INFLATION, TAXATION, RISK AND CAPITAL MARKETS: PORTFOLIO ASSET ALLOCATION BETWEEN HOUSING AND MANUFACTURING CAPITAL IN THE U.K.

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TABLE OF CONTENTS.

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Summary

The role of owner occupied housing and manufacturing industry have been both high profile and controversial topics, particularly over the last decade. The present study attempts to identify and evaluate the effect of government taxation policy, inflation, risk and capital markets on individuals long run allocation of resources between these sectors. The majority of economic literature, particularly in the U.K., focuses on these sectors in isolation and is often (especially in housing studies) interested in the short to medium run implications.

The first part of the study (Chapter 1) identifies various key investment rules to which our model can appeal. In order to expose the factors outlined above the investment hurdle has been formulated within the confines of the user cost of capital theory. Economic and institutional conditions prevalent in the period 1965 to 1979 were imposed on the basic portfolio model which is a two sector multi-equation general equilibrium model whose output determines asset allocation, real user cost of capital and real cash flows (Chapter 2). Plausible data estimates were calculated, or where econometrically derived estimates were necessary, these were obtained from relevant empirical studies (Chapter 3).

The model is subjected to sensitivity analysis and then we apply growth, general and relative price inflation and finally mortgage rationing (Chapter 4). These simulations culminate to produce conditions which are similar to those actually experienced during the period of interest. Principal results of interest of the model are portfolio asset allocations, user costs of capital, the mortgage loan to valuation ratio and real cash flows. Output may also be obtained for required rates of return, risk premia and the effects of the mortgage capital market. The study finds that, in the long run, portfolio shifts occur away from manufacturing assets towards owner occupied housing in the presence of general and relative house price inflation. Mortgage rationing on the other hand offsets much, though not all, of this bias. We then adjust the model by fixing the risk free rate of interest. We also reduce both the relative real house price inflation and manufacturing equity variance which were a particular feature of this period in order to provide us with a long run model with which we may regard as a base for comparison in the following Chapter.

The model is utilised to trace the effects of variant tax policies under identical inflation and capital market conditions (Chapter 5) in order to suggest methods of compensating or eliminating the above bias. This is of particular interest, as the identification and evaluation of the long run indirect as well as direct effects of government policy (taxation and capital market influence), under alternative

economic environments, is a prerequisite for informed policy prescription. Two policies are directed at owner occupied housing and two at manufacturing. All policies are designed to encourage portfolio switching towards manufacturing. We present and assess each policies effectiveness under various economic conditions.

Finally, we discuss our results in the context of the U.K. literature and suggest areas of further research to which our model may be applied (Chapter 6).

Abbreviations.

A	=	Present value of investment allowances and grants to manufacturing.
a^*	=	Accelerator coefficient.
ACE	=	Allowance for corporate equity.
ACT	=	Advance corporation tax.
B	=	Total real stock of manufacturing debt.
b	=	Ratio of manufacturing debt to equity.
BSA	=	Building Society Association.
C	=	Cost of finance (discount rate).
ç	=	MIRAS ceiling parameter.
C*	=	Post tax cost of finance.
C_f	=	Risk free cost of finance.
CGT	=	Capital Gains Tax.
C_i	=	Internal discount rate of return.
$Ç_k$	=	Cobb-Douglas constant (Efficiency parameter).
$Ç_{kl}$	=	Cobb-Douglas constant (Incorporating labour factors).
CR	=	Profit deducting operating expenses.
crit	=	Algorithm tolerance limit.
CSO	=	Central Statistics Office.
D	=	Real personal disposable income.
d, f'	=	First derivative of the function.
d^2, f''	=	Second derivative of the function.
Dnd	=	Real manufacturing dividends.
E	=	Real stock of equity.
e	=	Natural exponential function.
E^*	=	Mathematical expectation.
EAT	=	Real manufacturing earnings after tax.
EPS	=	Earnings per share.
$EV_{t,n}$	=	Estimated value of endogenous variable at time t, iteration number n.
FV	=	Future value.
g	=	Rate at which grants are applied to manufacturing investment.
GB	=	Real government balance.
GDP	=	Gross Domestic Product.
gp	=	Risk premium on a gilt edged bond.
H	=	Real stock of owner occupied housing capital.
HH	=	Hendershott and Hu (1983).
H^{mb}	=	Real mortgage stock borrowed.
H^{md}	=	Real mortgage stock demand.
H^{ml}	=	Real mortgage stock lent (equals H^{mb}).
H^{ms}	=	Real supply of mortgage stock.

H^{pd} = Real stock of fully paid housing.
i = Risk-free rate of interest.
I = Gross investment.
IFS = Institute of Fiscal Studies.
I^n = Net investment.
I_o = Initial investment outlay.
I^r = Replacement investment.
IRR = Internal rate of return.
i_s = Initial risk free rate of interest.
IY = Rate of imputed income from owner occupied housing.
j = When subscript denotes a specific risky asset.
J = Specifies a risky asset.
J_s = Real sum of risky assets.
K = Real stock of manufacturing capital.
K^* = Desired manufacturing capital stock.
K_W = Capital stock of the whole economy.
1^* = $(1-\tau)/(1-A)$.
L = Labour input.
Lb = Real stock of long bonds.
ln = Natural logarithm.
L_W = Labour available in the whole economy.
M1 = Depreciation allowances.
MC = Marginal cost.
MCT = Mainstream corporation tax.
MIRAS = Mortgage interest relief at source.
mp = Mortgage premium.
MPP_k = Marginal physical product of manufacturing capital.
MR = Marginal revenue.
MRP_k = Marginal revenue product of manufacturing capital.
n = Elasticity of housing demand with respect to the user cost.
n = Real price of manufacturing capital.
NAIRU = Non accelerating inflation rate of unemployment.
NPV = Net present value.
NPV^{PT} = Post tax NPV.
p = Post tax expected risk premium.
p = Real price of housing capital.
PE = Price to earnings ratio.
p_E = Manufacturing equity risk premium.
PEP = Personal Equity Plan.
$p_{H^{pd}}$ = Paid up housing risk premium.

