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TAX REFORMS AND ASSET MARKETS

by
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THE INDUSTRIAL INSTITUTE FOR
ECONOMIC AND SOCIAL RESEARCH

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FOREWORD

On behalf of the Commission on Expenditures Taxation a study of alternative reforms of the income tax system is being carried out at IUI. Responsible for the project have been professor Agnar Sandmo and professor Bengt-Christer Ysander.

As part of this project, Jonas Agell from the University of Uppsala was asked to assess the short-run impact of alternative reforms on asset prices. The results of these simulation experiments are presented in this book.

Apart from the particular insights and policy conclusions to be drawn in regard to specific tax reform proposals the analysis of portfolio choices in the asset market and their dependence on fiscal policy should prove instructive and broaden the basis for future public debate on the taxation of capital.

Stockholm in August, 1985

Gunnar Eliasson

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I ASSET MARKETS, PORTFOLIO CHOICE, AND TAXES - AN INTRODUCTION*

I.1 The Issues

A well-known insight in public finance is the difficulties of implementing a practicable scheme of comprehensive income taxation based on a concept of "true" economic income. Standard stumbling blocks in this context is how to measure economic depreciation, and how to satisfactorily tax - and measure - accrued capital gains. As a result, all existing systems of income taxation treat the return on different types of savings very unevenly. Hence, the effective tax rates on different asset yields will depend on whether they occur as capital gain, dividend yield, or imputed income on consumer durables.

In addition to these features of any income tax system, the inflation experience of the 1970s has highlighted the potential distortionary effects caused by the interaction of inflation and nominal systems of income taxation. Some often cited inflation induced anomalies of the tax system are, first, the use of first-in-first-out (FIFO) inventory accounting and historic cost depreciation when calculating taxable corporate income; second, the taxation of nominal capital gains on

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corporate shares; and, finally, the deductibility of nominal interest expenses and the taxation of nominal interest income. As a result, the effective tax rates on the returns on different types of investment will also be sensitive to the rate of inflation.

The potential effects of existing systems of income taxation on the allocation of savings and investment have attracted much attention in the last decade. For example, a lot of recent academic work focus on tax induced effects of inflation on after-tax asset yields, asset prices, and the accumulation of physical capital in different sectors of the economy.[1] A similar interest can be noted among policy-makers, who in several countries have initiated major reports advocating tax reforms designed to eliminate the varied and inflation sensitive treatment of different forms of savings. For instance, Lodin (1976) in Sweden, the U.S. Treasury (1977), and the Meade committee (1978) in the U.K. have advocated the introduction of comprehensive schemes of personal expenditure taxation, whereas Lindencrona (1982) in Sweden and the Sandilands report (1975) in the U.K. have discussed different ways of indexing the personal and corporate income tax.

The purpose of the present study is to investigate the effects of alternative tax regimes at both the personal and corporate level on the short-run general equilibrium of the financial markets of the economy using a numerical simulation model. Our proposed model is developed using four distinct building blocks. The first is a balance sheet framework developed along the lines of Brainard and Tobin (1968) and Tobin (1969), identifying the assets and liabilities of different sectors of the economy. The second is the assumption that the asset preferences of financial investors are derived from maximization of expected utility. The third is an explicit recognition of different sources of risk facing investors, with due regard to the risk sharing facilities provided by the tax system. The fourth building block, finally, is a detailed modeling of the tax system at both the personal and corporate levels, incorporating the inflation induced non-neutralities of the tax system referred to in the introductory paragraphs.

The complete nonlinear general equilibrium system is parametrized and calibrated - using a special procedure - to make it replicate a rough version of the Swedish capital market, tax system and portfolio structure of 1980. This numerical framework is then used to simulate the impact of various alternative tax regimes, like introducing expenditure taxation, indexing the personal income tax, reforming the corporate income tax, etc. The simulation experiments allow us to examine the effects of different tax systems on the simultaneous determination of asset prices; means, variances and covariances of equilibrium returns on different assets; the level and distribution of wealth, capital income and risk-bearing across different types of investors; the incentives to accumulate physical capital in production sectors; and government expected revenue from different taxes.

Some of the limitations of our analysis should be stressed at the outset. In particular, underlying our analysis of the simultaneous equilibrium of financial markets is the modeling strategy of Tobin (1969), frequently adopted in financial economics: The focus is on the determination of the stock equilibrium of the financial sector, whereas "real" variables like production and stocks of physical capital are treated as exogenous - although possibly random - throughout the analysis. This separation of "financial" and "real" economic decisions has two obvious consequences. First, the long-run effects of alternative tax regimes on capital allocation and social welfare emphasized in the recent literature on applied "real" general equilibrium modeling (for a survey, see Shoven and Whalley, 1984) are beyond the scope of the present analysis. Second, by keeping nonfinancial economic variables fixed, we implicitly impose static expectations of investors, since they do not recognize that the initial response of asset markets to alternative tax regimes will have long-term repercussions on the real side. With forward-looking investors, these future dynamic developments would have a feedback on the initial tax effects on asset market equilibrium.

I.2 Review of the Literature

Before proceeding, it is instructive to briefly review some of the previous theoretical work on the effects of taxes on portfolio choice and asset markets. Very schematically, this work falls in two different categories: Partial equilibrium analysis of the effects of taxes on individual portfolio choice, and multi-market analysis of the effects of different types of taxes on the equilibrium pricing of risky financial assets.

The theoretical analysis of the impact of taxes on asset choice and individual risk-taking has been on the research agenda since the classical article by Domar and Musgrave (1944). Their analysis - implying that the introduction of a proportional income tax with full loss offset encourages risk-taking, since the government bears a part of any losses incurred - has been refined and generalized by later authors. Thus, Mossin (1968) and Stiglitz (1969) have investigated the effects of various types of taxes on the demand for risky assets using the von Neumann-Morgenstern model of expected utility maximization. Unfortunately, a general conclusion of these developments is that there are no unambiguous theoretical results concerning the effects of taxes on asset choice and risk-taking (see Sandmo, 1984, for a comprehensive survey of the literature) - all results depend on the precise formulation of the utility function and the specification of any special provisions of the tax system.

The impact of taxes on the general equilibrium valuation of risky financial assets has previously been examined by the adoption of a variant of the Capital Asset Pricing Model (CAPM). The basic one-period CAPM in the absence of taxes (see Sharpe, 1964, Lintner, 1965, and Mossin, 1966) starts with the micro-behavior of individual investors, derives their asset demand functions, and aggregates the individual demand schedules to obtain the equilibrium pricing relation of a given security as a function of observable market parameters (like the typical risky asset's covariance of return with the "market portfolio"; i.e. its systematic risk). The CAPM framwork was first extended to a capital market with income taxes by Brennan (1970). He derived an expression for the required risk premium on the jth security ($j = 1,\dots,n$) as a function of its dividend yield (since he assumes differential tax rates on dividends and capital gains), a variable reflecting the averages of the marginal tax rates on capital gains and dividends of investors, and - as before - its systematic risk. Although the tax version of the CAPM may - in principle - be used to address many issues concerning the impact of taxes on the capital market, it has so far not been applied very extensively. Some of the examples are the econometric analysis of Gordon and Bradford (1980) on the relative value of dividends and capital gains, theoretical work on corporate investment and financial policy (where the tax-CAPM is used as a valuation theory of the firm; see for instance Gordon, 1984) and the analysis by Elton and Gruber (1978) on the structure of investors' stock portfolios when security returns can be described by a tax-CAPM.

These theoretical developments have, of course, served as important sources of inspiration for the present analysis. However, there are distinct features that differentiates the present framework from earlier work. First, the purpose is not (unlike the theory of portfolio choice with taxes) to examine at a high level of generality the theoretical properties of idealized tax systems. Instead, the aim is to evaluate the workings of the actual tax system, with its diverse treatment of different assets and investors, and complicated mixture of nominal and real principles of income measurement. As a consequence, great care is taken to integrate a variety of special features of the present tax system at both the corporate and personal level in the asset market framework.

Second, whereas the tax-CAPM provides a useful general characterization of asset market equilibrium with personal taxes, the present paper develops no generalized pricing relations for different assets. Instead, the present paper incorporates an explicit portfolio choice approach into a balance sheet framework of the economy. This allows us to "go behind" the pricing relations of the tax-CAPM to investigate the implications of existing taxes and individual optimizing behavior for variables like the distribution of wealth and income, government tax revenue, etc.

Third, this study can be distinguished from the vast majority of earlier work on the effects of taxes on portfolio choice and asset markets by its reliance on simulation methods.[2] The advantage of the simulation approach is that it allows us to explore adjustment mechanisms, that are beyond the scope of smaller analytical models. Obviously, the negative aspect of many simulation models is that they are so large that they become impenetrable - consequently, the present model is purposely made rather small, emphasizing understanding rather than detail.

I.3 Plan of the Study

The study is organized in the following way. The second chapter develops the general equilibrium asset market framework underlying the simulation experiments of subsequent chapters. Section II.1 introduces the balance sheet framework of our hypothetical economy. The asset demands of investors are derived from maximization of expected utility in Section II.2. Section II.3 identifies the sources of risk facing investors, and goes on to specify the means, variances and covariances of asset yields. Finally, Section II.4 integrates the component parts of the earlier sections, and outlines the workings and numerical implementation of the financial sector equilibrium model.

In Chapter III, the complete general equilibrium model is parametrized using Swedish data for 1980, and a benchmark equilibrium is constructed using a special calibration procedure.

Chapter IV uses the model to simulate the effects of alternative tax regimes, and compares the outcomes - computed by using an optimization algorithm for solving nonlinear equation systems - with the 1980 benchmark equilibrium. Section IV.1 considers the effects of introducing personal expenditure taxation. The second section simulates the impact of indexing the personal income tax. The third section turns to different reforms of the corporate income tax. Section IV.4 examines the effect of joint reforms of the personal and corporate income tax. In particular, the impact of indexing the complete tax system is investigated; this amounts to examining the consequences of eliminating all inflation induced asymmetries of the Swedish system of capital taxation. Finally, Section IV.5 provides a guide to the sensitivity analysis of Appendix III, which examines the robustness of results with respect to some alternative model specifications.

Chapter V adopts a more intuitive approach, and discusses to what extent relaxing some of the framework's heuristic assumptions might make a difference to the results. Section V.1 examines some issues raised in earlier chapters concerning the role of different expectations assumptions when studying the effects of various disturbances on asset markets. Section V.2 discusses the potential effects of altering the notion of foreign investors and international capital flows underlying the simulation analysis. Section V.3 turns to the effects of our modeling of the demand for housing "as if" households' portfolio demand for housing assets can be treated separately from their consumption demand for housing services.

The sixth and concluding chapter briefly summarizes the basic insights, and suggests some straightforward extensions of the present analysis.

Appendix I and II give the derivations of some of the effective tax and depreciation rates used in the main text. Appendix III provides the sensitivity analysis underlying the discussion in Section IV.5. The first sensitivity test of this appendix involves examining the robustness of results to different types and degrees of risk. The second test quantifies the effects of introducing transaction costs in the model, whereas the third test checks the sensitivity of results to the assumptions concerning investors' attitudes towards risk.

Appendix IV, finally, develops an alternative perfect foresight model of stock market equilibrium with taxes, inflation, and endogenous capital formation. This analysis provides the formal underpinnings of the arguments in Section V.1, with a particular emphasis on, first, the role of different expectations assumptions when examining tax effects on asset markets; and, second, the dynamic effects of tax reform on capital accumulation and real share prices in a small open economy.

II THE MODEL

This chapter presents the equilibrium asset market framework underlying the simulation experiments of subsequent chapters. Section II.1 introduces the balance sheet framework of our hypothetical economy. The asset demands of investors are derived from maximization of expected utility in Section II.2. Section II.3 identifies the sources of risk facing investors, and goes on to specify the means, variances and covariances of asset yields. Finally, Section II.4 integrates the component parts of the earlier sections, and outlines the workings and numerical implementation of the complete general equilibrium asset market model.

However, let me first briefly elaborate on some of the general characteristics of the framework:

Financial stock equilibrium. As already mentioned, the basic modeling strategy is that of Tobin (1969): The focus is on the immediate stock equilibrium of the asset markets of the economy, whereas the real side is treated as an exogenous entity. Consequently, the comparative static experiments should be interpreted as being of a "snapshot" variety, implying the study of the first round impact of various tax changes on financial market equilibrium. Furthermore, a complete analysis of financial market equilibrium would require modeling the simultaneous, and interactive, behavior of cost minimizing firms - issuing an optimal mix of financial instruments and deciding upon an optimal dividend policy - and financial investors choosing the desired composition of their investment portfolios. The present model goes only a partial way in this direction, in the sense that it focuses attention on the endogenous determination of the portfolio equilibrium of financial investors, with only a crude notion of endogenous financial behavior of the agents of the real side of the economy.

The institutional setting and level of aggregation. All models of economic behavior are, of course, abstractions highlighting certain aspects of the complexities of the real world. This truism is not less true for the analysis of this study. Thus, the proposed model is aimed neither at describing the complex patterns of ownership, multitude of government regulations, and diversity of financial instruments that characterize many financial markets, nor to give an accurate forecast of the impact of changing tax regime. Instead, the aim is to use a consistent model to investigate potentially important asset market adjustments induced by different tax regimes. Consequently, the proposed model is designed to serve as a "tax-laboratory" providing a controlled and coherent benchmark when analyzing tax policy. Keeping this consistency requirement in mind, two guiding principles underlie the analytical framework. First, in order to facilitate interpretation, the level of asset and investor aggregation is high, emphasizing a few important aggregates. Second, the model tells an essentially walrasian story of tax induced asset market adjustments, emphasizing the portfolio choice of nonrationed agents - a feature that eliminates the need for specifying ad hoc rationing schemes.[3]

Heterogeneous stocks of physical capital. One of the aims of this study is to cast light on the interplay between the "real" and financial asset markets, and how the stock of corporate capital is valued vis-á-vis the housing stock. For this reason, a distinction is made between the predetermined stocks of physical capital in the corporate and housing sectors, respectively. Similar generalizations of the Brainard and Tobin balance sheet framework to the case of heterogeneous stocks of physical capital have previously been made by Smith and Starnes (1979), and Ebrill and Possen (1982b).

Treatment of housing assets. Owner-occupied housing will in the following be considered as a financial asset, which is subject to standard portfolio considerations. This "portfolio-view" of the demand for the stock of owner-occupied housing is based on the notion that an owner-occupier fulfils three - from an analytical point of view - distinct functions. First, he plays the role of a tenant, who pays an implicit rent for the user value of the house. Second, he can be seen as an entrepreneur, whose task is to earn (by selling owner-occupied housing services) the market rate of return on the capital of the owner of the house. Third, he plays the role of a financial investor, who bases the investment in owner-occupied housing on traditional portfolio considerations. This separation of economic decisions is further elaborated in the model, where it is assumed that the different functions are fulfilled by three separate agents. This simplifying device allows us to model an idealized household demanding housing assets merely for their portfolio characteristics.[4] The owner-occupied housing sector in itself is treated as a separate production sector, which is managed by special "housing-entrepreneurs" without proprietorship of the housing capital. The output of the sector is sold in the market for housing services, and the thereby established rent level defines the (exogenously given) pre-tax real rate of return on the housing capital. The equity capital of the owner-occupied housing sector consists of financial claims on the underlying real property - all transactions in housing equity takes place in a financial market. Hence, an owner-occupier is a household, that has bought a financial claim on the housing sector.

Heterogeneous categories of investors. Three types of financial investors are identified when defining asset market equilibrium. The first one is an institutional investor, whose empirical counterpart is a broad aggregate of financial institutions such as banks, pension funds, insurance companies, etc.[5] The other types are simply two different kinds of households (wealthy - respectively nonwealthy households) - a distinction being made for the purpose of capturing tax induced changes in the distribution of wealth, income, and risk-bearing. Since the different types of investors may face different tax rates, as well as having different attitudes towards risk, they can be expected to hold nonuniform investment portfolios.

The tax system. The main thrust of the present analysis is the integration of a carefully specified tax system in a simple model of asset market equilibrium. The corporate tax system is modeled recognizing tax incentives such as accelerated depreciation and initial investment allowances, while the specification of the tax system at the investor level includes both taxes on investment income (capital gains taxes, as well as taxes on dividends and interest income), and wealth taxes. Furthermore, we explicitly recognize the inflation induced distortions of the tax system mentioned in the first chapter. Also, the risk sharing provided by the tax system is modeled in detail, with due regard to the fact that different taxes provide very different risk sharing facilities depending on the assumed sources of risk.

Small open economy assumption. There is no explicit modeling of external capital flows and the links between domestic and international financial markets. However, the spirit of a small open economy is retained by a particular choice of numéraire in the numerical applications. Thus, it is assumed that the interest rate on short-term debt is determined exogenously - a case which can be most easily interpreted as applying for a small country facing perfect capital mobility.

Asset demand functions. Investors' asset demand functions are derived using a version of the mean-variance model of portfolio choice. As is well-known, mean-variance representation of preferences is consistent with the more fundamental idea of maximizing von Neumann-Morgenstern expected utility if (a) irrespective of the form of investors' utility functions, portfolio returns are normally distributed, or (b) investors' utility functions are quadratic.[6]

Numerical solutions. The model is solved numerically, and all comparative static experiments are performed using the complete nonlinear general equilibrium model. Thus, it is possible - since no linear approximations are involved - to examine the impact of discrete tax changes (like switching from an income to an expenditure tax).

II.1 The Balance Sheet of the Economy

The balance sheet of the economy is presented in Table 1, together with some notation. Rows denote the assets and debts of the model; the columns represent the different sectors. Six sectors are distinguished. First, there are - as already mentioned - three types of investors: wealthy households (H1), non-wealthy households (H2), and financial institutions (I). There are, second, two production sectors issuing financial claims on their respective (predetermined) stocks of physical capital: the corporate (C) and housing (H) sectors, respectively. Finally, there is a government sector (G) supplying government debt. I distinguish four different financial assets, being held by investors as claims against the two production sectors and the government. The equity of the corporate sector is ordinary shares (S), whereas the equity claims of the owner-occupied housing sector consist of special "owner-certificates" (O), entitling their owner with the right of disposition of the residual cash flow of that sector. There are two types of marketable debt, the first one being a one period bond (SD) with a variable nominal interest rate, and the second one being a consol (LD) with a fixed nominal coupon. These debt instruments are supplied by both the production and government sectors, which implies that government and private debt are treated as perfect substitutes. All asset values are defined in real terms. Thus, the real wealth of each of the three investors is given by vertical summation of the

Table 1 The balance sheet

	Wealthy households (H1)	Non-wealthy households (H2)	Financial institutions (I)	Government (G)	Corporate sector (C)	Housing sector (H)	Net total holdings
a. Financial assets							
1. Shares	S_{H1}	S_{H2}	S_I		$-q_C(1-b_{SD}-q_{LD}b_{LD})K_C$		0
2. "Owner certificates"	O_{H1}	O_{H2}				$-q_H(1-h_{SD}-q_{LD}h_{LD})K_H$	0
3. Short-term debt	SD_{H1}	SD_{H2}	SD_I	$-SD_G$	$-b_{SD}K_C$	$-h_{SD}K_H$	0
4. Long-term debt	LD_{H1}	LD_{H2}	LD_I	$-q_{LD}LD_G$	$-q_{LD}b_{LD}K_C$	$-q_{LD}h_{LD}K_H$	0
b. Real assets							
5. Stock of corporate capital					K_C		K_C
6. Stock of housing capital						K_H	K_H
7. Real wealth	W_{H1}	W_{H2}	W_I	W_G			

K_i = Physical stock of capital of production sector i (at replacement cost); i = C,H.

q_i = Tobin's q of the equity of production sector i; i = C,H,.

q_{LD} = Tobin's q of long-term debt.

S_i = Real value of shares in the wealth portfolio of investor i; i = H1,H2,I.

O_i = Real value of "owner-certificates" in the wealth portfolio of investor i; i = H1,H2.

SD_i = Real value of short-term debt in the wealth portfolio of investor i; i = H1,H2,I,G.

LD_i = Real value of long-term debt in the wealth portfolio of investor i; i = H1,H2,I.

LD_G = Accounting value of long-term government debt.

b_i = Proportion of the ith debt instrument used in the corporate sector; i = SD,LD.

h_i = Proportion of the ith debt instrument used in the housing sector; i = SD,LD.

elements of the respective columns (note that government net wealth W_G is negative). Some of the cells in the balance sheet might be empty. In particular, we assume throughout the present application that financial institutions do not hold "owner-certificates".

The outstanding volume of corporate shares (row 1, column 5) and corporate debt (row 3, column 5; row 4, column 5) is determined by the stock of physical, corporate capital. It is assumed, by appropriate choice of accounting units, that each unit of corporate capital commands a replacement cost of SEK 1. Since the total stock of corporate capital consists of K_C such units, and each unit has been financed by short- and long-term debt in the proportions b_{SD} and b_{LD}, respectively, it follows that $K_C(1-b_{SD}-b_{LD})$ is the equity once subscribed to by shareholders, and $K_C b_{SD}$ and $K_C b_{LD}$ the amounts once financed by short- respectively long-term debt. However, the current market values of corporate equity and long-term debt instruments may diverge from the current replacement value of the underlying capital stock. Consequently, we introduce the two variables q_C and q_{LD}, which define the real market prices of corporate shares and long-term debt relative to the reproduction cost of physical corporate capital. Recognizing that changes in q_{LD} generate equivalent capital gains or losses to equity holders, the real stock market value of corporate shares is defined as $q_C(1-b_{SD}-q_{LD}b_{LD})K_C$ (row 1, column 5). Similarly, the real market value of long-term corporate debt in the portfolios of financial investors is defined as $q_{LD}b_{LD}K_C$. Finally, there is no "q"-variable for short-term corporate debt - the outstanding volume of short-term debt is turned over in each period, so the real market value of short-term debt must coincide with the real amortization taking place in the same period.

The previously developed view on home-ownership, and the owner-occupied housing sector as a separate production sector, permits a treatment of the market for "owner-certificates" analogous to that of the corporate share market. Thus, it is assumed, by once more choosing appropriate accounting units, that each unit of housing capital commands a replacement cost of SEK 1. Since there are K_H such units, each one being financed by long-term debt in a proportion h_{LD}, short-term debt in a proportion h_{SD}, and an issue of "owner-certificates" in a proportion $(1-h_{LD}-h_{SD})$, it is implied that $K_H(1-h_{LD}-h_{SD})$ is the housing equity once subscribed to by owner-occupiers, and K_Hh_{LD} and K_Hh_{SD} the amounts once financed by short- respectively long-term debt. Recognizing the possibility of a discrepancy between the current reproduction cost of physical housing capital and the prices of owner-certificates and long-term debt, the real market value of the outstanding stock of owner-certificates can be written as $q_HK_H(1-h_{SD}-q_{LD}h_{LD})$ (row 2, column 6), where q_H is the corresponding Tobin's "q"-variable for housing equity. Similarly, the real market value of long-term housing debt is given by $q_{LD}K_Hh_{LD}$ (row 4, column 6), which makes - recognizing the outstanding ("book-keeping") value LD_G of long-term government debt - the total real value of long-term marketable debt in the portfolios of investors equal to $q_{LD}(K_Hh_{LD} + K_Cb_{LD} + LD_G)$. Finally, the real market value of short-term housing debt is given as K_Hh_{SD} (row 3, column 6), which in a similar manner gives a real market value of total short-term debt of $K_Hh_{SD} + K_Cb_{SD} + SD_G$.

II.2 The Asset Demand System

Let me now turn to the demand side and the specification of parametric asset demand functions - suitable for numerical implementation of the model - determining the asset holdings O_j, S_j, LD_j and SD_j (where j = H1,H2,I) of Table 1.

Underlying the optimal portfolio choice of the jth investor is a utility function of the general form:

$$U_j(\cdot) = U_j[W_j(1+r_j)]$$

where W_j = Investor's initial wealth
r_j = Single period rate of return on initial wealth.

$U_j(\cdot)$ is assumed to be an increasing strictly concave function of final wealth. Next, additional structure is imposed on the utility function by assuming that Arrow-Pratt's measure of relative risk aversion is a constant R_j:

$$R_j = -W_j(1+r_j)U''(\cdot)/U'(\cdot).$$

Solving this homogeneous second order differential equation gives

$$U_j(\cdot) = C_1 + \frac{C_0[W_j(1+r_j)]^{1-R_j}}{1 - R_j}$$

where C_0 and C_1 are the constants of integration. Next, $U_j(\cdot)$ is approximated by a second order Taylor's series expansion around $r_j = 0$. After rearranging, we find that

$$U_j[W_j(1+r_j)] \cong U_j(W_j) + C_0 W_j^{1-R_j}[r_j - \frac{R_j}{2} r_j^2].$$

Assuming that r_j is random with mean $\bar{r}_j$ and variance $\text{var}(\tilde{r}_j)$, it follows that

$$EU_j(\cdot) \cong U_j(W_j) + C_0 W_j^{1-R_j}[\bar{r}_j - \frac{R_j}{2} (\bar{r}_j^2 + \text{var}(\tilde{r}_j))]$$

which is equivalent to

$$EV_j(\cdot) \cong \bar{r}_j - \frac{R_j}{2}(\bar{r}_j^2 + \text{var}(\tilde{r}_j)),$$

since any linear transformation preserves the properties of the expected utility function. For small $\bar{r}_j$:s, it is the case that $\bar{r}_j^2$ is negligible, which makes the relation

$$EV_j(\cdot) \cong \bar{r}_j - \frac{R_j}{2} \text{var}(\tilde{r}_j)$$

hold as an approximation. This convenient mean-variance representation of preferences permits a straightforward analysis of the portfolio choice of the investor. Let $\bar{r}_j^i$ be the expected after-tax rate of return on an investment in the ith asset by the jth investor, $\text{cov}(\tilde{r}_j^i, \tilde{r}_j^k)$ the covariance of the returns on the ith and kth assets as expected by the jth investor, and x_j^i the proportion of the jth investor's wealth invested in the ith asset (i,k = S,O,SD,LD; j = H1,H2,I). Then the portfolio problem of the jth investor can be stated as a concave programming problem:

$$\max\ U_j(\bar{r}_j, var(\tilde{r}_j)) = \bar{r}_j - \frac{R_j}{2} var(\tilde{r}_j) \qquad (1)$$

$$\text{s.t. } x_j^O + x_j^S + x_j^{SD} + x_j^{LD} = 1,$$

$$\text{and } x_j^O,\ x_j^S,\ x_j^{LD} \geq 0,$$

$$\text{where } \bar{r}_j = x_j^O \bar{r}_j^O + x_j^S \bar{r}_j^S + x_j^{SD} \bar{r}_j^{SD} + x_j^{LD} \bar{r}_j^{LD},$$

$$var(\tilde{r}_j) = \sum_{i=O}^{LD} \sum_{k=O}^{LD} x_j^i x_j^k cov(\tilde{r}_j^i, \tilde{r}_j^k).$$

Thus, we assume the existence of short sales constraints for long-term debt, shares, and owner-certificates - but not for short-term debt. The investor's attitude towards risk is given by the constant R_j, which is greater than 0, and - as a local approximation for small $\bar{r}_j$:s - equivalent to Arrow-Pratt's measure of relative risk aversion.[7] The optimal portfolio of the representative investor consists of the column vector $\hat{x}_j^* = (*x_j^S, *x_j^O, *x_j^{SD}, *x_j^{LD})$ that maximizes (1) subject to the adding up and non-negativity constraints. Henceforth, we shall for ease of exposition assume, first, the existence of an interior solution ($*x_j^S, *x_j^O, *x_j^{LD} > 0$); and, second, that short-term debt is considered riskless ($cov(r_j^{SD}, r_j^k) = 0$ for k = S,O,SD,LD).[8] Then, the first-order Kuhn-Tucker conditions obtained when solving the portfolio problem (1) can be inverted in a recursive manner - due to the assumptions of Tobin's separation theorem being fulfilled - to obtain an explicit solution for the optimal portfolio fractions:

$$*\hat{x}'_j = \frac{1}{R_j} M_j^{-1} \hat{r}_j$$

$$*x_j^{SD} = 1 - *x_j^S - *x_j^O - *x_j^{LD} \qquad (2)$$

where $*\hat{x}'_j = (*x_j^S, *x_j^O, *x_j^{LD})$; a column vector.

M_j^{-1} = The inverse of the covariance matrix of after-tax real rates of return on risky assets (a matrix of rank 3).

$\hat{r}_j$ = $(\bar{r}_j^S - r_j^{SD},\ \bar{r}_j^O - r_j^{SD},\ \bar{r}_j^{LD} - r_j^{SD})$; a column vector.

The system (2) represents the asset demands of the investor conditional upon ownership of all the risky assets - there is a change in functional form whenever some of the non-negativity constraints are binding. Multiplying the left- and right-hand sides of (2) with initial wealth W_j gives the equivalent "value demand" functions corresponding to the elements of the 4 x 3 matrix in the upper left-hand corner of the balance sheet of Table 1:

$$\hat{D}_j^* = \frac{1}{R_j} M_j^{-1} \hat{r}_j W_j$$

$$SD_j^* = W_j - S_j^* - O_j^* - LD_j^* \qquad (3)$$

where $\hat{D}_j^* = (S_j^*, O_j^*, LD_j^*)$.

The derived demand system (3) expresses the jth investor's demand for the ith risky asset as a function of the elements $\bar{r}_j^i - r_j^{SD}$ of the expected excess return vector $\hat{r}_j$, the riskiness of the asset (defined by the variance-covariance matrix, as perceived by the investor), the parameter of risk aversion R_j, and initial wealth.

