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Corporate Tax Structure and Production

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and
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Investment tax credits, investment allowances, and accelerated capital consumption allowances are more cost-effective in promoting investment than more general tax incentives such as corporate tax rate reductions.

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Bernstein and Shah provide an empirical framework for assessing the effects of tax policy on an array of producer decisions about output supplies and input demands in Mexico, Pakistan, and Turkey. They specify and estimate a dynamic production structure model with imperfect competition for selected industries in these countries.

The model results suggest that tax policy affected production and investment and further that selective tax incentives such as investment tax credits, investment allowances, and accelerated capital consumption (depreciation) allowances are more cost-effective at promoting investment than more general tax incentives such as corporate tax rate reductions. The long-run cost-effectiveness of these incentives — except corporate tax rate reductions, which proved cost-ineffective in all cases — varies by country. In Turkey, investment allowances and capital consumption allowances were cost-effective. In Mexico, neither investment tax credits nor accelerated capital consumption allowances were cost-effective. In contrast, in Pakistan, both investment tax credits and accelerated capital consumption allowances were cost-effective. In the intermediate run, defined as tax policy impact after one year, only the investment allowances and accelerated capital consumption allowances available to Turkish industries proved cost-effective.

To make selective tax incentives more effective, investment tax credits must be refundable and carrying forward investment and depreciation allowances must be permitted. If stimulating investment expenditure is the sole objective of tax policy, reducing the corporate tax rate is not a cost-effective instrument to achieve this objective.

CORPORATE TAX STRUCTURE AND PRODUCTION

by

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* Of Carleton University and National Bureau of Economic Research, and World Bank, respectively. This is one of a series of papers prepared for the research project (RPO No. 675-10) on tax incentives directed by Anwar Shah, PRDPE. Research assistance for this paper by Bjorn Larsen, John Baffes, and Costas Christou is gratefully acknowledged. The authors are grateful to Frank Lysy for comments.

1.0 INTRODUCTION

Fiscal incentives for investment promotion are prevalent in most developing countries. The effectiveness of these instruments in meeting stated policy goals is an important area of public policy concern yet rigorous developing country empirical evidence to guide policy in this area is almost completely lacking. To address these concerns, in the past, policy makers relied on opinion survey of firms (see for example, Guisinger and Associates, 1985), and more recently, on marginal effective tax rate analysis (see for example Boadway and Shah, 1992). However, none of these approaches is able to analyze the effects of tax policy changes on the structure of production and the rate of capital accumulation.

This paper develops and estimates a dynamic model of production to examine tax effects on an array of production decisions regarding inputs and output for six industries in three developing countries namely Mexico, Pakistan and Turkey. The paper evaluates investment tax credits, investment tax allowances, capital cost allowances and corporate income taxes as instruments for investment promotion. Under an investment tax credit corporations are allowed to deduct against their tax liabilities a fraction of expenditures on new additions to physical capital stock. Tax credits provide a direct subsidy to such activities. An investment tax allowance allows a deduction from taxable income based on a fraction of investment expenditures. Capital cost allowances permit depreciation for tax purposes as a deduction from taxable income. Corporate income tax reductions permit a lower rate of taxation on corporate income. The paper is organized into the following sections. Section 1.1 presents illustrative calculations on the post-tax cost of capital expenditures under alternate tax policy provisions and a history of tax changes in three countries. Section 1.2 presents the theoretical model. Section

1.3 specifies the empirical framework and derives relevant elasticity formulate. Section 1.4 discusses the impact of tax policy on investment and government revenues. Sections 1.5 through 1.7 present the empirical results for selected industries in the sample countries. A final section summarizes these results.

1.1 COST OF CAPITAL EXPENDITURES

Four tax instruments that affect the purchase prices of capital stocks are considered here namely; the corporate income tax rate, the allowed depreciation rate, investment allowance and investment tax credit rate. To see the effects of tax policy on the after tax or post tax purchase prices, consider a machine that has a price of one unit denominated in the local currency. Dealing first with the allowed depreciation rate, suppose that depreciation occurs at an annual rate of 30%. In addition, the expenditure on the machine must be capitalized and assume that the future depreciation deductions are discounted at the rate of 15%. The present value of depreciation deductions based on declining balance depreciation is, $z = d(1 + r)/(r + d)$, where d is the allowed depreciation rate and r is the discount rate. Thus the tax deduction due to depreciation is 0.77.

Next consider the corporate income tax rate. In the present example the tax reduction due to depreciation equals $0.77u_c$, where u_c is the corporate income tax rate and the post tax cost of the unit value of the machine is $1 - 0.77u_c$. If the corporate income tax rate is 0.46, and there is taxable income, then the post tax cost is 0.65 and the tax reduction is 0.35 on a machine of unit value in the local currency.

It is of interest to compare the tax reduction due to depreciation deductions and the reduction due to the immediate write-off of the machine. In the latter case, assuming there is taxable income, the tax reduction is u_c and the post tax cost is $1 - u_c$. Hence with a corporate tax rate of 0.46 the post tax cost is 0.54 and the tax reduction is 0.46. The tax reduction in the depreciation deductions case is 23% smaller than the tax reduction from immediate write-off.

Next, consider the investment tax credit. Let the credit rate be v. The tax reduction on the unit value of the machine is $zu_c(1-v)+v$. There are three aspects to this tax reduction. The first, is zu_c which is the depreciation part. The second is $-zu_c v$ which is the amount that the tax credit reduces the depreciation base. The third is v which is the investment tax credit. Thus the post tax cost of the unit value machine is $1-[zu_c(1-v)+v]$. If u_c is 0.46 and v is 0.10 then the tax reduction is 0.42 and the post tax cost of the machine is 0.68.

Some countries, for example Turkey, rather than offering a credit for investment expenditure allow a fraction of these expenditures to be deducted from taxable income in the year such outlays are made. This is an investment tax allowance. Under such a regime, the post tax cost of the unit value of machine is $1 - [zu_c + u_c\psi]$. If $z = 0.77$, $u_c = 0.46$ and ψ (the allowance rate) = 0.10 then the tax allowance contributes 0.40 to tax reduction with the final cost of the machine equal to 0.60.

Table 1.1 shows examples of the post tax cost of unit value machinery and equipment for three countries; Mexico, Pakistan and Turkey. The highest post tax cost of a unit value of

Table 1.1

Cost of a unit value of capital expenditure

Discount Rate	0.05	0.15
Mexico[a]	0.46	0.53
Pakistan[b]	0.43	0.52
Turkey[c]	0.46	0.53

[a]u_c = 0.42, straightline depreciation at 0.10, this is an average rate, v = 0.30, and z = 0.811 for r = 0.05 and z = 0.577 for r = 0.15.

[b]u_c = 0.55, this includes the supertax rate, declining balance depreciation at 0.10, v = 0.30, and z = 0.7 for r = 0.05 and z = 0.46 for r = 0.15.

[c]u_c = 0.46, declining balance depreciation at 0.25, investment allowance rate = 0.30, this is the minimum rate allowed and z = 0.875 for r = 0.05 and z = 0.719 for r = 0.15.

capital expenditure is found in Turkey, followed by Mexico and Pakistan. As future depreciation deductions are discounted at a higher rate, their value diminishes and the post tax cost of the expenditure rises. This can be seen from the table, as the second column figures are higher than those found in the first column.

1.2 TAX STRUCTURE AND PRODUCTION: A DYNAMIC THEORETICAL MODEL

The technology of a representative firm within an industry can be defined as

$$y_t = f(K_{t-1}, v_t, \Delta K_t, A_t) \qquad (1)$$

where y is the output quantity, K is the m dimensional vector of quasi-fixed factors, v is the n dimensional vector of variable factors and A is the indicator of the level of technology. The production function is denoted by f, which is defined for nonnegative input quantities, and is nonnegative with positive marginal products. The production function also declines with respect to the net investment vector, $\Delta K = K_t - K_{t-1}$. Adjustment costs are represented through the net investment vector in the production function and are measured as foregone output. The cost of changing a quasi-fixed factor is the loss in output that could have been produced. Adjustment costs are, thereby, internal to the production process (see for example, Treadway [1971,1974], Mortensen [1973] and Epstein (1981]). The subscript t represents the time period [1]

Quasi-fixed factors are also referred to as capital inputs. In this model, capital inputs relate to various types of plant and equipment. The stocks of the capital inputs accumulate according to

$$K_t = I_t + (I_m - \delta)K_{t-1}, \qquad (2)$$

where I is the m dimensional investment vector, δ is an m dimensional diagonal matrix of fixed depreciation rates such that $0 \leq \delta_i \leq 1, \quad i = 1, \ldots, m$. It is assumed that capital services are proportional to the capital stocks (see Bernstein and Nadiri [1988]).[2] In addition, I_m is the dimensional identity matrix.

Firms sell their products, hire or purchase factors of production, invest in capital stocks and finance their operations, such that the flow of funds is given by,

$$p_t y_t - w_t^T v_t - q_t^T I_t + \Delta B_t + P_{st} \Delta N_{st} - r_{bt} B_{t-1} - T_{et} - D_t = 0. \tag{3}$$

The product price is denoted by p, w is the vector of variable input prices, q is the vector of capital purchase prices, B is the value of outstanding bond issues, $\Delta B_t = B_t - B_{t-1}$ is the value of net bond issues (net of retirements), p_s is the price of shares, N_s is the quantity of outstanding shares, $\Delta N_{st} = N_{st} - N_{st-1}$ are new share issues, r_b is the interest rate on bonds, T_e are income taxes and D is the value of dividends.

The flow of funds can be further decomposed by considering income taxes. First, investment incentives are often in the form of credits such that at time t with a credit rate of $0<v_{it}<1, i=1,\ldots m$, the ith capital stock investment tax credit is,

$$ITC_{it} = v_{it} q_{it} I_{it} \quad i=1,\ldots,m. \tag{4}$$

Second, there are capital cost allowances associated with the depreciation of the capital stocks. In general, depreciation deductions equal $d_{i\tau}$ on a unit value of the original cost of the ith capital stock of age τ. Since capital must be fully depreciated, then it must be the case that $\sum_{\tau=0}^{\infty} d_{i\tau} = 1, \quad i = 1, \ldots, m$. The capital cost allowance at time t for the ith capital stock installed at different times is,

$$CCA_{it} = \sum_{\tau=0}^{\infty} q_{it-\tau}\, I_{it-\tau}(1 - \phi_{it} v_{it})\, d_{i\tau} \qquad i = 1, \ldots, m \tag{5}$$

where $0 \leq \phi_{it} \leq 1$ is the proportion of the investment tax credit which reduces the depreciation base for tax purposes.