P_I = Price of manufacturing input.
p_{Lb} = Manufacturing long bond risk premium.
ps = When subscript equals policy simulation.
PV = Present value.
PV^m = Market value of the firm.
P_W = Price of manufacturing output.
q,Q = Ratio of the market value of manufacturing capital to its replacement cost.
R = Relative risk aversion.
r = Required rate of return.
R_A = Absolute risk aversion.
r_B = Required return from bonds.
r_{Ba} = Post tax required return from bonds.
RE = Retained Earnings.
r_E = Required return from manufacturing equity.
r_{Eac} = Post tax required return from manufacturing equity - classical system.
r_{Eai} = Post tax required return from manufacturing equity - imputation system.
r_{Ec} = Required return from manufacturing equity - classical system.
r_{Ei} = Required return from manufacturing equity - imputation system.
r_G = Required return from a gilt edged security.
r_h = Required return from housing capital.
r_{ha} = Post subsidy required return from housing capital.
$r_{H^{mb}}$ = Required return from mortgaged stock.
$r_{H^{mba}}$ = Post MIRAS required return from mortgaged stock.
$r_{H^{pd}}$ = Required return from paid up housing.
$r_{H^{pda}}$ = Post tax required return from paid up housing.
r_{ja} = Post tax return from the jth asset.
r_k = Required return from manufacturing capital.
r_{ka} = Post tax required return from manufacturing capital.
r_{Lb} = Required return from manufacturing long bonds.
r_m = Required return from a market portfolio.
r_{Sb} = Required return from short bonds.
Sb = Real stock of short bonds.
SSAP = Statements of Standard Accounting Practice.
T = State of technical knowledge.
t,s = When subscript denotes unit of time.
TR = Total revenue.
TX_h = Real tax paid by individuals.
TX_{hc} = Real tax paid by individuals - classic system.
TX_{hi} = Real tax paid by individuals - imputation system.

TX_k	=	Real tax paid by manufacturing.
TX_{kc}	=	Real tax paid by manufacturing - classic system.
TX_{ki}	=	Real tax paid by manufacturing - imputation system.
$U(W)$	=	Individuals utility function with respect to wealth.
UC	=	General user cost of capital.
UC_h	=	Real general user cost of housing capital.
UC_{ha}	=	Real user cost of housing capital to the individual.
UC_k	=	Real general user cost of manufacturing capital.
UC_{ka}	=	Real user cost of manufacturing capital to the individual.
UC_{kac}	=	Real manufacturing user cost - classical system.
UC_{kai}	=	Real manufacturing user cost - imputation system.
UC_m	=	Real user cost of mortgage stock.
v	=	Housing loan to valuation ratio.
VAT	=	Value added tax.
w	=	Lag structure.
W	=	Real value of wealth.
Wr	=	Real stock of wealth.
Y	=	Real manufacturing Output.
y(t)	=	Standardised normal random variate.
Y_W	=	Output of the whole economy.
z	=	Ratio of manufacturing short-term debt to long-term debt.
f	=	Denotes a function or mapping.
$\alpha_{1\text{-}4}$	=	Manufacturing user cost tax parameters.
α_h	=	Housing demand function constant.
α_k	=	Cobb-Douglas substitution elasticity.
α_m	=	Mortgage demand function constant.
$\beta_{1\text{-}4}$	=	Housing user cost tax parameters.
Γ	=	Mortgage rationing parameter (Loan to income).
π	=	Actual rate of inflation.
π^e	=	Expected rate of inflation.
π^{eh}	=	Expected capital gains of housing capital.
$\dot{\pi}^{eh}$	=	Change in expected capital gains of housing capital.
π^{ek}	=	Expected capital gains of manufacturing capital.
$\dot{\pi}^{ek}$	=	Change in expected capital gains of housing capital.
Σ	=	Summation of.
$\int$	=	Integral sign.
σ^2	=	Variance of return.

$\sigma^2{}_E$ = Variance of return from manufacturing equity.
$\sigma^2{}_{H^{mb}}$ = Variance of return from mortgaged stock.
$\sigma^2{}_{H^{pd}}$ = Variance of return from paid up housing.
$\sigma^2{}_j$ = Variance of the return from the jth risky asset.
$\sigma^2{}_{Lb}$ = Variance of return from long bonds.
$\sigma^2{}_m$ = Variance of return of the market portfolio.
σ_m = Standard deviation of the market portfolio.
μ_k = Manufacturing capital gains tax rate.
μ_{ke} = Effective manufacturing capital gains tax.
μ_p = Personal capital gains rate.
τ = Marginal rate of corporation tax.
Φ_h = Domestic local authority rates.
Φ_k = Manufacturing rates.
Θ = Marginal rate of personal income tax.
Ω = Scaling factor for investment allowances.
δ = Depreciation rate.
δ_h = Depreciation rate of housing capital.
δ_k = Depreciation rate of manufacturing capital.
∞ = Infinity.
ϕ = Dividend payout ratio.
ϵ = Elasticity of housing demand with respect to income.
$\epsilon_{n,x,y}$ = Elasticity of x with respect to y in period n.

1. INTRODUCTION.

1.1. Introduction.

The objective of this research is to develop a model framework which will facilitate the analysis of inflation, taxation, risk and capital markets on individuals portfolio investment. A long run general equilibrium simulation model utilising user cost of capital theory is identified as the most pertinent modelling vehicle for this task. We present the owner occupied housing and manufacturing sectors as key to the performance of the UK economy and model these over the period 1965 to 1979 in Chapter 2. A discussion of appropriate parameters and model solution technique is presented in Chapter 3. In Chapter 4 we simulate various parameter changes in order to explore pertinent areas of the model and simulate the growth, inflation and capital market conditions of that period. Our final objective of this Chapter is to slightly alter both the model structure and a limited number of parameters in order that we may obtain a long run model suitable for comparing various policy shocks which are presented in Chapter 5. The process of cumulatively imposing growth, general inflation, relative inflation and mortgage rationing enables a comparative static analysis of the effects of these changes under alternative policy frameworks. Chapter 6 provides a summary of conclusions followed by an outline for further research.

The objective of this Chapter is to outline the foundations of asset allocation studies and discuss some of the long-run implications of these models. Following a discussion of the micro-economic principals of the investment decision, the three main investment theories of the firm are presented along with a review of the empirical evidence. Given the long-run nature of most sector or asset allocation models and the complexity of the investment decision process, it is argued that utilisation of the user cost of capital theory will most beneficially enable the explicit isolation of the effects on asset allocation of taxation, risk capital markets and inflation. A review of investment allocation models which encompass the above issues is presented and a conclusion derived suggesting the most fruitful vehicle for researching issues within a U.K. context. Following this we present a discussion which focuses on why owner occupied housing and manufacturing are key sectors. In particular the interaction of owner occupation and the political environment is discussed along with the role of building societies and the potential effects on the rest of the economy of housing wealth. It is argued that manufacturing investment is significant in introducing technical improvements which are crucial to economic growth and international competitiveness. A discussion of the U.K.'s productivity slowdown in the 1970's is provided which places investment misallocation in the context of alternative hypotheses explaining this phenomenon. In order to provide the foundations of the model presented in Chapter 2 each sectors respective fiscal regimes are presented followed by a discussion of contemporary policy issues which may be tested by our model.

1.2. Economic Growth, Investment and Resource Allocation.

The purpose of this Section is to set in context the importance of investment for resource allocation and economic growth. During this process we review a number of theories of investment and determine which is the most appropriate when constructing our model.