The demand system is homogeneous of degree one in initial wealth (implying unit wealth elasticities for all assets), and is linear in expected after-tax rates of return.[9]

II.3 Stochastic Modeling, and Means, Variances and Covariances of After-Tax Real Rates of Return

This section derives the means of post-tax returns on the four assets and the elements of the inverse covariance matrix M_j^{-1}. This requires specifying expressions for the uncertain rates of return on each asset as perceived by investors, recognizing a number of different factors - marginal productivities of capital in production sectors, tax rules, financial policies of production sectors, inflation, payout decision of corporate sector, etc. - that determine asset yields. Also, we must explicitly identify the sources of uncertainty generating the variances and covariances of after-tax real rates of return.

a Stochastic modeling

I will first turn to the sources of uncertainty generating the non-zero elements in M_j^{-1}. A complete analysis of risk and asset market equilibrium would explicitly incorporate several sources of uncertainty. For instance, one could recognize the possibility of uncertain general inflation, or postulate uncertainty in the form of random tax rates.[10] However, in the present context both general inflation and tax rates are presumed to be known with certainty. Instead, we assume the existence of two other distinct types of uncertainty (letting a tilde (~) indicate random variables):

(1) I assume that the production technologies and the relative prices of goods and housing services within the housing and corporate sectors are stochastic, causing income uncertainty. This is recognized by defining the pre-tax real rates of return to physical capital in these sectors as two random variables $\tilde{\rho}_C$ and $\tilde{\rho}_H$ (where C and H, as before, identify the production sectors).

(2) The source of the second type of uncertainty is investors' uncertainty concerning end-of-period asset market values of the risky assets. This type of uncertainty is henceforth termed capital uncertainty. In the present static framework, capital uncertainty is modeled by assuming that the exogenously given rate of nominal price increase of the ith risky asset is a random variable $\tilde{p}^i$ (i=S,O,LD), whereas the - likewise exogenous - general inflation rate is assumed to be a nonrandom variable p.[11]

Given assumptions (1) and (2), the sources of uncertainty in the economy is given by the 5-dimensional random vector $\tilde{X} = (\tilde{\rho}_C, \tilde{\rho}_H, \tilde{p}^S, \tilde{p}^O, \tilde{p}^{LD})$. $\tilde{X}$ is assumed to follow a multivariate normal distribution; i.e., we let $\tilde{X} \sim N(\Gamma, \Omega)$, where the vector Γ contains the means of random variables, and Ω is a symmetric 5 by 5 covariance matrix of full rank.

Basic capital market theory typically assumes that investors make identical - and correct - assessments of the distribution functions of stochastic variables (see for instance the Sharpe-Lintner-Mossin capital asset pricing model). The assumption of homogeneous expectations implies that - in the absence of taxes and transaction costs - investors will hold portfolios of identical composition. This unrealistic prediction has led to the development of alternative models, that by allowing for the possibility of heterogeneous probability beliefs of investors (see Lintner (1969), Sharpe (1970), Gonedes (1976), Williams (1978), Mayshar (1981)) suggest that agents may hold different portfolios. Here, I will follow this latter approach, and assume that each investor j due to incomplete information has to form subjective judgements Γ_j and Ω_j of the true mean vector Γ and covariance matrix Ω (index j denotes the subjectively held expectation of the jth agent).

b Uncertain after-tax real rates of return

I will next turn to the specifications of the uncertain real after-tax rates of return on each of the four assets as perceived by the jth investor. Derivations of the means, variances, and covariances of returns follow subsequently.

Corporate shares

The starting point is a unit of corporate capital, commanding a replacement cost of SEK 1. We then introduce the following assumptions and definitions:

(i) We let, as already mentioned, the subjectively perceived net pre-tax real rate of return to physical corporate capital be a random variable $\tilde{\rho}_{Cj}$, and denote the certain exponential rate of economic depreciation by δ_C. Then, at a given moment, the uncertain gross income per unit of corporate capital is $\tilde{\rho}_{Cj} + \delta_C$.

(ii) The firm is assumed to pursue an investment program that keeps the capital stock constant over time. At a given moment - using a continuous analysis - it therefore follows that the rate of replacement investment per unit of capital equals the rate of economic depreciation δ_C.

(iii) The representative firm is assumed to pursue a financial policy of keeping the real market value of corporate debt constant in the portfolios of investors. This implies that the nominal value of debt instruments at each instant must rise by the steady state inflation rate p times the market value of debt (i.e. the firm issues new debt). We thus assume that a buyer of bonds is obliged to increase the volume of his bond holdings at a rate corresponding to the rate of general inflation. The market price of the long-term bonds may vary over time, but the total interest payments from the fixed coupons will remain a constant share of the invested capital valued at reproduction cost (original cost indexed for general inflation). The cash inflow of new debt for the firms will at each moment equal the rate of inflation times the market value of short- and long-term debt. Per unit of capital at reproduction cost the firms' interest payments will thus at any given moment be $i_{SD}b_{SD} + i_{LD}b_{LD}$, while the inflow of new money will be $p(b_{SD}+q_{LD}b_{LD})$[12], where q_{LD} measures the discounted market price for long-term debt. Recognizing that all interest payments are deductible when calculating the corporate tax base, and letting τ be the statutory corporate tax rate, it is implied that the overall cash flow impact of corporate debt may be written as $p(b_{SD}+q_{LD}b_{LD}) - (i^n_{SD}b_{SD}+i_{LD}b_{LD})(1-\tau)$ per unit of corporate capital valued at reproduction cost.

(iv) Depreciation for tax purposes is allowed on a historic cost base at a constant exponential rate β. However, the use of historic cost depreciation leads, in an inflationary environment, to less than complete recovery of the acquisition cost of our single unit of corporate capital. Thus, for a given rate of replacement investment δ_C, the real value of tax depreciations in steady-state falls as the general inflation rate increases. Consequently, at a given instant it can be shown that (the signs of the partial derivatives are indicated in the parantheses):

$$a = a(\overset{(?)}{\beta},\overset{(-)}{p},\overset{(+)}{\delta_C})$$

where $a(\cdot)$ = Real value of depreciation allowances for tax purposes per unit of corporate capital.

β = Exponential rate of tax depreciation.

p = Steady-state rate of inflation.

δ_C = Rate of replacement investment and economic depreciation.

This general specification of the real value of tax depreciations will be used throughout the main text. The algebraic equivalent of $a(\cdot)$ - suitable for numerical implementation of the model - is derived and discussed in the Appendix.

(v) Assuming that our "representative" unit of capital is of the "sandwich" variety proposed by Feldstein and Summers (1978), it follows that each unit of corporate capital is a mix of machinery, structures, and inventories. Now, the Swedish corporate tax system implies the use of FIFO inventory accounting rules. This has well known consequences for corporate tax payments in times of inflation - the FIFO rules include purely nominal capital gains on inventories in the corporate tax base. Let ℓ be the fraction of inventory holdings per unit of "sandwich" capital. Then the inflation induced overstatement of real corporate profits is ℓp per unit of capital.

(vi) Finally, it is assumed that a fraction G of the current replacement investment δ_C qualifies for an investment allowance against income at the moment the investment cost is incurred. The tax saving of the investment allowance per unit of capital is then given by $\tau G\delta_C$.

The definitions and assumptions (i) to (vi) allow the real cash flow $\tilde{y}$ - after subtracting replacement investment at a rate δ_C - per unit of corporate capital to be written as

$$\tilde{y}_j = \tilde{\rho}_{Cj} - (i^n_{SD}b_{SD}+i_{LD}b_{LD})(1-\tau) + p(b_{SD}+q_{LD}b_{LD}) - \tau[\tilde{\rho}_{Cj} - (a(\beta,p,\delta_C)-\delta_c) - G\delta_C + \ell p].$$

At a given instant, $\tilde{y}_j$ is the residually determined income accruing to the owners of a single unit of corporate capital. The first term on the right hand side is the subjectively perceived real income per unit of capital. The sum of the second and third terms shows the real cost of corporate debt. The third expression, finally, defines the real amount of profit taxes paid, taking account of depreciation and investment allowances.

The next step is to consider the representative investor's return from holding a single corporate share constituting a claim on the residual income $\tilde{y}_j$. Now, following an established - but not entirely convincing - procedure, it is assumed that the firm distributes a fraction d of the real cash flow as dividends, whereas the remaining fraction (1-d) is ploughed back as retained earnings.[13] The real dividends per share, amounting to $d\tilde{y}_j$, are assumed to be taxed according to the marginal dividend tax rate u_j (where j = H1, H2, I) of the representative investor. The ploughed back profit, amounting to $(1-d)\tilde{y}_j$, is assumed to give rise to a real capital gain of $q_C(1-d)\tilde{y}_j$ (q_C is the already introduced Tobin's "q" variable for corporate equity), which is taxed on an accrual basis according to the effective capital gains tax rate g_j(j=H1,H2,I).[14]

Thus, abstracting from inflation and wealth taxes, it follows that the jth investor's after-tax income $\tilde{y}_j^a$ from a single share equals

$$\tilde{y}_j^a = \tilde{y}_j[d(1-u_j) + (1-d)(1-g_j)q_C].$$

Recognizing uncertain asset inflation and the taxation of shareholder wealth necessitates two modifications of $\tilde{y}_j^a$. First, since the current value of a single share is $q_C(1-q_{LD}b_{LD}-b_{SD})$, and the uncertain rate of change of the nominal share value as perceived by the jth investor is $\tilde{p}_j^S$, it is implied that the nominal stochastic capital gain at a given moment is $\tilde{p}_j^S q_C(1-q_{LD}b_{LD}-b_{SD})$ per share. This purely nominal capital gain is taxed at the effective tax rate g_j, which is levied symmetrically on both losses and gains. Consequently, the nominal after-tax capital gain $\tilde{p}_j^S q_C(1-q_{LD}b_{LD}-b_{SD})(1-g_j)$ can be translated into a corresponding real after-tax capital gain $(\tilde{p}_j^S(1-g_j) - p)q_C(1-q_{LD}b_{LD}-b_{SD})$. Second, the representative investor is assumed to pay wealth taxes on his shareholdings. Letting λ_S be the fraction of share value liable to wealth taxation, and w_j the wealth tax rate facing the jth investor, the real wealth tax payment per share becomes $w_j\lambda_S q_C(1-q_{LD}b_{LD}-b_{SD})$. Consequently, we obtain an inflation adjusted expression $\tilde{y}_j^{a\prime}$ defining the uncertain real after-tax income per share as perceived by the jth investor:

$$\tilde{y}_j^{a\prime} = \tilde{y}_j^a + (\tilde{p}_j^S(1-g_j) - p)q_C(1-q_{LD}b_{LD}-b_{SD}) - w_j\lambda_S q_C(1-q_{LD}b_{LD}-b_{SD})$$

It is now easy to define the jth investor's subjectively perceived random real after-tax rate of return on a single share; simply dividing $\tilde{y}_j^{a\prime}$ by $q_C(1-q_{LD}b_{LD}-b_{SD})$ gives:

$$\tilde{r}_j^S = \tilde{y}_j^{a\prime}/q_C(1-q_{LD}b_{LD}-b_{SD}). \tag{4}$$

Owner-certificates

Consider a unit of housing capital commanding a replacement cost of SEK 1. Let $\tilde{\rho}_{Hj}$ be the random real pre-tax rate of return (after economic depreciation) per unit of housing capital, and h_{LD} and h_{SD} the historically given proportions of long- respectively short-term debt finance. A fraction

k_j (where j=H1,H2) of the interest payments $i_{LD}h_{LD} + i^n_{SD}h_{SD}$ are paid by the government in the form of interest subsidies. Remaining interest payments are deductible in calculating the owner-occupier's taxable income, where the relevant tax rate - used in defining the consequent tax saving - is given by z_j (where j = H1,H2). Then, assuming that the owner-occupier maintains the real market value of existing debt in the portfolios of investors by issuing new debt at a rate coinciding with the general inflation rate p, the real after-tax cost of housing debt - per unit of housing capital - is given as

$$(1-k_j)(1-z_j)[h_{LD}i_{LD} + h_{SD}i^n_{SD}] - p(h_{SD}+q_{LD}h_{LD}).$$

Obviously, implicit in this specification is a simple representation of endogenous financial behavior of the housing sector equivalent to the already discussed financial response function of the representative firm. Thus, whenever q_{LD} changes, the representative owner-occupier alters both the instantaneous rate of new issues of long-term debt, as well as the steady state ratio of debt to total assets. The Swedish tax system then enters the picture in three additional ways. First, the owner-occupier has to declare a percentage ψ_j of the current market value V of the single unit of housing capital as imputed "housing-income". This income is taxed at the rate v_j. The market value of a unit of housing capital is defined as the current market value of the corresponding financial instruments used to finance the housing investment. Thus, recognizing the already introduced Tobin's "q" notation for long-term debt and "owner-certificates", it follows that

$$V = q_H(1-q_{LD}h_{LD}-h_{SD}) + q_{LD}h_{LD} + h_{SD},$$

implying tax payments of $v_j\psi V$ per unit of physical housing capital. Second, the wealth tax liability induced by holding a unit of housing capital equals $\lambda_O q_H(1-q_{LD}h_{LD}-h_{SD})w_j$, where λ_O is the fraction of housing equity liable to wealth taxation. Third, the present Swedish taxation of realized capital gains on owner-occupied housing is based on a complicated mixture of real and nominal principles. Thus, the overall impact of the existing tax system is to tax at least a fraction of purely nominal capital gains on housing capital. Let $\tilde{p}_j^O$ be the random rate of nominal price increase of owner-certificates as perceived by the jth investor, and c_j the relevant effective capital gains tax rate.[15] Then we define the nominal stochastic after-tax capital gain per unit housing equity as $\tilde{p}_j^O q_H(1-q_{LD}h_{LD}-h_{SD})(1-c_j)$, which can be translated into a corresponding real after-tax capital gain of $(\tilde{p}_j^O(1-c_j) - p)q_H(1-q_{LD}h_{LD}-h_{SD})$. After incorporating these features of the tax system, the real uncertain equity return equals

$$\begin{aligned}\tilde{e}_j = {} & \tilde{\rho}_{Hj} - (1-k_j)(1-z_j)[h_{LD}i_{LD}+h_{SD}i_{SD}^n] + \\ & p(q_{LD}h_{LD}+h_{SD}) - v_j\psi_j V + (\tilde{p}_j^O(1-c_j) - p)\cdot \\ & q_H(1-q_{LD}h_{LD}-h_{SD}) - \lambda_O q_H(1-q_{LD}h_{LD}-h_{SD})w_j,\end{aligned}$$

per unit housing capital. Dividing $\tilde{e}_j$ by $q_H(1-q_{LD}h_{LD}-h_{SD})$ gives the stochastic real after-tax rate of return - as perceived by the jth investor - on a single owner-certificate as

$$\tilde{r}_j^O = \tilde{e}_j/q_H(1-q_{LD}h_{LD}-h_{SD}). \tag{5}$$

Long-term debt

Consider the representative investor holding a long-term debt instrument (a consol), constituting a financial claim on the two production sectors and the government. The present purchase price of one unit of long-term debt is q_{LD} - a variable that may deviate from the replacement value of the underlying stocks of physical capital. The nominal nonrandom coupon associated with holding long-term debt is i_{LD}. This interest income is taxed at the rate m_j, yielding an after-tax return of $i_{LD}(1-m_j)$. The wealth tax liability induced by holding a unit of long-term debt is $\lambda_{LD}q_{LD}w_j$, where λ_{LD} is the fraction of investors' holdings of long-term debt liable to wealth taxation. Since the two production sectors - as well as the government - pursue a long-term financial policy of keeping the real market value of outstanding debt constant, it is assumed that any single unit of long-term debt obliges its owner to buy new long-term of a nominal amount pq_{LD} at each instant. The flow of new long-term debt issues give rise to a corresponding - but not equivalent - increase in the market value of investors' holdings of long-term debt. Letting $\tilde{p}_j^{LD}$ be the subjectively perceived rate of change of the nominal market value, the bondholder's expected capital gain can be written as $\tilde{p}_j^{LD}q_{LD}$. This can be translated into a corresponding stochastic real after-tax capital gain $(1-s_j)(\tilde{p}_j^{LD}-p)q_{LD}$, where s_j is the effective tax rate on accrued capital gains on long-term debt (levied symmetrically on both losses and gains), and it is recognized that new debt issues at the known rate p reduces the base of the capital gains tax. Then, we can write the subjectively perceived real after-tax rate of return on a single unit of long-term debt as:

$$\tilde{r}_j^{LD} = \frac{i_{LD}(1-m_j) - \lambda_{LD} q_{LD} w_j + (1-s_j)(\tilde{p}_j^{LD} - p) q_{LD} - p q_{LD}}{q_{LD}} \tag{6}$$

<u>Short-term debt</u>

Consider the jth investor holding SEK 1 of short-term debt (i.e., the safe asset). The non-random nominal interest rate is i^n_{SD}. This interest income is, again, taxed at the rate m_j, whereas the wealth tax liability induced by holding a unit of short-term debt is $\lambda_{SD} w_j$, where λ_{SD} is the fraction of the investor's holdings of short-term debt liable to wealth taxation. Recognizing the real loss of purchasing power of holding the asset at a given moment (corresponding to the new issues of nominal short-term debt by the two production sectors and the government), the certain real after-tax rate of return is given as

$$r_j^{SD} = i^n_{SD}(1-m_j) - \lambda_{SD} w_j - p. \tag{7}$$

c Means, variances, and covariances of after-tax real rates of return

Using the definitions (4) to (6), and the elements of the vector Γ_j and covariance matrix Ω_j, we can finally compute the means, variances and covariances of the real after-tax rates of return on the risky assets. First, taking the mathematical expectation of (4) to (6) yields the subjectively perceived means of after-tax real rates of return:

$$\bar{r}_j^S = \{\bar{y}_j^a + (\bar{p}_j^S(1-g_j) - p) q_C (1-q_{LD} b_{LD} - b_{SD}) - \lambda_S q_C (1-q_{LD} b_{LD} - b_{SD}) w_j\} / q_C (1-q_{LD} b_{LD} - b_{SD}) \tag{8}$$

$$\bar{r}_j^O = \{\bar{\rho}_{Hj} - (1-k_j)(1-z_j)(i_{LD}h_{LD}+i_{SD}^n h_{SD}) + p(q_{LD}h_{LD}+h_{SD}) - v_j\psi_j V + (\bar{p}_j^O(1-c_j) - p)q_H(1-q_{LD}h_{LD}-h_{SD}) - \lambda_O q_H(1-q_{LD}h_{LD}-h_{SD})w_j\} / q_H(1-q_{LD}h_{LD}-h_{SD}) \quad (9)$$

$$\bar{r}_j^{LD} = \{i_{LD}(1-m_j) - \lambda_{LD}q_{LD}w_j + (1-s_j)(\bar{p}_j^{LD}-p)q_{LD} - pq_{LD}\}/q_{LD} \quad (10)$$

where j = H1, H2, I; and bars over random variables denote their expected values.

Next, we turn to the subjective variances and covariances of after-tax real rates of return. Each element of M_j^{-1} will, in general, be a complicated function of the underlying variances and covariances of the elements of the 5-dimensional random vector $\tilde{X} = (\tilde{\rho}_{Cj}, \tilde{\rho}_{Hj}, \tilde{p}_j^S, \tilde{p}_j^O, \tilde{p}_j^{LD})$. In order to simplify the exposition, it is henceforth assumed that the variables causing income uncertainty ($\tilde{\rho}_{Cj}$ and $\tilde{\rho}_{Hj}$) are independent of the variables causing capital uncertainty ($\tilde{p}_j^S, \tilde{p}_j^O, \tilde{p}_j^{LD}$). Then, several of the entries in Ω_j become zeros, and the variances and covariances of M_j^{-1} are given as:

$$\mathrm{var}(\tilde{r}_j^S) = E(\tilde{r}_j^S-\bar{r}_j^S)^2 = \mathrm{var}(\tilde{\rho}_{Cj})(1-\tau)^2[d(1-u_j) + (1-d)(1-g_j)q_C]^2/q_C^2(1-q_{LD}b_{LD}-b_{SD})^2 + \mathrm{var}(\tilde{p}_j^S)(1-g_j)^2 \quad (11)$$

$$\mathrm{var}(\tilde{r}_j^O) = E(\tilde{r}_j^O-\bar{r}_j^O)^2 = \mathrm{var}(\tilde{\rho}_{Hj})/q_H^2(1-q_{LD}h_{LD}-h_{SD})^2 + \mathrm{var}(\tilde{p}_j^O)(1-c_j)^2 \quad (12)$$

$$\mathrm{var}(\tilde{r}_j^{LD}) = E(\tilde{r}_j^{LD} - \bar{r}_j^{LD})^2 = \mathrm{var}(\tilde{p}_j^{LD})(1-s_j)^2 \qquad (13)$$

$$\begin{aligned}\mathrm{cov}(\tilde{r}_j^S, \tilde{r}_j^O) &= E(\tilde{r}_j^S - \bar{r}_j^S)(\tilde{r}_j^O - \bar{r}_j^O) = \\ &= \mathrm{cov}(\tilde{p}_j^S, \tilde{p}_j^O)(1-g_j)(1-c_j) + \\ &\quad \mathrm{cov}(\tilde{\rho}_{Cj}, \tilde{\rho}_{Hj})(1-\tau)[d(1-u_j) + \\ &\quad (1-d)(1-g_j)q_C]/[q_C(1-q_{LD}b_{LD}-b_{SD}) \cdot \\ &\quad q_H(1-q_{LD}h_{LD}-h_{SD})]\end{aligned} \qquad (14)$$

$$\begin{aligned}\mathrm{cov}(\tilde{r}_j^S, \tilde{r}_j^{LD}) &= E(\tilde{r}_j^S - \bar{r}_j^S)(\tilde{r}_j^{LD} - \bar{r}_j^{LD}) = \\ &= \mathrm{cov}(\tilde{p}_j^S, \tilde{p}_j^{LD})(1-g_j)(1-s_j)\end{aligned} \qquad (15)$$

$$\begin{aligned}\mathrm{cov}(\tilde{r}_j^O, \tilde{r}_j^{LD}) &= E(\tilde{r}_j^O - \bar{r}_j^O)(\tilde{r}_j^{LD} - \bar{r}_j^{LD}) = \\ &= \mathrm{cov}(\tilde{p}_j^O, \tilde{p}_j^{LD})(1-c_j)(1-s_j)\end{aligned} \qquad (16)$$

The expectations concerning means, variances, and covariances of return on the risky assets may differ between investors because of, first, different tax rates facing investors; and, second, the possibility of heterogeneous expectations concerning the means, variances, and covariances of the exogenous random variables.

The crucial importance of the tax system in determining the riskiness of different assets is evident when inspecting (11)-(16). For instance, the riskiness of the earnings component of the return on corporate shares (the term involving $\mathrm{var}(\tilde{\rho}_{Cj})$ in Eq. (11)) is shared by the government through the corporate income tax as well as the taxes on investor's dividends and capital gains. On the other hand, the income uncertainty part of the variance of return on owner-certificates (the term including var($\tilde{\rho}_{Hj}$) in eq. (12)) is unaffected by the tax system; i.e. the procedure of taxing imputed housing income does not shield taxpayers from income risk. Also, the distinction between income and capital uncertainty has implications for the risksharing provided by the government, since the effective capital gains tax rates are different from the tax rates on other capital income. For instance, the tax system provides a better insurance against the income uncertainty part of the variability of share returns than it does against the capital risk component, since τ is generally larger than g_j.[16]

II.4 The Complete Model, and Its Numerical Implementation

The complete general equilibrium model is presented in Table 2, which integrates the component parts discussed in earlier sections. First, there are four wealth restrictions. Each investor is constrained by the condition that the real market value of their respective wealth portfolios must not exceed the value of their initial wealth (Eqs. b to d). The α_i:s and γ_i:s appearing in these equations define the initial wealth distribution of the economy. These individual restrictions have a correspondence at the macro-level, implying that the value of total real wealth must not exceed the value of the given endowments (Eq. a).

Equations e to h are the equilibrium conditions of the markets for - in turn - corporate shares, long-term debt, owner-certificates, and short-term

Table 2 The model

Wealth definitions

$$W = q_C(1-b_{SD}-q_{LD}b_{LD})K_C + q_H(1-h_{SD}-q_{LD}h_{LD})K_H + q_{LD}(K_Hh_{LD}+K_Cb_{LD}+LD_G) + K_Hh_{SD} + K_Cb_{SD} + SD_G \quad (a)$$

$$W_{H1} = \alpha_S q_C(1-b_{SD}-q_{LD}b_{LD})K_C + \alpha_H q_H(1-h_{SD}-q_{LD}h_{LD})K_H + \alpha_{LD}q_{LD}(K_Hh_{LD}+K_Cb_{LD}+LD_G) + \alpha_{SD}(K_Hh_{SD}+K_Cb_{SD}+SD_G) \quad (b)$$

$$W_{H2} = \gamma_S q_C(1-b_{SD}-q_{LD}b_{LD})K_C + \gamma_H q_H(1-h_{SD}-q_{LD}h_{LD})K_H + \gamma_{LD}q_{LD}(K_Hh_{LD}+K_Cb_{LD}+LD_G) + \gamma_{SD}(K_Hh_{SD}+K_Cb_{SD}+SD_G) \quad (c)$$

$$W_I = W - W_{H1} - W_{H2} \quad (d)$$

Asset market equilibrium

$$\sum_{j=H1}^{I} S_j^*(\hat{r}_j, M_j^{-1}, R_j, W_j) = q_C K_C(1-b_{SD}-q_{LD}b_{LD}), \quad j = H1, H2, I \quad (e)$$

$$\sum_{j=H1}^{I} LD_j^*(\hat{r}_j, M_j^{-1}, R_j, W_j) = q_{LD}(K_Hh_{LD}+K_Cb_{LD}+LD_G), \quad j = H1, H2, I \quad (f)$$

$$\sum_{j=H1}^{H2} O_j^*(\hat{r}_j, M_j^{-1}, R_j, W_j) = q_H K_H(1-h_{SD}-q_{LD}h_{LD}), \quad j = H1, H2 \quad (g)$$

$$\sum_{j=H1}^{I} SD_j^*(\hat{r}_j, M_j^{-1}, R_j, W_j) = K_Hh_{SD} + K_Cb_{SD} + SD_G, \quad j = H1, H2, I \quad (h)$$

where $S_j^*(\cdot), LD_j^*(\cdot), O_j^*(\cdot) > 0$.

<u>Elements of $\hat{r}_j$ and M_j^{-1}</u>

$$\bar{r}_j^i = \bar{r}_j^i(\Gamma_j, \hat{\tau}_l \ \ldots) \qquad \text{(i)}$$

$$\text{cov}(\tilde{r}_j^i, \tilde{r}_j^k) = \varepsilon(\Omega_j, \hat{\tau}_l \ \ldots) \qquad \begin{aligned} i,k &= S,O,LD,SD \\ j &= H1,H2,I \\ l &= H1,H2,I,C \end{aligned} \qquad \text{(j)}$$

where α_i = The first household's initial share of the outstanding value of the ith asset; i = S, LD, O, SD.

γ_i = The second household's initial share of the outstanding value of the ith asset; i = S, LD, O, SD.

debt. The supply of the respective assets on the right-hand side of the equality sign is in agreement with the balance sheet of Table 1. The elements in the demand functions on the left-hand side are those of the asset demand system (3). Non-negativity constraints are imposed on the asset demands for shares, owner-certificates, and long-term debt, whereas SD_j^* might be negative. Since investors respect their wealth constraints, Walras' law applies and one of the market excess demands is a linear combination of the asset demands on the three remaining markets. Consequently, the general equilibrium structure only determines a set of relative rates of return - all market determined rates of return must be expressed in terms of a <u>numéraire</u>.

Finally, I incorporate the tax system in a shorthand manner by defining $\hat{\tau}_l$ as a vector of tax parameters capturing all relevant aspects of wealth and capital taxation - on which I elaborated in Section II.3 - applicable to the lth agent (l = H1,H2,I,C). Then, the general expressions (i) and (j) are introduced in order to represent the already computed subjective means, variances, and covariances of real after-tax rates of return.

Consequently, the variables and parameters of the model may be classified in the following manner:

Tax parameters: $\hat{\tau}_{H1}, \hat{\tau}_{H2}, \hat{\tau}_I, \hat{\tau}_C$

Other parameters and exogenous variables: $\Omega_{H1}, \Omega_{H2}, \Omega_I, \Gamma_{H1}, \Gamma_{H2}, \Gamma_I, R_{H1}, R_{H2}, R_I, \alpha_S, \alpha_O, \alpha_{LD}, \alpha_{SD}, \gamma_S, \gamma_O, \gamma_{LD}, \gamma_{SD}, d, p, i_{LD}, SD_G, LD_G, K_C, K_H, b_{LD}, b_{SD}, h_{LD}, h_{SD}, \delta_C, \delta_H$.

Numéraire: i^r_{SD}

Endogenous variables: $W_j, W, q_C, q_H, q_{LD}, \hat{r}_j, M_j^{-1}$,

$S_j^*, LD_j^*, O_j^*, SD_j^*, i^n_{SD}$,

i^n_{LD} $(=i_{LD}/q_{LD})$; j = H1,H2,I.

This version of the model can be interpreted in terms of an unregulated capital market, where all rates of return - except the numéraire - are determined simultaneously on the different asset markets. For given values of parameters and exogenous variables (including the elements of the four tax vectors, and the subjectively perceived vector Γ_j and matrix Ω_j of the means, variances and covariances of the random exogenous variables), the model is solved for - assuming the existence of a unique solution - first, the means, variances and covariances of the equilibrium after-tax returns on the assets of the economy; second, the net wealth and portfolio composition of investors; and, finally, the real prices of common stock, owner-certificates, and long-term debt. Given this solution, we can solve in a recursive manner for the allocation of risk-bearing among investors, government expected tax revenue, etc. The numéraire is the real rate of interest on short-term debt. The natural interpretation of this particular choice of numéraire refers (as mentioned above) to the exogeneity of the real rate of interest in a small open economy being fully integrated with the world capital market.