Third, with respect to the labor inputs there are no payroll taxes but with respect to the intermediate inputs there are value added taxes. Let the tax rate on the jth variable input at time t be $0 < \varphi_{jt} < 1$ and so the post value added tax is $\Sigma_{j=1}^{n} \varphi_{jt} w_{jt} v_{jt}$. The income tax is defined at time t by the rate $0 < u_{\alpha} < 1$, based on revenue net of the post value added tax cost of the variable inputs, net of interest payments, net of capital cost allowances and net of investment tax credits[3]. Thus income taxes at time t are

$$T_{\alpha} = u_{\alpha}(p_t y_t - w_t^T (I_n - \varphi)v_t - r_{bt} B_{t-1} - i_m CCA_t) - i_m ITC_t + w_t^T \varphi v_t \tag{6}$$

where I_n is the n dimensional identity matrix, (φ is a diagonal matrix of value added tax rates (including payroll tax rates), i_m is the m dimensional identity vector, CCA and ITC are m dimensional vectors of capital cost allowances and investment tax credits respectively. Substituting equation (6) (the income tax equation) into the flow of funds equation (given as equation (3), yields,

$$\begin{aligned}
&[p_t y_t - w_t^T (I_n - \varphi)v_t](1 - u_{\alpha}) - q_t^T I_t + i_m(u_{\alpha} CCA_t + ITC_t) \\
&\quad = [D_t/(p_{st} N_{st-1}) + \Delta p_{st}/p_{st}] p_{st} N_{st-1} + r_{bt}(1 - u_{\alpha})B_{t-1} \\
&\quad - \Delta (P_{st} N_{st}) - \Delta B_t
\end{aligned} \tag{7}$$

The left side of equation (7) shows revenue net of tax, net of variable input cost and net of investment expenditures. The right side of the equation shows the flow of funds to bondholders and shareholders. Equations (1), (2), and (7) summarize the technology, capital accumulation and flow of funds for the representative firm in the industry.

Turning to the nature of market structure, the first market to be considered is the product market. Product demand is represented by

$$p_t = D(Y_t, e_t), \tag{8}$$

where $Y = \Sigma_{j=1}^{f} y^j$ is industry output, with the superscript representing the particular firm, and e is a vector of exogenous variables affecting product demand. The inverse product demand function is given by D, which is defined for nonnegative industry output, nonnegative and decreasing in industry output. Implied by the inverse product demand function, is that firms within an industry produce homogeneous products. Moreover, depending on the conjectural relationship between the output of a firm and industry, the product market in the model can be competitive, monopolistic or oligopolistic (see Bernstein and Mohnen [1991]).

Second, the variable and capital input markets are assumed to be competitive. Thus firms face exogenous variable and quasi-fixed input prices. The last set of markets are the financial markets. Given the less developed nature of the economy, firms are not able to affect the rates of return on their shares or bonds. These rates of returns are essentially constrained by world financial markets. Define financial capital as $V_t = P_{st}N_{st} + B_t$ and so $\Delta V_t = \Delta(p_{st}N_{st}) + \Delta B_t$, then equation (7) can be rewritten as

$$F_t = [r_{st} + r_{bt}(1 - u_{ct})\ \lambda_{t-1}](1 + \lambda_{t-1})^{-1} V_{t-1} - \Delta V_t \tag{9}$$

where F_t is the left side of equation (7), which is net after tax revenue, the rate of return on the shares of a firm is $r_{st} = \frac{D_t}{p_{st} N_{st-1}} + \frac{\Delta p_{st}}{p_{st}}$, and the leverage ratio is $\lambda_{t-1} = \frac{B_{t-1}}{V_{t-1}}$. The rate of return on shares consists of the payout ratio, which is dividends per value of outstanding shares, plus the capital gains (or losses) on the share prices. The leverage of a firm is λ which is the ratio of debt to financial capital. Define ρ as the coefficient of V_{t-1} in equation (9). It is the rate of return on financial capital which is a weighted average of the rates of return on equity and debt. It is assumed that the rate of return on financial capital issued by a firm is exogenous.[4]

The objective of a firm is to operate in the interest of its owners by maximizing the expected present value of the flow of funds to its shareholders. In the context of the present model, because the rates of return on equity and debt capital are exogenous, and therefore cannot be influenced by shareholders, the objective is equivalent to maximizing the expected present value of the flow of funds to shareholders and bondholders. In other words a firm maximizes the expected present value of financial capital. The objective can be obtained from equation (9). Solving for V_t and applying the conditional expectations operator yields.

$$J_t = E_t \sum_{s=1}^{\infty} \alpha(t,s)[P_s y_s - W_s^T v_s - Q_s^T I_s - i_m^T M_s] \tag{10}$$

where E_t is the expectations operator conditional on information known at time t, the discount rate is the rate of return on financial capital, $\alpha(t,t) = 1$, $\alpha(t,t+1) = (1+\rho_t)^{-1}$, $P = p(1-u_c)$ is the after tax product price, $W_j = w_j(1-u_c)(1-\varphi_j)$ $j = 1,\dots n$ are the after tax variable factor prices, and Q is an m dimensional vector of after tax capital stock purchase prices,

$$Q_{is} = q_{is}(1 - v_{is} - \sum_{\tau=0}^{\infty} \alpha(t, s+\tau)\, \alpha(t,s)^{-1} u_{cs+\tau} (1 - \phi_{is} v_{is}) d_{i\tau})$$

and M is an m dimensional vector of tax reductions at time t, due to capital cost allowances arising from past investment expenditures, $M_{is} = u_{cs} \sum_{\tau=s}^{\infty} q_{is-\tau} I_{is-\tau} (1 - \phi_{is-\tau} v_{is-\tau}) d_{i\tau}$. At any time t, M does not affect output supply and input demand decisions because from the vantage point of the present the vector is predetermined. A significant feature of a dynamic model is that current and future tax rates, credits and allowances are explicitly accounted for in the analysis. Indeed, the future tax purchase prices of the capital stocks shows the array of current and future tax policy instruments which affect the analysis.[5]

A firm maximizes the expected present value of the flow of funds (in other words the right side of equation (10)) by selecting output supply, variable input and investment demand subject to the production function (equation (1)), capital accumulation equations (equation (2)), the inverse product demand function (equation (8)), the exogenous current and future after tax factor prices and discount rates. This program can be solved in two stages. The first stage relates to the short run decisions and the second stage concerns the intertemporal production choices. Conditional on the capital stocks, output supply and variable factor demand are determined. With this solution, a firm then proceeds to determine the demand for the capital inputs. In breaking the problem into two subsets, the first stage solution or short-run equilibrium is found by maximizing after tax variable profit at each point in time. Thus

$$\max_{(y_s, v_s)} \; P_s y_s - W_s^T v_s \tag{11}$$

subject to equations (1) and (8), and given the capital stocks. Substituting equation (8) into (11), the first order conditions are,

$$D(Y_s^e, e_s)[1 + \xi_s^e \theta_s^e](1 - u_{cs}) - \lambda_s^e = 0 \tag{12.1}$$

$$-W_s + \lambda_s^{eT} \nabla f_v = 0 \tag{12.2}$$

where $\xi = Y(\partial D/\partial Y)/p$ is the inverse price elasticity of product demand, $\theta = (\partial Y/\partial y)y/Y$ is the conjectural elasticity, λ is the Lagrangian multiplier and the superscript e denotes equilibrium values.[8] From equation (12.1), in short-run equilibrium a firm equates after tax marginal revenue to marginal cost. The Lagrangian multiplier equals marginal cost. Equation set (12.2) implies that relative after tax variable factor prices equal relative marginal products of the respective variable factors. Equation set (12) holds for all time periods and, of course, for all firms in the industry. Equation set (12) shows how tax policy affects the short-run equilibrium The corporate income tax rate does not directly affect the short-run equilibrium. From equation set (12) relative variable factor prices and the relative product price (all prices are normalized for example by the nth variable factor price) are independent of the corporate income tax rate. The reason is that the corporate income tax is a tax on variable profit in the short run, and as a consequence, it is based on the residual of the short run income stream. Third, the corporat income tax rate, like the investment tax credit and capital cost allowance rates indirectly affect the short-run equilibrium through their influence on the demand for the capital inputs. Change in these rates affect the after tax purchase price of the capital inputs and thereby alter th demand for the quasi-fixed factors. These changes in the capital input levels then influence th short run supply of output and demand for the variable factors of production.

The short-run equilibrium conditions are consistent with a number of product market structures. The conjectural elasticity, θ, shows the nature of firm interdependence in the product market. If $\theta = 0$ then the product market is purely competitive as firms are price takers. If $\theta = 1$ then the product market is purely monopolistic as there is only a single producer. If $\theta = y/Y$ then the product market is oligopolistic and the firms are characterized as Cournot-Nash oligopolists. In the latter case, if firms have the same marginal cost in short-run equilibrium then from equation (12.1), firms have the same conjectural elasticity in short-run equilibrium.

An alternative way that the short run equilibrium conditions can be characterized, emphasizes both product market imperfections and the dual relationship between price and quantity effects on variable profit. Consider a first order approximation to the revenue of a firm in equilibrium,

$$D(Y_t, e_t)y_t = D(Y_t^e, e_t)y_t^e + D(Y_t^e, e_t)[1 + \xi_t^e \theta_t^e](y_t - y_t^e) \tag{13}$$

Collecting terms yields,

$$p_t y_t = p_t^e(1 + \xi_t^e\theta_t^e)y_t - p_t^e y_t^e \xi_t^e \theta_t^e \tag{14}$$

From equation (14), total revenue equals revenue earned in a purely competitive product market plus the additional revenue earned in equilibrium because of oligopoly power.[7] Defining the purely competitive or shadow product price as $p_t^s = p_t^e(1 + \xi_t^e\theta_t^e)$ and the after tax shadow product price as $P_t^s = p_t^s(1 - u_\alpha)$ then the short-run equilibrium conditions (equation set (12) can be obtained by

$$\max_{(y_s, v_s)} \; P_s^s y_s - W_s^T v_s \tag{15}$$

subject to the production function and the given levels of the capital inputs. Thus firms act as if they, maximize after tax shadow variable profit, which is defined as after tax shadow revenue minus after tax variable input cost.[1] The reason is that the degree of product market imperfection is captured in the definition of shadow product price.

The short-run equilibrium conditions can be substituted into (15) to obtain the after tax shadow variable profit function.

$$\pi_s^s = \Pi^s (P_s^s, W_s, K_{s-1}, \Delta K_s, A_s) \qquad (16)$$

where π^s is after tax shadow variable profit, Π^s is the after tax shadow variable profit function which is defined for non-negative after tax prices and capital inputs, increasing in the after tax shadow product price and capital inputs, decreasing in the after tax variable factor prices and net investment in the capital stocks.[2]

The dual relationship between price and quantity effects in equilibrium can be seen by differentiating the after tax shadow variable profit function by the after tax shadow product price and the after tax variable factor prices. This yields,

$$y_s^* = \Pi_p^s \qquad (17.1)$$

$$v_s^* = -\nabla \Pi_w^s \qquad (17.2)$$

The short-run equilibrium output supply and variable factor demands can be obtained from the after tax shadow variable profit function. It implies that short-run equilibrium can be characterized by equations (16), (17.1) and (17.2). The attractive feature of this approach is that reduced form output supply and variable factor demand equations are readily obtainable from the after tax shadow variable profit function.