1.2.1. Investment Theory.

In order to demonstrate the importance of investment for economic growth we can look at the basic framework of a simple neoclassical growth model and then suggest some realistic complexities which reinforce the importance of investment.

In the long run, an economy's level of output is mainly a function of the size of the labour force, the capital stock and the state of the technology. Standard neoclassical long run steady-state growth models demonstrate that the growth rate is a function of the growth in both the labour force and, in technical knowledge, not the rate of investment (Phelps, 1961, pp. 643; Levacic and Rebman, 1982, pp. 276). Generally, these models demonstrate that an increase in the rate of investment raises the short run rate of growth. In time, the economy reverts back to the "natural" rate of growth, but at a higher income per head and capital-output ratio.

A standard aggregate production function would take the form:

$$Y_w = f\ (L_w, K_w, T), \tag{1.1}$$

where the subscript w represents the whole economy rather than any subsector. L_w is the stock of available labour, K_w. represents the total capital stock and T is the state of technical knowledge.

Abstracting from technical progress, the average product of labour is an increasing function of the capital to labour ratio:

$$Y_w\ /\ L_w = f\ (K_w\ /\ L_w). \tag{1.2}$$

A key contribution to growth theory was made by Solow (1956) who maintained that factor prices are variable in the long run and respond to excess demand. This introduced the possibility of factor substitution by agents in response to changes in relative factor prices. These assumptions formed the corner stone of the neoclassical model of economic growth.

A notable feature of this model is that there is no explicit investment function, investment being a change in the capital stock:

$$I = dK_w / dt, \tag{1.3}$$

where I represents investment and t is a unit of time. Perfect competition is assumed and, consequently, profit maximising firms equate the marginal product of an input to its price.

This research utilises the assumption that, in the long run, factor prices are flexible, and consequently given demand conditions factor substitution occurs.

Usually, growth analysis is concerned with the relationship between the factors of production labour and capital. At one disaggregate level, Y_w consists of a set of industries such as manufacturing, services or housing. The composition of these industries may affect the overall performance of the economy. Neoclassical theory would argue that the composition of K_w was irrelevant as each industry's marginal products would be optimal but when we introduce taxation and inflation, this result cannot be taken for granted. For example, it could be argued that both disembodied and embodied technical changes naturally occur in one industry to a greater extent than on another. Thus, increased levels of investment in this sector would directly impinge on the growth rate of the economy. The level of capacity in certain sectors may have a bearing on inflation and the balance of payments.

It is clear then that economic performance is directly influenced by the level and direction of investment flows which represent resource allocation by investors in the economy who are assumed to be standard profit-maximising agents. These simple assumptions of factor substitution in the long run, and profit maximisation, enable governments to affect resource allocation through fiscal measures, that is, taxes and subsidies. Thus, government action, whether intentional or unintentional, will affect, through personal sector portfolio allocation, the economy's output and productivity levels. In a similar way rising inflation or volatile risk premiums may favour investment in particular sectors which again suggests that in a more complex environment, economic growth will depend on the direction and magnitude of investment flows.

1.2.2. The Concept of Investment.

Given the importance of investment it is desirable to examine some of the key concepts which underlie the process. Investment is the accumulation over time of real capital goods by economic agents where capital yields a flow of services to its owner. There are four main forms of real investment: Firstly, business investment in fixed capital, that is plant or machinery which maintain their physical form throughout their working lives. Secondly, inventories or stocks of working capital which play an important function in the economy by enabling industry to respond effectively to changes in demand (A brief discussion of inventories is presented in Greenaway and Shaw 1983, Kelly and Owen 1985 and Wallis *et al.* 1987, Chapter 5). Thirdly, investment in housing construction and finally, public sector investment.

Keynes (1936, pp. 63) states that once consumption is set by the personal sector, saving and investment, which, by definition are equal, is the residual between income and consumption. In the short run, it is not surprising that investment is the most volatile component in the traditional national income identity and is a major factor in determining the level of economic activity.

The agents motive to invest is essentially an attempt to maximise wealth subject to a suitable intertemporal trade-off between present and future consumption. Investment must be capable of increasing future output. This can be achieved by either increasing the size of the fixed capital base or through technological advances.

A neglected aspect of investment (Feldstein and Foot, 1971; Berndt, 1991, pp. 229-232) is the distinction between gross (I), net (I^n) and replacement (I^r) investment. Gross investment represents the total outlay on capital goods, whilst net investment measures that part of the outlay which increases the size of the capital stock. The difference, depreciation, or I^r is that amount of the capital which has completed its economic life either as a result of physical deterioration or technical obsolescence. If capital depreciates at a rate δ then:

$$dK_t \,/\, dt = I_t - \delta K_t = I^n_t = I_t - I^r_t, \tag{1.4}$$

and

$$K_t = K_{t-1} + I^n_t, \tag{1.5}$$

where K_t represents the stock of manufacturing capital. Throughout this Chapter K_w and K may be substituted and we use K for simplicity. Depreciation alone requires investment in capital if the size of the capital stock is to even remain constant and is therefore a significant component of total investment outlay for many productive sectors, for example manufacturing. Only when $I_t > I^r_t$ is new investment adding to the capital stock and consequently wealth.

Having allocated present income for investment, the investor must then assess both the likely return from each potential project and the associated risk incurred. In this respect, the formation of expectations are crucial to investment (Arrow, 1964; Ando *et al.*1974; Nickell, 1974) and consequently, the standard neoclassical theory has been criticised for its myopic assumptions. More recently, rational expectations theory (see Muth 1960; Sheffrin 1983, Chapter 1; Cuthbertson and Taylor, 1987, Chapter 3), where long-run expectations are based on an assessment of all available information using the true predictive model of the economy, have been applied to models of the whole economy (Wallis *et al.* 1987, pp. 3). Dow and Dow (1985) argue that even rational expectations theory cannot account for "Animal Spirits" associated with the investment process. An important aspect of risk minimisation is through product or portfolio diversification (a general framework of portfolio characteristics is discussed in Blake (1986a)). Having assessed these parameters, investments are chosen so as to optimise the risk return trade off.

We shall assume that, ultimately, individuals own all net wealth in the economy and therefore, it is the set of risk and return combinations facing them which fundamentally determine resource allocation (eg. HH, where HH denotes Hendershott and Hu (1983); Kau and Keenan, 1983; Gahvari, 1984; King and Fullerton, 1984; Fullerton and Henderson, 1987; Davis, 1988; Barr and Cuthbertson, 1989). Clearly, there is a direct link between individuals and their decision to invest in an asset such as housing. This is complicated when assessing manufacturing investment given the existence of the corporate entity which itself has to choose between strategies and investments. Whilst individuals and firms are naturally interdependent, there is an important difference in function illustrated by Goodhart (1975, pp. 89). Corporates perform an organising function, the creation of teams, whilst the personal sector supplies labour and, ultimately, owns all the assets used in the corporate sector. The important point of this study is that corporates can only invest to the extent that individuals will fund them, which, in turn, depends on the relative attraction of corporate debt and equity.