The numerical implementation of the model is straightforward. The first task is to assemble a data set defining the initial equilibrium of the model.[17] This consists of numerical values of, first, the elements of the different tax vectors; second, exogenous variables like capital stocks valued at replacement costs, initial steady state borrowing fractions of the production sectors, value of government debt, steady state inflation, pay-out ratio of corporate sector, rates of economic depreciation, etc.; third, the parameters of initial wealth distribution; fourth, the numéraire; and, finally, initial equilibrium values of the endogenous variables of the model (net wealth and portfolio composition of investors, "q"-variables, etc.).

Given this "benchmark" equilibrium, the model is calibrated in such a manner that it reproduces the relevant equilibrium configuration. In principle, this calibration procedure involves solving the model "backwards" for the values of the (unobservable) elements of each subjectively perceived matrix Ω_j, the vectors of subjective means Γ_j, and the risk aversion parameters R_j, that make the solution of the model duplicate the benchmark equilibrium. However, the structure of the model does obviously not allow us to uniquely determine all these parameters - there is an underidentification problem, since the number of unknown parameters exceed the number of equations. Thus, additional exogenous information is required concerning a subset of these parameters before the other parameters can be uniquely identified.[18]

Of course, which subset of parameters to specify using extraneous information is at the researcher's own discretion. In the applications of the main text - with their emphasis on illustration and understanding rather than prediction - several simplifying assumptions will be made. First, the parameters of risk-aversion will be set with reference to some recent empirical evidence. Second, I will make use of Swedish data concerning the historical record of correlations among the real rates of return on shares, government bonds, and owner-occupied housing. Third, the marginal productivities of capital in production sectors will be considered as non-random exogenous variables (this rather restrictive assumption is relaxed in the sensitivity analysis). Finally, I will postulate homogeneous expectations of the subjective means of uncertain asset inflation.

Using these additional assumptions - together with the equilibrium data set - the model is calibrated by solving backwards for the three remaining elements on the principal diagonal of each subjective matrix Ω_j. In other words, the model is calibrated by determining the subjectively perceived variances of asset inflation $var(\tilde{p}_j^i)$ (i = S,O,LD; j = H1,H2,I). Next, the model is set for policy analysis. Thus, assuming a particular tax change, a new equilibrium solution is calculated - using the already computed elements on the principal diagonal of each matrix Ω_j - and the difference between the benchmark equilibrium and the policy replacement equilibrium defines the overall impact of the new tax regime.

Finally, since solving the model involves dealing with a highly nonlinear system of simultaneous equations, a few words on the numerical solution technique is in order. An equilibrium point for the model is computed using a version - included in the International Mathematical and Statistical Library (IMSL) - of Powell's hybrid method for nonlinear equation systems. This method is based on a combination of standard gradient (i.e. the method of "steepest descent") and Newton type methods, which takes advantage of the nice convergence properties of the gradient method, as well as the efficiency of the Newton method in the neighbourhood of a well behaved solution (see Thuné (1984) for a general presentation of Powell's hybrid method). One potential problem with this procedure is, of course, that the solution algorithm only establishes a locally valid equilibrium point; we can not exclude the theoretical possibility of multiple equilibria. However, repeated tests (which involved trying different initial guesses for the computational procedures) have not located any case of nonuniqueness in the region of economically meaningful solutions.

III PARAMETRIZATION, CALIBRATION, AND THE BENCHMARK ECONOMY

The benchmark equilibrium can be constructed using either an "invented" data set, or data derived from empirical sources. Here, I will follow the latter approach, and parametrize the model using Swedish data for 1980 concerning tax rates, stocks of physical capital of the two production sectors, initial values of endogenous variables, etc. However, in spite of the fact that the numerical model has certain characteristics in common with the real world, the analogue can for obvious reasons not be stretched very far. Thus, the chosen parametrization serves as a familiar background when analyzing some aspects of hypothetical tax regimes, but it is not intended as a starting point for forecasts about the actual impact of tax reform.

Let me briefly indicate some major problems - not discussed in the main text - associated with this particular 1980 parametrization and subsequent calibration. First, the idea of constructing a benchmark equilibrium for a general equilibrium model using empirical data, derived from an economy characterized by disequilibrium phenomenon and continuous adjustments, is of course a questionable one. Second, the available data is often inadequate and conflicting information is derived from different data sources, which provides ample room for arbitrary guesses. Third, there is a fundamental aggregation problem involved when going from complex reality to abstract model: The model identifies three representative investors and four financial assets, whereas the available statistical material accounts for a much wider spectrum of assets and investors. Finally, the calibration procedure - which involves solving the model "backwards" for parameter values making it perfectly fit a single benchmark data set - is, of course, not the same thing as an econometric test of the specifications of the model. Thus, there are substantial issues reinforcing the already stated case for regarding the present model as a "tax-laboratory" without forecasting ambitions. (Of course, this conclusion is equally applicable to most of the work being done within the soaring literature on applied "real" general equilibrium modeling; for further discussion, see Mansur and Whalley, 1984, and Shoven and Whalley, 1984.)

III.1 Value of Exogenous Variables and Initial Wealth Distribution

Steady-state inflation p and subjective means of uncertain asset inflation ($\bar{p}_j^S, \bar{p}_j^O, \bar{p}_j^{LD}$). The average rate of change of the consumer price index for the years 1978 to 1980 was 10 percent. As a consequence, I shall assume that the nonrandom rate of steady state inflation p is 0.1. Turning to the values of the elements of the three vectors of subjective means of asset inflation $\hat{p}_j = (\bar{p}_j^S, \bar{p}_j^O, \bar{p}_j^{LD})$, we assume, first, that each investor knows the "true" means of the random rates of asset inflation; and, second, that these means in stationary equilibrium equal the steady state inflation rate. Consequently, it is implied that $\hat{p}_j = (.1, .1, .1)$ for each investor j.

Subjective means of random real pre-tax rates of return ($\tilde{\rho}_{Cj}, \tilde{\rho}_{Hj}$). The true mean of the uncertain real pre-tax rate of return $\tilde{\rho}_C$ on physical corporate capital is set at 5 percent, whereas the mean of the random rate of return $\tilde{\rho}_H$ on housing capital is assumed to be 2 percent.[19] Once more assuming that investors have inferred the true means, we obtain $\bar{\rho}_{Hj} = .02$ and $\bar{\rho}_{Cj} = .05$ for each agent j.

Capital stocks (K_C, K_H). Södersten and Lindberg (1983) calculate the replacement value of the private corporate capital stock as SEK 460 billion in 1980. The 1980 stock of owner-occupied housing capital valued at replacement cost was SEK 420 billion.[20]

Initial values of borrowing fractions (h_{SD}, h_{LD}, b_{SD},b_{LD}). For the present purpose, the crucial distinction between short- and long-term debt is not the formal maturity to redemption, but the length of time a bond is running with a fixed coupon. In Sweden, the fixed-coupon period of formally long-term debt has been shortened side by side with the rising inflation of the 1970s (see SOU 1982:52). Today, most new bond loans have special clauses permitting the adjustment of coupon rates after five years. For this reason, I will in the following define debt with a fixed-coupon period of less than five years as short-term, whereas everything else is classified as long-term debt. Södersten and Lindberg (S-L) estimate the value of financial debt of the private corporate sector as SEK 244 billion in 1980. Of this total amount, there were SEK 31 billion of corporate bonds and debenture loans (see Löwenthal and Sjöberg, 1982) - both being debt instruments falling within the category "long-term" debt. Taking the ratio of the value of corporate debt to the replacement value of the total stock of corporate capital, it is implied that b_{LD} = 0.07 and b_{SD} = 0.46. In a similar manner, the short- and long-term debt fractions of the real estate sector are derived as h_{SD} = 0.14 and h_{LD} = 0.26.[21]

Stock of government debt (SD_G,LD_G). By the end of 1980, there were about SEK 105 billion of long-term government bonds being held by domestic lenders outside the central bank, whereas the commercial banks held apporoximately SEK 10 billion of short-term treasury bills.[22] Ignoring the outstanding volume of premium bonds and savings certificates held by household investors, it is implied that $SD_G = 10$ and $LD_G = 105$.

Rates of economic depreciation (δ_C, δ_H). Since I assume that a representative unit of corporate capital is a "sandwich" of machinery, structures, and inventories, it follows that the rate of economic depreciation δ_C becomes a weighted average of the depreciation rates for these three types of corporate assets. Using the calculations in S-L on the rates of economic depreciation for machinery and buildings in the industrial sectors "manufacturing", "other industry", and "commerce", assuming that the rate of economic depreciation is zero for inventories, and - finally - utilizing the figures in S-L concerning the distribution of the corporate capital stock among assets and industries in 1980, it is straightforward to derive an average rate δ_C across all assets and industries. This rate turns out to be 4 percent. The rate of economic depreciation δ_H in the housing sector is assumed to equal 1.4 percent - a figure corresponding to estimates used by the SCB.

Interest rates (i^n_{SD}, i_{LD}). The nominal coupon on long-term debt i_{LD} is set at 13.5 percent. This corresponds to the terms of new issues of long-term corporate bonds by the end of 1980. The short-term interest rate i^n_{SD} is set at 11.5 percent, which is a 1980 average of the 10.5 percent interest rate obtainable on household savings accounts, and the 12.5 percent payable on three months treasury bills held by financial institutions (source: Kredit och Valutaöversikt 1981:1).

Payout ratio (d). As evident from our specification of the real after-tax rate of return $\tilde{r}_j^S$ on shares, the dividend payment of the representative firm is based on a cash flow containing new debt - a circumstance that necessitates some care when interpreting the available data. Here, I assume d = 0.1, which is the average debt-adjusted payout ratio for the years 1978-80.[23]

Parameters of initial wealth distribution (α_i, γ_i; i = S,O,SD,LD). Here, my main reference is the HINK 81 study of the 1981 wealth distribution across Swedish households.[24] In the following, I define wealthy (non-wealthy) households as households with a net wealth exceeding (below) SEK 300 000. With this definition, the HINK 81 study indicates that 16 percent of Swedish households constitute wealthy households. Starting with the distribution of shareownership, estimates by Boman (1982) indicates that the total share of the household sector in its capacity as "final" shareholders is 54 percent. Out of this fraction, 86 percent is according to HINK 81 held by wealthy households. This implies that $\alpha_S = 0.46$, $\gamma_S = 0.08$ and $1 - \alpha_S - \gamma_S = 0.46$ (i.e. the share of financial institutions). Turning to the distribution of homeownership across households, the estimates of HINK 81 imply that $\alpha_O = 0.48$ and $\gamma_O = 0.52$. By the end of 1980, the aggregate household sector held the equivalent of SEK 175 billion of demand deposits and savings accounts (see Kredit och Valutaöversikt 1981:1). Together with the chosen parametrization - which sets the total supply of short-term debt in the model at SEK 280.4 billion - it is then implied that the overall household share of short-term debt equals 65 percent. According to HINK 81, 42 percent of household bank savings is held by wealthy households, which makes α_{SD} = 0.265, γ_{SD} = 0.365, and $1 - \alpha_{SD} - \gamma_{SD} = 0.37$.

Finally, turning to the supply of long-term debt, this particular parametrization implies a total supply of SEK 246.4 billion. Now, since I ignore long-term debt issued directly to the household sector (mainly premium bonds and government savings certificates), it follows that $\alpha_{LD} = 0$, $\gamma_{LD} = 0$ and $1 - \alpha_{LD} - \gamma_{LD} = 1$; i.e., the whole supply of long-term debt is held by financial institutions - an assumption used throughout the simulations.

III.2 Value of Tax Parameters

(i) Taxation of investors ($\hat{\tau}_{H1}, \hat{\tau}_{H2}, \hat{\tau}_I$)

Table 3 summarizes the chosen values of tax parameters of investors, based on the 1980 tax laws. First, my treatment of financial institutions deserves some discussion. As already mentioned, their empirical counterpart is a heterogeneous aggregate of tax exempt institutions (charities, insurance companies running pension plans of the so called P-type), banks, insurance companies (dealing with property insurance and non-pension life insurance of the so called K-type), etc. As a consequence, the ideal parametrization of the institutional tax rates (m_I, u_I, etc.) would be a set of average tax rates, reflecting the wide array of taxes and special clauses applying for the diversity of real world institutions. However, in the present application I will use a less ambitious approach, and simply assume that all institutions are tax exempt (m_I, = 0, u_I = 0, etc.).[25]

The starting point for the derivation of the tax rates of the two types of household investors are three separate pieces of empirical information. The first one is calculations in Palmer (1984), indicating that the 1980 Swedish average marginal tax rate facing household income falling within tax brackets above 50 percent is 67 percent. The second piece of information is an estimate in S-L which sets the 1980 average marginal income tax rate for households receiving interest income to 52 percent. Finally, according to HINK 81, the share of wealthy households (once more using SEK 300 000 as benchmark wealth) of total household bank savings is 42 percent. Now, by assuming (i) that the marginal tax rate of wealthy households corresponds to the average rate calculated in Palmer for the "above 50 percent" tax bracket, and (ii) that the marginal income tax of the jth household equals its marginal income tax on interest income [(i) and (ii) together imply that m_{H1} = 0.67], it is possible to derive a consistent estimate of the marginal income tax rate m_{H2} facing the interest income of non-wealthy investors. Thus, letting ε_{H1} be the fraction of total household interest income going to the wealthy households, using the definition

$$m = \varepsilon_{H1} m_{H1} + (1-\varepsilon_{H1}) m_{H2}$$

of the average marginal income tax rate (m) on ordinary interest income, and substituting the chosen numerical values of m, ε_{H1} and m_{H1}, it is implied that m_{H2} = 0.41. Next, keeping in mind that the presently implemented marginal tax reform

Table 3 1980 tax and subsidy rates (in percent)

Tax parameter	Investor (j) H1	H2	I
m_j	67	41	0
u_j	67	41	0
g_j	12[a]	7.5[a]	0
z_j	67	41	-
v_j	67	41	-
c_j	3[a]	2[a]	-
w_j	1	0	0
ϕ_j	2.4	1.2	-
k_j	23	23	-

Sources: See text.

[a] Effective capital gains tax rates are calculated using procedures discussed in Appendix II.

- with its implications for the tax deductibility of household interest expenses - is of no relevance for our stylized 1980 economy, and ignoring the temporary scheme - introduced in 1981 - of reducing the tax burden on dividends, it follows that the values of u_j, z_j and v_j must correspond to those of m_j.

The effective capital gains tax rate c_j on accrued capital gains on owner-occupied housing is calculated using the model proposed by Agell and Södersten (1982), whereas the effective tax rate g_j on accrued capital gains on shareholdings is estimated using a method developed by King (1977).[26] Turning to the taxation of household wealth, it is assumed that only the wealthy household is subject to taxation, and that $w_{H1} = 0.01$. (According to the 1980 tax code, net wealth exceeding SEK 200 000 is taxed using a progressive schedule, with a one percent tax levied on the first slice of taxable wealth.)

The imputed taxable income on owner-occupied housing is a percentage ψ_j of the market value of the house. A figure for ψ_j is derived as the product of a "nominal" imputation rate (given by the tax code as a percentage of the tax assessed value of the house) and the ratio of the house value as assessed by the tax authorities to the "true" market value. Assuming (i), that the assessed value of the house is 60 percent of its market value,[27] and (ii), that the "nominal" imputation rate is 4 percent on the housing wealth of wealthy households, whereas it is 2 percent on the housing wealth of less wealthy households (note that the schedule of imputation rates is progressive, implying that less expensive houses are taxed at lower rates), it is implied that $\psi_{H1} = 0.024$ and $\psi_{H2} = 0.012$. Government subsidies to mortgage interest expenses of owner-occupiers amounted to SEK 5 billion in 1980 (see SOU 1982:14). Now, in the model, the total amount of mortgage interest payments is given as $K_H(h_{LD}i_{LD} + h_{SD}i^n_{SD})$ - an amount that equals SEK 21.5 billion using the relevant parametrization. Assuming that both wealthy and non-wealthy households are admitted the same subsidy fraction k (k is defined in Section II.3) on their respective interest expenses (i.e. $k_{H1} = k_{H2} = k$), the value of k is easily obtained from the expression $k21.5 = 5$.

Finally, there are four parameters λ_i (i = S,O,SD,LD) defining the fraction of investors' holdings of the ith asset that is liable to wealth taxation. The 1980 Swedish tax law simply implies that λ_S, λ_{SD}, and λ_{LD} equal one, whereas $\lambda_O = 0.6$ (since the tax assessed housing value is assumed to be 60 percent of the market value).

(ii) The corporate tax system ($\hat{\tau}_C$)

Corporate tax rate (τ). Corporations pay income taxes at both the local and national levels. The national corporate income tax was 40 percent in 1980, whereas the local one averaged 29 percent across all Swedish municipalities. This implies that the total corporate tax rate τ is approximately 57 percent, since the local tax payments is deductible (with a one year time lag) when calculating the national corporate income tax liability.

Rate of depreciation for tax purposes (β). One of the determinants of the real value of corporate depreciation allowances $a(\cdot)$ for tax purposes (see Appendix for the specification of $a(\cdot)$) is the exponential rate β of tax depreciation. The derivation of β is relatively straightforward, once it is recognized that, (i), we have to account for all the special tax clauses applying for corporate capital held in the form of inventories, machinery, and structures, since we are dealing with physical capital of the "sandwich" variety - a circumstance that effectively makes β an average depreciation rate across different assets; (ii), the depreciation rates as given by the tax law are often "straight-line", which necessitates a special transformation procedure in order to make them comparable with the "declining balance" average rate β.

The starting point is a SEK 1 "sandwich" unit of corporate capital. Let m be the share of machinery, ℓ the share of inventories, and b the fraction of structures. Keeping in mind that the firm is assumed to pursue an investment program that keeps its stock of capital constant over time, the replacement investment per unit of capital can be written as $\delta_C = m\delta_m + b\delta_b + \ell\delta_\ell$, where δ_i is the rate of economic depreciation on the ith type of asset ($i = m,b,\ell$). In accordance with the Swedish tax law, it is assumed that the replacement investment at a given moment is written off for tax purposes in the following manner: The fraction $m\delta_m$ is written off on a declining balance base with a proportion β_m, the share $b\delta_b$ is written off on a straight line base with a fraction β_b during $1/\beta_b$ years, and the purchase $\ell\delta_\ell$ of inventories gives rise to an initial one time deduction of β_ℓ against taxable corporate income.[28] Then, denoting the corporate discount rate by a parameter Θ, the present value of depreciation allowances A is - once more using a continuous analysis - given as

$$A = m\delta_m A_m + b\delta_b A_b + \ell\delta_\ell A_\ell,$$

$$\text{where } A_m = \beta_m \int_{t=0}^{\infty} e^{-(\Theta+\beta_m)t} dt$$

$$A_b = \beta_b \int_{t=0}^{1/\beta_b} e^{-\Theta t} dt$$

$$A_\ell = \beta_\ell.$$

Our problem now consists of finding an average declining balance depreciation rate β on the instantaneous replacement investment δ_C that makes the expression

$$S = \beta\delta_C \int_{t=0}^{\infty} e^{-(\Theta+\beta)t} dt$$

equal A. Setting A = S and solving for β finally gives

$$\beta = \Theta A/(\delta_C - A).$$

According to the Swedish tax law of 1980 $\beta_m = 0.3$, $\beta_b = 0.04$, and $\beta_\ell = 0.6$. Also, the value of δ_C has been derived as 0.04, whereas by assumption $\delta_\ell = 0$. Furthermore, letting $\Theta = 0.12$, and using the S-L figures on the percentage composition of the private corporate capital stock ($m = 0.323$, $b = 0.341$, $\ell = 0.336$), it is implied that the average exponential depreciation rate β is 20 percent.

<u>Value of investment allowance</u> ($G\delta_C$). It is assumed that a fraction G of current replacement investment at the rate δ_C qualifies for an investment allowance against income at the moment the investment cost is incurred. Now, keeping a representative unit of sandwich capital intact over time requires instantaneous replacement investments at a rate $m\delta_m + b\delta_b$. Let G_m and G_b be the shares of investments in machinery respectively buildings that qualify for investment allowances. It is then implied that the overall investment allowance $G\delta_C$ can be written as $m\delta_m G_m + b\delta_b G_b$ per unit of sandwich capital. Once more using the relevant figures for m, b, δ_m and δ_b, and adopting the 1980 tax

incentive scheme - giving $G_m = 0.2$ and $G_b = 0.1$ - it is implied that $G\delta_C = 0.007$.

<u>Value of depreciation allowances</u> $(a(\beta, p, \delta_C))$. Using the parametric function - derived in the Appendix - for the real value of tax depreciations per unit of "sandwich" capital, and substituting the relevant values of β, p and δ_C, we find that $a(\cdot) = 0.027$.

III.3 Benchmark Equilibrium Values of Endogenous Variables

The initial values of the endogenous "q"-variables (q_C, q_H, q_{LD}) remain to be specified. First, the 1980 value of q_C - value of stock market relative to replacement value of corporate equity - is taken to be 0.35.[29] Second, it is assumed that q_{LD} equals 1; this implies that new issues of long-term debt takes place at par value. Third, Tobin's q of the owner-occupied housing sector is given as $q_H(1-h_{SD}-q_{LD}h_{LD}) + q_{LD}h_{LD} + h_{SD}$. According to a recent estimate, the value of this variable was 1.18 in 1980.[30] Using this information, together with the assumed values of h_{SD}, h_{LD}, and q_{LD}, it is finally implied that $q_H = 1.3$ in the initial equilibrium.

III.4 Calibration

Given the benchmark data set described above, and the asset market framework of Chapter II, the model is solved "backwards" for a set of parameters that makes it duplicate the 1980 benchmark economy. The parameters to be solved for are the riskaversion coefficients R_j, and the elements of the subjective covariance matrices Ω_j (j = H1,H2,I). However, as already noted in Section II.4, the structure of the model does not allow us to determine all these parameters. Therefore, some additional exogenous information is required concerning the values of a subset of these parameters before the others can be uniquely identified. Here, three additional sources of information will be used. The first one concerns the values of the riskparameters (which as local approximations are equivalent to Arrow-Pratt's measure of relative risk aversion); second, we assume that the marginal products of capital in the two production sectors are nonrandom; third, we use information provided by the historical record of correlations among the real pre-tax rates of return on corporate shares, government bonds, and owner-occupied housing. Given this additional information, it is straightforward to uniquely identify the value of the (before capital gains tax) variance of asset inflation - $var(\tilde{p}_j^i)$ - of each risky asset i as perceived by the jth investor.

Let me first turn to the values of the R_j:s. Here, I shall assume $R_j = 6$ for each type of investor. This assumption is based on recent results obtained by Friend and Hasbrouck (1982), who estimated a generalized equilibrium asset pricing model - in which portfolio decisions were affected by human wealth - using cross-sectional U.S. data on household asset holdings.[31] Of course, assuming that Arrow-Pratt's measure of relative risk aversion equals six across all investors is a strong simplification. Thus, in reality it seems likely that R_j will vary across different types of investors due to underlying socioeconomic factors (see

Friend and Blume (1975) for a brief discussion). However, these additional complications are beyond the illustrative purpose of the present study.

Second, although the analytical framework explicitly incorporates both income and capital risk, we will abstract from the former in the applications of the main text (see the sensitivity analysis of Appendix III and the discussion in Section IV.5 for a treatment of both types of uncertainty). This involves setting all elements in the matrix Ω_j involving $\tilde{\rho}_{Cj}$ and $\tilde{\rho}_{Hj}$ equal to zero. Then we can cross out all but 3 rows and 3 columns of Ω_j, leaving us with a 3 by 3 submatrix of subjectively perceived variances and covariances of random rates of asset inflation. An empirical rationale for ignoring income risk is its minor importance compared to capital risk. For instance, the standard deviation of the annual pre-tax real rate of return on total corporate capital was about 1.5 percent for the 1970-79 period (according to figures in Uutma and Hållsten (1981)), whereas the standard deviation of the annual rate of change of the "Affärsvärldens" common stock index was 16 percent for the same period. Thus - in the terminology of the analytical framework - the variability of $\tilde{\rho}_C$ is only 9 percent of the variation in $\tilde{p}^S$, indicating that the yearly revaluations on the stock market are the major source of risk facing stock market investors.

Finally, Table 4 presents information on the Swedish historical record of pre-tax real rates of return on each of the risky assets of the model for the period 1960 to 1979. The first column gives the real rate of return (including dividends and capital gains) on corporate shares; the second

Table 4 Annual pre-tax real rates of return 1960-79

In percent

	Corporate shares	Bonds	Owner-occupied housing		Corporate shares	Bonds	Owner-occupied housing
1960	0	1.33	-3.01	1970	-21.81	2.28	5.32
61	0.74	3.13	3.23	71	16.15	-0.84	-3.70
62	-7.97	1.07	1.86	72	6.96	0.67	0.66
63	23.44	1.82	4.14	73	-3.44	-0.10	1.02
64	15.09	2.00	6.43	74	-6.21	-1.46	-4.48
65	4.71	0.71	1.32	75	19.97	-1.94	9.74
66	-23.53	-0.01	1.38	76	-4.77	-1.44	4.24
67	2.57	0.64	0.78	77	-19.73	-0.80	2.98
68	35.43	4.47	5.18	78	8.06	-1.10	2.07
69	2.23	3.46	4.12	79	-2.63	2.66	2.14
Mean	2.26	0.83	2.26				
Std.Dev.	15.04	1.81	3.44				

Correlation coefficients:

	Shares
Bonds	0.23
Owner-occupied housing	-0.22

Method and sources: All real rates of return were calculated using the exact formula $r_t^i = 100 \times (\frac{1 + (\text{nominal effective return})_t}{1 + (\text{inflation rate})_t} - 1)$, where r_t^i is the real pre-tax rate of return on the ith asset in year t. The implicit GNP deflator was used as our measure of inflation. The data on the nominal effective average rate of return on corporate shares listed on the Stockholm Stock Exchange was provided by the Financial Analysts Department of the Svenska Handelsbanken. Data on the nominal bond yield was taken from various issues of the Yearbook of the Riksbank, which contains yearly average figures on the actual yield on government bond loans with 15 years to maturity. (Note that the bond returns for 1978 and 1979 are those on government bonds with ten years to maturity.) The nominal return on owner-occupied housing is measured as the rate of price increase of houses of unchanged quality; data for the years 1960 to 1970 was provided by Lennart Berg, Department of Economics, University of Uppsala, whereas data for 1971 to 1979 are from the SCB (SM P 1984:10). (Obviously, this price series underestimates the "true" return to housing in the sense that it ignores the value of the implicit service flows provided by owner-occupied housing.)

column presents the real effective yield per year obtained by maintaining a portfolio of Swedish government bonds with 15 years to maturity; the third column, finally, gives the real rate of yearly price increases of owner-occupied homes of unchanged quality (see the bottom of table for more details on the method and sources underlying the calculations). Focusing attention on the correlation coefficients presented at the bottom of Table 4, it is observed that the returns on bonds and shares are positively correlated, whereas the returns on corporate shares and residential real estate are negatively correlated (the correlation coefficient is -.22). This implies that the representative household investor for this particular time period could have used investments in owner-occupied homes to hedge his position in corporate stocks; in principle the representative household investor could have diversified even to the extent of eliminating <u>all</u> risk. Using this historical information as a crude indication, it is assumed that (i) the financial institutions of the model perceive the correlation coefficient of rates of price increase of shares and long-term debt to be .25; (ii) both the wealthy and non-wealthy households expect the correlation coefficient for the rates of price increase of corporate stock and owner-occupied housing to be -.2.

Using this additional information on riskparameters, income uncertainty, and correlation coefficients, we have finally reduced the number of free parameters of the general equilibrium system to such an extent as to allow us to uniquely calibrate the model. Thus, with the given parametrization, the model is solved "backwards" for the subjective after-tax variances of asset inflation on the principal diagonal of each covariance matrix Ω_j. The resulting variances are as follows:

	$var(\tilde{p}_j^S)$	$var(\tilde{p}_j^O)$	$var(\tilde{p}_j^{LD})$
Household 1	0.252	0.033	-
Household 2	1.895	0.021	-
Financial Institutions	0.060	-	0.005

These variances are, of course, not comparable to the dispersion measures at the bottom of Table 4. Thus, they are subjectively perceived ex ante figures derived when calibrating a theoretical equilibrium model, whereas the standard deviations of Table 4 are ex post measures. It is nevertheless reassuring that the "equilibrium" variances conform to the general pattern of ex post standard deviations, implying a substantial riskiness of shares as compared to owner-occupied housing and bonds. Other interesting things to note are the household investors' perceptions of - compared to the subjective expectations of financial institutions - high variances of price incréase of shares.

At a lower level of abstraction, this result is compatible with empirical evidence on the structure of household share portfolios, indicating that households hold substantially less well diversified stock portfolios than institutional investors; see for instance Blume and Friend (1975), Lease, et al. (1974), and the discussion in McDonald (1974). (The Blume and Friend study -

based on a sample of 17,000 individual U.S. income tax forms filed for the 1971 tax year - suggested that fifty percent of individual shareholders held no more than two different security-items.) Also, econometric analysis of the composition of household portfolios strongly indicates that the extent of financial diversification tends to increase with household net wealth (see Uhler and Cragg (1971), King and Leape (1984), and Agell and Edin (1985)). Consequently, in the terminology of the basic CAPM framework of Sharpe, Lintner, and Mossin, we would expect non-wealthy households to bear more unsystematic (diversifiable) risk in their corporate share portfolios than do their wealthier counterparts, who in turn bear more diversifiable risk than financial institutions.[32] This indicates that an investor's subjectively perceived risk of investments in corporate shares ought to be negatively correlated with net wealth, since larger wealth induces diversification, which in turn reduces unsystematic risk.

