 0.5$ and different values of a- for 1993.

a	0	0.025	0.05	0.075	0.1
CN	0.0714286	0.067582	0.0637354	0.0598889	0.0560423
CR	0.0635351	0.0635351	0.0635351	0.0635351	0.0635351
CD	0.05	0.05	0.05	0.05	0.05
PAD	0.097773	0.097773	0.097773	0.097773	0.097773
PS	0.0356871	0.0356871	0.0356871	0.0356871	0.0356871
PN	0.277566	0.277566	0.277566	0.277566	0.277566
PD	0.277566	0.277566	0.277566	0.277566	0.277566
PR	0.311407	0.311407	0.311407	0.311407	0.311407
TCC	0.0534898	0.0524221	0.0513544	0.0502867	0.049219

1993 will become higher than the total cost of capital for 1994 when a is less than 0.05.

Sensitivity analysis of SURV allocation: A sensitivity analysis of SURV allocation can be undertaken by varying the parameter ε. We want to examine how the results in Table 2 would alter because of a reduction of the limit for the allocation to the tax equalization reserve. The results of such an analysis are shown in Table 4. The total cost of capital increases because of this reduction. However, the proportions of different financing sources used for investment changes. New share issues and debt proportions increase while the retention proportion decreases. A comparison between 1993 and 1994 [compare Table 2 (when $i = 0.05$ and year = 1994) and Table 4] shows that the total cost of capital is higher during 1994 even after the reduction. Furthermore, new share issues and debt proportions are higher during 1993, for ε greater than or equal to 10%. For ε less than 10%, the opposite is true. The retention proportion is higher during 1994, for ε greater than or equal to 10%. For ε less than 10%, the opposite is true.

Sensitivity analysis of the credit constraint: A sensitivity analysis of the credit constraint can be carried out by varying the parameter σ. The results are shown in Table 5 for 1993, and in Table 6 for 1994. The costs of the different financing sources are not affected by the credit constraint. The same is true for the tax debt that arises because of accelerated deduction. The proportion of tax debt from the SURV allocation decreases when we relax the credit constraint. This is simply because the firm chooses to borrow the maximum- allowed amount, thereby decreasing the equity capital base for the SURV allocation. The proportion of new share issues decrease with a higher value of σ. The proportion of debt is naturally increasing. The retention proportion decreases for 1993, while it remains unchanged for 1994, when the credit constraint is relaxed. The total cost of capital is decreasing for both 1993 and 1994. A comparison shows that the total cost of capi-

Table 4. Numerical values of the different terms in (26) and the total cost of capital for $a = 0.1$, $i = 0.05$, $\sigma = 0.5$ and different values of ε- for 1993.

ε	0	0.1	0.2	0.25	0.3
CN	0.0560423	0.0560423	0.0560423	0.0560423	0.0560423
CR	0.0635351	0.0635351	0.0635351	0.0635351	0.0635351
CD	0.05	0.05	0.05	0.05	0.05
PAD	0.097773	0.097773	0.097773	0.097773	0.097773
PS	0	0.0106435	0.0224697	0.0288896	0.0356871
PN	0.337045	0.319306	0.299596	0.288896	0.277566
PD	0.337045	0.319306	0.299596	0.288896	0.277566
PR	0.228137	0.252972	0.280566	0.295546	0.311407
TCC	0.0502357	0.0499325	0.0495956	0.0494127	0.049219

Table 5. Numerical values of different terms in (26) and the total cost of capital for $a = 0.1$, $\varepsilon = 0.3$, $i = 0.05$ and different values of σ- for 1993.

σ	0	0.25	0.5	0.75	1
CN	0.0560423	0.0560423	0.0560423	0.0560423	0.0560423
CR	0.0635351	0.0635351	0.0635351	0.0635351	0.0635351
CD	0.05	0.05	0.05	0.05	0.05
PAD	0.097773	0.097773	0.097773	0.097773	0.097773
PS	0.0606681	0.0491903	0.0356871	0.0195704	0
PN	0.471863	0.382592	0.277566	0.152214	0
PD	0	0.127531	0.277566	0.456642	0.67409
PR	0.369696	0.342915	0.311407	0.273801	0.228137
TCC	0.0499329	0.0496049	0.049219	0.0487585	0.0481992

Table 6. Numerical values of different terms in (26) and the total cost of capital for $a = 0.1$, $\varepsilon = 0.3$, $i = 0.05$ and different values of σ, for 1994.

σ	0	0.25	0.5	0.75	1
CN	0.0592973	0.0592973	0.0592973	0.0592973	0.0592973
CR	0.0600995	0.0600995	0.0600995	0.0600995	0.0600995
CD	0.05	0.05	0.05	0.05	0.05
PAD	0.088088	0.088088	0.088088	0.088088	0.088088
PS	0	0	0	0	0
PN	0.671888	0.503916	0.335944	0.167972	0
PD	0	0.167972	0.335944	0.503916	0.671888
PR	0.240024	0.240024	0.240024	0.240024	0.240024
TCC	0.0542665	0.0527048	0.0511431	0.0495814	0.0480197

tal is higher during 1993, for a value of σ which is less than or equal to 75%. Retained earnings and debt proportions are higher during 1993, for a value of σ which is less than 75%.

The sensitivity analysis of the credit constraint shows how important such a constraint actually is. The proportion of different financing sources change dramatically if we assume that lenders become more restrictive in their granting of credits.

5. *Conclusions*

The tax reform act of 1994 meant a reduction of the tax rates and a broadening of the tax bases. The numerical calculations based on a theoretical model of firm behavior indicate that the tax reform affected both the firm's financial and investment behavior.

The comparison of the costs of different financial sources indicate that, in 1993 and 1994, both new share issues and debt financing strongly dominated financing through retention of profits. At the same time debt financing was superior to financing through new share issues. By using these results we find that the total cost of capital increased for 1994, even though the increase was small. The availability of tax debt from accelerated depreciation and other reserve options was reduced. As a result of this, and given the assumption of the theoretical model, the firm was driven to use other more expensive sources of funds. The proportion of financing through new share issues increased, even though the cost of this source of finance rose. The proportion of debt financing increased, even though the cost of this source of finance was unchanged. The proportion of financing through retention, finally, was lower after the reform, even though the cost of retention fell. The reason for this seemingly strange behavior is the fact that the SURV reserve option was removed, while at the same time the value of accelerated depreciation was reduced because of the cut in the statutory corporate tax rate.

Finally, the analysis shows that my numerical results are very sensitive to the exact specification of the credit constraint.

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