The nature of investment in real fixed assets will directly link today's investment with the composition of future capital stock. Thus, Arrow (1964) points out that whilst profit is a function of the capital stock, this function will change through time as technology and relative prices change. Robinson (1961) and Nickell (1974) argue that investment models assuming a "putty-putty" capital stock (one where there is perfect substitution of capital *ex ante* and *ex post*) are flawed. Their argument is based on the premise that after the decision to choose a project has occurred, the capital is "bolted down" and hence, investment is irreversible, the capital is in clay form and $I \geq O$. Evidence of premature scrapping (Wadhwani and Wall, 1986) in times of recession does weaken this argument to some extent. Their point is important as a criticism of pure neoclassical investment models and their full employment of capital predictions. This argument only magnifies the need for government to understand how it may be affecting investment decisions while they are at a putty stage. Given that our model seeks to shed light on the long run allocation implications of taxation, inflation and risk then it is putty-putty in nature.

In the long run, investors may substitute assets freely investing in order to maximise returns. We have assumed that individuals own all net wealth and therefore we are, by definition, interested in the decisions they make given a choice of post tax real asset yields and associated risks.

1.2.3. Theories of Investment.

We can now discuss investment theory in order to establish investment rules which represent the behaviour of investors which we may utilise in our model. Initially we discuss the single project rules of Net Present Value (NPV) and Internal Rate of Return (IRR) in their basic forms (Section 1.2.4.1.). Following this we discuss the crucial roles of the cost of capital (finance) and equity valuation. Using the single project rules framework we analyse the effect of inflation, taxation and risk on the investment decision. For completeness we discuss the less technically oriented payback method in Section 1.2.4.2. which leads us into our discussion of investment theories of the firm.

1.2.4. Single Project Rules.

At an individual project level, there are two similar methods for evaluating an investment: the net present value method (NPV), the internal rate of return (IRR) and a more general rule of thumb, the pay back method. Utilising such methods, the individual or firm chooses investments with the object of profit or shareholder wealth maximisation.

1.2.4.1. Net Present Value and Internal Rate of Return.

The concept of NPV and IRR are related and can be discussed together, with identical investment conditions, they produce exactly the same results (Levy and Sarnet, 1986, pp. 58). It should also be noted that the user cost of capital (see Section 1.2.5.1. focuses on these principals, in particular the NPV concept. More detailed descriptions can be found in most standard finance text books (Rutterford, 1983; Levy and Sarnat, 1986; Adams, 1989).

Equation (1.6) is a simple formula which allows us to calculate the present value, PV, of some value known in the future, FV, at a time period t when the actor is aware of the relevant discount rate, C, thus:

$$PV = FV_t \;/\; (1+C)^t. \qquad (1.6)$$

Conversely, multiplying both sides by $(1+C)^t$ we can calculate a future value given the present value of the sum at time period 1.

Equation (1.6) can be split into a more obviously operationally relevant formula which introduces net cash receipts, CR (profit deducting operating expenses) for each time period until the investment is expected to end its usefulness in period s and by deducting the initial investment outlay, I_o, we obtain a general formula to calculate the NPV as:

$$NPV = \sum_{t=1}^{s} \frac{CR_t}{(1+C)^t} - I_o\,. \qquad (1.7)$$

Equation (1.7) is utilised by investing in a project as long as the NPV > O. If the NPV = O, the investor is indifferent to the project.

The IRR method of project selection is very similar to the NPV principal. The object is to find the discount rate which equates the PV of the stream of net receipts to the value of the initial investment outlay. We can call this discount rate C_i. More complex factors may be introduced such as comparing projects with the same IRR but with different cash flow profiles (Gronchi, 1986; Wright, 1986). However, such complexities are unnecessary for the present analysis. The investor must find a value for C_i such that equation (1.8) is satisfied:

$$\sum_{t=1}^{s} \frac{CR_t}{(1+C_i)^t} - I_o = O. \tag{1.8}$$

Remembering that C is the cost of capital facing the investor (the opportunity cost) and therefore represents the minimum required return from a project. The investor will invest in a project as long as the condition $C_i > C$ and is indifferent where $C_i = C$.

The IRR method is sometimes known as the "discounted cash flow" or the "marginal efficiency of capital". The latter term was used by Keynes (1936, pp. 135) where he states, "I define the marginal efficiency of capital as being equal to the rate of discount which would make the present value of a series of annuities given by the returns expected from the capital-asset during its life just equal to its supply price". It is from this analysis that Keynes describes a downward sloping marginal efficiency of capital schedule equating the rate of interest and the stock of fixed capital. The slope results from the downward pressure on the projects profit stream, as rising output tends to push price down for a given demand while capitals supply price rises as the demand for capital increases. In this respect Keynes did not attempt to provide an alternative to the marginalist theory of distribution in the long run (Sebastiani, 1984, pp. 186). It is this process is that which lies behind the law of diminishing returns. The desired capital stock will be chosen utilising the above NPV or IRR methods subject to the law of diminishing returns which ensures a limited value for the desired capital stock, K^*.

1.2.4.1.1. Cost of Capital.

We demonstrated the key role of the cost of capital in Section 1.2.4.1. Given this, it is important to understand what alternatives may contribute to the cost of capital in the real world.

The cost of capital is the cost of financing an investment project (opportunity cost) and is different from the user cost of capital (although it is part of it) and the price paid for a capital good or asset. Clearly from equations (1.6) to (1.8), the cost of capital (C, or C_i); will affect the attractiveness of an investment. Corporates can finance investment by utilising retained earnings (RE), debt (B) or equity (E). In reality the actual C will be a weighted average of these financing routes.

A good starting point to discuss the relationship between these financing vehicles is to begin with a paper written by Modigliani and Miller (1958). The aim of this paper is to demonstrate that under certain conditions, the financing and investment decisions are separate. That is, the cost of capital is independent of the ratio of RE, B and E. In order to achieve this result, no corporate or personal taxes are assumed, capital markets are perfect and financial transactions and bankruptcies are executed cost free. All funds can be borrowed at a single rate and published information is equally available to all.

Naturally, such assumptions are far from realistic and therefore, financial structure will depend on the extent to which these assumptions evaporate. King (1974; 1977, Chapter 4) argues that taxation (for example, the interest deductability of corporate debt) does affect the investment finance decision and in both papers concludes that for purely tax reasons, corporates would not issue equity. Auerbach (1983, pp. 909) derives a similar conclusion for the U.S. Casual observation suggests that this is not a corporates typical financial structure. Capital markets reflect the view that as the proportion of debt rises the probability of bankruptcy increases and therefore, increased debt would either cost the corporate disproportionately more or not be forthcoming at all.