III.5 The Benchmark Economy

Using the above parametrization and calibration, the model is solved numerically. Some of the resulting information is reported in Table 5. This will be our norm of comparison in the ensuing simulation experiments. The results of the table are, for a number of reasons, not an exact replication of the Swedish capital market of 1980. Nevertheless, they share the same basic characteristics as the actual 1980 outcome.

The value of the stock exchange is only 23 percent of the equity value of the real estate sector - a circumstance that reflects the contemporaneous decline in real share prices and increase in real estate values that occurred during the 1970s, with 1979 marking the final year of these price developments (see Table 4). Basically the same information is conveyed in the Tobin's "q" variables (defined at the bottom of Table 5) of the housing and corporate sectors, respectively. Introducing these two variables serves the purpose of introducing some "real" aspects into the discussion - we will at any given instant consider the values of these variables as measures of the incentives to accumulate new physical capital in production sectors (see Tobin, 1969, for the basic reference). Then, it can be expected that the calculated values of the "q"-variables (q_C^T = 0.69 and and q_H^T = 1.18) constitute a substantial disincentive to investments in physical corporate capital, and a corresponding incentive to the accumulation of housing capital.[33] In Sweden, as well as in many other western industrialized countries, there has throughout the 1970s been both public and academic concern that various inflation induced "non-neutralities" of the tax system (formalized in Section II) induces "overinvestment" in housing capital at the expense of more "productive" corporate capital. (See for instance several of the papers in Feldstein (1983) for an analytical treatment of this particular issue.) We will in the ensuing simulation experiments interpret changes in the ratio of the "q"-variables (q_C^T/q_H^T) as an indication of tax induced changes in instantaneous incentives to invest in new physical capital in the corporate vis-a-vis housing sectors.

It is furthermore implied that the aggregate of financial institutions holds SEK 384 billion of

Table 5 The 1980 benchmark economy: Equilibrium values of selected endogenous variables

Value of stock exchange	= SEK 75.7 billion			
Value of housing equity	= SEK 327.6 billion			
Value of housing stock	= SEK 495.6 billion			
Tobin's q of corporate sector (q_C^T)[a]	= .69			
Tobin's q of housing sector (q_H^T)[a]	= 1.18			
q_C^T/q_H^T	= .58			
Wealth of wealthy households (W_{H1})	= SEK 266.4 billion			
Wealth of non-wealthy households (W_{H2})	= SEK 278.8 billion			
Wealth of financial institutions (W_I)	= SEK 385 billion			
Total private wealth (W_p)	= SEK 930.2 billion			
Real effective interest rate on long-term debt	= 0.035			
		H1	H2	I
Expected after-tax real rate of return on corporate shares		.025	.046	.063
Expected after-tax real rate of return on housing equity		.027	.038	-
Expected after-tax real rate of return on short-term debt		-.072	-.032	.015
Expected after-tax real rate of return on long-term debt		-	-	.035
Real after-tax rate of return on total portfolio ($\bar{r}_j^p$)		-.001	.012	.032
Real after-tax rate of return on total private wealth ($\bar{r}_{Wp}$)		= .017		
Distribution of real after-tax capital income				
Share of wealthy households[b]		=-.015		
Share of non-wealthy households[b]		= .219		
Share of financial institutions[b]		= .796		
		1.000		
Allocation of risk-bearing				
Share of wealthy households[c]		= .457		
Share of non-wealthy households[c]		= .312		
Share of financial institutions[c]		= .231		
		1.000		

[a] q_C^T and q_H^T are defined as

$$q_C^T = (1-b_{SD}-q_{LD}b_{LD})q_C + b_{LD}q_{LD} + b_{SD}, \text{ and}$$

$$q_H^T = (1-h_{SD}-q_{LD}h_{LD})q_H + h_{LD}q_{LD} + h_{SD}.$$

[b] Calculated according to text.

[c] Calculated according to text.

financial assets, which makes it the largest investor of the model. The wealth of less wealthy households is in turn slightly larger than the total wealth of their wealthier counterparts; a circumstance being due to the fact that total holdings of short-term debt and owner-certificates are skewed towards the less wealthy households. (See Section III.1 for information on the initial portfolio composition of investors.)

The computed expected equilibrium real after-tax rates of return indicate the considerable discrepancies in the tax treatment across assets and portfolio investors. Thus, the returns range from the -7.2 percent obtained on wealthy households' holdings of riskless debt, to the 6.3 percent received by financial institutions holding corporate equity. Weighing the equilibrium rates of return across the asset portfolios of the investors then produces information on the average real after-tax rates of return on their respective total portfolios. These measures exhibit a much more uniform picture, with a spread between maximum (financial institutions) and minimum (wealthy households) average real rates of return of less than four percent - a not very surprising result, since the portfolio choices of agents maximizing expected utility underlie the utilized portfolio weights. Aggregating across investors then permits calculating the expected real after-tax rate of return $\bar{r}_{Wp}$ available on the total stock of financial capital. Then, the share σ_j of the jth investor of total real after-tax capital income can be calculated as $\sigma_j = \bar{r}_j^p W_j / \bar{r}_{Wp} W_p$, where $\bar{r}_j^p$ is the expected real after-tax return on the portfolio of the jth investor, and W_p is the value of total private wealth. As is evident from the table, the capital income share of financial institutions is far larger than their share of total private wealth - a result primarily due to the combined impact of inflation and full taxation of nominal interest receipts on the real income of household investors (note that σ_{H1} is negative).

Next, the allocation of private risk-taking is examined. The subjectively perceived uncertain real after-tax capital income $\tilde{Y}_j$ of the jth investor is given as

$$\tilde{Y}_j = \tilde{r}_j^O O_j + \tilde{r}_j^S S_j + \tilde{r}_j^{LD} LD_j + \tilde{r}_j^{SD} SD_j,$$

and its variance $var(\tilde{Y}_j)$ as

$$var(\tilde{Y}_j) = O_j^2 var(\tilde{r}_j^O) + S_j^2 var(\tilde{r}_j^S) + LD_j^2 var(\tilde{r}_j^{LD}) + 2O_j S_j cov(\tilde{r}_j^O, \tilde{r}_j^S) + 2O_j LD_j cov(\tilde{r}_j^O, \tilde{r}_j^{LD}) + 2S_j LD_j cov(\tilde{r}_j^S, \tilde{r}_j^{LD}),$$

where $O_j = 0$ for $j = I$,

$LD_j = 0$ for $j = H1, H2$.

Given this variance expression, the share of risk-bearing of the jth investor is simply defined as $var(\tilde{Y}_j) / \sum_{j=H1}^{I} var(\tilde{Y}_j)$. With the 1980 parametrization, the wealthy households' share of total private risk-bearing is 46 percent, which taken together with the 31 percent share of non-wealthy households leaves a 23 percent share of financial institutions - i.e., a distribution which is inversely related to the distribution of real after-tax capital income just referred to.

Finally, Table 6 presents the benchmark values of total expected local and central government revenue from capital taxation (including interest subsidies to owner-occupiers). The simulated revenue figures are in some instances higher than the actual 1980 outcome. This is explained by the fact that the analytical framework does not incorporate certain types of limited tax exemptions, that reduces the actual tax base when taxing imputed income on owner-occupied housing, interest receipts, and wealth.

Table 6 Local and Central Government revenue from taxation of capital (simulated values)

1	Revenue from interest and dividend taxes	= SEK 10.9	billion
2	Revenue from taxation of imputed income of owner-occupied housing	= SEK 5.1	billion
3	Revenue from taxation of capital gains	= SEK 0.7	billion
4	Revenue from wealth taxes	= SEK 2	billion
5	Revenue from corporate income tax	= SEK 7.1	billion
6	Revenue loss due to deductibility of household interest expenses	=-SEK 8.9	billion
7	Revenue loss due to mortage interest subsidies to owner-occupiers	=-SEK 4.9	billion
8	Net revenue from capital taxation	SEK 12	billion

IV ALTERNATIVE TAX REGIMES: SOME SIMULATION EXPERIMENTS

The initial simulation with the model provided us with a benchmark solution, being a crude replication of the 1980 Swedish capital market and tax system. This result will henceforth serve as our norm of comparison when examining the effects on asset markets of different tax regimes. These experiments illustrate the effects of unanticipated changes in different tax rates on the equilibrium of the financial markets of the economy under the assumption that most of the variables describing the behavior of production sectors (with the exception of the rate of new debt issues) remain at their initial values throughout the analysis. This is equivalent to imposing static expectations on behalf of investors, since they do not anticipate that the initial revaluations on asset markets will cause various long-term responses of production sectors, which in turn might have repurcussions on the financial side of the economy.[34]

As in most of the empirical general equilibrium models of taxation, our comparison of alternative tax regimes will involve tax changes leaving the government budget balanced. In our asset market framework, there are two possible "closing rules" being consistent with a balanced budget requirement. A first route would be to assume that the government uses its revenue from the taxation of wealth and capital income to finance spending on a public good G, and that the utility function of the jth investor is additively separable, so that $u_j^* = u_j(\bar{r}_j, var(\tilde{r}_j)) + f(G)$. Then it is implied that the portfolio choice of the jth investor is independent of tax induced changes on the expenditure side of the government budget (see for instance Atkinson and Stiglitz (1980), Ch. 4). An alternative route would be to interpret the results with reference to the concept of differential tax incidence of Wicksell (1896) and Musgrave (1959), once it is recognized that the equivalent of a nondistortionary lump-sum tax in the present static asset market framework is a proportional tax on the jth investor's wealth: a proportional wealth tax where the base is the market values of financial assets will leave the excess return vector $\hat{r}_j$ as well as the elements of the covariance matrix M_j^{-1} unchanged, and will therefore not affect the portfolio choice of the jth investor. Then, a reduction in government tax revenue induced when removing certain taxes on capital can always be thought of as being compensated for by raising an equal amount from the hypothetical nondistortionary wealth tax.[35]

This chapter examines the effects of various alternative systems of corporate and personal income taxation. Section IV.1 considers the effects of introducing personal expenditure taxation. The second section simulates the impact of indexing the personal income tax. The third section turns to different reforms of the corporate income tax. Section IV.4 examines the effect of joint reforms of the personal and corporate income tax. In particular, the impact of indexing the complete tax system is investigated; this amounts to examining the consequences of eliminating all inflation induced asymmetries of the Swedish system of capital taxation. Finally, Section IV.5 provides a guide to the sensitivity analysis of Appendix III, which extends the present analysis by incorporating - among other things - holding costs and liquidity premia in the model.

IV.1 Expenditure Taxation

The first application consists of calculating a new equilibrium solution for the model for a government that retains the taxes and tax rates on corporate profits and household wealth, whereas it exempts interest income, dividends, imputed income of owner-occupied housing and accrued capital gains from the tax base, and disallows tax deductions of mortgage interest expenses. In the present static framework - where the time path of tax revenue is irrelevant - abolishing personal taxes on capital income is equivalent to introducing an expenditure tax regime on the side of investors (on this and other equivalence results, see Atkinson and Stiglitz (1980), Ch. 3).

Table 7 presents some of the new equilibrium values (with the percentage change upon the corresponding benchmark value given in parenthesis). The value of the corporate share market declines with 31 percent, reaching a new equilibrium value of SEK 52.2 billion. The ownership share of financial institutions increases from 46 percent to 77 percent of total value of corporate shares, the share of wealthy households declines to 18 percent, and the ownership fraction of non-wealthy households reaches a low of 5 percent. The asset revaluations are more drastic in the housing sector, with the value of total housing stock falling to SEK 294 billion (a decrease of 41 percent), and the value of housing equity falling to

Table 7 An expenditure tax regime - equilibrium values of selected endogenous variables

Value of stock exchange	= SEK 52.2 billion	(- 31 percent)
Value of housing equity	= " 126.5 "	(- 61 ")
Value of housing stock	= " 293.7 "	(- 41 ")
Tobin's q of corporate sector (q_C^T)	= .64	(- 7 ")
Tobin's q of housing sector (q_H^T)	= .7	(- 41 ")
q_C^T/q_H^T	= .91	(+ 57 ")
Wealth of wealthy households	= SEK 159 billion	(- 40 percent)
Wealth of non-wealthy households	= " 172.3 "	(- 38 ")
Wealth of financial institutions	= " 372.5 "	(- 3 ")
Total private wealth	= " 703.8 "	(- 24 ")
Real effective interest rate on long-term debt	= .036	(0.035)

	H1	H2	I
Expected after-tax real rate of return on corporate shares	.060	.070	.070
Expected after-tax real rate of return on housing equity	.062	.068	-
Expected after-tax real rate of return on short-term debt	.005	.015	.015
Expected after-tax real rate of return on long-term debt	-	-	.036
Real after-tax rate of return on total portfolio	.026	.039	.035

Real after-tax rate of return on total private wealth .034 (.017)

Distribution of real after-tax capital income		
Share of wealthy households	= .175	(-.015)
Share of non-wealthy households	= .283	(.219)
Share of financial institutions	= .542	(.796)
	= 1.000	
Allocation of risk-bearing		
Share of wealthy households	= .134	(.457)
Share of non-wealthy households	= .180	(.312)
Share of financial institutions	= .686	(.231)
	= 1.000	

SEK 127 billion (a decline of 61 percent). The less wealthy households' share of the stock of "owner-certificates" increases from 52 percent to 60 percent. The relative holdings of short-term debt also undergo substantial changes: The wealthy households increase their holdings from SEK 74.3 billion to SEK 99.3 billion, whereas non-wealthy households and financial institutions both decrease their holdings to SEK 93.6 respectively 87.5 billion.

Tobin's "q" of the corporate sector falls modestly from .69 to .64 (the new equilibrium value of q_C - the "q" of corporate equity - is .24), whereas "q" of the housing sector drops from 1.18 to .7 (q_H decreases to .5). The ratio of these two variables increases to .91. This implies that the expenditure tax regime achieves approximate neutrality as concerns the incentives to invest in physical capital in the corporate and housing sectors, respectively. Finally, the effective long-term interest rate slightly increases to 13.6 percent, implying an effective real long-term rate of interest of 3.6 percent.

The decreasing equity values of the housing and corporate sectors reduce net wealth of the aggregate of portfolio investors from SEK 930.2 billion to SEK 703.8 billion. However, this tax induced loss in the real market value of privately owned wealth is very unevenly distributed - the value of household wealth is reduced by 45 percent, whereas the wealth of financial institutions falls a negligible 3 percent due to the fact that they do not hold equity in the housing sector.

The average real after-tax rate of return $\bar{r}_{Wp}$ on total private financial capital increases from 1.7 percent to 3.4 percent. This is due to, first, the direct increase of the income of investors following upon the elimination of taxes on interest income, dividends, imputed income of housing capital, and capital gains; and, second, the general equilibrium response - implying falling prices of shares and residential real estate, and, therefore, rising effective yields on owner-certificates and common stock - induced by the higher real after-tax interst rate that the wealthy and non-wealthy households obtain on the riskfree asset. Total expected real after-tax capital income is SEK 23.8 billion. This can be compared to an expected real after-tax capital income of SEK 15.5 billion on total private wealth in the benchmark economy. Out of this net increase of SEK 8.3 billion, wealthy households receive SEK 4.4 billion, non-wealthy households SEK 3.3 billion, and financial institutions SEK .5 billion.

The implemented tax reform also alters the risk characteristics of assets. Therefore, an indication of the personal incidence of the tax change can be obtained only by examining the new distribution of expected real after-tax capital income, as well as the implied reallocation of risk-bearing. As is obvious from the table, the aggregate of household investors benefits considerably in both respects, at the expense of financial institutions. First, the aggregate household income share increases from 20.4 percent to 45.8 percent. Second, in spite of the fact that the variances of real rates of return on household assets increase when abolishing the capital gains tax, the aggregate household share of total risk-bearing decreases from 77 percent to 31.4 percent due to substantially larger holdings - as a percentage of aggregate household wealth - of the riskfree asset. This is particularly evident for wealthy households, whose share of total riskbearing decreases from a dominant 46 percent to a mere 13.4 percent - a circumstance due to the fact that they decrease their share of both housing equity and corporate shares.

Table 8 displays the distribution across sources of total government revenue from taxation of capital. Expected net tax revenue drops to SEK 3.7 billion - i.e., a reduction of SEK 8.3 billion as compared to the benchmark equilibrium. This is explained partly by the direct revenue loss from taxes on dividends, interest income, imputed income of owner-occupied housing, and capital gains, partly by the induced reduction in net private wealth, which reduces the base of the wealth tax. Next, we assume that the government

Table 8 Local and Central Government revenue from taxation of capital - expenditure tax regime

1	Revenue from interest and dividend taxes	= SEK 0 billion
2	Revenue from taxation of imputed income of owner-occupied housing	= SEK 0 billion
3	Revenue from taxation of capital gains	= SEK 0 billion
4	Revenue from wealth taxes	= SEK 1.4 billion
5	Revenue from corporate income tax	= SEK 7.1 billion
6	Revenue loss due to deductibility of household interest expenses	= SEK 0 billion
7	Revenue loss due to mortgage interest subsidies	=-SEK 4.9 billion
8	Net revenue from capital taxation	SEK 3.6 billion

compensates for this revenue loss by implementing a uniform lump-sum tax on total privately owned wealth valued at the new equilibrium prices of Table 7. In this case, the required lump-sum tax rate - yielding a revenue of SEK 8.3 billion - turns out to be 1.2 percent.

So far, several pages have been devoted to describing and comparing the benchmark and expenditure tax equilibria. What remains is to give an outline of the underlying economic adjustment mechanisms. Thus, by using the comparative static results as a frame of reference, I will sketch <u>one</u> consistent adjustment scenario. Our starting point is the benchmark equilibrium of Tables 5 and 6. The initial impact of abolishing taxes on dividends, interest income, imputed income of owner-occupied housing, and capital gains is to alter the means, variances and covariances of after-tax returns confronting household investors. First, the expected real after-tax rates of return on short-term debt and corporate shares held by household investors increase, with the largest proportional rate of return gain accruing to holdings of short-term debt, since the dominant part of the return on corporate shares accrue in the form of capital gains, which are lightly taxed already in the initial equilibrium. Second, the real after-tax rate of return on owner-certificates decreases, since the loss of tax deductibility of nominal interest expenses clearly outweighs the abolished taxation of nominal capital gains on residential real estate and imputed housing income. Finally, the variances and covariances of return on owner-certificates and corporate shares increase, since the government no longer bears part of the capital risk by levying capital gains taxes with a symmetrical treatment of gains and losses.

The first round impact of the tax change in turn alters the desired portfolio composition of households. Thus, the attractiveness of the riskfree asset increases substantially, partly due to smaller differences in after-tax returns against the risky assets, partly as a result of the increased riskiness of corporate shares and owner-certificates. Consequently, there is a simultaneous excess demand for short-term debt, and - since household investors respect their wealth constraints - excess supply on the markets for corporate shares and owner-certificates. The nominal riskfree interest rate - the numéraire - is exogenously given (this is the essence of the "small-country" assumption referred to above), and cannot adjust to clear the asset markets. Instead, the equity "q"s of the corporate and housing sectors (q_C and q_H) adjust downwards, with the downward pressure being the strongest on real estate "q", since the tax change causes - as already mentioned - an initial decrease in the return on housing equity.

These market revaluations initiate several dampening mechanisms working in the direction of restoring general market equilibrium. First, the portfolio equilibrium of financial institutions is disturbed when the effective yield on corporate shares increases (the result of lowered valuation of corporate equity). Therefore, they substitute an increased demand for corporate shares for part of their initial holdings of short- and long-term debt. The asset substitution between corporate shares and long-term debt - which is explained by the fact that financial institutions by assumption perceive a positive covariance of return between corporate shares and long-term debt - creates excess supply on the market for long-term debt, which in turn raises the effective long-term interest rate; the substitution between corporate shares and the riskfree asset reduces the disequilibria on the markets for common stock and short-term debt. Second, the reduction in household wealth induced by the fall in the prices of corporate shares and owner-certificates further constrains the excess demand for the riskfree asset, since all asset demand functions are linearly homogeneous in wealth. Finally, the rather drastic fall in q_H tends in itself to reduce the disequilibrium in the housing market, since the induced increase in the effective yield on housing equity soon turns the excess supply of owner-certificates of the non-wealthy households into an excess demand counter-balancing the excess supply on behalf of the wealthy households. (The loss of tax deductibility of nominal interest expenses is the most damaging for wealthy (high tax) households; consequently, wealthy households demand a greater increase in the yield on housing than do the non-wealthy households before being content with holding a given amount of housing equity.) These hypothetical adjustments continue, until the structure of after-tax rates of return has changed in such a manner that all financial markets clear, there are no incentives for investors to reallocate their asset holdings, and the implied values of the endogenous variables are those of Tables 7 and 8.

One of the driving forces underlying the above adjustments is the exogeneity - implied by the small open economy assumption - of the riskfree real rate of interest. Thus, the revaluations of the equity of the housing and corporate sectors following upon introducing the expenditure tax regime would be less drastic if the short-term real after-tax rate of interest was somehow adjusted downwards, thereby reducing the initial excess demand for short-term debt. For instance, this could be accomplished by combining the expenditure tax regime with the introduction of a special wealth tax on household holdings of the risk-free asset. Thus, somewhat paradoxically, we can imagine a situation where introducing a special wealth tax on short-term debt actually diminishes losses of household wealth by preventing reductions in the prices of risky assets.

IV.2 Indexing the Personal Tax Base

The detrimental effects of the combination of relatively high inflation rates and basically nominal systems of taxation has aroused much concern in many western industrialized countries. Consequently, much effort has been spent on investigating practicable schemes of indexing the tax base.[36] In Sweden, the Government Committee on real taxation (under chairmanship of professor Gustaf Lindencrona) has delivered a report (SOU 1982:1) recommending a special scheme of indexing the personal and corporate tax bases. Here, I will simulate the impact of indexing the personal income tax according to the Lindencrona-scheme, while retaining nominal taxation of corporate income (including full deductibility of nominal interst payments, historic cost depreciation, and FIFO inventory accounting). The proposed reform can be described briefly as follows. The taxation of interest income recognizes only real interest income, and permits deductions for tax purposes for only real interest expenses; for an ordinary money loan, this implies that that part of the nominal interest rate that only serves to compensate the lender for the inflation induced erosion of the real value of his capital has to be eliminated (using the consumer price index) before calculating taxable income or deductible expenses. Similarly, realized capital gains on shares and residential real estate will for tax purposes be adjusted for changes in the consumer price index under the relevant holding period (presently, there is a partial indexation scheme for capital gains on owner-occupied housing only). Finally, the commission recommends abolishing the progressive rate structure for imputed income on owner-occupied housing - leaving a fixed 2 percent of the tax assessed value of every house to be declared as taxable imputed income, irrespective of the expensiveness of the house - as well as tying the tax assessed value of residential real estate to an inflation index adjusted annually (compared to the present standard of revaluations every fifth year).

After incorporating this proposal in the analytical structure - which necessitates some minor technical operations[37] - the model is resolved for another equilibrium configuration. This new solution is described in Table 9 (as before, figures in brackets denote percentage changes as compared to the benchmark equilibrium). The value of the stock market declines with 29 percent, with the ownership share of financial institutions increasing to 74 percent of total value of corporate shares, the share of wealthy households declining to 21 percent, and that of less wealthy households

Table 9 Indexing the personal tax base - equilibrium values of selected endogenous variables

Value of stock exchange	= SEK	53.6 billion	(- 29 percent)
Value of housing equity	= "	141.8 "	(- 57 ")
Value of housing stock	= "	309.1 "	(- 37 ")
Tobin's q of corporate sector (q_C^T)	=	.65	(- 6 ")
Tobin's q of housing sector (q_H^T)	=	.74	(- 37 ")
q_C^T/q_H^T	=	.88	(+ 52 ")
Wealth of wealthy households	= SEK	167.0 billion	(- 37 percent)
Wealth of non-wealthy households	= "	180.4 "	(- 35 ")
Wealth of financial institutions	= "	373.3 "	(- 3 ")
Total private wealth	= "	720.7 "	(- 23 ")
Real effective interest rate on long-term debt	=	.036	(0.035)

	H1	H2	I
Expected after-tax real rate of return on corporate shares	.039	.057	.070
Expected after-tax real rate of return on housing equity	.055	.062	-
Expected after-tax real rate of return on short-term debt	-.005	.009	.015
Expected after-tax real rate of return on long-term debt	-	-	.036
Real after-tax rate of return on total portfolio	.019	.034	.034
Real after-tax rate of return on total private wealth	.031	(.017)	

Distribution of real after-tax capital income		
Share of wealthy households	= .144	(-.015)
Share of non-wealthy households	= .275	(.219)
Share of financial institutions	= .581	(.796)
	= 1.000	
Allocation of risk-bearing		
Share of wealthy households	= .161	(.457)
Share of non-wealthy households	= .193	(.312)
Share of financial institutions	= .646	(.231)
	= 1.000	

falling to 5 percent. The value of the housing stock decreases with 37 percent, and the value of owner-certificates reaches a low of SEK 141.8 billion (a 57 percent decline). The less wealthy households' share of housing equity increases from 52 percent to 58 percent. Turning to the relative holdings of short term debt, the fraction of wealthy households increases to 35 percent, the share of financial institutions is reduced to 31 percent, whereas the less wealthy households' share falls to 34 percent. Tobin's q of the corporate sector drops slightly to .65 (reflecting the reduced value of the stock exchange), whereas the q of the housing stock decreases with 37 percent to reach a new value of $q_H^T = .74$. The ratio of the q-variables increases to .88; i.e., indexing the personal income tax can be viewed as a substantial - albeit smaller than in the expenditure tax case - step in the direction of achieving neutrality as concerns the incentives to invest in new physical capital in the corporate and housing sectors, respectively. The real effective long-term interest rate increases modestly with .1 percentage point to 3.6 percent. Also the wealth effects are of a magnitude similar to those in the expenditure tax case. Thus, total private wealth is reduced by 23 percent, which can be compared to a decrease of 27 percent in the expenditure tax case. The loss of real household wealth amounts to 36 percent - approximately evenly distributed among wealthy - and non-wealthy households - whereas the wealth of financial institutions falls by a mere 3 percent.

Total expected real after-tax capital income on total private wealth increases from SEK 15.5 billion in the benchmark equilibrium to SEK 22.1

billion when indexing the personal income tax. The largest share of this increased capital income accrues to household investors. Their aggregate share of private after-tax capital income increases from 20.4 percent in the benchmark equilibrium to 41.9 percent in the present equilibrium, with the largest relative gainer once more being the wealthy households, whose share increases from minus 1.5 percent to 14.4 percent. Turning to the distribution of total private risk-bearing, it is observed that indexing the capital gains tax does not affect the expected after-tax variances and covariances of return; i.e., the government still bears a part of privately perceived risk. However, the new equilibrium solution implies that the aggregate of household investors simultaneously increase their relative holdings of the riskfree asset and reduce their relative shareholdings. This is reflected in a sharp decline of the aggregate household share of total private risk-bearing (though the decline is even larger in the expenditure tax case) at the expense of financial institutions.

Finally, Table 10 displays the new distribution across sources of expected local and central government revenue from taxation of capital. First, it is observed that eliminating taxation of purely nominal household interest income reduces the revenue from interest and dividend taxes with more than SEK 9 billion from SEK 10.9 billion to SEK 1.8 billion. At the same time, tax revenue is increased by SEK 7 billion due to abolishment of the deductibility of nominal interest expenses of households (the revenue loss is reduced from SEK 8.9 billion in the benchmark equilibrium to SEK 1.9 billion in the new equilibrium). Thus, the net

Table 10 Local and Central Government revenue from taxation of capital - indexing the personal tax base

1 Revenue from interest and dividend taxes	= SEK 1.8 billion
2 Revenue from taxation of imputed income of owner-occupied housing	= SEK 2.2 billion
3 Revenue from taxation of capital gains	= SEK 0.1 billion
4 Revenue from wealth taxes	= SEK 1.5 billion
5 Revenue from corporate income tax	= SEK 7.1 billion
6 Revenue loss due to deductibility of household interest expenses	=-SEK 1.9 billion
7 Revenue loss due to mortgage interest subsidies	=-SEK 4.9 billion
8 Net revenue from capital taxation	= SEK 5.9 billion

effect of indexing household interest income and interest expenses is to reduce tax revenue with about SEK 2 billion. Second, indexing the capital gains tax reduces its expected revenue with SEK 600 million from SEK 700 million to a mere SEK 100 million; i.e., the revenue from the capital gains tax in the benchmark equilibrium is almost exclusively due to the taxation of purely nominal capital gains. Third, government income from both wealth taxes and taxation of imputed income of owner-occupied housing are reduced due to lower prices of common stock and real estate. Finally, we compute the lump-sum tax rate on total wealth, valued at post-reform prices, necessary to compensate for the induced revenue loss of SEK 6.1 billion. This rate turns out to be .8 percent.

Obviously, the effects of indexing the personal income tax are very similar - in direction as well as magnitude - to those of the expenditure tax. In fact, the adjustment scenario outlined in the previous section is equally applicable to the case of indexing the personal tax base. This is explained by the present inflationary setting - which magnifies the "non-neutralities" of the ordinary (unindexed) income tax - since both expenditure taxation and indexation of the personal tax base eliminate inflation induced distortions of the tax system.