The second stage of the program involves the determination of demand for the capital inputs. This stage relates to the intertemporal aspects of production decisions. Capital input demand can be obtained by considering the expected present value of the after tax shadow flow of funds. The objective is to

$$\max_{\{K_s\}_{s=t}^{\infty}} \; E_t \sum_{s=t}^{\infty} \alpha(t,s)\left[\Pi^s(P_s^s, W_s, K_{s-1}, \Delta K_s, A_s) - Q_s^T I_s\right] \tag{18}$$

subject to the capital accumulation equations (denoted by equation set (2)). The first order conditions for this problem at any time period, after substituting equation set (2) into (18), are,

$$\begin{aligned}&\nabla(\partial\pi_s^s/\partial\Delta K_s) - Q_s + E_s\alpha(s,s+1)\left[\nabla(\partial\pi_{s+1}^s/\partial K_s) - \nabla(\partial\pi_{s+1}^s/\partial\Delta K_{s+1})\right.\\ &\left. + (I_m - \delta)\,Q_{s+1}\right] = 0_m\end{aligned} \tag{19}$$

Equation set (19) implies that the marginal cost of a capital input is equated to the expected marginal benefit of that capital input.[10] The marginal cost consists of two components; the after tax marginal adjustment cost and the after tax purchase price. The expected marginal benefit consists of three components; the expected after tax marginal profit, the expected after tax adjustment cost saving and after tax purchase price saving from installing and purchasing (or renting) the respective capital input in the previous period. Equation set (19) shows the intertemporal trade-off between greater expected future after tax profit due to increases in the capital inputs and smaller current after tax profit resulting from increases in the capital inputs. It is important to notice that this equation set contains all current, as well as, expected future tax, credit and allowance rates. These rates enter through the after tax purchase prices of the capital inputs.

The complete set of equilibrium conditions are given by equations (16), (17) and (19). Equations (16) and (17) define a short run equilibrium, while equations (16), (17) and (19) define a temporary equilibrium of producer behavior. In the temporary equilibrium output supply, variable factor and capital input demands are determined.

1.3 ESTIMATION MODEL AND TAX ELASTICITIES

This section parameterizes the dynamic model of production presented in section 1.2. The dynamic nature of the model offers many advantages in determining the impact of tax policy on output supply and input demands. First, the model treats capital inputs different from other factors of production as producers must incur adjustment costs to invest in capital. Second, the model allows for short-run, intermediate-run and long-run effects of tax policy initiatives to differ. These effects differ according to the extent that capital adjustment has occurred.

In the empirical specification of the model, it is assumed that there is one output, two variable factors (labor and intermediate inputs), and one quasi-fiscal factor. In order to estimate the dynamic model of production we need to parameterize the after tax normalized shadow variable profit function (given as equation (16)). This function is assumed to be normalized quadratic and is written as

$$\begin{aligned}
\pi_s^s = {} & \beta_0 + \beta_p P_s^s + \beta_l W_{ls} + \beta_k K_{s-1} + \beta_a A_s \\
& + 0.5\left[\beta_{pp} P_s^{s2} + \beta_{ll} W_{ls}^2 + \beta_{kk} K_{s-1}^2 + \beta_{aa} A_s^2\right] \\
& + \beta_{pl} W_{ls} P_s^s + \beta_{pk} P_s^s K_{s-1} + \beta_{pa} P_s^s A_s \\
& + \beta_{lk} W_{ls} K_{s-1} + \beta_{la} W_{ls} A_s + \beta_{ka} K_{s-1} A_s + 0.5\beta_{II} \Delta K_s^2
\end{aligned} \qquad (20)$$

where π^s_s is the after tax normalized shadow variable profit (normalization is by the after tax price of intermediate inputs), P^s_s is the after tax normalized shadow price of output (see equations (13)-(15)), W_{ls} is the normalized labor input price or normalized wage rate, K_s is the capital input, A_s is the indicator of technology and ΔK_s represents net investment. All variables are indexed by the time period s.

From the profit function, we find the equilibrium conditions for output supply and variable factor demands by differentiating the after tax normalized shadow variable profit function (equation 20) with respect to the relevant prices. Thus we obtain the following specific output supply and input demand functions (which we are given as equations (17.1) and (17.2) in section 1.2),

$$y_s = \beta_p + \beta_{pp}P^s_s + \beta_{pl}W_{ls} + \beta_{pk}K_{s-1} + \beta_{pa}A_s \tag{21}$$

$$-v_{ls} = \beta_l + \beta_{ll}W_{ls} + \beta_{pl}P^s_s + \beta_{lk}K_{s-1} + \beta_{la}A_s \tag{22}$$

Since $-v_m = \pi^s - P^s y + W_l v_l$, then the intermediate input demand equation is

$$\begin{aligned} -v_{ms} = {} & \beta_0 + \beta_k K_{s-1} + \beta_a A_{s-1} + \beta_a A_{s-1} - 0.5\beta_{pp}P^{s2}_s - 0.5\beta_{ll}W^2_{ls} \\ & + 0.5\beta_{kk}K^2_{s-1} + 0.5\beta_{aa}A^2_s - \beta_{pl}P^s_s W_{ls} + \beta_{ka}K_{s-1}A_s \\ & + 0.5\beta_{II}\Delta K^2_s \end{aligned} \tag{23}$$

Thus, equations (21), (22) and (23) define the short-run equilibrium conditions based on the normalized quadratic after tax shadow variable profit function. These equations show how after tax output and variable input prices affect output supply and variable input demands, given the levels of the capital stocks.

The equilibrium condition for the capital input, is given by equation (19) in section 1.2. Based on the normalized quadratic after tax shadow variable profit function, the equilibrium condition for capital can be written as

$$\beta_{ll}\Delta K_s - Q_s + (1+\rho)^{-1}[E_s(\beta_k + \beta_{kk}K_s + \beta_{pk}P^{e}_{s+1} + \beta_{lk}W_{s+1} + \beta_{km}A_{s+1} - \beta_{ll}\Delta K_{s+1} + Q_{s+1}(1-\delta))] = 0 \qquad (24)$$

where Q_s is the normalized after tax purchase price of capital, δ is the depreciation rate and ρ is the discount rate.

If we assume that after tax relative prices, discount rate and technology indicator are expected to remain constant then we obtain the following,

$$-\beta_{ll}\Delta K_{s+1} + (1+\rho)\beta_{ll}\Delta K_s + \beta_{kk}K_s + \beta_k + \beta_{pk}P^{e}_s + \beta_{lk}W_{ls} + \beta_{ka}A_s - Q_s(1+\rho) + Q_s(1-\delta) = 0 \qquad (25)$$

Re-arranging we get

$$-\beta_{ll}K_{s+1} + (\beta_{kk}\ (2+\rho)\beta_{ll})K_s - (1+\rho)\beta_{ll}K_{s-1} = W_{ks} - (\beta_k + \beta_{pk}P^{e}_s + \beta_{lk}W_{ls} + \beta_{ka}A_s) \qquad (26)$$

where the normalized after tax rental rate is $W_{ks} = Q_s(\rho+\delta)$.

Equation (26) defines a second order difference equation in terms of the capital stock. The solution to this equation is a flexible accelerator,

$$K_s - K_{s-1} = m\ (K^{1}_s - K_{s-1}) \qquad (27)$$

where $m = -\ 0.5(\rho + \beta_{kk}/\beta_{ll} - [(\rho + \beta_{kk}/\beta_{ll})^2 + 4\beta_{kk}/\beta_{ll}]^{0.5})$ is the speed of adjustment of the capital stock and the long-run capital stock is $K^{1}_s = (-1/\beta_{kk})(\beta_k + \beta_{pk}P^{e}_s + \beta_{lk}W_{ls} + \beta_{ka}A_s - W_{ks})$.

Therefore, by combining equations (7) and (8) we get,

$$
\begin{aligned}
K_s = {} & (+0.5/\beta_{kk})(\rho + \beta_{kk}/\beta_{ll} - [(\rho + \beta_{kk}/\beta_{ll})^2 \\
& + 4\beta_{kk}/\beta_{ll}]^{0.5})(\beta_k + \beta_{pk}P_s^s + \beta_{lk}W_{ls} + \beta_{kt}A_s - W_{ks}) \\
& + (1 + 0.5(\rho + \beta_{kk}/\beta_{ll} - [(\rho + \beta_{kk}/\beta_{ll})^2 \\
& + 4\beta_{kk}/\beta_{ll}]^{0.5}))K_{s-1}
\end{aligned}
\tag{28}
$$

Equation (9) shows the demand for the capital input. It is a function of the relative after tax output prices, variable input prices and rental rate, along with the discount rate and lagged quantity of the capital input. This equation is nonlinear in the parameters.

The estimation model consists of the system of equations made up of equations (21), (22), (23) and (28). These equations describe a temporary equilibrium. There are four endogenous variables output supply Y_s, labor and material input demands v_{ls} and v_{ms} and capital input demand, K_s. In addition, in the production model the exogenous variables are the normalized after tax prices, P_s^s, W_{ls}, W_{ks}, the discount rate, ρ, lagged capital, K_{s-1}, the technology indicator, A_s. The model is linear in the endogenous variables and nonlinear in the parameters.

The model estimates are obtained by jointly estimating equations (21), (22), (23) and (28) using the maximum Likelihood estimator. The estimated profit function must be convex in prices. Thus the parameters must satisfy $\beta_{pp} > 0$ $\beta_{ll} > 0$ and $\beta_{ll} - \beta_{pl}^2 > 0$. In addition, the profit function must be concave in capital and net investment so that, $\beta_{kk} < 0$ and $\beta_{ii} < 0$.

An important feature of this model is that there are adjustment costs associated with capital accumulation. These costs prevent producers from immediately adopting their long-run desired levels of capital, and thereby also labor, materials and output. Producers adjust towards the long run. The speed of adjustment is given by m in equation (27). The dynamic adjustment process has implications for the effectiveness of tax policy changes. For example, in the short-run output supply depends on existing capital, but not on the rental rate. This means that changes in the capital cost allowance rate which alter the rental rate of capital do not have an effect on the supply of output. However, as capital adjustment occurs and the capital input changes in response to the new capital cost allowance rate then output supply is affected by the new rate. Thus, in a dynamic context it is important to distinguish between the short, intermediate and long-run effects of tax policy. In the short run, no capital adjustment has occurred, in the intermediate run capital adjustment has occurred for one period, and in the long run, the capital adjustment process has been completed.