It would consequently be advantageous if our model could facilitate financing from various sources with separate costs and tax structures.

1.2.4.1.2. Equity Valuation.

The valuation placed on the ownership of certain assets, particularly equity, can also effect the incentive to invest. Given this our model will incorporate a parameter which enables equity valuations to shift.

The need for equity financing introduces further complexities for corporate financial structure. Efficient market theory (briefly outlined in Rutterford (1983, Chapter 9) and Phlipps (1988, Chapter 8)) suggests that share prices fully reflect the underlying worth of the company. Under these conditions, corporates would be unwilling to finance by issuing equity if the stock markets valuation was lower than their perceived worth of the company. Efficient markets are a prerequisite for the Modigliani and Millar (1958) conclusion.

Many economists have questioned this theory given the extreme volatility and sustained deviations of market valuations from underlying valuations. Efficient market theorists argue that these observations are a result of new information or changes in the discount rate. Grossman and Shiller (1981) and Nickell and Wadhwani (1987) reject the efficient market hypothesis. The former authors reject the changing discount rate theory while the latter authors support the "fads model" explanation. "Fads models" suggest that stock markets become driven by sentiment or fashions. Hendershott (1981) focuses on the undervaluation of the U.S. stock market in the 1970's, particularly the effects inflation may have through taxation, increased risk premiums, the effects of government deflationary policy and alternative assets becoming more attractive. There is currently little consensus as to what theory, if any, should replace the efficient market hypothesis.

This problem is not isolated to the corporate sector, Case and Shiller (1989) use time series data between 1970 and 1986 for selected regions in the U.S. and rejected the hypothesis that the housing market is efficient. Phillips (1988) finds that while investors in housing are sensitive to changes in the user cost of housing the immediate response can be small and the speed of adjustment is asymmetric as investment rises relatively quickly if costs fall but individuals tend to cut expenditure in other areas if housing costs rise.

Evaluating the true worth of a corporate is not straight forward. Fazzari *et al.* (1988a) and Edwards (1987) argue that capital markets present the problem of asymmetric information which makes it costly for providers of external finance to evaluate the quality of firm's investment opportunities. Edwards (1987) furthers this argument by indicating that this information problem itself may have secondary effects on financing. Owners of firms (outsiders) may use capital markets as a form of controlling the actions of managers (insiders), to the extent that when this happens it can be thought of as an "agency cost". Furthermore, a signalling cost can also be identified in which managers pay out greater than financially optimal dividends in order to attract funds. Fazzari *et al.* (1988b) show that asymmetric information and taxation impinge to a large extent on corporates (particularly rapidly growing ones who are quantity constrained in the capital markets and are therefore dependent on retained earnings. If this is the case, then the average tax rate on returns from existing projects will affect the investment decision.

Clearly, given the arguments presented above, any investment theory which explicitly incorporates the cost of capital should allow for different methods and costs of finance.

A common method of incorporating multiple financing sources is to include each with a relevant weight attached. This method is incorporated into our model and is also utilised in the work of King (1974, pp. 29), Auerbach (1983, pp. 926-929), Kelly and Owen (1985, pp, 8-12) and Levy and Sarnet (1986, Chapter 18).

1.2.4.1.3. Taxation and Investment.

The role of taxation on resource allocation is key to the rationale for the model presented, particularly in view of the effect on economic growth argued in Section 1.2.1. Apart from the critical function of raising revenue, fiscal measures are clearly regarded by government as "control variables" or "instruments" and therefore, form an integral part in overall economic policy (eg. see Gordon, 1981, pp. 435-436). As such, we have witnessed a plethora of changes in tax rules not only during the period of interest, but throughout the century. It is not the purpose of this work to discuss the theory of taxation in any great depth (the reader is referred to Prest and Barr (1985), James and Nobes (1988) or Hardie (1989) for a brief history), but to discuss the main areas where tax policy influences investment and resource allocation. More specific aspects of the tax regime and its interaction with the user cost of capital is discussed in Chapter 2.

The government can tax using either indirect or direct taxes and it can tax the consumption of a good which, depending on income and substitution effects, may reduce the demand for that good and thus influence resources devoted to that industry. If it is the intention of the government to influence resource allocation between sectors, then a more efficient method would be to directly tax or subsidise the sectors in question. This could be done by altering the sectors cost of capital (see Devereux (1987) for a summary of the U.K), effectively increasing the rate at which firms must discount their cash flow or to directly tax cash flow. This influence is weakened if efficient "tax capitalisation" occurs in the asset market, that is, the price of the asset rises or falls in order to equate post tax return to its original level before the fiscal change.

We can use the example of taxing a firm's cash flow by τ (the corporate tax rate) and for simplicity, relate this to the investment rule in equation (1.8), although the same principal of incorporating tax into the three investment theories of the firm applies. By introducing corporation tax, we can calculate a post tax net present value (denoted by the superscript PT) of a project. Equation (1.8) then becomes:

$$NPV^{PT} = \sum_{t=1}^{s} \frac{(1-\tau)CR_t}{(1+C)^t} - I_o, \qquad (1.9)$$

We can see that firm's investment decisions in a sector which is subject to corporation tax will find fewer viable projects compared to firms in a sector with no corporation tax. Simply, for all t, if the condition $\tau > O$ holds, then $NPV^{PT} <$

NPV.

Annual depreciation allowances have the opposite effect in that they allow firms to subtract the cost of depreciation of capital from its annual tax charge. A tax rate of τ makes a 100% allowance worth τ pence in the pound while a 25% first year allowance is worth 0.25 x τ in the pound. Future years allowances can be calculated and a present value created. This does not directly affect the firm's cash flow but influences the post tax cash flow and therefore, corporate tax becomes $\tau(CR_t\text{-}M1_t)$, where $M1_t$ is the accelerated depreciation allowance. Since $M1_t$ is subtracted to calculate the corporation tax burden, it has to be added back to give a post tax cash flow of $(1\text{-}\tau)(CR_t\text{-}M1_t)+M1_t$. Equation (1.9) becomes :

$$NPV^{PT} = \sum_{t=1}^{s} \left[\frac{(1-\tau)CR_t}{(1+C^*)^t} + \frac{\tau M1_t}{(1+C_f)^t} - (1-g)I_o \right] \tag{1.10}$$

Where C^* is the post tax cost of finance, C_f is the "risk free" cost of finance which is applied to depreciation allowance because it is certain unlike profits flow.
The term g represents an investment grant which effectively reduces the price of the capital good to the investor. As the value of g rises, the NPV to an investor also rises. Thus, a sector which attracts such grants, *ceteris* paribus, will find it more profitable to expand capacity than one which does not.