IV.3 Alternative Corporate Tax Regimes

Evaluating the effects of the corporate income tax is for two reasons a difficult task. First, the corporate income tax interacts with inflation in a complicated manner due to the use of historic cost methods of depreciation, FIFO inventory accounting, and full deductibility of nominal interest expenses on corporate debt. Second, the wish to promote corporate accumulation of physical capital has in most western industrialized countries led to the development of elaborate tax incentive programs, incorporating such measures as accelerated depreciation, initial investment allowances, income tax holdidays, etc. In the following, we examine various aspects of the interaction of the tax system, inflation, and corporate investment incentives by comparing our benchmark equilibrium to the corresponding solutions under three alternative corporate tax regimes. First, the model is resolved for a new equilibrium under the assumption of complete indexation of the base of the corporate income tax. A second simulation evaluates the impact of introducing a corporate income tax of a cash flow type, implying immediate write-off of new investments, and the removal of tax-deductibility of interest expenses. Finally, the effects of abolishing the corporate income tax is examined.

Table 11 presents the resulting equilibrium values of the endogenous variables. Underlying the indexation case of column 1 are three particular regime changes: (i) FIFO inventory accounting is replaced by the LIFO inventory valuation method; (ii) the historic cost method of depreciation for tax purposes is replaced by replacement cost depreciation, implying that the base of taxable depreciation allowances is at any instant increased by the rate of general inflation; (iii) the tax authorities eliminate the benefit of full deductibility of nominal interest payments on corporate debt, and permit deductions for only the real costs of debt. As a consequence, the expected revenue from the corporate income tax increases with 24 percent compared to the benchmark equilibrium, and the value of the stock exchange decreases with almost 15 percent. The value of the housing stock decreases slightly, the reason being that the weakening of the stock market reduces the value of net private wealth, which in turn dampens the demand for residential real estate (since the underlying asset demand functions are linearly homogeneous in initial wealth). The relative decrease in net private wealth is unevenly distributed among investors - the wealth of wealthy households exhibits the largest percentage decrease due to substantial initial holdings of corporate shares relative to the size of their total portfolio. Turning to subtable B, it is clear that the ef-

Table 11 Corporate tax reform

A. Percentage change as compared to benchmark equilibrium

	1 Indexing the corporate income tax	2 Cash flow approach to corporate income tax	3 Abolished corporate income tax
Value of stock exchange	-14	+2.1	+ 63
Value of housing stock	- .8	+ .1	+ 3.9
Wealth of wealthy households	- 2.6	+ .4	+ 11.8
Wealth of non-wealthy households	- 1.1	+ .2	+ 5.1
Wealth of financial institutions	- 1.1	+ .2	+ 5.2
Revenue from corporate income tax	+23.9	-3.4	-100

B. Equilibrium values of selected endogenous variables

	1	2	3	Benchmark equilibrium
Distribution of real after-tax capital income				
Share of wealthy households	- .027	- .013	.039	- .015
Share of non-wealthy households	.238	.216	.144	.219
Share of financial institutions	.789	.797	.817	.796
	1.000	1.000	1.000	1.000
Allocation of risk-bearing				
Share of wealthy households	.455	.458	.455	.457
Share of non-wealthy households	.327	.310	.249	.312
Share of financial institutions	.218	.232	.296	.231
	1.000	1.000	1.000	1.000
Real effective interest rate on long-term debt	.035	.035	.036	.035
q_C^T/q_H^T	.57	.59	.65	.58

fects on the distribution of risk and capital income are small. Also, it is observed that indexing the corporate income tax somewhat decreases the ratio of the Tobin's q variables of the corporate and housing sectors. However, this tendency to a worsening of the relative incentives to invest in physical corporate capital is almost negligible, and far from comparable to the rather substantial changes obtained in earlier sections.

The basic mechanism explaining the above adjustments is, of course, that indexing the corporate income tax leads to increased tax payments of the representative steady state firm. The reason is that with the chosen parametrization, the loss of nominal interest deductibility outweighs the gains obtained by introducing replacement cost depreciation and LIFO inventory accounting. This result is at odds with much of the conventional wisdom on the effects of inflation on the corporate income tax, suggesting that inflation induces increased corporate tax payments due to the non-indexation of the tax system, and, consequently, that indexation would lower the corporate tax burden (see for instance Feldstein and Summers (1978), Feldstein (1980a), SOU 1982:1). These conflicting results are easily explained within the present framework by observing that the net effect of indexation on corporate tax payments is to both its size and sign a function of the steady state inflation rate p. The reason is that the representative firm's real gain from nominal interest deductions is - assuming unchanged behavior of the firm - a linear function of p, while it can be shown that the real loss associated with historic cost depreciation is an increasing strictly concave function of p (the following argument ignores, without loss of generality, the effect of FIFO inventory valuation).[38] This implies that at low rates of inflation will - for any reasonable parametrization - the real loss of depreciation allowances dominate the gains from nominal interest deductions; consequently, indexing the corporate income tax will then decrease tax payments. However, as p rises, the real gains from nominal interest deductions will eventually overtake the accumulated real losses of historic cost depreciation, which in turn implies - as in our simulation - that indexation leads to increased taxation.[39]

Column 2 presents the new equilibrium values for a corporate tax regime of a cash flow type, involving immediate write-off of gross investments, removal of deductibility of interest expenses, abolished investment allowances, and a lowering of the statutory corporate tax rate to 30 percent. Variations of this scheme have been suggested by several authors (Sumner (1975), King (1977), Södersten and Ysander (1985)), who have emphasized its appealing properties, implying, first, intertemporal efficiency,[40] and, second, neutrality with respect to inflation (without devising an elaborate indexation system). The results suggest that the immediate effects on the capital market of introducing the cash flow tax would be very modest. Corporate tax revenue decreases with 3.4 percent, and the value of the stock market increases with 2 percent. The allocation of capital income and risk is practically unchanged, whereas the ratio of the "q"-variables increases from .58 to .59. However, the outcome is sensitive to the assumed value of the corporate tax rate, since the combination of free depreciation and no tax-deductibility of interest payments implies that all income earned on existing physical capital will be taxed at the full statutory rate.

Finally, the third column displays the effects of abolishing the corporate income tax. Corporate tax payments fall from SEK 7.1 billion in the benchmark solution to zero with the new tax regime, while the new equilibrium value of the stock exchange is SEK 123.4 billion. Net private wealth increases, with the largest percentage gain accruing to the wealthy households. This is, in turn, one of the two reasons for the increased value of the housing stock (all asset demands are - as already noted - linearly homogeneous in wealth). The other reason is that the induced increase in the yield on corporate shares raises demand for owner-certificates, since these assets are complements in the portfolios of households (the subjectively perceived covariance between the exogenously given rates of random nominal price increase of shares and owner-certificates is negative).[41] Another consequence of the higher corporate equity yield is that financial institutions demand a higher real rate of return on long-term debt instruments in order to willingly hold the available supply. However, this tendency for a rising real interest rate is almost negligible - the real effective rate rises with only .1 percentage point (subtable B). The capital income share of wealthy households increases from a negative 1.5 percent to a positive 3.9 percent, whereas the share of non-wealthy households drops from 21.9 percent to 14.4 percent. However, these effects are not large when compared to those occurring when introducing expenditure taxation or indexing the personal income tax. Similarly, the allocation of riskbearing undergoes no dramatic changes. Thus, the share of wealthy households is approximately unchanged, whereas the share of non-wealthy households decreases at the expense of financial institutions. Finally, it is observed that abolishing the corporate income tax goes some way in the direction of achieving neutrality as concerns the incentives to invest in physical capital in the corporate relative to the housing sector - the ratio of the "q"-variables increases from .58 to .65.

IV.4 Joint Corporate and Personal Tax Changes

We have so far analyzed the effects of separate reforms of the personal and corporate income tax. This section integrates these separate pieces of information by examining combined reforms of the personal and corporate income tax. The first experiment consists of jointly indexing the personal and corporate tax systems; this will illustrate the effects of eliminating all inflation induced distortions in the measurement of taxable real capital income. The second simulation combines the personal expenditure tax of Section IV.1 with the cash flow approach to the corporate income tax discussed in Section IV.3. Finally, a third simulation examines the consequences of eliminating all taxes on wealth and capital income, as well as abolishing subsidies to owner-occupiers. This will permit an investigation of all distortions introduced by the present tax system - in particular, we will see how the relative incentives to accumulate real capital in the corporate and housing sectors are affected.

The equilibrium solution obtained when eliminating all inflation induced asymmetries of the tax system is characterized in the first column of Table 12. When discussing these results, it should be remembered that they are the net outcome of jointly introducing the separate indexation schemes for households and firms discussed in earlier sections. This indicates, in turn, that the adjustment scenarios suggested in Sections IV.2 and IV.3 are equally applicable to the present simulation. We observe, first, that expected total revenue from capital taxation decreases by SEK 4.7 billion compared to the benchmark equilibrium (a decline with 38 percent from SEK 12.1 billion to SEK 7.4 billion). This revenus loss is exclusively due to the effects of indexing the personal tax base - expected corporate tax payments will, for reasons discussed at some length in the previous section, increase when indexing the corporate tax base.

The structure of after-tax rates of return is altered. Indexing the personal income tax increases the return on household holdings of short-term debt instruments, eliminates the tax advantage to housing mortgages (which raises the cost of housing), and exempts purely inflationary gains on corporate shares and owner-certificates from capital gains taxation. Indexing the corporate income tax reduces, ceteris paribus, the return on corporate shares. This leads, without detailing the rather involved adjustment mechanisms, to substantial shifts in the portfolios of investors. As expected, the fraction of the asset portfolios of households held in the form of short-term debt increases dramatically: the share of the riskless asset in the portfolios of wealthy households increases from 28 to 58 percent, whereas the corresponding portfolio share of non-wealthy households increases from 37 to 52 percent. On the other hand, the proportions of household wealth held in corporate shares and owner-certificates are reduced. The fraction of net wealth of wealthy households held in owner-certificates decreases from 59 to 35 percent, whereas the proportion of corporate shares declines from 13 to 7 percent. For non-wealthy households, the porfolio share of housing equity declines from 61 to 46 percent, and the fraction of corporate shares drops from 2.1 to 1.5 percent.

There are corresponding changes at the macro-level. The value of the stock exchange has in the new equilibrium fallen with more than 40 percent in order to, first, make the expected yield on corporate shares compatible with the increased after-tax returns on short-term debt, and, second, capitalize the increased corporate tax burden. The value of the housing stock declines with 38 percent due to the abolished tax-deductibility of nominal interest payments and increased return on alternative financial investments (the value of owner-certificates declines with 57 percent). The implied decline in the value of net private wealth is - once more - unevenly distributed among investors. The wealth of household investors decreases with more than 36 percent, whereas the percentage decline in the value of the wealth of financial institutions is 3.9 percent. Turning to the distribution of real after-tax capital income, it is clear that household investors benefit greatly from indexation at the expense of financial institutions. Thus, the income share of wealthy households increases from -.015 to .144, the share of

Table 12 Joint reform of personal and corporate income tax

A. Percentage change as compared to benchmark equilibrium

	1 Indexing the personal and corporate income tax	2 Personal expenditure tax and cash flow approach to corporate income tax	3 Abolishing all subsidies and taxes on capital
Value of stock exchange	-40.6	-29.4	+ 10.7
Value of housing stock	-37.8	-40.7	- 51.7
Wealth of wealthy households	-39	-40.1	- 44.1
Wealth of non-wealthy households	-35.8	-38.1	- 47.2
Wealth of financial institutions	- 3.9	- 3.1	+ .2
Revenue from corporate income tax	+23.9	- 3.4	-100
Total revenue from capital taxation	-38.3	-72.3	-100

B. Equilibrium values of selected endogenous variables

	1	2	3	Benchmark equilibrium
Distribution of real after-tax capital income				
Share of wealthy households	.144	.175	.164	- .015
Share of non-wealthy households	.287	.281	.150	.219
Share of financial institutions	.569	.544	.686	.796
	1.000	1.000	1.000	1.000
Allocation of risk-bearing				
Share of wealthy households	.163	.134	.057	.457
Share of non-wealthy households	.209	.178	.047	.312
Share of financial institutions	.628	.688	.896	.231
	1.000	1.000	1.000	1.000
Real effective interest rate on long-term debt	.036	.036	.037	.035
q_C^T/q_H^T	.86	.92	1.26	.58

non-wealthy households is raised from .219 to .287, whereas the share of financial institutions decreases from .796 to .569. Household investors also reduce their share of private risk-bearing, with the largest percentage decline benefiting the wealthy households because of a drastically reduced amount of corporate shares held in their portfolios. Finally, the simulation results indicate, as expected, that indexation is one possible route to eliminate tax induced distortions of the relative incentives to invest in new physical capital in the corporate and housing sectors - the ratio of the Tobin's q variables increases from .58 to .86.

Interestingly, these simulation results do not support the claim of several economists that the interaction of inflation with the tax system leads to lower real share prices [see Feldstein (1980a, 1980b, 1980c), Summers (1981a), Ebrill and Possen (1982a, 1982b)]. According to this view, the appearance of unexpected inflation in an economy with unindexed corporate and personal tax systems - implying historic cost methods of depreciation, taxation of nominal capital gains, etc. - tends to reduce the real after-tax rate of return on corporate shares and raise the return on alternative assets (such as owner-occupied homes), both factors which in the short run are expected to depress real share values. Recognizing that examining the consequences of indexing the tax system is equivalent to analyzing the effects of changes in the rate of inflation, it is clear that the results of Table 12 provide indirect support for the antithesis that the combination of increased inflation and a nominal tax system <u>increases</u> real share prices. There are at least three reasons explaining these conflicting outcomes.

First, the present analysis incorporates an explicit portfolio choice framework into a multimarket model of the capital market, whereas the argument of Feldstein and others is typically based on partial equilibrium modeling of the stock market. Although partial equilibrium reasoning might provide useful insights, it is easy to construe cases where it is misguided. For instance, underlying partial equilibrium stock market models is a simple two asset economy, where increases in the (exogenously given) return on the alternative asset necessarily reduces desired shareholdings (see for instance Feldstein (1980a, 1980c)). In the multiasset framework of the present study, however, some of the other assets may be complementary to corporate shares in investors' portfolios; consequently, an increase in the (endogenously determined) yield on some alternative asset may raise demand for corporate shares. Underlying our 1980 benchmark parametrization is the empirical observation that the returns on corporate shares and residential real estate are negatively correlated, indicating that household investors can take positions in real estate to hedge the risk of any given stock portfolio. Then, in our multimarket framework, an inflation induced increase in the after-tax rate of return on owner-occupied homes will stimulate demand for corporate shares; i.e. a result directly opposite to the implications of partial equilibrium reasoning.

Second, the explicit use of a balance sheet framework identifying the assets and liabilities of different investors allows us to incorporate important wealth effects in the analysis. For instance, an inflation induced increase in the value of housing assets would in our framework stimulate household demand for corporate shares, the reason being that increased housing prices imply increasing household wealth, which in turn have - since asset demands are linearly homogeneous in wealth - positive spillover effects on the stock market.

Third, the analysis of this paper uses - as already discussed - a general formulation to describe the impact of inflation on corporate tax burden, with due regard to the fact that the real loss associated with historic cost depreciation is a concave function of the rate of inflation. The authors cited above, on the other hand, use linear approximations to describe the impact of inflation on the real value of depreciation allowances, and thereby overstate the depressant effect of inflation on real after-tax corporate profits (see also Hasbrouck (1983)). In sum, the present analysis indicates that there are no reasons why increased inflation due to a nominal tax system should cause a decline in real share values, once we use a general equilibrium framework of asset markets and portfolio choice, and recognize the complexities of the corporate income tax.[42]

The second column of Table 12 shows the results of introducing an integrated consumption tax treatment of firms and investors, which implies combining the personal expenditure tax of Section IV.1 with the cash flow approach to the corporate income tax discussed in the previous section. Not very surprisingly, the results are almost identical to those found when introducing the personal expenditure tax in Section IV.1, the reason being that the effects of the corporate tax change *per se* are almost negligible. Thus, it suffices to note that the simulation indicates that the effects of introducing an integrated consumption tax are very similar to those occurring under the indexation scheme of the first column of Table 12, owing to the fact that the expenditure tax regime also serves to eliminate all inflation induced asymmetries of the tax system.

The third column, finally, gives the results of the hypothetical experiment of eliminating all taxes and subsidies on capital income (including wealth taxes, the corporate income tax, and subsidies to interest payments of owner-occupiers). Then, at the macro-level, the value of the stock exchange increases with almost 11 percent, the value of the housing stock falls with more than 50 percent, and the value of housing equity decreases sharply with 77 percent. The real effective interest rate on long-term debt increases from 3.5 to 3.7 percent, implying that the real market value of long-term debt decreases. At the same time, the net wealth of wealthy and non-wealthy households declines with 44 and 47 percent, respectively, with the greater relative loss of non-wealthy households being due to smaller initial holdings of corporate shares; for financial institutions, there is a barely noticeable increase of .2 percentage points.

The ratio of the "q"-variables of the two production sectors increases dramatically from .58 to 1.26. This result - the most interesting of this simulation - indicates that removing all taxes on capital leads to a sustantially increased incentive to accumulate physical capital in the corporate sector relative to the incentive to invest in the housing sector. Thus, we might conclude that the tax and subsidy system of the benchmark economy serve - compared to the non-distortionary norm given by the results in column 3 of Table 12 - as a powerful stimulation of investments in residential real estate at the expense of corporate investments.[43]

Total government tax revenue declines with SEK 12.1 billion. As before, this revenue loss can be thought of as being compensated for by raising an equivalent amount by introducing a uniform lump sum tax on all privately owned wealth valued at post-reform asset prices. In this case, the required tax rate turns out to be 1.8 percent.

Turning to the micro-level, we can observe rather large changes in the composition of asset portfolios. In the new equilibrium, wealthy households have an asset portfolio with 7 (13) percent in corporate shares, 21 (59) percent in owner-certificates, and 72 (28) percent in short-term debt (figures for the benchmark equilibrium are given in brackets); in the portfolio of non-wealthy households, 1.4 (2.2) percent is corporate shares, 29 (61) percent is owner-certificates, and 69.6 (36.8) percent is short-term debt; finally, financial institutions have a portfolio with 19 (9) percent in corporate shares, 63 (64) percent in long-term debt, and 18 (27) percent in short-term debt. Thus, the response of household investors when abolishing capital taxation is to increase holdings of the riskless asset, and drastically reduce the portfolio fractions of owner-certificates and corporate shares. Financial institutions, on the other hand, exchange increased holdings of corporate shares for a smaller position in short-term debt. The intuition explaining these shifts is straightforward. Thus, abolishing all taxes on capital income and wealth, and eliminating subsidies to owner-occupied housing, will raise the cost of housing, increase the return on shareholdings, substantially increase the real rate of return earned on households' positions in short-term debt, and increase the riskiness of investments in both owner-certificates and corporate shares. Consequently, households sharply cut down their holdings of residential real estate, reduce shareholdings (the rising return on short-term debt and increased riskiness of shares outweigh the increased dividend yield), and increase demand for the riskless asset. Financial institutions, on the other hand, experience an increased excess return on shares; as a consequence, they substitute increased shareholdings for smaller positions in long- and short-term debt (this explains the rise in the effective yield on long-term debt).

Finally, turning to the incidence question, it is evident that abolishing capital taxes causes an increase in wealthy households' share of total expected private capital income and a declining income fraction of non-wealthy households and financial institutions. Wealthy households also benefit considerably from the implied reallocation of risk-bearing - their share of total private risk decreases from 46 to 6 percent. Similarly, the share of non-wealthy households decreases from 31 to 5 percent.

IV.5 A Guide and Interpretation of the Sensitivity Analysis

The robustness of the quantitative estimates of earlier sections can only be evaluated after performing a comprehensive sensitivity analysis. This is the purpose of Appendix III. This section summarizes the issues discussed at some length in the appendix.

The first sensitivity test of the appendix involves examining the sensitivity of results to relaxing the rather restrictive assumption of absence of income risk used in the earlier simulations. This is accomplished by allowing for an uncertain marginal product of capital in the corporate sector in addition to the capital uncertainty related to the end of period market values of risky assets. Formally, this is modeled by letting the $\mathrm{var}(\tilde{\rho}_C)$ element on the main diagonal of each subjective covariance matrix Ω_j be some positive constant (see section II.3). The simulations of the appendix indicate that the price effects of reforming the personal income tax hardly change when allowing for different degrees of income risk.[44] However, the results obtained when altering the corporate income tax are more sensitive to the assumed level of income risk. For instance, the stimulating impact on the stock market - found in section IV.3 - of abolishing the corporate income tax is reduced when the variability of pre-tax corporate earnings increases. The intuition underlying this last result is obvious: As the corporate income tax absorbs part of the income risk confronting corporate equity investors, but none of the capital risk related to the volatility of corporate share prices, it is implied that the corporate income tax appears less distortionary for large values of var($\tilde{\rho}_C$). Then, the stimulating effect on the stock market of abolishing the corporate income tax will be less pronounced, since the loss of risksharing provided by the government will now counteract the induced increase in corporate cash flow net of borrowing costs. However, for "reasonable" values of corporate income risk, this risk increasing effect is shown to be quite modest.

In sum, recognizing both income and capital risk, we might conclude - as do Bulow and Summers (1982) - that the corporate income tax falls on expected corporate equity income, while only providing limited risksharing to corporate shareowners.[45] Consequently, we cannot support the view of - among others - Fullerton and Gordon (1983), who argue that the corporate income tax is nondistortionary, the reason being that it falls proportionally on both expected income and risk.

The second sensitivity test quantifies the effects of introducing transaction costs in the model. As discussed in the appendix, transaction costs may occur in several different forms, not all of which can be meaningfully incorporated in the simulation framework.[46] For instance, the calculus methods used in Chapter II when deriving the asset demand functions of investors are inappropriate when dealing with fixed costs related to investors' discrete choice of which assets to include in the optimal portfolio. Also, in our static model, there can be no distinction between transaction costs associated with the volume of assets traded or held. As a consequence, our sensitivity analysis is limited to examining the consequences of introducing transaction costs proportional to the amount held of assets included in the portfolios of investors. Specifically, the sensitivity test has been performed for the case of proportional holding costs for short-term debt and owner-certificates. This is modeled by simply subtracting a uniform transaction cost parameter c^i (i=SD,O) from the means of the subjective return expressions $\tilde{r}_j^O$ and r_j^{SD} derived in Chapter II. In the case of short-term debt, the transaction cost parameter is assumed to take on only negative values; i.e. we introduce liquidity considerations in the analysis and interpret the negative of c^{SD} as the untaxed convenience yield on short-term debt.

Somewhat surprisingly, the common sense view that transaction costs - broadly defined - inhibit portfolio adjustments and make asset prices less sensitive to various disturbances is not supported by the sensitivity tests. Instead, the results indicate that the response of asset prices to alternative tax regimes increase with increasing values of convenience yields and transaction cost parameters. However, it would for two reasons be rash to draw the conclusion that transaction costs in general increase the sensitivity of asset prices. First, we have only explored the sensitivity of results to a narrowly defined form of transaction costs; in particular, we have not incorporated the potentially important fixed transaction costs involved when the representative investor selects which assets to hold. Second, for each set of values of the transaction cost parameters c^i, the relevant sensitivity experiment first involves recalibrating the model by solving backwards for new sets of subjective variances of asset inflation that make the model replicate the benchmark data set. Consequently, there is no unambiguous sensitivity test of the effects of transaction costs *per se* - instead, we test for the combined effects of transaction costs and adjustment of the initial data set.

The final sensitivity experiment of Appendix III involves examining the sensitivity of results to the assumed values of the risk aversion parameters R_j. Here, we find that the implied impact of different tax regimes is insensitive to the assumed values of the risk aversion parameters. However, as before, the precise interpretation of this result is ambiguous, since it also reflects the effects of new sets of subjective expectations assumptions derived when recalibrating the model for alternative values of the risk aversion parameters.

V ADJUSTMENTS BEYOND THE MODEL

As stressed in earlier chapters, the present model is designed to serve as a pedagogic "tax-laboratory", providing a controlled and theoretically consistent framework when examining the impact of alternative tax regimes on asset markets and the portfolio equilibrium of different types of investors. Consequently, the purpose of the simulation experiments is to educate our intuition rather than provide accurate forecasts of the effects of implementing alternative systems of capital taxation. Nevertheless, for the insights of the model to be of some practical interest, we can not simply bypass the question of the empirical applicability of our framework. Unfortunately, there is no simple criterion function allowing us to mechanically evaluate the empirical content of the model, the reason being that the deterministic procedure employed when calibrating the model is very different from econometrically estimating and testing the behavioral assumptions. As a consequence, the present chapter adopts a more intuitive approach, and discusses to what extent relaxing some of the framework's heuristic assumptions might make a difference to the results.[47]

V.1 Modeling of Expectations

A first set of heuristic assumptions which might limit the intuitive plausibility of the simulation results is - as already mentioned - the model's static nature and the assumption of a fixed allocation of physical capital between production sectors. For instance, the immediate revaluations on the markets for corporate shares and residential real estate when changing tax regime can be expected to change the long-run equilibrium levels of the capital stocks in the corporate and housing sectors, which in turn would affect the marginal productivities of capital in each sector. But then, if asset markets were reasonably efficient, knowledge of these future developments would clearly influence the size of the initial price effects. This argument has led many economists to the belief that using static asset market models - implying stationary expectations and disregard of future capital accumulation - when investigating the effects of tax policy will produce exaggerated short-run price responses (Feldstein, 1980a; Summers, 1980; Poterba, 1980, 1984; Hendershott, 1981). Unfortunately, evaluating the relevance of this proposition in the present context would require the demanding task of constructing a dynamic portfolio model integrating uncertainty and rational expectations with endogenous savings and capital formation of different types of investors and production sectors.

In Appendix IV, we follow a more tractable approach and make the "expectations" argument precise by developing a simple perfect foresight model (i.e. we abstract from uncertainty) of stock market equilibrium and endogenous capital accumulation in a two asset economy with inflation and non-neutral income taxes. This model allows us - without going into the technical details - to compare the initial price response of corporate shares under perfect foresight (investors anticipate future capital accumulation) with the response under static expectations (investors neglect future capital accumulation) when implementing unexpected tax changes. Interestingly, the analytical experiments with the model show that the contention of the above economists is not generally true: Depending on the curvature of the corporate production function and the type of adjustment costs underlying the gross investment function of the corporate sector, the static expectations price change might be smaller than the initial perfect foresight "jump". Consequently, it is the specifications of the underlying model, rather than the expectations assumption per se, that determine any qualitative differences of results when comparing perfect foresight and static expectations.

Also, staying within the dynamic asset market framework of the appendix, intuition suggests that the quantitative difference between the price changes occurring under the two expectations assumptions depends on the sensitivity of net investments to changes in the real share price. Thus, the more responsive net investments are, the faster the capital stock reaches its new equilibrium level after some disturbance, and - as a consequence - the larger the potential deviation of the static expectations price change from the initial perfect foresight jump.[48] Next, assume the absence of a second hand market for used capital goods. It is then implied that net investments are bounded from below by the negative of the rate of economic depreciation. This in turn suggests that when examining unanticipated tax changes implying a reduced equilibrium capital stock and zero gross investments during the transition phase, the static expectations price change will be a better approximation of the initial perfect foresight jump, the smaller the rate of economic depreciation of capital goods.

In sum, what can we deduce about the implications of the static nature of the simulation framework from the above arguments? Unfortunately, the insights seem to be mainly on the negative side. Not even in our simple perfect foresight asset market model - whose static counterpart is a much simpler portfolio model than the simulation model - is it possible to state as a general conclusion that assuming static expectations rather than forward-looking expectations exaggerate the initial price effects of tax changes: Everything depends on the precise specification of the underlying characteristics of the economy such as adjustment cost schedules, form of production functions, etc. However, the intuitive insight that the static expectations price change is a good approximation to the forward-looking expectations price jump whenever the capital stock adjustment process is slow is more helpful. In particular, given that the depeciation rate on the housing stock is a little more than 1 percent per year, assuming stationary expectations of investors might not be too far off the mark when analyzing tax changes expected to shrink the long-run housing stock.[49]

V.2 Modeling of International Capital Flows

Another set of potentially restrictive assumptions concerns the view of foreign investors and international capital flows underlying the simulation experiments. Although formally supressed, it is easily established that our particular choice of numéraire asset together with the balance sheet framework of Table 1 is consistent with a somewhat peculiar notion of international capital mobility. On the one hand, treating the real interest rate on short-term debt as a parameter determined outside the model is equivalent to assume that (1) the domestic country is a small open economy, and (2) domestic and foreign short-term debt instruments are perfect substitutes.[50] On the other hand, by ignoring foreign holdings of the remaining long-term assets, we implicitly assume the existence of rigidities that eliminate long-term capital movements between countries. Then, the question is: How reasonably do these polar assumptions reflect the "real" world, and to what extent would alternative assumptions alter the conclusions drawn from the simulation analysis?

For Sweden, the empirical evidence indicates that the extent of arbitrage between domestic and foreign short-term liquid assets has increased substantially since the 1970s. For instance, by examining the departures from covered interest rate parity for short-term assets of different maturities, Englund, McPhee and Viotti (1985) conclude that at least since the early 1980s, Sweden has had no - or very limited - freedom to independently set the level of real short-term interest rates. Thus, our particular choice of numéraire asset is compatible with the increased sophistication of Swedish money markets, as well as the observed rapid movements of short-term financial capital to arbitrage yield differences across countries.

Things become more complicated when turning to the degree of international mobility of long-term financial capital. On the one hand, it could be argued that official restrictions, costs of information gathering, and the difficulties of correctly identifying the relevant risks, substantially retard or stem foreign portfolio investments of Swedish households and different categories of financial institutions. On the other hand, the financial transactions of multinational companies and the potential for foreign investors to operate on the Stockholm Security Exchange suggest that the set of restraints on long-term capital flows are far from complete. Also, the existing empirical evidence is ambiguous. After examining the correlations between the savings and investment rates of some major industrialized countries, Feldstein and Horioka (1980) conclude that the international mobility of short-term liquid capital is "consistent with much less mobile long-term capital", indicating only a very limited degree of substitutability between domestic and foreign long-term debt instruments (see also Feldstein, 1982b). A different conclusion is reached by Harberger (1980), who - after finding that rates of return in different countries are essentially uncorrelated with their aggregate capital-labor ratios - suggests that in the long-run international capital flows work in the direction of equating returns across countries. In sum, it seems clear that although long-term portfolio capital is - especially in the short-run - far from as responsive to international yield differences as liquid short-term capital, the evidence hardly supports the "closed economy" view either.