Short-Run

The short-run equilibrium conditions are based on equations (21), (22), (23) and (28) The short-run equilibrium condition for output supply is

$$y_s^s = \beta_p + \beta_{pp} P_s^s + \beta_{pl} W_{ls} + \beta_{pk} K_{s-1} + \beta_{pa} A_s \tag{29.1}$$

The labor and material input short-run demand functions are

$$-v_{ls}^s = \beta_l + \beta_{ll} W_{ls} + \beta_{pl} P_s^s + \beta_{lk} K_{s-1} + \beta_{la} A_s \qquad (29.2$$

$$\begin{aligned} -v_{ms}^s = \; & \beta_0 + \beta_k K_{s-1} + \beta_a A_s - 0.5\beta_{pp} P_s^{s2} - 0.5\beta_{ll} W_{ls}^2 \\ & + 0.5\beta_{kk} K_{s-1}^2 + 0.5\beta_{aa} A_s^2 - \beta_{pl} P_s^s W_{ls} + \beta_{ka} K_{s-1} A_s \qquad (29.3 \\ & + 0.5\beta_{kk}(K_s^s - K_{s-1})^2 \end{aligned}$$

The equation for the short-run demand for the capital input is

$$K_s^s = \left(\frac{-0.5}{\beta_{kk}}\right)\left(\rho + \frac{\beta_{kk}}{\beta_{ll}} + \left[\left(\rho + \frac{\beta_{kk}}{\beta_{ll}}\right)^2 + \frac{4\beta_{kk}}{\beta_{ll}}\right]^{0.5}\right)$$

$$\left(\beta_k + \beta_{pk}P_s^s + \beta_{lk}W_{ls} + \beta_{ka}A_s - W_{ks}\right) \tag{29.4}$$

$$+ \left(1 - 0.5\left(\rho + \frac{\beta_{kk}}{\beta_{ll}} + [(\rho + \frac{\beta_{kk}}{\beta_{ll}})^2 + \frac{4\beta_{kk}}{\beta_{ll}}]^{0.5}\right)\right)K_{s-1}$$

where the superscript s for the endogenous variables signifies the short-run equilibrium of the demand functions.

The short-run equilibrium magnitudes of output supply and input demands are determined in the following manner. The short-run demand for capital depends on predetermined variables. These variables are relative after tax prices, indicator of technology, discount rate and lagged capital input. Next, the output supply and variable input demands are simultaneously determined. These variables depend on the after tax relative prices of output and labor (not the rental rate), the technology indicator and lagged capital input.

Intermediate-Run

The equations for the intermediate-run are derived from the short-run equations. The intermediate-run is defined with respect to the capital adjustment process after one period. The intermediate-run equilibrium condition for output supply is

$$y_{s+1}^i = \beta_p + \beta_{pp}P_s^s + \beta_{pl}W_{ls} + \beta_{pk}K_s^s + \beta_{pa}A_s \tag{30.1}$$

The labor and material input demand functions for the intermediate-run are described as

$$-v_{ls+1}^i = \beta_l + \beta_{ll}W_{ls} + \beta_{pl}P_s^s + \beta_{lk}K_s^s + \beta_{la}A_s \tag{30.2}$$

$$-v^i_{ns+1} = \beta_0 + \beta_k K^s_s + \beta_a A_s - 0.5\beta_{pp} P^{s2}_s - 0.5\beta_{ll} W^2_{ls} + 0.5\beta_{kk} K^{s2}_s + 0.5\beta_{aa} A^2_s - \beta_{pl} P^s_s W_{ls} + \beta_{ka} K^s_s A_s + 0.5\beta_{ii}(K^i_{s+1} - K^s_s)^2 \tag{30.3}$$

The equation for capital input intermediate-run demand is

$$K^i_{s+1} = (+0.5/\beta_{kk})(\rho + \beta_{kk}/\beta_{ii} - [(\rho + \beta_{kk}/\beta_{ii})^2 + 4\beta_{kk}/\beta_{ii}]0.5)(\beta_k + \beta_{pk} P_s + \beta_{lk} W_{ls} + \beta_{ka} A_s - W_{ks}) + (1 + 0.5(\rho + \beta_{kk}/\beta_{ii}) - [(\rho + \beta_{kk}/\beta_{ii})^2 + 4\beta_{kk}/\beta_{ii}]\ 0.5)\ K^s_s \tag{30.4}$$

Given the technology indicator and relative prices, these equations show the equilibrium after one year. The superscript i indicates the intermediate-run. The intermediate-run equilibrium magnitudes of output supply and input demands are determined in the following manner. The intermediate-run demand for capital depends on predetermined variables. These variables are relative after tax prices, indicator of technology, discount rate and short-run capital input. Next, the output supply and variable input demands are simultaneously determined. These variables depend on the after tax relative prices of output and labor (not the rental rate), the technology indicator and the short-run demand for capital.

Long-Run

In the long-run, $\Delta K_s = 0$. Thus, investment in the long-run only occurs for replacemen purposes. The long-run output supply equation is

$$y^l_s = \beta_p + \beta_{pp} P^s_s + \beta_{pl} W_{ls} + \beta_{pk} K^l_s + \beta_{pa} A_s \tag{31.1}$$

The labor and material input demand equations for the long-run are

$$-v_{ls}^{l} = \beta_l + \beta_{ll}W_{ls} + \beta_{pl}P_s^e + \beta_{lk}K_s^l + \beta_{la}A_s \tag{31.2}$$

$$\begin{aligned} -v_{ms}^{l} = {} & \beta_0 + \beta_k K_s^l + \beta_a A_s - 0.5\beta_{pp}P_s^{e2} - 0.5\beta_{ll}W_{ls}^2 \\ & + 0.5\beta_{kk}K_s^{l2} + 0.5\beta_{pp}P_s^{e2} + 0.5\beta_{aa}A_s^2 - \beta^{pl}P_s^e W_{ls} \\ & + \beta_{ka}K_s^l A_s \end{aligned} \tag{31.3}$$

Capital input demand is given by the following equation

$$K_s^l = (-1/\beta_{kk})[\beta_k + \beta_{pk}P_s^e + \beta_{lk}W_{ls} + \beta_{ka}A_s - W_{ks}] \tag{31.4}$$

In the long-run, since the capital adjustment process is completed, output supplies and input demands are functions of the long-run demand for capital. The demand for capital depends on exogenous variables. Once this demand is obtained, then output supply, labor and material demands can be determined. Since the long-run demand for capital affects output supply, labor and material demands then the rental rate affects these variables. Indeed, in the long-run all inputs are variable factors.

Rental Rate Elasticities with Respect to Tax Instruments

In order to determine the effect of tax policy in stimulating investment, it is necessary to determine the tax instrument elasticities of capital demand in each of the production runs. The tax instrument elasticities consist of two components. The first element is the effect of the tax instrument on the after tax relative rental rate of capital (since this is the only relative price directly affected by the tax policy). The second component is the elasticity of the rental rate on the demand for capital in each of the production runs.

We now consider the effects of the tax instruments on the after tax relative rental rate. The elasticity of the after tax rental rate with respect to the ITC rate is

$$e_{itc,s} = -Q_s(\rho + \delta)(1 + u_{cs}(\partial z_s/\partial \upsilon_s))\upsilon_s/W_{ks}(1 - u_{cs}) < 0 \tag{32}$$

Increases in the ITC rate lower the relative price of the capital input. In cases where investment tax or incentive allowance (IIA) exist, the elasticity of rental rate of capital with respect to allowance rate is:

$$e_{iia,s} = -Q_s(\rho + \delta)(u_{cs} + u_{cs}(\partial z_s/\partial \psi_s))\psi_s/W_{ks}(1 - u_{cs}) < 0 \tag{33}$$

Next, the effects of changes in the capital cost allowance (CCA) rate also operate through the rental rate. This elasticity is

$$e_{cca,s} = -Q_s(\rho + \delta)u_{cs}(\partial z_s/\partial d_s)d_s/W_{ks}(1 - u_{cs}) < 0 \tag{34}$$

Increases in the CCA rate lower the relative price of the capital input.

The corporate income tax (CIT) rate affects the normalized or relative after tax rental rate. However, the CIT does not directly affect the other relative output and input prices. The CIT elasticity on the rental rate is

$$e_{cit,s} = Q(\rho + \delta)(1 - \nu_s - u_{cs}z_s)u_{cs}/W_{ks}(1 - u_{cs}) > 0 \tag{35}$$

Clearly, decreases in the CIT rate cause the relative price of the capital input to fall.

The effect of tax policy on capital demand in each of the short, intermediate and long-run is obtained by calculating the tax effect on the rental rate and then multiplying this effect by the rental rate elasticity of capital demand.

1.4 TAX POLICY, IMPACT ON INVESTMENT AND GOVERNMENT REVENUES

In this section we present the results of changes in each tax instrument on the demand for capital per cost to the government of stimulating capital demand. This ratio we refer to as the benefit-cost ratio.

Investment Tax Credit and Allowance

For an investment tax credit, the change in government revenue is

$$\Delta GR_s^e = Q_s\left(K_s^e - (1-\delta)K_{s-1}^e\right)v_s \tag{36}$$

The superscript e denotes the particular equilibrium, e = s,i,l for short, intermediate and long-run. For an allowance with a rate of ψ_s then in the formula, v_s is replaced by $\psi_s u_{cs}$. For a 1% change in a rate multiply the formula by 0.01.

Capital Cost Allowance

If depreciation for tax purposes is declining balance, and tax credits do not affect depreciation for tax purposes, then the change in government revenue is

$$\Delta GR_s^e = Q_s\left(K_s^e - (1-\delta)K_{s-1}^e\right)u_{cs}\,\frac{\rho}{\rho+v_s} \tag{37}$$

If depreciation for tax purposes is straightline, and tax credits do not affect it, then the change in government revenue is

$$\Delta GR_s^e = Q_s\left(K_s^e-(1-\delta)K_{s-1}^e\right)u_{cs} \tag{38}$$

Corporate Income Tax

The base for the income tax rate is revenue net of variable cost, interest payments and allowances (all allowances, for example capital cost and investment). Define the base in year s as

$$E_s^e = P_s^s y_s^e - W_t^T v_t^e - r_{bs} B_{s-1} - CCA_s^e - IIA_s^e \tag{39}$$

where (with one type of capital, see equation (5)).

$$CCA_s^e = \Sigma_{\psi=0}^{\infty} Q_{s-\psi} I_{s-\psi}^e d_s \tag{40}$$

where $I_{s-\psi}^e = (K_{s-\psi}^e - (1-\delta) K_{s-\psi-1}^e)$. Also

$$ITA_s^e = \psi_s\, Q_s \left(K_s^e - (1-\delta)K_{s-1}^e\right)$$

Now the change in government revenue in this case is

$$\Delta GR_s = E_s^e u_{cs}$$

Benefit-Cost Ratio

$$B_j^e = \frac{Q_s K_{is}^e e_{kj}^e}{\Delta GR_{js}^e} \tag{41}$$

where the numerator is the nominal value of capital (before tax, not normalized) in the appropriate equilibrium, multiplied by the elasticity of capital with respect to the j[th] tax instrument (investment tax credit, tax allowance, capital cost allowance, income tax). The numerator is the additional capital generated by a specific tax instrument. The denominator is the cost to the government of generating the additional capital. The ratio denotes the benefit-cost ratio.