The argument that taxation has no effect on the investment decision has been forwarded by Stiglitz (1973) who criticises Jorgensen and others who apply tax parameters to marginal costs of capital for resource allocation purposes on the basis that they have no effect on the investment decision. A similar argument was put forward by the Colwyn Committee Report of 1927 (Prest and Barr, 1985, pp. 47) with respect to income taxes. Prest and Barr (1985) argue that this criticism is misconceived on the grounds that marginal firms are not zero profit firms but make normal profits and thus, would pay tax on these.

Another theoretical problem when assessing the effect of tax changes on resource allocation is the *"Ceteris Paribus"* complexity (Prest and Barr, 1985, pp. 32). This is the difficulty of identifying what other variables in a model are assumed to be held constant when the effects of a tax change are being traced. For example, if government expenditure is assumed to increase *pari passu* with the imposition of a new tax, it is difficult to differentiate between the changes arising from the tax and the increased government expenditure. This can be achieved by assuming that any tax change is "fully compensated" by the opposite change in another tax which is known to have no effect on individuals' income or the government budget, but only changes the relative prices facing the individual. This methodology is applied to resource allocation between non-residential and residential sectors by Gahvari (1984). This problem is discussed in relation to our model in Chapter 2.

1.2.4.1.4. Inflation and Taxation.

On its own inflation, through relative prices can affect a sectors investment or financing ability, even the government (a study of the gains and losses on the real value of monetary assets between 1979 and 1987 can be found in Kennedy (1989)). The interaction of inflation and a tax regime can distort the signals which investors' face and as such alternative investments are best looked at in real post tax terms. Our model is designed to expose the effects of inflation and taxation at a general and asset specific level. All model results will be in real terms.

Inflation and taxation interacts with investment decisions in several ways: The net present value calculation described above is sensitive to changes in inflation because of the compounding effect on cash flow. The holder of the asset may be moved into progressively higher marginal tax brackets, although this process, fiscal drag (See Prest and Barr (1985, pp. 334) or James and Nobes (1988, pp. 139)), would not directly affect resource allocation except to the extent that competing assets had different income elasticities.

For industrial assets, inflation, coupled with historic cost accounting does effect real returns. Corporate profits become overstated because stock gains are taxed on a nominal basis and because depreciation is based on historic figures. King and Wookey (1987) argue that this argument may be too simple and that for a given tax structure, effects on the economy may be symmetrical in that the effects on investment may be positive below a certain rate of inflation and negative above it. For this reason, they emphasise the need for careful modelling of such areas in order to fully understand the implications of tax structures. This argument can be extended in that such effects will occur at different rates of inflation for different sectors of industry, the particular rate being a function of relative stock to capital and debt to equity ratios. A disaggregated approach is also useful given that inflation is generally not neutral, thus price signals and expectations become important. During the 1970's corporate returns looked spectacular, but intuition and inflation adjusted measures confirm otherwise. Under inflationary conditions, excessive dividend payout and wage claims may be the norm.

The accountancy profession did attempt to introduce some form of inflation accounting with the Statements of Standard Accounting Practice (SSAPs) 16 and Exposure Draft 35 (see Holmes and Sugden, 1986, Chapter 22). A further structure which differs from current cost accounting is the current purchasing power method (Kay and Meyer, 1984). Owing to disagreement among the accountancy profession and reservations of industry, these methods have never achieved mass popularity and, consequently, the historic cost basis has remained the norm.

Inflation can bring its apparent advantages to investment. To the extent that an asset is debt financed, the owner will benefit from the erosion of the real value of this debt through time. Furthermore, if nominal interest rates can be deducted against taxable income, then high nominal interest rates increase the value of this deduction. Even where the tax regime achieved neutrality across assets, if people perceived any of these as better inflation hedges than others, that asset would benefit as inflation rose.

Despite the logic for economic agents to make decisions from a real base, nominal figures clearly operate in complex ways. A good example of this outwith investment theory is the argument presented by Deaton (1977) that "mass illusion" can occur because consumers are unable to distinguish between relative and absolute price charges and, as a result, in an inflationary environment, real consumption falls. For the above reasons, Anderson (1981) suggest analysing investment expenditure in a nominal framework. Bean (1981), on the other hand, points out that this argument implies that all price movements are unanticipated and suggests that a better way forward would be to maintain the conventional real approach, but include prices as an additional variable. The approach suggested by Bean (1981) is used in our model.

1.2.4.1.5. Risk and Taxation.

Like inflation, the combination of risk and taxation can theoretically have important implications for the allocation of investment. This is likely to be especially true with assets at divergent ends of the risk spectrum. Given this our model explicitly incorporates risk premiums and enables the effect of taxation on these to be analysed.

Assuming that investors are risk averse, then the *quid pro quo* for incurring additional risk must be a higher expected return (a more detailed discussion is presented in Prest and Barr, 1985, pp. 43-47). Under this assumption the existence of a fixed rate tax results in the post tax risk premium received by the investor being less than at the pre tax level. Moreover, the taxing of risk premium is asymmetric in that the government does not share in any losses, thus taxation reduces the mean expected return of progressively riskier projects. This proposition is diluted to some extent if the tax on all returns reduces income and therefore increases the desire to undertake risky investments in order to compensate for this (Prest and Barr, 1985, pp. 45). Evidently, housing is considered a relatively "safe" investment, for example, Bootle (1985, pp. 38) compares it with that of an index linked gilt, thus even if it were taxed, the returns would not suffer in the manner described above.

Risk and inflation are not independent. High levels of inflation (more precisely varying rates) tend to be associated with greater uncertainty and the likelihood of austere anti-inflation policies. Risky investments will tend to suffer in such an environment. In the U.S. Malkiel (1979) has argued that investment in fixed capital was not only sluggish during the 1970's, but that much of the investment which did take place was skewed towards equipment and relatively short term projects. He concludes that inflation disproportionately increased the risk premium on long-term investments.

1.2.4.2. The Payback Method.

A less theoretically rigorous, but commonly used, investment decision rule is the payback method (discussed in Rutterford (1983, pp. 142-148) and Levy and Sarnat (1986, pp. 197-198)). The payback is a non-discounted rule of thumb which tells the investor how many years are required in order to recover the initial investment outlay. Despite this simplicity, it remains a popular investment appraisal tool, especially in equity capital markets all over the world. Given the increasing importance of these markets, this rule cannot not be ignored.

The payback is denominated in time, generally years, and is given either by the initial investment outlay divided by the annual cash receipt or, more commonly, in capital markets as the PE ratio - share price divided by the earnings per share (EPS). EPS is defined as profit after tax, interest on corporate borrowing and preference share dividends, divided by the number of shares issued.

Given that the PE is a ratio, it can be used to compare the valuation placed on one project/company compared to another. The higher the PE, the greater the growth of future returns (dividends and capital growth) expected of a company. Obtaining an aggregate PE for an entire market is often used to assess investment values on an international basis. It should be noted, however, that because of differences in international accounting standards, cross country comparisons require more careful interpretation. This arises chiefly from the differences which affect reported earnings (Schieneman, 1988).