Recognizing the potential for interest sensitive international long-term portfolio capital and the complicated issues related to domestic tax policy toward foreign investors motivates a careful interpretation when discussing the effects of alternative tax regimes on asset market equilibrium. First, as Swedish withholding taxes on foreign portfolio investors' capital income would typically be left unchanged (or credited for against the tax of investors' home countries if changed) when changing tax regime, many of the tax regimes discussed in the previous chapter would affect foreign portfolio investors only to the extent that they induced market revaluations that changed the pre-tax yield structure on domestic assets. For instance, indexing the personal tax base or introducing a personal expenditure tax would directly and substantially increase the return on corporate shares obtained by domestic households, but only indirectly - via a new equilibrium price of corporate shares - alter the return obtained by foreign investors. However, as was shown in the previous chapter, this indirect effect can be expected to be of only a second order magnitude,[51] which suggests only limited responses of foreign investors. This in turn suggests that ignoring international mobility of long-term portfolio capital is - at least as an approximation - justified when studying the effects on asset markets of tax changes aimed directly at domestic investors.

However, turning to tax changes involving the corporate income tax, this position is no longer justified. The reason is, of course, that the corporate income tax falls on all corporate equity capital, irrespective of the domicile of corporate shareowners. Then, reforming the corporate income tax will directly - and not only indirectly via the response of the domestic stock market - alter the return on domestic corporate shares as expected by foreign portfolio investors. As was shown in the simulation analysis, this direct effect might be substantial, which indicates that ignoring foreign stock market investors when examining the effects on domestic asset markets of alternative corporate tax regimes is - from an empirical point of view - less appropriate. For instance, when abolishing the corporate income tax in section IV.3, foreign portfolio investors' expected return on corporate shares (ignoring withholding taxes and assuming a fixed exchange rate) increases from 6.3 to 9 percent. This yield change can, in normal cases,[52] be expected to induce an inflow of foreign capital on the stock market, which increases the equilibrium share price above the level indicated by the simulation analysis. Similarly, indexing the corporate income tax will - using our particular 1980 parametrization - directly reduce foreign investors' return on corporate shares. This in turn suggests an outflow of foreign capital, which depresses the stock market below the level indicated by the simulation experiment of section IV.3. Summing up, we observe, first, that when examining "large" corporate tax changes, the potential for interest-sensitive flows of international long-term capital can no longer be dismissed as being of only second-order importance; and, second, that the analysis of section IV.3 by ignoring international capital flows underrates the response of the stock market to reforms of the corporate income tax.

V.3 Modeling of Housing Demand

A final potentially restrictive assumption is related to our treatment of housing as an asset subject to standard portfolio theoretic considerations. Underlying this emphasis on the marginal investment decision of households is the view that the demand for housing assets can be separated from the consumption demand for housing services. Although this separation of economic decisions allows us to conveniently incorporate owner-occupied housing in the asset market framework, it is obviously not an accurate description of the "real world". For instance, it could be argued that households in reality have to solve a complex non-separable housing demand problem, involving both portfolio and consumption considerations. Similarly, it is probably the case that for many households the central choice problem is the discrete choice of whether to own a house or not, rather than a continuous choice of how much wealth to allocate to owner-occupied housing conditional upon ownership.

It is impossible to assess a priori the likely effects of our simplified treatment of housing demand. However, we have - in order to get a crude indication - performed a simple ceteris paribus experiment with the model. The background is as follows. In June 1982, the Swedish parliament enacted a major reform - announced in the spring of 1981 - of the personal income tax. The reform had two main components. The first was a general reduction of the marginal tax rates of households, whereas the second was a lowering of the value of interest deductions for households in the above 50 percent tax brackets. After a three year phase-in period, the reform was fully implemented in 1985. Although the second part of the reform was widely expected to cause a sharp decline in the prices of owner-occupied houses, the actual capitalization effects turned out to be moderate. According to

Berg (1985), the real value of the stock of owner-occupied housing fell by 7 percent from July 1981 to July 1982, and by 14 percent during the two year period from mid-1981 to mid-1983.

After incorporating the tax reform in the model,[53] the new equilibrium solution was calculated. It turned out that the real value of the housing stock declined with about 9 percent compared to the 1980 benchmark equilibrium. Of course, this type of ceteris paribus experiment can be of only limited value when assessing the empirical plausibility of the model. Nevertheless, the result suggests that modeling the demand for housing capital "as if" the portfolio choice of households can be treated independently of their consumption decisions will produce results that neither grossly over- or underpredicts actual outcomes.

VI CONCLUSIONS

A problem of central concern to both policy-makers and the academic profession is, as witnessed by numerous articles and government reports, the overall effects of different tax systems on portfolio choice, risk-taking, asset markets and the incentives to accumulate physical capital in different sectors of the economy. These complicated issues can, of course, be approached using different analytical tools, each one having its own particular strenghts and weaknesses. In the earlier chapters of this study, we have been mainly occupied with providing a lengthy formal analysis of the effects of alternative tax regimes on the financial markets using a numerical general equilibrium uncertainty model of the financial sector. At the cost of ignoring dynamic considerations related to the interaction of the real and financial markets, this multimarket framework has allowed us to address many questions frequently neglected in the literature. In particular, the model throws light on the effects of taxes on the simultaneous determination of the equilibrium yields on alternative assets, the value of wealth of different classes of investors, and the incentives to invest in different production sectors. Also, the analysis explicitly identifies different sources of risk confronting investors, which in turn permits us to examine the risksharing facilities provided by the tax system.

Although our analytical framework is parametrized in order to replicate a rough version of the Swedish capital market, overall tax system and portfolio structure of 1980, the quantitative simulation experiments of Chapter IV have - as repeatedly emphasized - only limited predictive value. Instead, our basic lesson is rather one of reasoning and illumination. Thus, the numerical model serves as a controlled and theoretically consistent framework when investigating potentially important asset market adjustments induced by different tax systems, but it is not rich enough to provide accurate forecasts of the likely effects of changing tax regime.

Our results emphasize the importance of using an interdependent multimarket framework when analyzing the financial repercussions of alternative tax systems. As discussed in Chapter IV, underlying the partial equilibrium asset market models frequently employed in the literature is a simple two asset economy, where increases in the exogenously given return on the alternative asset necessarily reduces desired holdings of the other asset. In the general equilibrium framework of the present study, assets may be gross complements as well as gross substitutes. As was demonstrated in Section IV.4, this has striking consequences for tax policy analysis. For instance, it is frequently argued that increased inflation in an economy with a nominal system of income taxation will depress real share prices, since inflation increases the return on alternative assets such as owner-occupied homes. However, in our multimarket framework, homes may be complementary to corporate shares in investors' portfolios. But increasing the return to home-ownership will then stimulate demand for corporate shares; i.e. a result directly opposite to the implications of partial equilibrium reasoning. Also, the endogenous determination of net wealth of different investors allow us to incorporate potentially important wealth effects in the analysis. But then, an inflation induced increase in the value of housing assets will even further stimulate demand for corporate shares, the reason being that increased housing prices imply increased household wealth, which in turn have positive spillover effects on the stock market.

Let me, finally, indicate some straightforward extensions of the present analysis. First, the balance sheet framework underlying the theoretical model can easily accomodate the introduction of additional assets and investors. Thus, there are no conceptual problems preventing us from a more realistic modeling of international capital flows, a disaggregated treatment of domestic financial institutions, etc. These simple extensions would strengthen our tax policy analysis, as well as provide scope for entirely new lines of investigation. For instance, the impact of government debt management on the financial sector - much discussed in recent literature (Friedman, 1978; Roley, 1979; Werin, 1983) - could be meaningfully examined by simply incorporating a somewhat richer menu of government debt instruments in the model. In particular, this would allow us to assess the effects of jointly changing the tax system and altering government debt policy.

Underlying our analysis is a detailed treatment of the portfolio choice of financial investors maximizing expected utility, but only a crude notion of endogenous financial behavior of production sectors. Consequently, a second natural generalization would be to explicitly incorporate theories of optimal capital structure and dividend policy in the analytical framework (see Auerbach and King, 1982; Feldstein and Green, 1983; and Gordon, 1982, for expositions of some of the competing theoretical models). By incorporating several new adjustment channels in the model, this extended equilibrium framework would permit a more realistic analysis of the impact of diverse taxes on financial markets.

APPENDIX I REAL VALUE OF TAX DEPRECIATIONS

The purpose of this Appendix is to derive the real value of tax depreciations for the representative steady state firm. Assume that the firm incurs an initial "sandwich" investment expenditure, and then pursues a reinvestment program that keeps its stock of capital constant over time. Let δ_C be the average rate of economic depreciation (on a declining balance base) per unit of sandwich capital, and p the steady state inflation rate. Then, the nominal value of the flow - assuming a continuous analysis - of gross investments per unit sandwich capital is at the moment 0 given as

$$I = \int_{t=n}^{0} \delta_C e^{pt} dt + e^{np}, \qquad \text{(AI:1)}$$

where $0 > t > n$, e^{np} is the value of the original sandwich investment implemented n moments ago, and $\delta_C e^{pt}$ is the nominal value of replacement investment installed t moments ago. These outlays are, for tax purposes, allowed to be written off on a historic cost base at an exponential rate β (where β is the previously derived average depreciation rate across different assets). Consequently, the value of depreciation allowances at the moment 0 - being the result of the investment program I - is given as

$$a(\cdot) = \int_{t=n}^{0} \beta \delta_C e^{(\beta+p)t} dt + \beta e^{(\beta+p)n}, \qquad \text{(AI:2)}$$

or, after evaluating the integral, as

$$a(\cdot) = \frac{\beta\delta_C}{\beta+p}(1-e^{(\beta+p)n}) + \beta e^{(\beta+p)n}. \qquad \text{(AI:3)}$$

Obviously, $a(\cdot)$ is a rather complicated function of the age n of the representative firm, the steady state inflation rate p, the rate of replacement investment δ_C, and the rate of tax depreciation β. Now, for the steady state firm, it is the case that the value of tax depreciations per unit sandwich capital is independent of n; i.e., $a(\cdot)$ does not change as the firm grows older. This particular steady state value is obtained simply by taking $\lim_{n\to-\infty} a(\cdot)$. Thus

$$\lim_{n\to-\infty} a(\cdot) = \frac{\beta\delta_C}{\beta+p} \qquad \text{(AI:4)}$$

This can be interpreted as the real value of tax depreciations for an infinitely old firm. Henceforth, this limiting case will be used as our measure of $a(\cdot)$. Taking the partial derivatives of (AI:4) with respect to β, p, and δ_C, we get

$$\text{(i) } \frac{\partial a(\cdot)}{\partial\beta} \gtrless 0; \quad \text{(ii) } \frac{\partial a(\cdot)}{\partial p} < 0; \quad \text{(iii) } \frac{\partial a(\cdot)}{\partial \delta_C} > 0$$

The signs of (ii) and (iii) are as expected: The higher the inflation rate, or the smaller the rate of replacement investment, the lower the real base of tax depreciations and, consequently, the lower the real value of depreciation allowances. The sign of (i) can go either way, depending on the value of p. First, when p = 0, it is the case that $a(\cdot) = \delta_C$ independently of the rate of tax depreciation β. Thus, it is implied that increasing the rate of tax depreciation β does not increase the real value of depreciation allowances for a firm following a steady state path with zero inflation. Second, when p is negative - implying steady state deflation - it follows that $\frac{\partial a(\cdot)}{\partial \beta} < 0$, due to the fact that with deflation historic cost accounting makes the real value of the firm's depreciation allowances larger the longer they are postponed. Finally, it is implied that only in the case of a positive p is $\frac{\partial a(\cdot)}{\partial \beta} > 0$; i.e., with steady state inflation the firm always finds accelerated depreciation worthwhile.

APPENDIX II ESTIMATING THE EFFECTIVE CAPITAL GAINS TAX RATE

The tax treatment of capital gains is for four reasons generally different from that pertaining to earned income. First, the statutory tax rates applicable to realized capital gains are often lower than those applying to other kinds of income (for instance, in Sweden only 40 percent of realized capital gains on corporate shares held for more than two years constitute taxable income). Second, and equally important, the realization principle - which violates the accreation concept of economic income of Lindahl, Haig-Simons, and others - benefits the representative investor by allowing him to defer his tax payments. Thus, deferral of tax payments can be likened to an interest-free loan from the government to the taxpayer, which reduces the effective capital gains tax rate below the statutory rate. Third, recognizing the progressive rate schedules, realization of a non-infinitesimal capital gain might push the investor into a higher tax bracket, which thus increases the effective capital gains tax rate. Finally, the tax codes of most countries make no distinction between nominal and real capital gains, and include purely inflationary capital gains in the tax base.

The impact of these factors can be evaluated by transforming the statutory capital gains tax rate into an equivalent effective capital gains tax rate on accrued (and unrealized) capital gains. This approach to evaluating the capital gains tax - which underlies the analytical specifications of the main text for the return on owner-occupied housing and corporate shares - is well-established in the literature; starting with Bailey (1969), various models have been proposed for estimating the effective capital gains tax rate.[54] This appendix presents two different models of effective tax rate determination. The first is the one proposed by Agell and Södersten (1982) when calculating the effective tax rates on accrued capital gains on different kinds of real estate, whereas the second is the "realization" model of King (1977). Whereas both models use similar ad hoc assumptions (the King model postulates a certain desired realization pattern of investors; the model proposed by Agell and Södersten assumes a certain holding period of assets), they differ somewhat in their interpretation. The model of King focuses on the tax treatment of a given initial capital gain being realized according to a fixed pattern, whereas the Agell-Södersten model emphasizes the tax treatment of subsequent capital gains accruing on an asset being held for a certain length of time.

Owner-Occupied Housing

Following Agell and Södersten (1982), it is assumed that the typical investor buys residential real estate for SEK 1 at time 0. The investor plans to sell his property at time n at the expected price $e^{(\pi-\delta_H)n}$, where π is the expected rate of inflation (known with certainty) of a unit residential real estate of unchanged quality, and δ_H is the exponential rate of capacity depreciation of housing capital. When calculating the expected taxable capital gain at time n, it is recognized that the Swedish tax code permits partial indexation of the acquisition cost of residential real estate. Thus, from time w and onwards ($n > w > 0$), the tax authorities allow the investor to link the acquisition cost to a building price index. Letting π_b be the expected rate of change of this particular index, the expected capital gains tax payment T, due at time n, can be written as

$$T = m(e^{(\pi-\delta_H)n} - e^{\pi_b(n-w)}), \qquad \text{(AII:1)}$$

where m is the marginal tax rate of the investor. Taking the present value PV of T gives

$$PV = Te^{-\Theta_h n}, \qquad \text{(AII:2)}$$

where Θ_h is the discount rate of the representative household investor. Our problem now consists of finding an effective capital gains tax rate c, such that the present value of a continuous stream of tax payments - drawn on all accrued nominal capital gains from time 0 to time n, equals (AII:2). Formally, we look for a c such that

$$PV = c(\pi-\delta_H) \int_{t=0}^{n} e^{(\pi-\delta_H)t-\Theta_h t} dt, \qquad \text{(AII:3)}$$

where it is assumed that $\Theta_h + \delta_H > \pi$. Solving for c gives the effective tax rate formula in the case of owner-occupied housing:

$$c = \frac{m(\Theta_h+\delta_H-\pi)(e^{(\pi-\delta_H)n} - e^{\pi_b(n-w)})e^{-\Theta_h n}}{(\pi-\delta_H)(1-e^{-(\Theta_h+\delta_H-\pi)n})}. \qquad \text{(AII:4)}$$

Examining some of the partial derivatives of c, it is implied that

(i) $\frac{\partial c}{\partial n} < 0$; (i) $\frac{\partial c}{\partial w} > 0$.

The negative derivative (i) simply reflects the deferral effect referred to above. Thus, the equivalent effective tax rate on accrued capital gains is reduced when n increases, since the longer the postponement of tax payments, the larger becomes the implicit interest-free loan from the government to the tax-payer. Not surprisingly, the sign of $\frac{\partial c}{\partial w}$ is positive; i.e., a shortening of the length of time for which the government permits indexation of the acquisition cost of the asset is equivalent to an increase in the effective capital gains tax rate. The derived formula (AII:4) underlies the effective tax rate estimates of Section III.2. With the given parametrization, and assuming steady state inflation ($\pi=\pi_b=p$), we have that $\delta_H = 0.014$, $\pi = \pi_b = 0.1$, $w = 4$ (according to the present Swedish tax code), $m_{H1} = 0.67$, and $m_{H2} = 0.41$. Then, by simply assuming that the average holding period n of owner-occupied homes is 20 years,[55] and that the discount rate Θ_h is 12 percent, it is implied that $c_{H1} = 0.03$, and $c_{H2} = 0.02$.

Corporate Shares

The starting point of the model of King (1977) is an accrued unrealized capital gain of SEK 1 at time 0. The investor is assumed to realize this gain according to a certain desired pattern; thus, we suppose that the investor chooses to realize a given fraction η of the remaining unrealized value of the initial capital gain at each instant. Then, at time t the realized capital gain is $\eta e^{-\eta t}$. Given that realized capital gains are taxed at the rate u, the equivalent effective tax rate g is given as the present value of total tax payments on the initially accrued SEK 1 capital gain. Formally, g is given by the continuous sum[56]

$$g = u\eta \int_{t=0}^{\infty} e^{-(\eta+\Theta_h)t} dt = u\eta/(\eta+\Theta_h), \qquad \text{(AII:5)}$$

where Θ_h once more is the discount rate of the representative household. Obviously, the higher the realization rate η, the higher is the effective tax rate g ($\frac{\partial g}{\partial \eta} > 0$). There are no empirical estimates of the average value of η for Sweden. However, King reports results obtained from U.S. data (Bossons, 1971), indicating a value of η of 0.1. Following Agell and Södersten, I will - somewhat crudely - use this value of η also for Sweden. The Swedish tax code of 1980 prescribed that 40 percent of nominal capital gains realized when selling corporate shares held for more than two years ("old" shares) should be declared as taxable income. Therefore, the statutory tax rate u utilized in (AII:5) is given by the product of 0.4 times m, where m - as before - is the marginal tax rate of the representative household investor. Then, with the given parametrization (and Θ_h=0.12), we have that g_{H1} = 0.12 and g_{H2} = 0.075.

APPENDIX III SENSITIVITY ANALYSIS

The sensitivity analysis of this appendix examines the robustness of the results of Chapter IV with respect to some alternative model specifications and parameter assumptions. The tests reported here can for two obvious reasons not be considered as exhaustive. First, as emphasized by Shoven and Whalley (1984), the robustness issue can only be discussed in connection with a given set of results. Thus, finding that the result of a particular simulation experiment is insensitive to alternative specifications is no proof of the robustness of other model results. Second, recognizing the possibility of jointly varying different parameter values, the sensitivity analysis can - for any reasonably large model - be performed along an intractable number of dimensions.

While admitting the limited generality of sensitivity tests, we will henceforth examine three particular respecifications of the model. The first one involves relaxing the rather restrictive assumption of absence of income risk used in Chapter IV. The second sensitivity test examines the consequences of introducing transaction costs in the model; in particular, we will investigate the effects of incorporating a tax exempt convenience yield on holdings of short-term debt, and holding costs of owning owner-certificates. Our third test, finally, assesses the effects of some alternative values for Arrow-Pratt's measure of relative risk aversion.

AIII.1 Sensitivity to Income Risk

This section performs a sensitivity analysis of the effects of allowing for an uncertain marginal product of capital in the corporate sector. Formally, this involves letting the $var(\tilde{\rho}_C)$ element on the main diagonal of the subjective covariance matrix Ω_j be some positive constant. Assuming homogeneous expectations of $var(\tilde{\rho}_C)$, Table AIII-1 shows some of the price effects occurring under different variance assumptions and under three alternative tax regimes.

The norm of comparison is given on the first line, which simply restates the results of the main text. The simulations have been run with values of $var(\tilde{\rho}_C)$ of 0.0004, 0.004 and 0.01.[57] The first of these values is consistent with the standard deviation of the annual percentage pre-tax real rate of return on total corporate capital observed for the 1970 to 1979 period, while the latter simply represent "large" changes. The results of the table indicate that the price effects of introducing personal expenditure taxation hardly change when allowing for different degrees of income risk. However, the results obtained when eliminating the corporate income tax or abolishing all taxes and subsidies on capital are more sensitive to the assumed value of $var(\tilde{\rho}_C)$.

These seemingly conflicting results are reconciled by observing (i) that the tax system provides a better hedge against the income uncertainty part of the variability of share returns than it does against the capital risk part, since the effective capital gains tax rate levied on the stochastic rate of nominal price increase of corporate shares

Table AIII-1 Effects of income uncertainty on sensitivity of asset prices

Variance of $\tilde{\rho}_C$	Personal expenditure tax			Abolished corporate income tax			Abolishing all taxes and subsidies on capital		
	q_C[a]	q_H[a]	q_{LD}[a]	q_C	q_H	q_{LD}	q_C	q_H	q_{LD}
0.0	.24	.50	.99	.57	1.38	.99	.40	.30	.98
0.0004	.24	.50	.99	.56	1.37	.99	.39	.29	.98
0.004	.24	.50	.99	.48	1.35	1.00	.32	.29	.99
0.01	.23	.50	.99	.39	1.32	1.00	.23	.28	.99

[a] The 1980 benchmark values are $q_C = 0.35$, $q_H = 1.30$, $q_{LD} = 1.00$.

is far lower than the statutory corporate tax rate levied on the stochastic marginal product of physical corporate capital; and (ii) that the shield provided by the personal income tax against the variability of corporate pre-tax returns will depend on the pay-out decision of the representative firm, because, first, the random increase in equity value induced by corporate retentions is taxed at the low capital gains tax rate, and, second, distributed profits are taxed at the ordinary marginal income tax rate of household investors.

Consequently, recognizing that the overwhelming part of uncertain corporate profits are retained, and that the accompanying increase in the equity value of the corporate sector is taxed only in the hands of household investors at the low capital gains tax rates, it is implied that introducing expenditure taxation does - irrespective of the degree of income risk - little to increase the variance of share returns. Therefore, the effects of the personal expenditure tax on the optimal portfolio composition of investors and the prices of risky assets hardly change as $var(\tilde{\rho}_C)$ increases. The other sets of results of Table AIII-I show - as already mentioned - greater sensitivity to the assumed value of the income risk element. Now, the intuition is straightforward: Whenever the value of $var(\tilde{\rho}_C)$ is positive, tax regimes eliminating the corporate income tax will - for all categories of financial investors - produce accentuated increases in the riskiness of share returns. Hence, the stimulating impact on the stock market - found in Chapter IV - of abolishing the corporate income tax is reduced when introducing income risk. This depressant effect is modest for our preferred value of corporate income risk ($var(\tilde{\rho}_C) = 0.0004$), but it increases rapidly as $var(\tilde{\rho}_C)$ becomes larger. In fact, for very high degrees of income risk, eliminating the corporate income tax will actually make shares less attractive, since the increase in risk now outweighs the stimulating effect of the induced enlargement of corporate cash flow net of borrowing costs.

AIII.2 Sensitivity to Transaction Costs

This section examines and quantifies the effects of introducing transaction costs in the model. Transaction costs may, of course, occur in a variety of different forms affecting the portfolio choice of investors in different ways. They include, following the classification of Goldsmith (1976), "costs of gathering and reviewing information about security prospects, and the cost of administrating security transactions and ownership, as well as direct costs such as brokerage commissions". Some of these costs are fixed, and related to the investor's discrete choice of which assets to trade in or to include in the optimal portfolio. Others are variable costs associated with the magnitude of trade or with the amount owned given the decision to own or to trade a specific asset (for further discussion of these distinctions, see Mayshar (1979, 1981)).

Not all of these different categories of transaction costs can be meaningfully included in the simulation framework. First, the calculus methods used in Chapter II when deriving the asset demands of investors are inappropriate when dealing with fixed costs and their effect on the decision of which assets to hold. Second, in our static model, there can be no distinction between transaction costs associated with the volume of assets traded or held. Consequently, we will henceforth limit ourselves to the case where transaction costs refer to volume related holding costs of - among other things - monitoring the return prospects for assets already included in investors' optimal portfolios.

Our sensitivity tests have been performed for the case where there are proportional holding costs for short-term debt and owner-certificates. Technically, this is modeled by simply subtracting a uniform transaction cost parameter c^i (i = SD,O) from the means of the subjective return expressions $\tilde{r}^O$ and r^{SD} derived in Chapter II.[58] In the case of short-term debt, the transaction cost parameter is assumed to take on only negative values. This is, of course, a simple way of introducing liquidity considerations in the analysis - the negative of c^{SD} is henceforth to be interpreted as the (untaxed) convenience yield on short-term debt.

The results are reported in Table AIII-2. As before, the results of the main text - our norm of comparison - are restated on the first line. The simulations have been run with convenience yields and transaction cost parameters of .005, .01 and .015. The results indicate that the response of q_H and q_C to the three alternative tax regimes increase with increasing values of convenience

Table AIII-2 Effects of transaction costs on sensitivity of asset prices

	Personal expenditure tax			Abolished corporate income tax			Abolishing all taxes and subsidies on capital		
	q_C[a]	q_H[a]	q_{LD}[a]	q_C	q_H	q_{LD}	q_C	q_H	q_{LD}
Transaction cost parameters									
c^{SD}= .0; c^O=.0	.24	.50	.99	.57	1.38	.99	.40	.30	.98
c^{SD}=-.005; c^O=.005	.24	.49	.99	.58	1.37	.99	.41	.27	.99
c^{SD}=-.01; c^O=.01	.24	.47	1.00	.60	1.37	.99	.42	.25	.99
c^{SD}=-.015; c^O=.015	.24	.46	1.00	.61	1.37	.99	.43	.23	.99

[a] The 1980 benchmark values are q_C = 0.35, q_H = 1.30, q_{LD} = 1.00.

yields and transaction cost parameters. This is a rather surprising finding, being at odds with the common sense view that transaction costs - broadly defined - inhibit portfolio adjustments and make asset prices less sensitive to various disturbances. However, we can for two reasons not draw the conclusion that transaction costs in general increase the sensitivity of asset prices.

First, in our static asset market framework, transaction costs are - as already mentioned - to be interpreted narrowly as representing holding or information costs proportional to the amounts held. In particular, we have not incorporated the fixed transaction costs involved when the representative investor selects which assets to hold. As shown by Mayshar (1979, 1981), the existence of fixed transaction costs might imply equilibrium asset prices substantially different from those obtained from the basic capital asset pricing model of Sharpe, Lintner, and Mossin. Second, as the sensitivity tests on lines two to four first involves recalibrating the model by solving backwards for new sets of subjective variances of asset inflation that makes the model match the benchmark data set, the results of Table AIII-2 can be seen partly as a reflection of the sensitivity of results to alternative subjective expectations assumption. Consequently, there is no unambiguous sensitivity test of the effects of transaction costs <u>per se</u> - instead, we test for the combined effects of transaction costs and adjustment of the initial data set.

AIII.3 Sensitivity to Assumed Values of Risk Aversion Parameters

Finally, we examine the sensitivity of results to the assumed values of the risk aversion parameters R_j. The sensitivity tests are reported in Table AIII-3. Obviously, the implied impact of different tax regimes is to both its direction and magnitude highly insensitive to the assumed values of the risk aversion parameters. However, as before, the precise interpretation is ambiguous, since the results reflect the combined effect of new calibrations to the benchmark data and alternative values of the risk aversion parameters.

Table AIII-3 Effects of risk aversion parameters on sensitivity of asset prices

	Personal expenditure tax			Abolished corporate income tax			Abolishing all taxes and subsidies on capital		
	q_C[a]	q_H[a]	q_{LD}[a]	q_C	q_H	q_{LD}	q_C	q_H	q_{LD}
Risk aversion parameters									
$R_j = 6$	.24	.50	.99	.57	1.38	.99	.40	.30	.98
$R_j = 5$	.24	.50	.99	.57	1.37	.99	.40	.29	.98
$R_j = 4$	.24	.50	.99	.57	1.37	.99	.40	.29	.98
$R_j = 3$	.24	.50	.99	.57	1.37	.99	.40	.29	.98

[a] The 1980 benchmark values are $q_C = 0.35$, $q_H = 1.30$, $q_{LD} = 1.00$.

APPENDIX IV ASSET MARKETS, EXPECTATIONS, AND THE DYNAMICS OF TAX REFORM - A SIMPLE PERFECT FORESIGHT MODEL

The simulation analysis of Chapter IV examined the effects of tax reforms using a static equilibrium uncertainty model of the financial markets, incorporating an explicit treatment of portfolio choice. The results suggested that changing tax regime might have substantial initial effects on market valuations, and the distribution of wealth, income and risk. For instance, in the case of introducing expenditure taxation, the value of the housing stock fell by 41 percent, the value of the stock market declined with 30 percent, financial institutions substantially increased their share of net private wealth and of total private risk-bearing, whereas the aggregate of households considerably increased their share of total private after-tax capital income.