1.5 MEXICO

1.5.1 Tax History

The structure of corporate income taxation in Mexico has undergone major changes in recent years. During the 80's Mexican corporate tax system allowed indexation of capital consumption allowances only. Full indexation of the corporate income tax base is now permitted. With indexation, corporations are no longer allowed to deduct the inflationary component of interest expenditures nor would they have to accumulate the inflationary component of interest income (see Gil-Diaz, 1990, p. 79.) Taxable Profits (defined as gross receipts minus purchases and business expenses, and net losses carried forward from other periods) are subject to tax at a rate of 35% (a rate of 42% prevailed in the pre-1987 period). Depreciation deductions are indexed or as an alternative, the present value of depreciation calculated at a discount rate of 7.5% may be deducted fully in all regions except major metropolitan areas and in all sectors except the automobiles. In major metropolitan areas only 60% of such value can be deducted in the first year and the remaining 40% subjected to capital consumption allowances.

It is instructive to compare the Mexican taxation of business income with a few of its capital exporting partners namely United States and Canada. Table M1 shows that Mexico has moved some distance towards a cash flow type of taxation by allowing a deduction for the present value of the scheduled depreciation allowances for the life of each type of assets calculated at a 7.5 percent annual rate of interest (see Gil-Diaz, 1990). Tax incentives regime in Mexico has also undergone significant changes over time. During the past two decades, tax policy was seen as a major vehicle for regional and sectoral development while revenue

Table M1

Mexico: Taxation of Business Income, A Comparative Perspective
(percent)

Tax regime	Mexico (1991)	United States (1990)	Canada (1990)
Corporate income tax rate: general[a]	35 + 3.9 = 38.9	34 + 6 = 40	28 + 15 = 43
Withholding tax rates			
Interest	35	30	28
Dividends	0-40	30	25
Technology transfer fees	21	30	25
Royalties	40	30	25
Indexation of deductions	Full	No	No
Loss carry forward	5	15	7
Loss carry backward	0	3	3
Minimum/alternative Minimum tax	2% assets tax	20% on taxable income inclusive of tax preferences	0.175% on capital in excess of $10 million creditable against 3% surtax on corporate profits
Capital gains taxation			
Coverage	Full	Full	Two-thirds
Indexation	Full	No	No
Rate	35	34	28
Dividends deduction	No	Yes	Yes
Full expensing of investment	No. Present Value of CCAs immediately deductible	No	No
Investment tax credits	-	Energy investment, rehabilitation of real estate, targeted job credit	Regional and R&D

a/ In Mexico the profit-sharing rate and, in the United States and Canada, the average provincial or state tax rates are added to the basic federal rate.

Source: Ugarte (1988), Price Waterhouse (1992), International Bureau of Fiscal Documentation (1988), and Gil-Diaz (1990).

implications of these policies were overlooked. A brief review of historical changes in the tax incentive regime in Mexico is presented below:

1955-1972: Between 20% (for secondary industries) and 40% (for basic industries) corporate income of Mexican majority owned enterprises was exempted from corporate taxation for periods varying between five to ten years. The same industries also could receive, upon application, exemption from certain indirect taxes and import duties on capital goods imports.

1972-1979: Industries that were seen to promote decentralization and regional development were granted import duties relief varying from 50% to 100% and reduction in corporate tax liability ranging from 10% to 40% depending upon their location and type of activity.

1979-1986: The practice of import duty exemption was continued. In addition, tax incentives certificates (CEPROFIS) providing tax credit in the range of 10-25%, depending upon location, and type and size of the industry, for investment in physical assets were introduced. These certificates were negotiable and could be used against any federal tax liability by the holder. These certificates proved quite popular and in 1983 amounted to 0.83 percent of GDP in revenue losses. While the manufacturing sector was a major beneficiary of this scheme, mining, agriculture and transportation industries also received significant amount of resources. Among the manufacturing industries, paper and publishing, chemicals and food and beverages received a majority of the assistance.

While CEPROFIS were the most important fiscal incentive, Mexican government offered also offered special incentives were export promotion (CEDIS), development of duty-free zones special tax preferences to automobile, cement, publishing and mining industries.

1987-1990: The tax incentives certificates scheme was significantly tightened and targeted to priority industries and preferred zone. Top tax credit rate for CEPROFI was raised to 40% of total physical investment in 1986. In addition Mexican-owned enterprises are eligibl for employment tax credit up to 30% of three times the annual area minimum wage multipli by the number of new jobs created.

Starting in 1989, full expensing of the present value of capital consumption allowances calculated using a 7.5% discount rate was offered as an alternative option to standard capit consumption allowances in non-metropolitan areas. In the metropolitan industrialized areas of Mexico City, D.F., Monterrey and Guadalajara, only 60% of the present value of depreciatio allowances could be deducted in the first year. R&D investment tax credit at 15% for the purchase of technological research (20% for small and micro enterprises), and 20% for capital purchases by technological enterprises (30% for small and micro enterprises) were also permissible.

1991-Present: Effective 1991 all CEPROFI related incentives were eliminated. However, the immediate deduction of present value of investment expenditures discounted at 7.5% per annum still remains.

1.5.2 Tax Policy Effects on the Rental Rate and Capital

The model was applied to two Mexican industries; detergents and other chemicals. The data for these two three-digit Mexican industries for the period 1970 to 1983 was collected from a variety of Government of Mexico sources. These two industries are among the three largest industries in the industrial sector (SIC 35) comprising of chemicals, petroleum derivatives, rubber and plastics products. Together these two industries accounted for 5.2 percent of total manufacturing output and 2.9 percent of total employment. The data on industry capital stock was developed by using the perpetual inventory method with an assumed depreciation rate of 0.08, representing a weighted average of assumed depreciation rates of 0.1 for machinery and equipment and 0.025 for structures respectively.[11] Quantity of labor was measured as the average number of employees during the year. The price of labor was derived by dividing the total employment cost during the year by average number of employees. Quantity of intermediate input, was obtained by dividing the cost of intermediate inputs by the input price index.

We will now examine the effects of corporate tax policy initiatives in stimulating capital expenditures in the short, intermediate and long runs for the case of Mexico. The three tax instruments that we consider for Mexico are the corporate income tax (CIT) rate, the investment tax credit (ITC) rate, and the capital cost allowance (CCA) rate. As discussed earlier on the theoretical and empirical models, only the relative price of the capital input is directly affected by tax policy initiatives (see equations (32)-(35)). Thus, the relative after tax rental rate is a crucial variable in the determination of the effects of tax policy initiatives on capital expenditures. In table M2 we present the elasticities of the tax instruments on the rental rate.

Since the normalized after tax rental rate on capital is the same for both industries, the results found for the elasticities of rental rate of capital with respect to the three instruments are also the same. These elasticities remain relatively constant over the sample period. As seen in table M2, a 1 percent increase in the CCA rate results in a 0.63 percent decrease in the normalized after tax rental rate, whereas a 1 percent rise in the ITC rate leads to a 0.41 percent decline in the relative rental rate. In fact, a 1 percent increase in the CIT rate leads to around a 1.00 percent increase in the after tax relative rental rate. The results for the short, intermediate and long-run tax elasticities for capital demand appear in Table M3.

Table M2

Elasticities of Rental Rate of Capital with Respect to Tax Measures

Year	e_{itc}	e_{cca}	e_{cit}
1979	-0.405	-0.621	0.895
1980	-0.409	-0.635	0.918
1981	-0.409	-0.635	0.962
1982	-0.409	-0.635	1.021
1983	-0.409	-0.635	1.021

Table M3

Capital Demand Elasticities

	Detergents		Other Chemicals	
	1979	1983	1979	1983
<u>Short-Run</u>				
e_{kitc}	0.015	0.012	0.008	0.006
e_{kcca}	0.024	0.019	0.013	0.009
e_{kcit}	-0.034	-0.031	-0.018	-0.014
<u>Intermediate-Run</u>				
e_{kitc}	0.020	0.016	0.011	0.007
e_{kcca}	0.031	0.024	0.016	0.012
e_{kcit}	-0.045	-0.039	-0.023	-0.019
<u>Long-Run</u>				
e_{kitc}	0.022	0.017	0.012	0.008
e_{kcca}	0.034	0.027	0.018	0.013
e_{kcit}	-0.049	-0.043	-0.026	-0.021

1.5.3 Tax Incentives, Investment Impacts and Foregone Revenues

Although focusing on investment expenditure only provides a partial view of the effects of tax policy, in this section, we calculate investment input per unit value of foreign government revenue. This measure is referred to as the incremental benefit-cost ratio in Table M4. These calculations are presented for the most recent year (1983) in the data as well as an earlier year (1979), together with the mean and standard deviation for the 1979-83 period. The table suggests that the effectiveness of investment tax credit for both Mexican industries has deteriorated in recent years and the measure is not cost-effective in any of the runs. Accelerated capital consumption allowances, have also proved to be not cost-effective tax incentive instruments as the benefit-cost ratio for this measure is less than one in all runs for the two industries. Finally, while corporate tax rate reductions have had fairly large impacts on stimulating capital expenditures in the detergents and other chemicals industries, revenues foregone from such reductions far exceed the positive investment impacts thereby yielding a low benefit-cost ratio. Thus it is apparent that all three tax incentives proved to be cost-ineffective in all runs for the two industries examined here.

Table M4

Investment Impacts Per Unit Value of Lost Tax Revenue

			Impact		
Tax Instrument	Industry	Year	Short Run	Intermediate Run	Long Run
Investment Tax Credit	Detergents	1979	0.55	0.69	0.74
	Other Chemicals		0.28	0.36	0.40
	Detergents	1983	0.44	0.51	0.54
	Other Chemicals		0.26	0.32	0.34
	Detergents	Mean	0.57	0.71	0.77
		(s.d.)	(0.08)	(0.13)	(0.16)
	Other Chemicals		0.26	0.35	0.40
			(0.02)	(0.02)	(0.03)
Accelerated Capital Consumption Allowance	Detergents	1979	0.40	0.50	0.54
	Other Chemicals		0.20	0.27	0.29
	Detergents	1983	0.32	0.38	0.40
	Other Chemicals		0.19	0.24	0.25
	Detergents	Mean	0.42	0.52	0.57
		(s.d.)	(0.06)	(0.09)	(0.12)
	Other Chemicals		0.19	0.26	0.29
			(0.01)	(0.02)	(0.03)
Corporate Income Tax Rate Reductions	Detergents	1979	0.05	0.06	0.07
	Other Chemicals		0.01	0.02	0.02
	Detergents	1983	0.03	0.04	0.05
	Other Chemicals		0.01	0.01	0.01
	Detergents	Mean	0.04	0.06	0.06
		(s.d.)	(0.01)	(0.01)	(0.01)
	Other Chemicals		0.01	0.01	0.02
			(0.00)	(0.00)	(0.00)

1.6 PAKISTAN

1.6.1 Tax History

Pakistan has followed a stable corporate tax rate regime since the early 1960s. The corporate income tax at 30% and a super tax at 20-25% have been maintained consistently during the last two decades. Only in the fiscal year 1989-90 the super tax rate was brought down to 15%. Foreign direct investment receives tax treatment equivalent to domestic investment. Losses are allowed to be carried forward six years, but no carryback of such losses is permitted. A sales tax at 12.5% is payable on all domestically manufactured goods by the producer and on imported goods by the importer. In the fiscal year 1989-90, import duties at differential rates were imposed on imported machinery and equipment. These rates varied from 20% to 50% if similar machinery was not manufactured in Pakistan, and a higher rate of 80% applied to imported machinery with domestic substitutes.