Longmore (1989) finds that this rule of thumb is often used even in large sophisticated multinationals. Given the trend to reward executives in line with short run accounting earnings he argues that low PE acquisitions can be favoured even if longer life investments produce a higher NPV.

Further major disadvantages to the payback method are that it does not easily relate to a firm's cost of capital (discount rate) and can not explicitly account for the various factors determining the viability of a project/company.

1.2.5. Investment Theories of the Firm.

There are three main aggregate theories of investment based on firm behaviour. These are the "User Cost of Capital Theory", initially described by Jorgenson (1963) and Hall and Jorgenson (1967), "Tobin's Q Theory", expounded in Tobin (1969) and the "Accelerator Theory", first introduced by Clark (1917) and subsequently, favoured by Keynesians. These theories have in common the notion that, for a given level of demand, the firm maximises shareholder wealth (equivalently profit maximisation, Gravelle and Rees (1981, pp. 412-414)) by employing a desired level of capital stock, K^*. Where the theories diverge is in the main factors driving the firm's decision process and subsequently, the possible policy implications. There does exist some controversy as to whether firms may choose alternative objectives outlined in Hay and Morris (1979, pp. 255-276) such as size or growth maximisation while Reekie (1979, pp. 136-143) argues that managers are sufficiently disciplined to act fully in shareholders' interests.

1.2.5.1. User Cost of Capital.

The concept of the user cost of capital is well defined, it represents how much (in terms of monetary units or as a rate of return) would have to be paid in the form of rent in order to command use of certain resources over a specified time period.

The user cost theory of investment is traditionally known as the neoclassical theory of investment. Economic literature does not seem to have been able to consistently differentiate the terms "user cost of capital" and "cost of capital". Throughout this research, cost of capital is equivalent to the cost of finance, that is, the cost to the firm incurred by its methods of finance. The user cost of capital is as described below. Key aspects are the relevance given to relative factor prices in investment demand and the theories grounding in micro-economic theory. Exponents of this school do not reject the importance of effective demand and consequently, some aspects of the accelerator theory are similar when looking at investment demand.

Although chiefly attributed to Dale Jorgenson after his 1963 paper, the concept of paying for capital services (the user cost of capital) can be traced as far back as Bohm-Bawerk (1888) (Bohm-Bawerk, E. (1888) *The Positive Theory of Capital*, translated by Smart, W. (1891), GE Stechert and Co: New York. Cited in Downs (1986) page 298 and commented on in Blaug (1985) pp. 278). In the first half of this century, Keynes (1936, pp. 53) described a slightly broader, though similar, concept: "Let us call this quantity....which measures the sacrifice of value involved in the production of A, the user cost of A".

Despite capital being a fixed stock, it is accumulated in order to provide a flow of productive services through time to its owner. For the purposes of simplification, we shall assume, for the time being, that this effective owner is the manufacturing sector. The user cost of capital is the cost per period of time paid by a firm in order to obtain these services. Consequently, this cost can be used as the relevant discount rate when the firm applies an NPV or IRR analysis. The user cost is, therefore, sometimes referred to as the "rental cost of capital".

Standard assumptions of the theory are that all markets are competitive, efficient and that perfect certainty exists. The firm's objective being to maximise its PV subject to a production function which presents continuous substitution possibilities where all factor inputs are regarded as homogeneous. These assumptions allow traditional marginalist principals to be deployed when determining the capital stock. That is, the firm invests up to a point where the marginal user cost equals its marginal revenue product (see Chapter 2, Section 2.4.2.).

The firm's relationship between the change in the capital stock and gross investment is that described by equation (1.4). Output is generally achieved via a Cobb-Douglas production function which is consistent with assuming a unitary elasticity of substitution (see Berndt, 1991, pp. 252). Jorgenson (1963) assumes that an iterative process occurs in which first output and then labour are determined and the marginal productivity condition for labour is a function of the existing capital stock. Assuming that the capital stock cannot adjust instantaneously, the second marginal product condition is required to determine K^*_t:

$$K^*_t = \alpha_k(Y_t \,/\, UC_t). \qquad (1.11)$$

That is, K^*_t is proportioned to the value of output deflated by the price of capital services, UC_t. If relative factor prices play no part in determining K, then equation (1.11) becomes effectively equal to equation (1.17) where $\alpha_k = a^*$.

Having obtained a value for K^*_t , this is embedded in a general investment function:

$$I_t = w(K^*_t - K_{t-1}) + \delta K_{t-1}, \tag{1.12}$$

The optimal lag structure, represented by w could, then, be imposed (Jorgenson, 1963) or derived using a general to specific methodology (Anderson, 1981).

1.2.5.1.1. User Cost Components.

We have not yet discussed the contents of the user cost equation. Such equations can be simply specified containing only a price deflator a cost of capital (finance) and a rate of depreciation. More complex derivations may include expected capital gains, taxation or adjustment costs.

In order to expose the principal of the user cost, we can derive a simple example of a capital good acquired at time t and supplying capital services at time s. The user cost is the discount rate which equates the marginal cost of a new capital good (P_{It}) to the discounted value of all future services from that good:

$$P_{It} = \int_t^\infty e^{-r(s-t)}\, UC_{ks} e^{-\delta(s-t)}\, ds, \tag{1.13}$$

which characterises the marginal capital investment as a zero NPV alternative. Differentiating this relationship with respect to the time of acquisition:

$$UC_k = P_I(r + \delta) - \dot{P}_I, \tag{1.14}$$

where $\dot{P}_I$ is the period change in the price of the capital good and r represents the required rate of return (cost of financing).

Given equation (1.14), we can easily identify those components of the user cost which can affect K^*_t, the price of the capital goods, the cost of finance, the rate at which capital decays and any expected capital gains. Equation (1.14), as we stated, is a relatively simple user cost, many studies also analyse the effects of taxation on the user cost (Jorgenson, 1963; Hall and Jorgenson, 1967; Auerbach, 1979, 1983; Hendershott, 1981, 1987; Hendershott and Hu 1983; Downs, 1983 Kelly and Owen, 1985; Jorgenson *et al.* 1987; Fullerton and Henderson, 1987). It is also possible to analyse the effects of temporary changes in tax rules (Auerbach and Hines, 1988; Kollintzas and Rowley, 1985) or take account of adjustment costs (Auerbach, 1983).

Between the main aggregate investment theories our model centres around the user cost of capital theory. The major advantage of the theory is that by calculating the price of capital services it can be used for resource usage and asset allocation comparisons. The theory is also flexible as it combines demand and relative factor prices.