When interpreting these comparative static results, it must be kept in mind that they were derived using a short-run asset market framework implying stationary expectations of investors. However, it is likely that the initial response of rational agents when changing tax regime will depend on their view of the implications for the long-run dynamic behavior of the economy. Thus, the immediate revaluations on the markets for common stock and residential real estate will affect the long-run equilibrium levels of the capital stocks in the corporate and housing sectors. This will change the marginal productivities of capital in each sector in a way already anticipated by rational investors. With efficient asset markets, these anticipations will influence the initial revaluations on the markets for common stock and owner-certificates. In a similar manner, we might think of other medium- and long-term responses of the economy determining the immediate impact of tax reform by affecting the expectations of investors on asset markets. For instance, recognizing that portfolio decisions of investors might be interrelated with their savings decisions, and that the financial policies of production sectors influence the composition of outstanding debt instruments, it is obvious that the initial impact of tax reform will depend on to what extent investors anticipate the longer-term effects on savings and capital structure.

The purpose of the present appendix is to make the "expectations" argument precise by developing a simple perfect foresight model of the determination of stock market equilibrium and capital accumulation in a small open economy with inflation and income taxes. The structure of the model is similar to that of other perfect foresight models developed since the original work of Dornbusch (1976), stressing "over-shooting" phenomena in models combining efficient asset markets and "non-rational" goods markets.[59] The next section presents the model, whereas the final section examines the joint dynamic response of share prices and capital accumulation when introducing expenditure taxation, and concludes by contrasting these results with those of the portfolio approach of Chapter IV.

AIV.1 The Model

Consider the corporate sector in a small open economy. Production takes place according to a production function g(K,L), where K is the stock of corporate capital valued at replacement cost, and L is some unspecified factor (land, labor, etc.). Now, since L is assumed to be fixed in the short as well as long run, the domestic production technology will henceforth be described by the production function F(K), which is concave (but not strictly so) and twice differentiable. The capital stock is endogenous to the model, since the accumulation of domestic corporate capital will depend on the real share price as established on the stock market. Finally, all net investments of the corporate sector are financed on the domestic stock market through new equity issues.

Turning to the stock market, all outstanding shares are claims to the physical stock of domestic corporate capital. At any given instant, equilibrium in the absence of taxes requires that the many identical representative domestic investors operating in the market anticipate a real rate of return on shares equal to the exogenous real rate of interest r^* on foreign bonds. As the authorities of the home country are assumed to levy taxes on all kinds of capital income of domestic investors, equalizing the yields on foreign bonds and domestic shares involves comparing after-tax returns. Finally, assuming a fixed exchange rate, it is implied that the domestic inflation rate corresponds to the worldwide rate of inflation p^*.

The dynamic behavior of the stock market is summarized by an ordinary differential equation. Let q be the real share price, and define the rate of nominal price increase of a single share as the sum of the worldwide inflation rate p* and an anticipated real capital gain of $\dot{q}^a/q$ (where the dot denotes a time derivative). Recognizing that domestic corporations issue new equity of an amount e per share, equilibrium in the stock market with personal and corporate taxes is at any given moment defined by the arbitrage equation

$$(r^*+p^*)(1-m) = \frac{(1-u)(1-\tau_e)F'(K)}{q} + \frac{(1-g)}{q}\left[\dot{q}^a-e\right] + (1-g)p^* \qquad \text{(AIV:1)}$$

Here, m, u, and g are the representative domestic investor's tax rates on interest income, dividends, and accrued capital gains, and τ_e is an effective corporate tax rate. The left-hand side of (AIV:1) is the nominal after-tax rate of interest on alternative foreign portfolio investments, whereas the right-hand side specifies the different parts of the nominal after-tax equilibrium return on domestic shares. The first term on the right-hand side is the post-tax dividend yield, where F'(K) is the marginal product of capital net of economic depreciation. Obviously, this formulation implies that the corporate sector distributes the whole net marginal product of capital. The second term is the anticipated real capital gain net of any issues of new shares, where it is recognized that new issues reduce the base of the capital gains tax g. The last term accounts for share appreciation at the worldwide inflation rate p*, and recognizes that the representative investor must pay capital gains taxes also on purely nominal capital gains.

We then turn to the dynamics of domestic accumulation of corporate capital. At each instant the existing stock evaporates at a given rate δ. Gross additions $I(\cdot)$ to the capital stock (the sum of replacement investment and net investments) are assumed to depend on the real share price q. Thus, the higher is q, the larger the volume of gross investments; this implies $I = I(q)$, and $\infty > I'(q) > 0$. This Tobin's q approach to corporate investment can be rationalized by the presence of installation costs, preventing instantaneous jumps in the capital stock [see Abel (1980)]. With these assumptions, we can define a differential equation for the development of the stock of domestic corporate capital:

$$\dot{K} = \dot{E} = I(q) - \delta K \qquad \text{(AIV:2)}$$

The net change $\dot{K}$ of the capital stock at any given instant is the difference between gross investment and depreciation on the existing stock. Since the corporate sector is of an all-equity variety, and the whole net marginal product of capital is distributed to equity owners, $\dot{K} \neq 0$ implies that corporations either raise new equity on the stock market ($\dot{K} > 0$) or repurchase outstanding shares ($\dot{K} < 0$). Denoting total equity issued on the domestic stock market by E, it is implied that $\dot{K} = \dot{E}$. Assuming that each share constitutes a claim on a single unit of corporate capital, the amount of new issues per share can be simply expressed as $\dot{E}/K = e$, where e is the variable already introduced in equation (AIV:1).

Equations (AIV:1) to (AIV:2) constitute a simultaneous system of differential equations with the unknown functions q(t), K(t) and $\dot{q}^a(t)$. Next, the model is closed by assuming that $\dot{q}^a(t) = \dot{q}(t)$. This is the assumption of perfect foresight - anticipated capital gains equal actual capital gains except for moments when the government announces new tax regimes. This leaves us with two differential equations with the unknown functions q(t) and K(t). The phase portrait of this system in the qK-plane is investigated by drawing the two curves

$$\dot{q} = 0 \rightarrow r^*(1-m) + p^*(g-m) = \frac{(1-u)(1-\tau_e)F'(K)}{q} - \frac{(1-g)}{q}\left[\frac{I(q)}{K} - \delta\right] \tag{AIV:3}$$

$$\dot{K} = \dot{E} = 0 \rightarrow K = I(q)/\delta \tag{AIV:4}$$

where the relevant expression for new issues has been substituted in (AIV:3). Obviously, the curve $\dot{K} = 0$ is upward sloping in the qK-plane. This is most easily understood by assuming that total installation costs are a convex function of gross investments, with the minimum value attained when I(q) = 0 [see Abel and Blanchard (1982)]. Then any increase in steady state K will be associated with an even greater increase in the installation costs the corporate sector must incur simply to maintain its capital stock. Consequently, the value of q necessary to induce zero net investments must be positively correlated with the level of K.

Things become more complicated when turning to the slope of the curve $\dot{q} = 0$. Implicit differentiation of (AIV:3) yields, after some manipulation:

$$\frac{dq}{dK}\Big|_{\dot{q}=0} = \frac{qKF''(K)(1-u)(1-\tau_e)/I(q)(1-g) + q/K}{\frac{qK\left[r^*(1-m) + p(g-m)\right]}{(1-g)I(q)} + \varepsilon_{I,q}}$$

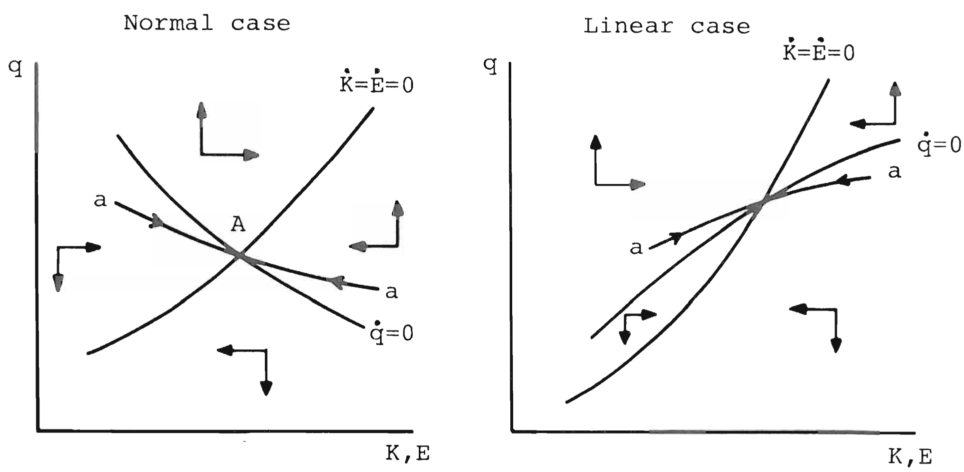
$$\text{where } \varepsilon_{I,q} = \frac{qI'(q)}{I(q)}$$

Obviously, the signs of both the numerator and the denominator are ambiguous. A sufficient condition for the denominator to be positive is that $r^*(1-m) + p(g-m)$ is greater than zero. As this is also necessary for a finite steady state value of q - this is evident by inspecting (AIV:3) for the case when net investments $I(q)/K-\delta$ are zero - we will henceforth consider only the case of a positive denominator. However, the possibility of a positive as well as a negative numerator will be considered. The first case - the "normal" case - is when the production function is sufficiently concave (in the sense that $F''(K) < - I(q)(1-g)/K^2(1-u)(1-\tau_e)$), implying a negative numerator and, therefore, that the loci $\dot{q} = 0$ slopes downward in the qK-space. The second case - the "linear" case - is when the production function exhibits constant returns to scale in the single variable factor K; then $F'(K)$ equals some arbitrary constant, and $F''(K) = 0$. In this case, the curve $\dot{q} = 0$ slopes upwards, with $\lim_{K\to\infty} \frac{dq}{dK}\Big|_{\dot{q}=0} = 0$. This implies - disregarding irregular cases - that there exists an equilibrium point where the $\dot{q} = 0$ curve intersects the $\dot{K} = 0$ curve from above.

The intuition behind these two cases is obvious when inspecting (AIV:3). Basically, there are two mechanisms at work. Increasing the stock of capital on the one hand decreases equity return by lowering $F'(K)$, and on the other hand increases equity yield by reducing the amount of new issues per share. In the normal case, the former mechanism dominates, and q must be lower along the loci $\dot{q} = 0$ to restore equilibrium on the stock market. However, in the linear case only the second effect is in operation, and equilibrium is restored when q is higher.

The phase diagrams of the two cases are displayed in Figure AIV.1, where the joint steady state solution for K, E and q is denoted by the point A. The dynamic behavior of the system in different regions around the equilibrium point is indicated by arrows in the diagram, where the directions have been derived by examining the differential equations (AIV:1) and (AIV:2). Obviously, in both cases the steady state solutions exhibit saddle point stability.[60] This implies that there exists one unique convergent path to the equilibrium point A. This stable trajectory is in each diagram

Figure AIV.1



illustrated by the curve aa. Following established convention, it is assumed that the perfect foresight assumption implies that the economy, when moved away from the rest point A, always adjusts instantaneously so as to reach the stable converging arm.[61]

AIV.2 Introducing Expenditure Taxation

The purpose of this section is, first, to illustrate the importance of the expectations assumption for the size of the initial effect of tax changes on q, and, second, to examine the dynamic behavior of share prices and capital accumulation when changing tax regime. In order to provide some additional perspective to the results of Section IV.1, I will in the following consider the effects of a switch to an expenditure tax. As in the previous chapter, this change will be represented by setting all tax rates on the capital income of the representative domestic investor equal to zero ($m = g = u = 0$). The steady state effects of implementing this particular policy are summarized in the following proposition:

Proposition: Assuming an income tax regime where $m > u$ and $m > g$,[62] then a sufficient condition for the introduction of an expenditure tax to reduce the steady state levels of K and q in both the normal case and the linear case is a positive worldwide inflation rate p^*.

Proof: We must show that introducing expenditure taxation decreases the steady state levels of q and K. Suppose not, and consider a shift of the $\dot{q} = 0$ loci along the schedule $\dot{K} = \dot{E} = 0$. Then by

(AIV:3) the value of q is at least as large as before the policy change if

$$\frac{(1-u)(1-\tau_e)F'(K^0)}{r^*(1-m) + p^*(g-m)} < \frac{(1-\tau_e)F'(K^1)}{r^*}$$

or

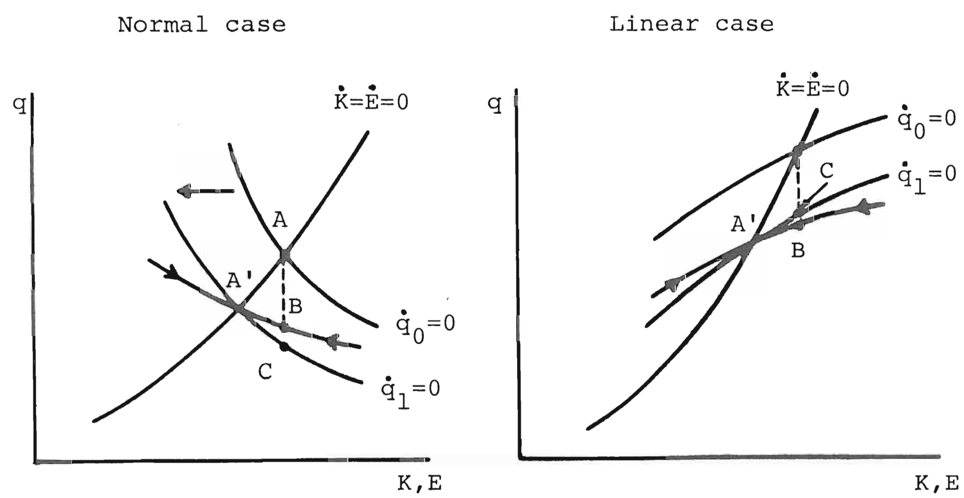
$$\frac{F'(K^0)}{F'(K^1)} < \frac{1 - m}{1 - u} + \frac{p^*(g-m)}{(1-u)r^*} \qquad \text{(AIV:5)}$$

where K^0 and K^1 are the steady state stocks of corporate capital under the income and expenditure tax regimes, respectively. Assuming that $m > u$ and $m > g$, it is implied that the right-hand side of the last inequality is less then one whenever $p^* > 0$. Now, since we consider shifts of the curve $\dot{q} = 0$ along the upward sloping loci $\dot{K} = 0$, a larger value of q must be associated with a larger value of steady state K ($K^0 < K^1$), which according to the concavity of the production function implies that $F'(K^0) > F'(K^1)$, where the sign of equality applies in the linear case. But then the ratio $F'(K^0)/F'(K^1)$ must be equal to or larger than one, which clearly contradicts the inequality of (AIV:5). Thus, introducing expenditure taxation cannot increase or leave unchanged the steady state levels of q and K, which proves the proposition.

The intuition behind this result is clear: The combination of nominal taxation of foreign interest income, "real" taxation of dividend yields, and a low accrual tax on nominal capital gains on domestic shares, implies that increasing inflation via the personal income tax favorizes portfolio investments in domestic shares at the expense of foreign debt instruments.[63] Since the expenditure tax eliminates inflation induced distortions on the side of domestic investors, the converse argument applies: Ceteris paribus, the relative return on portfolio investments in foreign debt increases, which in turn shifts the $\dot{q} = 0$ schedule inwards along the $\dot{K} = \dot{E} = 0$ curve. Thus, q is reduced, and the steady state stock of domestic capital decreases.

Figure AIV.2 displays the dynamic adjustment path to the new steady state equilibrium A'. Starting at the old income tax equilibrium at point A, there is an unanticipated switch to an expenditure tax regime. The $\dot{q} = 0$ curve shifts inwards and, assuming perfect foresight, q immediately jumps to the point B on the stable converging arm in order to restore equilibrium on the domestic stock market. Along the stable trajectory, firms repurchase shares, the capital stock decreases, and investors

Figure AIV.2



make perfectly anticipated capital gains or losses until the new equilibrium point is reached. The length of time of this transition to the new long-run equilibrium is determined by the rate of capital decumulation of the corporate sector, which in turn is a function of the rate of economic depreciation δ and the elasticity of gross investment with respect to q. For instance, a higher value of δ indicates faster convergence.

In the normal case the impact effect of the policy change on the real share price q is larger than the steady state effect. Of course, this is nothing but the conventional "overshooting" property of the vast majority of models combining efficient asset markets and sluggish goods markets. More interestingly, the linear case can instead be described as a situation of "undershooting". Thus, after the initial downward jump of the real share price, the system returns to long-run equilibrium along a path implying anticipations of lasting capital losses on shares. Once more, the economic intuition behind this result is straightforward.

When changing tax regime, q immediately falls in order to equilibrate the domestic share market. In the linear case, investors recognize that during the transition to long-run equilibrium with a reduced value of K, F'(K) remains unchanged and corporations repurchase shares at a rate $\delta K - I(q)$, which <u>ceteris paribus</u> increases equity yields. Therefore, to counter this effect and maintain stock market equilibrium, the real share price must fall continuously throughout the transition phase. Consequently, the impact effect on the real share price of introducing expenditure taxation must in the linear case be smaller than the long-run equilibrium effect, making "undershooting" the necessary outcome.

In earlier chapters it was assumed that expectations were stationary; for instance, everyone expected the original real pre-tax returns on physical capital and the financial policies of production sectors to prevail over an infinite future. The analogue assumption in the present framework is to assume that investors expect the steady state levels of K and E to remain constant when introducing expenditure taxation, which implies disregarding the dynamics of future capital accumulation and share repurchases. The value of q then jumps from the income tax equilibrium at point A to the point C on the loci $\dot{q}_1 = 0$ in Figure AIV.2. In the normal case the static expectations price change is obviously larger than the impact effect under perfect foresight (compare the distances AB and AC).

The more limited initial response of q in the normal case with perfect foresight is in agreement with the view of several economists suggesting that using static expectations - implying disregard of future investment activity - when analyzing the effects of various disturbances on markets for reproducible assets will produce exaggerated short-run results (see for instance Feldstein (1980a), Hendershott (1981), Poterba (1980, 1984), Summers (1980), etc.). However, inspection of the linear case reveals that this contention is not generally true. Here, the static expectations change is smaller than the perfect foresight jump, which in turn is less than the steady state change of q (see Figure AIV.2). Thus, it is the specifications of the underlying model, rather than the expectations assumption per se, that determine the direction of any divergence of results when comparing perfect foresight and static expectations.

AIV.3 A Summing Up

The perfect foresight approach to asset pricing and capital accumulation - implying absence of uncertainty and equalization of after-tax yields - employed in this appendix sheds light on some issues related to the simulation analysis of earlier chapters.

First, this appendix has compared the initial "jump" of the real share price when changing tax regime under static expectations and perfect foresight in a model allowing for future investment and new issues of equity instruments. The results were inconclusive: Not even in this simple model is it possible to state as a general proposition that the assumption of static expectations exaggerate the "true" perfect foresight jump when introducing various unanticipated disturbances. Consequently, it is not necessarily the case that the assumption of stationary expectations used in the simulation analysis of Chapter IV implies larger price changes than what would be the case in a hypothetical portfolio model integrating rational expectations with endogenous capital formation and financial behavior of different production sectors.

Second, a switch to expenditure taxation reduced - under reasonable assumptions - the steady state levels of both the real share price and the domestic capital stock. Interestingly, this result is compatible with a simultaneous increase in domestic savings occurring in response to a higher real after-tax rate of return. The reason is that since domestic investors are free to invest abroad, incremental savings induced by the expenditure tax will be invested in foreignly denominated debt instruments, making the home country a capital exporter, without leaving any additional resources for domestic capital formation.[64] Obviously, this paradoxical result is at odds with the conventional "closed economy" view of the expenditure tax, identifying the benefits of increased saving with accumulation of physical capital, and disregarding the possibility of international capital flows [see for instance Boskin (1978) and Summers (1981b)].

NOTES

[1] Much of this work is inspired by a hypothetical scenario of the following kind: The appearance of unexpected inflation - together with nominal taxation - tends to depress the real after-tax rate of return on nominally taxed assets such as bank deposits and shares, whereas the return on mortgaged real estate tends to increase. Households and financial institutions are thereby induced to transfer wealth from "financial" markets to the markets for "real" assets. The ensuing market adjustments are in the short-run displayed in the form of rising relative prices of real estate and consumer durables, whereas the value of corporate shares and long-term bonds declines. At the same time, the distribution of wealth is altered, since unexpected inflation together with nominal interest taxation transfers wealth from net lenders to net debtors. Furthermore, it is often argued that in the long-run these short-term inflation induced developments tend to deter the accumulation of physical capital in the business sector, whereas investments in housing and consumer durables are stimulated. Some recent work examining various aspects of this hypothetical "tax-inflation" scenario include Ebrill and Possen (1982a and b), Feldstein (1980a and b, 1982), Summers (1981a), Englund and Persson (1982), Cooley and Salyer (1984), Slemrod (1983) and Agell and Södersten (1982).

[2] A notable exception is Slemrod (1983), who by postulating a particular two-stage optimization problem of households incorporated financial considerations and the one period mean-variance framework of portfolio choice into a long-run numerical general equilibrium model of the U.S. economy.

[3] This is not to deny the potential importance of credit market regulations and quantity constraints in determining the equilibrium of the Swedish capital market. However, modeling these additional complications is beyond the illustrative purpose of the present model. See Werin (1983) for an innovative simulation analysis - incorporating rationing schemes - of the impact of government deficits on the Swedish capital market.

4 For other work adopting this portfolio treatment of homeownership, see for instance Ebrill and Possen (1982a), Litzenberger and Sosin (1978), Cooley and Salyer (1984), Kearl (1979), Poterba (1984), and Summers (1981a).

5 Financial institutions are considered as final holders of wealth; consequently, we abstract from their role as intermediate holders of household wealth.

6 See Feldstein (1969) for a proof of conclusion (a) in an economy with more than one risky asset. Merton (1971) has demonstrated that maximizing an objective function over the instantaneous means and variances of portfolio returns is - given the assumption of continuous and costless portfolio adjustments - consistent with maximizing an intertemporal additive utility function in continuous time.

7 I owe the above demonstration of the approximate relationship between the parameter R_i in the mean-variance model and Arrow-Pratt's measure of relative risk aversion to Agnar Sandmo and Bengt-Christer Ysander.

8 This particular choice of safe asset can be rationalized along the lines suggested by Stiglitz (1970), focusing on the "capital uncertainty" confronting investors investing in long-term assets, but having a short-run consumption horizon. Thus, an individual only paying attention to next period consumption will find a one period bond being the safe one, whereas long-term assets - due to the possibility of revaluations one period from now - are risky in terms of next period consumption.

9 These are standard properties of several portfolio models used in macroeconomic applications. See for instance the similar models employed by Kouri and de Macedo (1978) and Dornbusch (1980) for the study of international portfolio effects. Sufficient conditions for the derivation of wealth-homogeneous and linear-in-return asset demand functions are derived in Friedman and Roley (1980).

10 See Friend et al. (1976) for the seminal work incorporating uncertain inflation in the single period capital asset pricing model. Cooley and Salyer (1984) integrate stochastic tax rates in the dynamic programming problem of investors operating in a multiperiod economy.

[11] Our modeling of capital uncertainty is reminiscent of Keynes's concept of financial uncertainty, with its view of asset markets as being dominated by short-lived investors concerned with short-term market values rather than the "true" values of the underlying physical assets (see Keynes, 1936, Chapter 12; Mayshar, 1978). For tax policy analysis incorporating similar definitions of both income and capital uncertainty, see Feldstein (1980b) and Bulow and Summers (1982).

[12] Obviously, this notion of endogenous financial behavior of firms - where firms alter their desired ratio of long-term debt in response to changes in q_{LD} - is far from a theory of optimal capital structure. See Gordon (1982) for an exposition of theories of optimal capital structure decisions in the presence of inflation and bankruptcy costs.

[13] Our modeling of retained earnings follows the specification of Feldstein (1980a) and Hendershott (1981). This treatment of retained earnings is not unproblematic, since the assumption of retained earnings implies a dynamic process of capital deepening, which is not easily reconciled with the present static asset market framework.

[14] The practice of taxing capital gains on a realized basis instead of an accrual one has the well-known implication of reducing the effective capital gains tax rate below the statutory tax rate. The reason is that the realization rule allows the taxpayer to defer his tax payments. The deferral of tax payment can be likened to an interest free loan from the government to the taxpayer, which reduces the effective capital gains tax rate. The procedure of transforming the statutory capital gains tax rate into an equivalent effective tax rate on accrued capital gains is commonplace in the literature. See Appendix II for further discussion.

[15] See Appendix II for the specification of c_j.

[16] This is the point made - in a different context - by Bulow and Summers (1982). However, they do not recognize the personal taxation of investors, and the risksharing provided by the capital gains tax. See the sensitivity analysis of Appendix III and the discussion in Section IV.5 for further discussion.

[17] The data set consists of either purely hypothetical figures or empirical data.

[18] The calibration procedure outlined in the main text is similar to the methods used in the literature on applied "real" general equilibrium modeling (see Shoven and Whalley (1984) for a survey). Mansur and Whalley (1984) and Lau (1984) provide critical discussions of the deterministic calibration method typically used in this tradition. In particular, both papers provide good expositions of alternative econometric methods for estimating the unknown parameters of numerical general equilibrium models. However, the complexities of the econometric approach have so far made most researchers prefer the deterministic calibration procedure (but see Jorgenson (1984), and Jorgenson and Yun (1984) for an exception).

[19] According to Uutma and Hållsten (1981), the average pre-tax rate of return - including interest on financial debt - of the corporate sector (excluding banks and insurance companies) was 5.1 percent of adjusted book values for the 1978 to 1980 period. The two percent real rate of return on housing capital is slightly below the ex ante real interest rate of 2.4 percent on long-term government bonds estimated by Hansson (1982) for the period 1971-80.

[20] According to calculations in Berg (1983).

[21] These figures were obtained by (i) using calculations provided by the National Central Bureau of Statistics (SCB) concerning the percentage distribution of the financial debt of the owner-occupied housing sector across various debt instruments; (ii) utilizing information provided in HINK 81 (the income and wealth distribution survey of the SCB) concerning the total amount of debt of owner-occupiers; (iii) combining (i) and (ii) in order to obtain figures on the amount of short- respectively long-term debt of the housing sector; (iv) finally, relating the information of (iii) to the replacement value of the housing stock (K_H = SEK 420 billion) implies $h_{LD} = 0.26$ and $h_{SD} = 0.14$.

[22] Sources: Statistical yearbook 1980 of the Riksbank, and statistical yearbook 1980/81 of the Riksgäldskontoret.

[23] The figures were provided by Jan Södersten, Department of Economics, University of Uppsala.

[24] The figures were made available by kind assistance of Rolf Johansson and Leif Johansson at the SCB.

[25] The crudeness of this assumption should be judged against the fact that tax exempt institutions hold the greater part of total holdings of corporate shares and debt instruments of Swedish financial institutions. See S-L for estimates of the 1980 beneficial ownership weights for corporate debt and equity.

[26] Both numerical specifications are described in the Appendix.

[27] The tax authorities officially declared guideline is to aim for a tax assessed value of 75 percent of the market price at the time the assessment is made. However, this figure does not reflect reality, since the combination of inflation and a new tax assessment every fifth year produces a considerably lower ratio of tax assessment value to market value by the end of the assessment period - a circumstance motivating the 60 percent assumption of the text.

[28] The Swedish tax law gives the firm a choice between depreciations on a declining balance- respectively straight line base, when claiming depreciation allowances on its investments in machinery and equipment.

[29] This low value of q_c is in agreement with the estimates of some recent studies. S-L obtain an estimate of q_c of 31 percent in 1980, whereas Uutma and Hållsten (1981) report a 1980 estimate of approximately 40 percent.

[30] This estimate is due to calculations provided by Lennart Berg, Department of Economics, University of Uppsala.

[31] The numerical value of Arrow-Pratt's measure of relative risk aversion is an unsettled empirical question. The analysis in Pindyck (1984) suggests a value of R_j around 5 or 6, indirect evidence in Grossman and Shiller (1981) indicate a value in the neighbourhood of 4, whereas the estimates in Friend and Blume (1975) imply a value of at least 2. Although a value of R_j equal to 6 may appear large, there are reasons suggesting that virtually all econometric studies of the degree of relative risk aversion of households - whether they examine the proposed constancy of relative risk aversion (see King and Leape (1984), Cohn, et al. (1975), the papers by Friend and Blume, etc.), or estimate numerical values of the average coefficient of relative risk aversion - contain the potential for downward biased estimates. Thus, in the presence

of transaction costs in portfolio management, the fraction of household portfolios invested in risky assets can be expected to rise with wealth (see Goldsmith (1976) for a theoretical argument). Then, abstracting from transaction costs in econometric applications results in downward biased estimates of the average coefficient of relative risk aversion.

[32] Of course, the incompleteness of household share portfolios is perfectly compatible with optimizing behavior once transaction costs (in a broad sense) are recognized. For instance, for small scale investors, the advantage of diversification might be outweighed by information costs associated with monitoring a portfolio with small quantities of several different assets. See Goldsmith (1976).

[33] Here, I implicitly adopt the view that the long-run equilibrium value of Tobin's "q" - inducing zero net investments - is equal to one in both sectors. This is not to deny the short-run relevance of the "tax hypothesis" developed by various authors in order to explain why Tobin's "q" of the corporate sector for tax reasons may differ from one. Thus, Bergström and Södersten (1976), King (1977), and Auerbach (1979), have all shown how a shareholder equilibrium might exist when $q_c = (1-m)/(1-g)$; where m is the representative shareholder's tax rate on dividend income, and g is the effective tax rate on capital gains. If m is greater than g (which is the normal empirical situation), it follows that q_c is less than one. The reason is that the preferential treatment of capital gains makes the representative shareholder indifferent between dividends and retained earnings only when each SEK 1 of retentions produces a capital gain of a lesser amount. However, recognizing the potential for firms (being entities operating separately from their shareholders) to engage in arbitrage in physical capital as soon as market values quoted on the stock exchange differ from replacement values of the underlying stocks of capital, it seems likely that in the long-run strong forces work in the direction of equilibrating corporate "q" at the value of one. See Gordon and Bradford (1980) for empirical evidence supporting this view.