The regime of fiscal incentives through the corporate income tax has experienced significant changes over time, as Pakistan has relied upon a variety of fiscal incentives to stimulate investment. These include accelerated capital consumption allowances for certain physical assets, full expensing for R&D investments, tax rebates, regional and industry specific tax holidays, and investment tax credits. These are briefly discussed below. Further details of the current tax regime are given in Table P1.

Tax holidays: Tax holidays for two years for specific industries (e.g. engineering goods) and specific regions (most of the country except major metropolitan areas) were introduced in 1959-60. The holiday period was subsequently raised to four years in 1960-61. These tax holidays were eliminated in 1972-73 but reinstated again in 1974-75. Presently tax holidays for five years are permitted to engineering goods, poultry farming and processing, dairy farming, cattle or sheep breeding, fish farming, data processing, industries manufacturing agricultural machinery, and also to all industries in designated areas of the country.

Investment tax credits: Industries are eligible for varying tax credits according to location. A general tax credit for balancing, modernization, and replacement of plant and equipment was introduced at a rate of 15%, but its application was restricted to designated areas. Since 1976-77, the credit was made available regardless of location and type of industry. This credit was withdrawn in 1989-90 but reintroduced in 1990-91.

Accelerated capital consumption allowances: Capital consumption allowances follow accelerated schedules for machinery and equipment, transport vehicles and housing for workers (25%), oil exploration equipment (100%), ship building (20-30%), and structures (10%) on a declining balance method. Expenditures relating to research and development, transfer and adaptation of technologies and royalties are eligible for full expensing.

1.6.2 Tax Policy Effects on the Rental Rate and Capital

The model was applied to the wearing apparel (SIC Code: 322) and the leather and leather products industries (SIC Code: 323) industries of Pakistan for the period 1966 to 1984. The data on these two manufacturing industries was collected primarily from the various issues of the two annual publications of the Government of Pakistan namely the Census of Manufacturing Industries and the Economic Survey. The wearing apparel industry in 1984 contributed 0.63 percent of the total manufacturing output and employed roughly one percent of the total manufacturing labor force. The leather and leather products industry, on the other

Table P1

The Structure of Corporate Income Tax System in Pakistan 1990-91.

	(%)
A. CIT rates applied to all income except dividends and bonus shares:	
1. Income tax rate	30
2. Super tax rate:	
-Banking companies	25
-Non-banking companies (NB)	20
3. Surcharge[1]	10
B. CIT rates applied to intercorporate dividends (ID) & bonus shares (BS):	
1. Income tax on ID and BS	0
2. Super tax on dividends received by	
-Domestic public companies	5
-Foreign companies	15
-Domestic private companies	20
3. Super tax on bonus shares issued by	
-public companies	10
-private companies	15
C. Tax rebates:	
1. Tax rebates on super tax for NB public companies (NBPUC)	10
2. Tax rebates on super tax for small companies[2]	5
3. Tax rebates on super tax for companies engaged in specific economic activities[2]	10-15
4. Tax rebates on income & super taxes for exports	25-75
D. Tax Credits on the amount of investment in:	
1. Shares/debentures of the Equity Participation Fund	50
2. Debentures/negotiable bonds	5
3. Shares of industrial companies set up in backward areas	10-30
4. Plant/machinery for bal., mod., repl. or extension (BMR/E)	15
E. Depreciation Allowances:	
1. "Normal" (annual) depreciation allowances (ND)	5-30
2. Extra shift working allowances (as % of ND) on plant	50-100
3. Initial depreciation allowances	25-100

F. Full tax holiday, ranging from 4-10 years, for companies engaged in:

- -manufacturing garments
- -key industries
- -manufacturing electrical equipment/its components & set up in NWF
- -fish catching, cattle/sheep breeding & dairy farming
- -exploration of specific minerals
- -an industrial undertaking set up in an export processing zone
- -producing defense equipment or armaments set up in specific areas
- -industrial undertakings set up in specific backward regions

Partial tax holidays (25-50% of the capital), ranging for 5-10 years, for companies set up in specific regions and engaged in manufacturing goods, ship buildings and navigation, or generation and supply of electrical energy or hydraulic power.

[1] Surcharges are levied on total income and super taxes if the company's taxable income, including dividends, exceeds Rs. 100,000.

[2] In the case of NBPUCs, this is an additional tax rebate on super tax.

Source: Ehdaie, J. (1991).

hand, in 1984, accounted for 1.8% of total value of output and employed one percent of manufacturing labor force. Together, these two industries accounted for 2.4 percent of manufacturing output in 1984.

The quantity of labor is measured as total number of days worked during the year and a labor price index was developed by dividing total employment cost during the year by the number of days worked. The value of materials or intermediate inputs include electricity, petroleum fuel, natural gas, and imported and domestically produced miscellaneous materials. The quantity of materials was constructed by dividing the total value of materials by an industry level materials price deflator. The quantity of output was constructed by dividing the total value of output by an industry output deflator. The series on capital stock were developed by employing perpetual inventory method to investment series and assuming a depreciation rate of 0.08. This represents a weighted average of assumed depreciation rates of 0.1 for machinery and equipment and 0.025 for structures respectively.[12]

We now consider the effects of the three tax instruments; the investment tax credit (ITC) rate, capital cost allowance (CCA) rate and corporate income tax (CIT) rate on the rental rate of capital. Table P2 shows the empirical results we obtained for the elasticities of rental rate of capital with respect to various tax measures for Pakistan's wearing apparel and leather products industries. The magnitude of the ITC elasticity increased from 1977 to 1984. In 1984, a 1 percent rise in the ITC rate leads to a fall of 0.39 percent in the normalized after tax factor price of the capital input. Over the same period time, the CCA elasticity of the relative rental rate of capital decreased. The CIT elasticities differ slightly across the leather products and wearing apparel industries, but over time the elasticities differ dramatically. In the leather products industry a 1 percent change in the CIT rate leads to a 0.42 percent rise in 1977 in the normalized after tax rental rate of capital. However, in 1984, increases in the CIT rate result in a rise of only 0.04 percent in the relative rental rate. In 1977, a 1 percent increase in the CIT rate results in a 0.36 percent increase in the relative rental rate in the apparel industry. By 1984, a rise in the CIT rate leads to a rise in the price of capital input of about 0.03 percent in the same industry. The ITC elasticities are larger in absolute value than the CCA and CIT elasticities in 1984 although in 1977 the CIT elasticities are larger than comparable elasticities for the ITC and CCA rates. The results for the short, intermediate and long-run tax elasticities for capital demand appear in Table P3.

Table P2

Elasticity of Rental Rate of Capital With Respect to Tax Measures

Year	e_{itc}	e_{cca}	e_{cit}
Apparel			
1977	-0.338	-0.285	0.359
1984	-0.386	-0.225	0.034
Leather			
1977	-0.326	-0.287	0.425
1984	-0.386	-0.225	0.037

Table P3

Capital Demand Elasticities

	Apparel		Leather	
	1977	1984	1977	1984
<u>Short-Run</u>				
e_{kitc}	0.011	0 004	0.003	0.002
e_{kcca}	0.009	0.002	0.003	0.001
e_{kcit}	-0.012	-0.004	-0.004	-0.0002
<u>Intermediate-Run</u>				
e_{kitc}	0.019	0.008	0.006	0.003
e_{kcca}	0.016	0.005	0.006	0.002
e_{kcit}	-0.021	-0.007	-0.008	-0.0003
<u>Long-Run</u>				
e_{kitc}	0.046	0.029	0.016	0.006
e_{kcca}	0.038	0.017	0.014	0.004
e_{kcit}	-0.048	-0.003	-0.021	-0.0006

1.6.3 Tax Incentives, Investment Impacts and Foregone Revenues

The benefit cost ratios for each of the tax incentive for Pakistan are presented in Table P4 for the most recent year (1984) in the data as well as for an earlier year (1977), together with the mean and standard deviation for the 1977-84 period. In carrying out these calculations, we note that investment is most responsive to changes in investment tax credit. The loss in government revenues are quite similar for ITC and CCAs, and therefore, ITC yields a slightly higher benefit-cost ratio than CCA changes. For corporate tax rate reductions loss in government revenues far exceed the investment impacts. Investment impacts for all measures were smaller in recent years compared to earlier years for the short and immediate runs due to the observed decline in own price elasticity of capital in recent years. Thus the table suggests that the investment tax credit became a cost-effective measure for both industries in recent years based on its long run impact only. A similar pattern of cost-effectiveness emerges for accelerated capital consumption allowances. Such allowances were not cost-effective in the short and intermediate run, and became cost effective in recent years based on the long run impact. Finally, corporate tax rate reductions had very large positive impacts on stimulating investment on both the apparel or leather products industries but these impacts were outweighed by major revenue losses to the national treasury. Thus for Pakistani industries, the three tax incentives considered were ineffective in stimulating investment in recent years but in view of a better record of accelerated depreciation allowances and investment tax credits in earlier years, perhaps a redesign of such incentives with some consideration for refundability provisions and elimination of regulatory bottlenecks would help restore their effectiveness in stimulating investments.

Table P4

Investment Impacts Per Unit Value of Lost Tax Revenue

			Impact		
Tax Instrument	Industry	Year	Short Run	Intermediate Run	Long Run
Investment Tax Credit	Apparel	1977	0.72	0.88	1.11
	Leather		0.26	0.25	0.24
	Apparel	1984	0.28	0.71	2.50
	Leather		0.11	0.28	2.54
	Apparel	Mean	0.40	0.76	0.70
		(s.d.)	(0.18)	(0.34)	(2.13)
	Leather		0.24	0.36	0.37
			(0.22)	(0.32)	(1.44)
Accelerated Capital Consumption Allowances	Apparel	1977	0.52	0.64	0.81
	Leather		0.18	0.18	0.17
	Apparel	1984	0.23	0.59	2.10
	Leather		0.09	0.23	2.13
	Apparel	Mean	0.31	0.60	0.51
		(s.d.)	(0.13)	(0.27)	(1.70)
	Leather		0.19	0.28	0.25
			(0.18)	(0.26)	(1.14)
Corporate Income Tax Rate Reductions	Apparel	1977	0.05	0.13	0.21
	Leather		0.01	0.01	0.02
	Apparel	1984	0.00	0.00	0.00
	Leather		0.00	0.00	0.00
	Apparel	Mean	0.00	0.04	0.08
		(s.d.)	(0.06)	(0.04)	(0.07)
	Leather		0.00	0.00	0.01
			(0.00)	(0.00)	(0.01)

1.7 TURKEY

1.7.1 Tax History

The corporate income tax in Turkey provides a significant source of government revenues (accounting for 10% of total tax revenues) as well as serves as major tool of industrial policy. The government has changed both the tax rate and the tax base many times during the past three decades. The statutory corporate tax rate hovered around 10% during the 50's , rose to 20% in the 60's and to 25% in the 70's. In 1980, it was raised to 50%, lowered to 40% in 1981 and then raised again to 46% (plus a defense surcharge of 3%) in 1985 and has stayed at that level since then. Over these years there also have been significant tax base changes (see Bulutoglu and Thirsk, 1990). Preferential treatment of public enterprises has been eliminated since 1980. Inter-company dividends distribution have been made exempt from taxation and corporate reorganizations are no longer subject to capital gains taxation. Inflationary adjustment of assets but not of liabilities have been also allowed.

In the following, we briefly summarize the current provisions of the corporate taxation and investment incentives regimes which appear in Table T1. Taxable income of corporate entities (defined as book profits before taxes plus increases in pension reserves and general provision for bad debt minus investment and export allowances and depreciation deductions etc.) is currently taxed at a flat rate of 46%. A 3% defence surcharge is payable on this basic rate. In addition, a 1% tax is payable to the Social Assistance and Security Fund, and an additional 1% tax is levied for the Apprenticeship, Vocational and Training Encouragement Fund, for a combined corporate tax rate of 49.38%. Corporate tax is withheld at source at varying rates with 0% rates for dividend distributions, 5% for income from crude oil exploration, 10% on interest and moveable property income, 20% for income from immoveable property, and 25% for salaries and wages and patents and royalties.

Depreciation allowances are based on historical costs adjusted by the wholesale price index minus 10% and take the form of ten-year interest bearing bonds. Either the straight-line or declining balance method of depreciation may be chosen for any asset, but no switch is allowed from the straight-line to the declining balance method during the life of the asset. Depreciation on moveable fixed assets acquired on or after January 1, 1983 may be taken under a straight-line method at any rate chosen by the tax payer, up to an annual maximum of 25%. If the declining balance method is used, the maximum allowable depreciation rate is 50%. Assets having values less than 5,000 TL can be deducted. For structures and moveable fixed assets acquired before January 1, 1983, the Ministry of Finance publishes maximum depreciation rates (on a straight-line basis) permissible for tax purposes. These rates typically are 4% for factory buildings, 15% - 20% for transport equipment, and 12.5% for machinery and equipment.

A value-added tax is levied at a general rate of 12%. Banking and insurance transactions are subject to a 3% tax (BITT). There is an investment incentive allowance in Turkey which is a deduction from the taxable income for corporate tax purposes. The deduction is claimed in the year of investment on that portion of investment which is not subsidized by the government. Unused investment allowances can be carried forward indefinitely. The rate of investment allowance varies by region and type of investment.

Corporations can also set aside up to 25% of taxable income for future investments. The amount set aside at the discretion of the corporation is deducted from its taxable income and deposited in an interest bearing account (earning the same interest as government bonds, usually about 20% p.a.) with the Central Bank. It can be withdrawn any time with authorization from the State Planning Office and used for investment.

For tax purposes, capital is depreciated at a rate of up to 50% for machinery and equipment. Further assets can be revalued at the end of every calendar year.

A large number of non-tax incentives are available to eligible investments. These include low interest credit, funds for working capital, allocation of foreign exchange, and allowance for import of used equipment.

Table T1

The Structure of Corporate Income Tax System in Turkey 1990/91
(Figures in percent)

Corporate Income Tax: General	46
Withholding tax rates on payments by a domestic corporation to a foreign corporation	
Rental from fixed assets	20
Leasing	0.5
Royalties on patents	25
Professional services	15
Petroleum services	5
Interest on trade receivables	10
Other interest (loans and deposits)	10
Withholding taxes on payments to nonresident individuals	
Rentals from immovable assets	20
Royalties on patents	25
Services (professional)	15
interest on receivables & deposits	10
Value-added tax	
Standard rate	12
Agricultural product	1
Basic foods, books, natural gas	6
Luxury goods	20
Petroleum products	13
Banking and Insurance transactions tax	5
Investment incentive allowance	30-100 of the cost of specified assets
Export allowance	
Export earnings of manufacturer	12
Export earnings of traders	3
Export of fresh fruit, vegetables	12
International Transport	12
Tourist establishments	20
Depreciation Allowance	
Straight-line	25
Declining-balance	50

Source: Price Waterhouse (1992)

1.7.2 Tax Policy Effects on the Rental Rate and Capital

The model is applied to three Turkish industries; non-electrical machinery (SIC 382), electrical machinery (SIC 383) and transport equipment (SIC 384) industries in the private sector only and covers the period 1973 to 1985. These industries accounted for 20% of total manufacturing output and employment and 24% of manufacturing wages in 1985. The data on output, employment, intermediate input and investment were obtained from a variety of Government of Turkey sources. The quantity of labor was measured as the average number of employees during the year. The price index was constructed by dividing total employment cost during the year by average number of employees. Intermediate inputs or materials include raw materials, components, containers, fuel and electricity. The quantity of materials was constructed by dividing total value of materials by an industry materials deflator. The quantity of output was constructed by dividing the total value of output by the relevant industry output price deflator. The same deflator was used both for the electrical machinery and transport equipment industries. The capital stock series were developed by applying perpetual inventory method to investment series and by assuming depreciation rate equal to 0.08, representing a weighted average of assumed depreciation rates of 0.1 for machinery and equipment and 0.025 for structures.[13]

The effects of the three tax instruments on the rental rate of capital are given in Table T2. Since the normalized after tax rental rate on capital is the same for the three industries, the results found for the tax elasticities are also the same. From table T2, we observe that the IIA elasticity increases over the sample period, whereas the CCA and CIT elasticities remain relatively constant. Over the first half of the sample period, a 1 percent increase in the IIA rate decreases the after tax rental rate by 0.20 percent. Over the second half of the period, the elasticity ranges from -0.24 to -0.35. For most of the period the elasticity associated with the CIT rate ranges from 0.21 to 0.28 and then decreases of the last few years. Generally, the CCA rate elasticity ranges from 0.70 to 0.10 for most of the period. The results for the short, intermediate and long-run tax elasticities for capital demand appear in Table T3.

Table T2

Elasticities of Rental Rate of Capital With Respect To Tax Measures

Year	e_{its}	e_{cca}	e_{cit}
1973	-0.199	-0.065	0.210
1974	-0.195	-0.086	0.242
1975	-0.196	-0.084	0.238
1976	-0.199	-0.067	0.212
1977	-0.197	-0.078	0.229
1978	-0.193	-0.098	0.260
1979	-0.193	-0.096	0.259
1980	-0.242	-0.129	0.386
1981	-0.348	-0.147	0.259
1982	-0.345	-0.155	0.276
1983	-0.258	-0.064	0.057
1984	-0.258	-0.063	0.055
1985	-0.341	-0.099	0.101

Table T3

Capital Demand Elasticities

	Elec. Mach.		Non-Elec.Mach.		Trans. Equip.	
	1974	1985	1974	1985	1974	1988
Short-Run						
e_{kiia}	0.014	0.013	0.024	0.021	0.024	0.020
e_{kcca}	0.006	0.004	0.010	0.006	0.010	0.006
e_{kcit}	-0.017	-0.004	-0.029	-0.006	-0.029	-0.006
Intermediate-Run						
e_{kiia}	0.021	0.021	0.037	0.033	0.037	0.032
e_{kcca}	0.009	0.006	0.016	0.009	0.016	0.009
e_{kcit}	-0.027	-0.006	-0.046	-0.009	-0.046	-0.009
Long-Run						
e_{kiia}	0.034	0.034	0.059	0.052	0.055	0.051
e_{kcca}	0.015	0.009	0.026	0.015	0.026	0.015
e_{kcit}	-0.042	-0.009	-0.074	-0.015	-0.074	-0.015

1.7.3 Tax Incentives, Investment Impacts and Foregone Revenues

Table T4 presents the benefit-cost ratios for the three Turkish industries for two years 1975 and 1985 and the mean and standard derivation for the sample period 1975-1985. A 1% increase in investment allowance (IIA) had the largest effect on capital while a similar change in capital consumption allowances (CCAs) and corporate tax rate reductions had relatively smaller impacts. This is because the elasticity of rental rate of capital with respect to investment allowances is much higher than with respect to capital consumption allowances and corporate tax rate reductions. The loss in tax revenue associated with tax rate reduction are quite large and thereby yielding a low benefit-cost ratio for such a policy change. The revenue losses are larger for the investment allowance than for changes in capital consumption allowances and since investment impacts are higher for the former measure, the net effect is to yield similar benefit-cost ratios for the two measures. The benefit-cost ratio is smaller for almost all measures in 1985 relative to 1975. This results from a decline in the elasticity of capital stock to a change in its own rental rate. Note that the capital stock increases over time, implying that if the own price elasticity of capital were to be constant, investment response to changes in rental rate would have to increase at the same rate as the increases in capital stock. It is unlikely that investment response will increase at the same rate because it would imply an unrealistic increase in the marginal product of capital. Thus it is reasonable to expect own price elasticity of capital to decline over time. In conclusion, the table suggests that investment allowances and accelerated depreciation provisions proved to be effective instruments of public policy for investment promotion, especially based on their intermediate and long run impacts. The same could not however, be said about corporate tax rate reductions which clearly resulted in windfall gains to existing capital without encouraging new investment.

Table T4
Investment Impacts Per Unit Value of Lost Tax Revenue

Tax Instrument	Industry	Year	Impact Short Run	Impact Intermediate Run	Impact Long R
Investment Allowance	Electrical Machinery	1975	0.63	0.97	1.50
	Non-Electrical Machinery		1.00	1.59	2.62
	Transport Equipment		1.14	1.71	2.56
	Electrical Machinery	1985	0.40	0.72	1.54
	Non-Electrical Machinery		0.86	1.42	2.49
	Transport Equipment		1.00	1.54	2.40
	Electrical Machinery	Mean	0.53	0.84	1.37
		(s.d.)	(0.012)	(0.17)	(0.29)
	Non-Electrical Machinery		0.81	1.29	2.12
			(0.17)	(0.28)	(0.51)
	Transport Equipment		0.85	1.34	2.19
			(0.23)	(0.35)	(0.60)
Accelerated Capital Consumption Allowance	Electrical Machinery	1975	0.56	0.86	1.33
	Non-Electric Machinery		0.89	1.42	2.34
	Transport Equipment		1.01	1.53	2.28
	Electrical Machinery	1985	0.38	0.68	1.45
	Non-Electric Machinery		0.81	1.33	2.34
	Transport Equipment		0.94	1.44	2.25
	Electrical Machinery	Mean	0.47	0.75	1.22
		(s.d.)	(0.10)	(0.14)	(0.24)
	Non-Electrical Machinery		0.72	1.15	1.89
			(0.14)	(0.23)	(0.43)
	Transportation Equipment		0.76	1.20	1.94
			(0.20)	(0.31)	(0.51)
Corporate Income Tax Rate Reductions	Electrical Machinery	1975	0.32	0.56	0.84
	Non-Electrical Machinery		0.16	0.27	0.45
	Transport Equipment		0.20	0.31	0.50
	Electrical Machinery	1985	0.20	0.21	0.28
	Non-Electrical Machinery		0.07	0.11	0.19
	Transport Equipment		0.03	0.06	0.10
	Electrical Machinery	Mean	0.06	0.01	0.00
		(s.d.)	(0.36)	(0.28)	(0.45)
	Non-Electrical Machinery		0.05	0.03	0.07
			(0.37)	(0.51)	(0.88)
	Transport Equipment		0.08	0.02	0.12
			(0.71)	(0.28)	(0.96)

1.8 SUMMARY AND CONCLUSIONS

This paper provides an empirical framework for the assessment of tax policy effects on the array of producer decisions concerning output supplies and input demands in Mexico, Pakistan and Turkey. A dynamic production structure model is specified and estimated for this purpose for selected industries in each of the countries.