[34] For instance, the response of financial markets to various tax changes can be expected to cause reallocations of capital between production sectors, thereby altering the pretax yield on capital in both sectors. Obviously, rational investors

would anticipate the impact on asset markets of these longer term developments and subsequently modify their immediate response to proposed tax changes. This line of reasoning is pursued further in Chapter V and Appendix IV, which examines the expectational issues by developing a perfect foresight model of stock market equilibrium with taxes, inflation, and endogenous capital formation.

[35] However, as noted by Stiglitz (1969), the precise meaning of differential tax incidence is less clear in an uncertainty context of the present type, where taxes with the same expected yield may differ in the distribution of revenue across different states of the world.

[36] See Tanzi (1980) for a survey of proposed solutions in various countries.

[37] In particular, tying the tax assessed value of residential real estate to a price index adjusted annually is assumed to increase the average ratio of tax assessed to market price from 60 to 70 percent; this implies - together with the 2 percent imputation rate - that $\psi_{H1} = \psi_{H2} = 0.014$.

[38] The same argument is developed - in a different context - in Hasbrouck (1983).

[39] This can be shown formally using the expression $a(\cdot) = \beta\delta_C/(\beta+p)$ (derived in Appendix I) defining the real value of tax depreciations per unit of physical capital for the representative steady state firm. Let T and T' be the expected tax payments per unit physical capital of the representative firm operating under the non-indexed and indexed tax regimes, respectively. Then, using the already introduced notation, we define

$$T = \tau[\bar{\rho}_C - (\beta\delta_C/(\beta+p) - \delta_C) - (i_r+p)b + \ell p]$$

$$T' = \tau[\bar{\rho}_C - i_r b],$$

where i_r = the average real interest rate payable on corporate debt of different maturities,
b = the aggregate debt-value ratio across different debt instruments,
ℓ = fraction of inventory capital,

and we have made use of the fact that $a(\cdot)$ reduces to δ_C in the case of replacement cost depreciation. The additional tax payments due to non-indexation are then given as

$T - T' = \Phi(p, \delta_C, \beta, b, \ell) = \tau[\delta_C p/(\beta + p) - p(b-\ell)]$.

Setting $T - T' = 0$, we obtain an expression for the inflation rate p^* at which the excess taxation due to FIFO and historic cost depreciation is just counterbalanced by the gains from deductions of nominal interest payments:

$$p^* = \delta_C/(b-\ell) - \beta.$$

Due to the strict concavity of $\Phi(\cdot)$ with respect to p, we know that $T - T'$ is positive for $p < p^*$, and negative for $p > p^*$. With the parametrization of the text ($\delta_C = .04$, $b = .53$, $\ell = .34$, $\beta = .2$), we obtain $p^* = .01$. Then, for a steady state inflation rate of more than one percent, indexation will lead to increased corporate tax payments. Finally, it should be observed that p^* is sensitive to the parameter values reflecting corporate behavior; for instance, a smaller debt-value ratio b would increase p^*.

[40] Immediate write-off and no tax deductibility for interest payments ensures - combined with a personal expenditure tax - that there are no tax induced obstacles preventing the marginal rate of transformation in production between goods in this and the next period to equal the subjective rate of time preference of savers. Then, the revenue from the corporate income tax will come solely from profits on the intramarginal stock of corporate capital, without affecting the marginal investment decision of the representative firm.

[41] A note of warning is appropriate here. Throughout Chapter IV, we discuss the complementarity or substitutability of any two risky assets only in terms of the partial correlation coefficient between their returns. This is permissible only in the present application of the model, where each investor by assumption only holds two different risky assets. In the general case where investors hold many risky assets, the sign of the partial correlation coefficient between the returns on two assets does not imply anything about their substitutability. For a derivation of the necessary conditions for assets to be gross substitutes in a multiasset demand system, see Blanchard and Plantes (1977).

[42] Quite the contrary, the indexation experiment of Table 12 lends some support to the view that an increase in inflation should increase share values because of the interaction with the tax system. This result is consistent with the econometric

evidence in Pindyck (1984), who finds that the declining U.S. share values during the 70s should be attributed to increased riskiness of capital investments [this is the hypothesis first suggested in Malkiel (1979)], and that the increase in expected inflation during the same period has - if anything - served to mitigate the decline.

[43] The corresponding comparative static result in a simple two sector Harberger model with flexible capital would be a reallocation of productive capital from the corporate to the housing sector. See for instance Hendershott and Hu (1981) for a simulation analysis along these lines.

[44] See Appendix III for further discussion.

[45] Our treatment of capital risk differs somewhat from that of Bulow and Summers. The present study models capital risk as occurring in the form of volatile prices of the financial claims on corporations, whereas Bulow and Summers emphasize capital risk due to fluctuations in the economic depreciation rates of the underlying physical assets.

[46] See Mayshar (1979, 1981) for a theoretical investigation of the effects of introducing different kinds of transaction costs in the basic capital asset pricing model of Sharpe, Lintner and Mossin.

[47] Underlying this seemingly innocent procedure is some rather subtle methodological issues. According to the famous methodological dictum of Milton Friedman (1953), a theory should never be evaluated with reference to the descriptive accuracy of its assumptions - what matters is rather the precision of its predictions. As predictive tests of models calibrated to a single data point are seldom feasible, a strict adherence to the Friedman principle would obviously lead us to a dead end. A route of escape from this dilemma is provided by Musgrave (1981), who argues that Friedman's "irrelevance of assumption" position is based on a failure to distinguish the purpose of different types of assumptions in the development of a theory. In particular, in the first stage of the development of a theory the scientist might introduce "heuristic assumptions" as a way of simplifying the theory's otherwise excessively complicated formal structure. In the second stage he takes account of the potentially important factors assumed away in the first stage, by evaluating the effects of relaxing the heuristic assumptions.

[48] In the limiting case of a completely inelastic investment response, the equilibrium capital stock is fixed independently of the real share price, and the perfect foresight jump coincides with the static expectations price change.

[49] From his numerical simulations of tax effects in a perfect foresight housing market model (similar to the stock market model of Appendix IV), Poterba (1984) concludes that the initial price effect when assuming static expectations is about twice the size of the change occurring with perfect foresight. This quantitative result is partly explained by the fact that the author only examines tax changes causing increased housing construction; in the case of alternative tax regimes leading to a reduced housing stock, the lower bound on net investments becomes effective, and the static expectations price change more closely mirrors the perfect foresight jump.

[50] As Sweden does not tax foreign investors' interest income from holdings of SEK denominated short-term debt instruments, but do tax domestic investors' income from foreignly denominated liquid assets, neither foreign nor domestic investors should for tax reasons per se specialize in either type of short-term debt, and thereby invalidate the small open economy interpretation underlying our choice of numéraire.

[51] In Chapter IV, it was found that introducing expenditure taxation would initially reduce the value of the stock market and thereby change the expected real rate of return (before personal taxes) on corporate shares from 6.3 to 7 percent. From the point of view of foreign portfolio investors, this increase of .7 percentage points is the indirect effect of the tax change.

[52] As discussed in the sensitivity analysis of Appendix III, for very high degrees of income risk, eliminating the corporate income tax will actually make corporate shares less attractive, since the increase in risk then outweighs the stimulating effect of the expected increase of the corporate cash flow net of borrowing costs.

[53] The lowering of the value of interest deductions for households in the above 50 percent tax brackets was modeled by setting $z_{H1} = .5$ (see Chapter II for the definition of z_{H1}). The general reduction of the marginal tax rates was assumed to reduce wealthy households' marginal tax rate m_{H1} from 67 to 59 percent, whereas the marginal tax

rate m_{H2} of non-wealthy households was lowered from 41 to 36 percent. Although these latter marginal tax rate adjustments are no more than crude approximations, they are in accordance with calculations in Södersten and Lindberg (1983), who estimated that the average marginal income tax rate of households would have been reduced with 8 percentage points as a result of the tax reform.

[54] Note that this procedure of estimating effective capital gains tax rates is quite dissimilar to standard "empirical" methods of evaluating effective capital gains tax rates by calculating the ratio of actual tax revenue from the capital gains tax to some estimate of overall accrued capital gains for a specific year (see for instance Sandelin, 1977, for an investigation along these latter lines). The empirical approach might give useful information of the ex post liquidity effects of the capital gains tax for a given year, but it has nothing to say about the ex ante incentive effects of the capital gains tax on the portfolio choice of the representative investor.

[55] Unfortunately, there are no empirical data on average holding periods of owner-occupied homes. Therefore, the assumption n = 20 should be considered as an uninformed "guesstimate".

[56] King assumes discrete time. This difference is, of course, unessential.

[57] For each of the three variance assumptions, the model is recalibrated in order to reproduce the 1980 benchmark equilibrium. Thus, we calibrate the model - using the extraneous information of Chapter IV - by once more solving backwards for the subjective after-tax variances of asset inflation on the principal diagonal of Ω_j. As expected, the equilibrium variances of asset inflation turn out to be correspondingly reduced as the income uncertainty increases.

[58] Underlying this specification is the assumption that total transaction costs TC^i to the representative investor of holding the ith asset are linearly related to the amount invested. A straightforward extension - as in Mayshar (1981) - would be to let TC^i be a non-linear function of the size of asset holdings. This would, in turn, yield a variable marginal cost function $C^i(\cdot)$, having the amount of the ith asset held by the jth agent as its only argument.

[59] See Blanchard (1981) for an early application of this approach to the stock market in an IS-LM model. Tax policy analysis within this tradition includes the model of Poterba (1984) of the housing market, and the analysis of Summers of the effects of tax changes on corporate investments and market valuation of corporate capital (see Summers (1980)). For two general presentations of the perfect foresight approach to asset market modeling, see Begg (1982) and Sheffrin (1983).

[60] The saddle point property of the steady state solution is easily established. Linearizing the system composed of (AIV.1) and (AIV.2) by a first order Taylor series expansion around the equilibrium point (q_0, K_0) yields

$$\begin{bmatrix} \dot{q} \\ \dot{K} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} q - q_0 \\ K - K_0 \end{bmatrix} \qquad \text{(i)}$$

where
$$a_{11} = [r^*(1-m) + p^*(g-m)]/(1-g) + I'(q)$$
$$a_{12} = -(1-u)(1-\tau_e)F''(K)/(1-g) - I(q)/K^2$$
$$a_{21} = I'(q)$$
$$a_{22} = -\delta$$

The singular point (q_0, K_0) is a saddle point if the system (i) has two real characteristic roots of opposite signs (Gandolfo, 1980, p. 439). The necessary and sufficient condition for the roots to be of opposite signs is that the determinant of the Jacobian of (i) is negative. This is the case if

$$\frac{\delta}{I'(q)} > \frac{F''(K)(1-u)(1-\tau_e)/(1-g) + I(q)/K^2}{\frac{r^*(1-m) + p^*(g-m)}{1-g} + \frac{I'(q)}{K}} \qquad \text{(ii)}$$

(ii) is easily interpreted. The left hand side is simply the slope of the equilibrium locus $\dot{K} = 0$, whereas the right hand side is the corresponding derivative - derived in the main text - for the $\dot{q} = 0$ locus. Thus, the steady state solution is a saddle point if the $\dot{q} = 0$ locus intersects the $\dot{K} = 0$ locus from above - a condition which holds for both the "normal" and "linear" cases of Figure AIV.1.

[61] A common justification for this assumption is that optimality of infinitely lived agents with perfect knowledge implies that the stable arm aa will always be chosen outside steady state. See Blanchard (1979) for an examination of this idea.

[62] These assumptions are fulfilled for almost any conceivable system of nominal taxation of capital income. For instance, the classical system of company taxation implies that m = u, whereas measures aimed at mitigating the double taxation of corporate profits (for instance various imputation systems) imply m > u. Finally, the already discussed accrual effect makes g less than m.

[63] This argument ignores - without loss of content - the effects of inflation on the effective corporate tax rate τ_e, discussed at some length in previous chapters.

[64] The same conclusion is reached by Goulder, Shoven, and Whalley (1983), who examine the effects of incorporating different external sector specifications in an applied general equilibrium tax model of the U.S.

REFERENCES

Abel, A., (1980), "Empirical Investment Equations: an Integrative Framework", in On the State of Macro-Economics, (eds. Brunner, K. and Meltzer, A.), Carnegie-Rochester Conference Series on Public Policy 12, North-Holland.

Abel, A. and Blanchard, O., (1982), "An Intertemporal Model of Saving and Interest", The Hoover Institution, Stanford University, Working Paper No. E-82-7.

Agell, J., (1984), "Taxes and Short-Run Asset Market Equilibrium - a Computational General Equilibrium Model", Department of Economics, University of Uppsala, Working Paper No. 3.

Agell, J. and Edin, P.-A., (1985), "Taxes and the Portfolio Composition of Households: The Case of Sweden", mimeo, Department of Economics, University of Uppsala.

Agell, J. and Södersten, J., (1982), "Skatteregler och realinvesteringar", in SOU 1982:53, Kreditpolitiken - fakta, teorier och erfarenheter.

Atkinson, A. and Stiglitz, J., (1980), Lectures on Public Economics, McGraw-Hill.

Auerbach, A.J., (1979), "Share Valuation and Corporate Equity Policy", Journal of Public Economics 11, 291-305.

Auerbach, A.J. and King, M. (1982), "Corporate Financial Policy with Personal and Institutional Investors", Journal of Public Economics 17, 259-285.

Bailey, M.J., (1969), "Capital Gains and Income Taxation", in The Taxation of Income from Capital, (eds. Harberger, A.C. and Bailey, M.J.), Brookings Institution, Washington, D.C.

Begg, D., (1982), The Rational Expectations Revolution in Macroeconomics, The Johns Hopkins University Press.

Berg, L., (1983), Konsumtion och sparande - en studie av hushållens beteende, Uppsala.

Berg, L., (1985), "Hushållssparandet under 1970- och 1980-talen", Ekonomisk Debatt 13, 265-273.

Bergström, V. and Södersten, J., (1976), "Double Taxation and Corporate Capital Cost", Industriens Utredningsinstitut, Working Paper No. 9.

Blanchard, O., (1979), "Backward and Forward Solutions for Economies with Rational Expectations", American Economic Review 69, 114-118.

Blanchard, O., (1981), "Output, the Stock Market, and Interest Rates", American Economic Review 71, 132-143.

Blanchard, O. and Plantes, M., (1977), "A Note on Gross Substitutability of Financial Assets", Econometrica 45, 769-771.

Blume, M. and Friend, I., (1975), "The Asset Structure of Individual Portfolios and some Implications for Utility Functions", Journal of Finance 30, 585-603.

Boman, R., (1982), "Ägarstrukturen i börsföretagen", in SOU 1982:28, Löntagarna och kapitaltillväxten 9.

Boskin, M., (1978), "Taxation, Saving, and the Rate of Interest", Journal of Political Economy 86, 3-27.

Bossons, J., (1971), "An Economic Overview of the Tax Reform Legislation", 1971 Conference Report, Canadian Tax Foundation, Ottowa.

Brainard, W. and Tobin, J., (1968), "Pitfalls in Financial Model Building", American Economic Review 58, 99-122.

Brennan, M.J., (1970), "Taxes, Market Valuation and Corporate Financial Policy", National Tax Journal 23, 417-427.

Bulow, J. and Summers, L., (1982), "The Taxation of Risky Assets", National Bureau of Economic Resarch, Working Paper No. 897.

Cohn, A., Lewellen, W., Lease, R. and Schlarbaum, G., (1975), "Individual Investor Risk Aversion and Investment Portfolio Composition", Journal of Finance 30, 605-620.

Cooley, T.F. and Salyer, K., 1984, "Inflation, Taxes and the Price of Housing Assets", mimeo, University of California, Santa Barbara.

Domar, E.D. and Musgrave, R.A., (1944), "Proportional Income Taxation and Risk-Taking", Quarterly Journal of Economics 58, 388-422.

Dornbusch, R., (1976), "Expectations and Exchange Rate Dynamics", Journal of Political Economy 84, 1161-1176.

Dornbusch, R., (1980), "Exchange Rate Economics: Where Do We Stand?", Brookings Papers on Economic Activity, 143-205.

Ebrill, L.P. and Possen, U.M., (1982a), "Inflation and the Taxation of Equity in Corporations and Owner-Occupied Housing", Journal of Money, Credit and Banking 14, 33-47.

Ebrill, L.P. and Possen, U.M., (1982b), "The Interaction of Taxes and Inflation in a Macroeconomic Model", Quarterly Journal of Economics 97, 231-250.

Elton, E. and Gruber, M., (1978), "Taxes and Portfolio Composition", Journal of Financial Economics 6, 399-410.

Englund, P., McPhee, S. and Viotti, S., (1985), "Ränteparitet och ränteberoende", Ekonomisk Debatt 13, 275-288.

Englund, P. and Persson, M., (1982), "Housing Prices and Tenure Choice with Assymetric Taxes and Progressivity", Journal of Public Economics 19, 271-290.

Feldstein, M., (1969), "Mean-Variance Analysis in the Theory of Liquidity Preference and Portfolio Selection", Review of Economic Studies 36, 5-12.

Feldstein, M., (1980a), "Inflation, Tax Rules and the Stock Market", Journal of Monetary Economics 6, 309-331.

Feldstein, M., (1980b), "Inflation, Portfolio Choice, and the Prices of Land and Corporate Stock", American Journal of Agricultural Economics 62, 910-916.

Feldstein, M., (1980c), "Inflation and the Stock Market", American Economic Review 70, 839-847.

Feldstein, M., (1982a), "Inflation, Tax Rules, and the Accumulation of Residential and Non-Residential Capital", Scandinavian Journal of Economics 84, 293-311.

Feldstein, M., (1982b), "Domestic Saving and International Capital Movements in the Long Run and the Short Run", National Bureau of Economic Research, Working Paper No. 947.

Feldstein, M., (1983), Inflation, Tax Rules, and Capital Formation, The University of Chicago Press.

Feldstein, M. and Green, J., (1983), "Why Do Companies Pay Dividends?", American Economic Review 73, 17-30.

Feldstein, M. and Horioka, C., (1980), "Domestic Savings and International Capital Flows", Economic Journal 90, 314-329.

Feldstein, M. and Summers, L., (1978), "Inflation, Tax Rules, and the Long-Term Interest Rate", Brookings Papers on Economic Activity, 61-109.

Friedman, B., (1978), "Crowding Out or Crowding In? Economic Consequences of Financing Government Deficits", Brookings Papers on Economic Activity, 593-641.

Friedman, B. and Roley, V., (1979), "A Note on the Derivation of Linear Homogeneous Asset Demand Functions", mimeo, Department of Economics, Harvard University.

Friedman, M., (1953), "The Methodology of Positive Economics", in Friedman, M., Essays in Positive Economics, The University of Chicago Press.

Friend, I. and Blume, M., (1975), "The Demand for Risky Assets", American Economic Review 65, 900-22.

Friend, I. and Hasbrouck, J., (1982), "The Effect of Inflation on the Profitability and Valuation of U.S. Corporations", in Saving, Investment, and Capital Markets in an Inflationary Economy, (eds. Sarnat, M. and Szegö, G.), Ballinger.

Friend, I., Landskroner, Y. and Losq, E., (1976), "The Demand for Risky Assets under Uncertain Inflation", Journal of Finance 31, 1287-1297.

Fullerton, D. and Gordon, R.H., (1983), " A Reexamination of Tax Distortions in General Equilibrium Models", in Behavioral Simulation Methods in Tax Policy Analysis, (ed. Feldstein, M.), The University of Chicago Press.

Gandolfo, G., (1980), Economic Dynamics: Methods and Models, (2nd edition), North-Holland.

Goldsmith, D., (1976), "Transactions Costs and the Theory of Portfolio Selection", Journal of Finance 31, 1127-1139.

Gonedes, N., (1976), "Capital Market Equilibrium for a Class of Heterogeneous Expectations in a Two-Parameter World", Journal of Finance 31, 1-15.

Gordon, R.H., (1982), "Interest Rates, Inflation, and Corporate Financial Policy", Brookings Papers on Economic Activity, 461-488.

Gordon, R.H., (1984), "Inflation, Taxation, and Corporate Behaviour", Quarterly Journal of Economics 99, 313-327.

Gordon, R.H. and Bradford, D.F., (1980), "Taxation and the Stock Market Valuation of Capital Gains and Dividends", Journal of Public Economics 14, 109-136.

Goulder, L., Shoven, J. and Whalley, J., (1983), "Domestic Tax Policy and the Foreign Sector: the Importance of Alternative Foreign Sector Formulations to Results from a General Equilibrium Tax Analysis Model", in Behavioral Simulation Methods in Tax Policy Analysis (ed. Feldstein, M.), The University of Chicago Press.

Grossman, S. and Schiller, R., (1981), "The Determinants of the Variability of Stock Market Prices", American Economic Review 71, 222-227.

Hansson, I., 1982, "Realräntans nivå vid real beskattning", in SOU 1982:3, Real beskattning.

Harberger, A., (1980), "Vignettes on the World Capital Market", American Economic Review 70, 331-337.

Hasbrouck, J., (1983), "The Impact of Inflation upon Corporate Taxation", National Tax Journal 36, 65-81.

Hendershott, P.H., (1981), "The Decline in Aggregate Share Values: Taxation, Valuation Errors, Risk, and Profitability", American Economic Review 71, 909-922.

Hendershott, P. and Hu, C., (1981), "The Allocation of Capital Between Residential and Non-Residential Uses: Taxes, Inflation and Capital Market Constraints", National Bureau of Economic Research, Working Paper No. 718.

Jorgenson, D., (1984), "Econometric Methods for Applied General Equilibrium Analysis", in Applied General Equilibrium Analysis, (eds. Scarf, H.E. and Shoven, J.B.), Cambridge University Press.

Jorgenson, D. and Yun, K-Y., (1984), "Tax Policy and Capital Allocation", Harvard Institute of Economic Research, Harvard University, Discussion Paper No. 1107.

Kearl, J.R., (1979), "Inflation, Mortgages and Housing", Journal of Political Economy 87, 1115-1138.

Keynes, J.M., (1936), The General Theory of Employment, Interest, and Money, Macmillan.

King, M., (1977), Public Policy and the Corporation, London.

King, M. and Leape, J., (1984), "Wealth and Portfolio Composition: Theory and Evidence", Economic and Social Research Council Programme in Taxation, Incentives, and the Distribution of Income 68, London.

Kouri, P. and de Macedo, J.G., (1978), "Exchange Rates and the International Adjustment Process", Brookings Papers on Economic Activity, 111-150.

Lau, L., (1984), "Comments", (discussion of Mansur and Whalley (1984)), in Applied General Equilibrium Analysis, (eds. Scarf, H.E. and Shoven, J.B.), Cambridge University Press.

Lease, R., Lewellen, W. and Schlarbaum, G., (1974), "The Individual Investor: Attributes and Attitudes", Journal of Finance 29, 413-433.

Lintner, J., (1965), "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets", Review of Economics and Statistics 47, 13-37.

Lintner, J., (1969), "The Aggregation of Investors' Diverse Judgements and Preferences in Purely Competitive Security Markets", Journal of Financial and Quantitative Analysis 4, 347-400.

Litzenberger, R.H. and Sosin, H.B., (1978), "Taxation and the Incidence of Homeownership Across Income Groups", Journal of Finance 33, 947-964.

Lodin, S.O., (1976), "Progressiv utgiftsskatt - ett alternativ", SOU 1976:62, Stockholm.

Löwenthal, B.-G. and Sjöberg, E., (1982), "Krediterna i Sverige 1970-1980", in SOU 1982:53, Kreditpolitiken - fakta, teorier och erfarenheter.

McDonald, J., (1974), "Discussion", (discussion of Lease, Lewellen and Schlarbaum, 1974), Journal of Finance 29, 434-438.

Malkiel, B.G., (1979), "The Capital Formation Problem in the United States", Journal of Finance 34, 291-306.

Mansur, A. and Whalley, J., (1984), "Numerical Specification of Applied General Equilibrium Models: Estimation, Calibration and Data", in Applied General Equilibrium Analysis, (eds. Scarf, H.E. and Shoven, J.B.), Cambridge University Press.

Mayshar, J., (1978), "Investors' Time Horizon and the Inefficiency of Capital Markets", Quarterly Journal of Economics 92, 187-208.

Mayshar, J., (1979), "Transaction Costs in a Model of Capital Market Equilibrium", Journal of Political Economy 87, 673-700.

Mayshar, J., (1981), "Transaction Costs and the Pricing of Assets", Journal of Finance 36, 583-597.

Meade, J.E., (1978), The Structure and Reform of Direct Taxation, Allen and Unwin, London.

Merton, R.C., (1971), "Optimum Consumption and Portfolio Rules in a Continuous-Time Model", Journal of Economic Theory 3, 373-413.

Mossin, J., (1966), "Equilibrium in a Capital Asset Market", Econometrica 34, 768-783.

Mossin, J., (1968), "Taxation and Risk-Taking: An Expected Utility Approach", Economica 35, 74-82.

Musgrave, A., (1981), "'Unreal Assumptions' in Economic Theory: The F-Twist Untwisted", Kyklos 34, 377-387.

Musgrave, R., (1959), The Theory of Public Finance, McGraw-Hill.

Palmer, E., (1984), "Hushållssparandet", in SOU 1984:7, Långtidsutredningens modellsystem och ekonometriska studier.

Pindyck, R., (1984), "Risk, Inflation, and the Stock Market", American Economic Review 74, 335-351.

Poterba, J., (1980), "Inflation, Income Taxes and Owner-Occupied Housing", National Bureau of Economic Research, Working Paper No. 553.

Poterba, J., (1984), "Tax Subsidies to Owner-Occupied Housing: An Asset-Market Approach", Quarterly Journal of Economics 99, 729-752.

Roley, V., (1979), "A Theory of Federal Debt Management", American Economic Review 69, 915-926.

Sandelin, B., (1977), "Prisutveckling och kapitalvinster på bostadsfastigheter", Memorandum No. 66, Nationalekonomiska Institutionen vid Göteborgs Universitet.

Sandilands, F.E.P., (1975), "Inflation Accounting", Report of the Inflation Accounting Committee, H.M.S.O.

Sandmo, A., (1984), "The Effects of Taxation on Savings and Risk-Taking", in Handbook of Public Economics, (eds. Auerbach, A. and Feldstein, M.), North-Holland, forthcoming.

Sharpe, W., (1964), "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk", Journal of Finance 19, 425-442.

Sharpe, W., (1970), Portfolio Theory and Capital Markets, McGraw-Hill.

Sheffrin, S., (1983), Rational Expectations, Cambridge University Press.

Shoven, J. and Whalley, J., (1984), "Applied General Equilibrium Models of Taxation and International Trade: an Introductory and a Survey", Journal of Economic Literature 22, 1007-1051.

Slemrod, J., (1983), "A General Equilibrium Model of Taxation with Endogenous Financial Behavior", in Behavioral Simulation Methods in Tax Policy Analysis, (ed. Feldstein, M.), The University of Chicago Press.

Smith, G. and Starnes, W., (1979), "A Short-Run Two-Sector Model with Immobile Capital", Journal of Money, Credit, and Banking 11, 47-67.

Statens Offentliga Utredningar, (1982a), Real Beskattning, SOU 1982:1.

Statens Offentliga Utredningar, (1982b), Tillväxt eller stagnation?, SOU 1982:14.

Statens Offentliga Utredningar, (1982c), En effektivare kreditpolitik, SOU 1982:52.

Stiglitz, J.E., (1969), "The Effects of Income, Wealth and Capital Gains Taxation on Risk-Taking", Quarterly Journal of Economics 83, 262-283.

Stiglitz, J.E., (1970), "A Consumption-Oriented Theory of the Demand for Financial Assets and the Term Structure of Interest Rates", Review of Economic Studies 37, 321-351.

Summers, L., (1980), "Inflation, Taxation and Corporate Investment: A Q Theory Approach", National Bureau of Economic Research, Working Paper No. 604.

Summers, L., (1981a), "Inflation, the Stock Market, and Owner-Occupied Housing", American Economic Review 71, 429-434.

Summers, L., (1981b), "Capital Taxation and Accumulation in a Life Cycle Growth Model", American Economic Review 71, 533-544.

Sumner, M., (1975), "Neutrality of Corporate Taxation, or on not Accounting for Inflation", Manchester School 43, 353-361.

Södersten, J. and Lindberg, T., (1983), Skatt på bolagskapital, Industriens Utredningsinstitut, Stockholm.

Södersten, J. and Ysander, B.-C., (1985), "Förenklad bolagsskatt", Ekonomisk Debatt 13.

Tanzi, V., (1980), Inflation and the Personal Income Tax, Cambridge University Press.

Thuné, M., (1983), "En presentation av Powells hybridmetod för lösning av icke-linjära ekvationer", UDAC nytt 5, 1983.

Tobin, J., (1969), "A General Equilibrium Approach to Monetary Theory", Journal of Money, Credit, and Banking 1, 15-29.

Uhler, R.S. and Cragg, J.G., (1971), "The Structure of the Asset Portfolios of Households", Review of Economic Studies 38, 341-357.

U.S. Treasury, (1977), Blueprints for Basic Tax Reform, Washington, D.C.

Uutma, T. and Hållsten, B., (1981), "Börsbolagen 1980 - en jämförelse med tidigare år", Skandinaviska Enskilda Bankens Kvartalsskrift 3-4.

Werin, L., (1983), "Budgetunderskott, portföljval och tillgångsmarknader", in Ds Fi 1983:29, Perspektiv på budgetunderskottet.

Wicksell, K., (1896), Finanztheoretische Untersuchungen und das Steuerwesen Schweden's, Jena.

Williams, J., (1977), "Capital Asset Prices With Heterogeneous Beliefs", Journal of Financial Economics 5, 219-239.