<u>On the Elasticity of Rental Rate of Capital with Respect to Tax Instruments</u>: The tax sensitivity of rental rate of capital is quite inelastic with the single exception of its elasticity with respect to corporate tax rate in Mexico which is unitary (see Table S1). In Mexico, the rental rate of capital is most sensitive to corporate tax changes and relatively less to accelerated depreciations and investment tax credits. In Pakistan, the sensitivity ranking of three instruments is completely reversed and investment tax credit changes have the greatest influence on the rental rate of capital. In Turkey, the rental rate is more responsive to changes in investment allowances than accelerated capital consumption allowances (CCAs) or the corporate tax rate reductions.

Table S1

Elasticity of Rental Rate of Capital with Respect to Tax Measures

	e_{itc}	e_{ila}	e_{cca}	e_{cit}
Mexico (1983)	-0.409	-	-0.635	1.021
Pakistan (1984)	-0.386	-	-0.225	0.035
Turkey (1985)	-	-0.341	-0.099	0.101

On the Tax Sensitivity of the Capital Stock: The capital stock exhibits sensitivity to tax changes but this sensitivity varies by tax measure, by industry and by the adjustment period. Table S2 provides comparative evidence on the tax sensitivity of the capital stock by industry, by tax measure, and by adjustment period. For Mexico, elasticity estimates range from -0.014 to -0.043 for corporate tax changes; from 0.009 to 0.027 for CCAs; and from 0.006 to 0.017 for changes in investment tax credits. For Pakistani industries, the responsiveness of capital stock to changes in corporate income tax is quite small -- elasticity estimates range from 0.0002 to -0.006; for investment tax credit elasticity estimates range from 0.002 to 0.029; and finally for capital cost allowances between 0.001 and 0.017. The last two sets of elasticities are compatable with the ones obtained for the Mexican industries. For Turkish industries, changes in investment allowances matter more for the effects on capital formation than alternate tax measures. Specifically, elasticity estimates range from 0.013 to 0.052 with respect to changes in the investment incentive allowance; from 0.004 and 0.015 with respect to changes in the capital cost allowances; and from -0.004 to -0.015 with respect to changes in the corporate income tax.

On Benefit-Cost Ratios: The model results suggest that tax policy affected production and investment and further that some tax incentives were more effective than others in investment stimulation per government revenue loss (see Table S3). Among the incentives measures examined, investment allowances proved to be a cost-effective instrument for investment promotion only to Turkish industries; and investment tax credits and accelerated depreciation provisions had a mixed success while corporate tax reductions met with dismal failure in promoting investment in a cost-effective manner in all cases for all countries. In terms of their

Table S2

Tax Sensitivity of Capital Stock

	e_{kitc}			e_{kdia}			e_{kcca}			e_{kcit}		
	SR	IR	LR	SR	IR	LR	SR	IR	LR	SR	IR	LR
MEXICO (1983)												
Detergents	.012	.016	.017	-	-	-	.019	.024	.027	-.031	-.039	-.043
Other Chemical	.006	.007	.008	-	-	-	.009	.012	.013	-.014	-.019	-.021
PAKISTAN (1984)												
Apparel	.004	.008	.029	-	-	-	.002	.005	.017	-.0004	-.0007	-.003
Leather	.002	.003	.006	-	-	-	.001	.002	.004	-.0002	-.0003	-.006
TURKEY (1985)												
Electrical Mach.	-	-	-	.013	.04	.034	.004	.006	.009	-.004	-.006	-.009
Non-electrical Mach.	-	-	-	.021	.033	.052	.006	.009	.015	-.006	-.009	-.015
Transport Equipment	-	-	-	.020	.032	.051	.006	.009	.015	-.006	-.009	-.015

Table S3
Investment Expenditures per Unit Value of Lost Tax Revenue

	Impact		
Tax Instrument	Short Run	Intermediate Run	Long RunRun
Investment Tax Credit			
Mexico: Detergents Industries	0.44	0.51	0.54
Mexico: Other Chemical Industries	0.26	0.32	0.34
Pakistan: Apparel Industries	0.28	0.71	2.50
Pakistan: Leather Industries	0.11	0.28	2.54
Accelerated Capital Consumption Allowances			
Mexico: Detergents Industries	0.32	0.38	0.40
Mexico: Other Chemicals Industries	0.19	0.24	0.25
Pakistan: Apparel Industries	0.23	0.59	2.10
Pakistan: Leather Industries	0.09	0.23	2.13
Turkey: Electrical Machinery Industries	0.38	0.68	1.45
Turkey: Non-Electrical Machinery Industries	0.81	1.33	2.34
Turkey: Transport Industries	0.94	1.44	2.25
Corporate Income Tax Rate Reductions			
Mexico: Detergents Industries	0.03	0.04	0.05
Mexico: Other Chemicals Industries	0.01	0.01	0.01
Pakistan: Apparel Industries	0.001	0.0002	0.007
Pakistan: Leather Industries	0.00	0.00	0.00
Turkey: Electrical Machinery Industries	0.20	0.21	0.28
Turkey: Non-Electrical Machinery Industries	0.07	0.11	0.19
Turkey: Transport Industries	0.03	0.06	0.10
Investment Allowance			
Turkey: Electrical Machinery Industries	0.40	0.72	1.54
Turkey: Non-Electrical Machinery Industries	0.86	1.42	2.49
Turkey: Transport Equipment Industries	1.00	1.54	2.40

long-run impacts, investment tax credits were cost-effective in two of the four industries studied. Accelerated capital consumption allowances also registered a similar performance and had incremental benefit-cost ratio exceeding one in the long run for five out of seven industries studied. Corporate tax rate reductions stimulated investments but resulted in revenue losses exceeding this stimulative impact in all cases and in all runs considered in this study. Note that corporate tax rate reductions apply to a larger base of pre-tax profits than the smaller base of current investments relevant for investment tax credits. The long run cost-effectiveness of these incentives, except corporate tax rate reductions which proved cost-ineffective in all cases, varies by country. In Turkey, investment allowances and capital consumption allowances were cost-effective. In Mexico, both investment tax credit and accelerated capital consumption allowances were not cost-effective. In contrast, in Pakistan, both the investment tax credit and accelerated capital consumption allowances were cost-effective. In the intermediate run, defined as tax policy impact after one year, only the investment allowances and accelerated capital consumption allowances available to Turkish industries proved cost-effective.

In conclusion, selective tax incentives such as investment tax credits, investment allowances and accelerated capital consumption allowances are more cost-effective in promoting investment than more general tax incentives such as corporate tax rate reductions. In order to make selective tax incentives more effective, investment tax credits must be refundable and carry forward of investment and depreciation allowances be permitted. If stimulation of investment expenditure is the sole objective of tax policy, corporate tax rate reduction is not a cost-effective instrument to achieve this objective.

Endnotes

1. The model can be readily generalized to include multiple outputs. The production function is also assumed to be twice continuously differentiable, and quasi-concave in the inputs and net investments.

2. The issue of capital utilization is not addressed in this model. The problem of costly capital utilization implies that depreciation rates depend on prices, technology and market structure. Hence the use of existing measures of capital stocks would be inappropriate because service lives are assumed to be independent of prices and technology. Costly capital utilization implies that capital stock measurement and technology determination must be modelled simultaneously. This is an interesting, complex, but secondary problem to determining the effects of tax policy on output supply and input demand.

3. We abstract from introducing investment tax allowances. The model can be modified to include them along with capital cost allowances.

4. This assumption is the Mortigliani-Miller hypothesis. It is also possible that with market imperfections firms can influence the rate of return on their financial capital (see Steigum [1983] and Bernstein and Nadiri [1986] for dynamic models in this context).

5. The formula for the after tax purchase prices of the capital stocks can be simplified. If the discount rates are not expected to change then

   $Q_{is} = q_{is}\,(1 - v_{is} - (\sum_{\tau=0}^{\infty} u_{cs+\tau}(1 - \phi_{is}v_{is})\,d_{i\tau})/(1+\rho)^{\tau})$. If, in addition, the tax rates and

   credits are not expected to change then $Q_{is} = q_{is}(1 - v_i - u_c(1 - \phi_i v_i(\sum_{\tau=0}^{\infty} d_{i\tau}/(1+\rho)^{\tau})$.

   The latter is the more standard formula and is a special case of the after tax purchase price formula used in the model (see Hall and Jorgenson [1967, 1969] and Arrow and Kurz (1970)).

6. The inverse price elasticity and the conjectural elasticity are not assumed to be constant. Equation (12.1) contains their equilibrium magnitudes. The production function is also part of the first order conditions. The second order conditions are assumed to be satisfied. The symbol ∇ represents the gradient vector.

7. Recall that $\xi<0$ and $\theta>0$ so the last set of terms on the right side of equation (14), including the minus sign is positive.

8. The additional revenue and thereby profit arising from oligopoly power does not vary when it is evaluated at the equilibrium point. Thus the term affects the calculation of variable profit but does not affect the first order conditions characterizing an equilibrium As a consequence the expression can be ignored when defining shadow variable prof

9. The function is also twice continuously differentiable, homogeneous of degree one and convex in after tax prices, and concave in the capital inputs and net investment levels.

10. It is also assumed that the transversality conditions are satisfied. The symbol 0_m signifies a m dimensional vector of zeros.

11. Since depreciation rates for the sample industries are not available, Jorgenson and Yun (1991) estimates for U.S. industries were used. The depreciation rate for non-residential structures (0.025) was calculated as an average of the depreciation rates on various types of industrial structures. Inclusion of other types of buildings and structures did not alter the above depreciation rate significantly. The depreciation rate for producer durable equipment (0.10) was calculated as an average of the depreciation rates on a number of electrical, non-electrical and transportation machinery and equipment categories.

    Please note that while various studies use a range of depreciation rates, these are similar to the rates assumed here. For example, Epstein and Yatchew (1985) use a figure of 0.107 and Epstein and Denny (1983) use a range between 0.102 and 0.111.

12. See endnote No. 11.

13. See endnote No. 11.

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