Added to this, is the ability to specify comprehensively components of the user cost series which enables the researcher to isolate the effects on investment of changes in specified components, in particular taxation, risk premiums and inflation. Finally, while we will discuss the analysis below in terms of manufacturing capital (Jorgenson, 1963; Hall and Jorgenson; Poindexter and Jones, 1973; Anderson, 1981; Hendershott and Hu, 1981b; Kilpatrick and Naisbitt, 1984; Kelly and Owen, 1985; Robson, 1989), the user cost theory can easily be applied to a whole range of assets. A common application and one utilised in this study, is to apply the user cost to the individual's demand for housing, (Hendershott, 1980, 1983, 1988; Hendershott and Hu, 1981a, 1983; Buckley and Ermisch, 1982; Dougherty and Van Order, 1982; Hendershott and Slemrod, 1982; Poterba, 1984; Fry and Pashardes, 1986; Bennett and Krebs, 1987, 1988b; Spencer, 1987b, 1988, 1989; Ermisch, 1988; Hughes, 1988a, b; Shear *et al.* 1988; Bennett, 1990).

1.2.5.2. Tobin's Q.

Q is defined as the ratio of the market value of a firm (PV^m) to the replacement cost of its assets (K). Whilst the Q theory can stand alone as an explanation of investment, the Q ratio can also be introduced into other investment functions as described by Oulton (1981, pp. 177), "An investment function containing Q can be derived from a "desired stock of capital" model which employs such traditional concepts as the marginal efficiency and the cost of capital" and Berndt (1991, pp. 260). The main empirical advantage pertaining to the theory is that data is readily observable although its weakness lies in the need to forecast stock market levels.

Using the definition above, we obtain the simple formula:

$$Q = PV^m / K \tag{1.15}$$

Assuming that the value of the firm is a direct function of the expected future profitability of its existing capital stock then we can relate this to the investment outlay in a similar way to equation (1.8) where we solve for I_o and substitute in the general cost of capital. From these assumptions and introducing r as the average rate of return on the firms existing assets we obtain the general result.

$$Q = r / C. \tag{1.16}$$

We can see that Q is a valuation measure where the firm's decision rule is to invest in new plant and machinery when $Q > 1$. When this condition holds financial wealth holders are (possibly for good reasons) prepared to pay more for a claim to a unit of real capital than it costs to install it.

1.2.5.3. The Accelerator.

The Accelerator Theory of investment states that firms attempt to maintain a fixed relationship between their desired stock of capital and their flow of sales (or output, Y). This is called the "naive accelerator model". The optimal desired capital to output ratio is the accelerator coefficient (a^*) such that:

$$K^*_t = a^*Y_t. \tag{1.17}$$

This fixed relationship between K^*_t and Y_t can only be made by assuming labour and capital are not substituted, even *ex ante*, and that stocks of inventories are ignored. It is the difference between current capital stock (K_t), endowed from the previous period, and the desired capital stock (K^*_t) which prompts the firm to be net investors, I^n, such that:

$$I^n_t = K^*_t - K_{t-i} = a^*(Y_t - Y_{t-i}). \tag{1.18}$$

Stated simply, net investment is the change in output (or expected output) multiplied by the accelerator coefficient.

This analysis implicitly assumes that output (demand) is always rising. If output falls, then K may not be reduced because of its fixed nature (see Section 1.2.2.). Theoretically, if output falls by a significant amount, net investment will be zero and the possibility of excess capacity exists. Such an outcome is analysed in Chenery (1952) who suggests subtracting an excess capacity parameter from equation (1.18).

When empirically tested, Chenery (1952), found the accelerator above produced poor results. The solution suggested was to introduce an explicit lag structure to the equation on the basis that firms may not react immediately to an increase in demand, preferring to wait until it was felt that the probability of it being transitory was low. Once the decision to increase K^* has been made, it may take several years for the investment to be completed and therefore, the lack of a dynamic lag structure could lead to severe misspecification. Traditionally, a lag structure was introduced into the model via geometrically declining weights attached to previous output levels. This is called the "flexible accelerator model".

The basic hypothesis states that investment is related positively to the actual level of current output and negatively to the existing capital stock. Supply side factors and relative prices are ignored.

1.2.5.4. Empirical Evidence of Investment Theory of the Firm.

Jorgenson (1963) argued that, at the time of writing, there was a dichotomy between the advance in the acceptance of the neoclassical theory of capital and econometric evidence. The author's main premise to explain this was to argue that poor econometric evidence was a consequence of misspecified theory and therefore, invalidating any hypothesis tests.

Testing investment theories have largely centred around estimating the respective elasticities of output and relative prices with respect to capital stock. Unsurprisingly, Jorgenson (1963, Table 3, pp. 258) finds both relative factor prices and the price of output significant. Such work is centred around the confines imposed by utilising a Cobb-Douglas production function. Strict neoclassical theory would constrain the elasticity of capital with respect to both output and relative prices to be unity. Criticism of Jorgenson's results is presented in Eisner and Nadiri (1968) who argue that by utilising a putty-clay model the effects of relative factor prices and output prices can be separated in a more realistic dynamic investment process. They find an elasticity with respect to output close to unity and for relative factor prices around zero. The authors conclude that the divergence of results originate from Jorgenson's use of a putty-putty model and his uniform lag restrictions.

Reviews of investment literature (Jorgenson, 1971; Savage, 1978; Hay and Morris, 1979, pp. 389-404; Berndt, 1991, pp. 224-277) conclude, as would be expected, that real output is the most important single determinant of investment expenditure. Eight years after his first article on the subject, Jorgenson (1971, pp. 1142) still argued that many studies poorly specify the user cost variable, "In all but a few studies we have reviewed, the cost of capital services is measured in a way that fails to reflect the underlying durable goods model". A decade and a half later, we find Kelly and Owen (1985, pp. 1) arguing, "The failure to estimate significant factor price effects is more likely to be connected with the absence of suitable aggregate measures of the cost of capital". This argument, which is not restricted to the above authors in "Lakatos" terms, is a "protective belt" which can be used to defend the Scientific Research Project of economists whose "hard core" (metaphysical beliefs) is that, for example, relative factor price effects are important. The immunising strategy being that the role of relative prices cannot be refuted as they are not specified correctly in empirical tests (Further information regarding these methodological points are discussed in Blaug (1980), especially pages 36 and 226).

More recent studies do provide more encouraging support for the use of the user cost theory (Anderson, 1981; Kelly and Owen, 1985; Shapiro, 1986). Anderson (1981), argues that the correct dynamic specification is crucial to the determination of an investment function. By restricting the general putty-clay models, nested models of putty-putty and clay-clay were tested and rejected against the general model. The author concluded that whilst the effects of relative factor prices were diluted once factor proportions are fixed, along with output they are significant. Oulton (1981) primarily investigates the relevance of Tobin's "Q" theory in the U.K., but finds relative factor prices generally significant. Kelly and Owen (1985 pp. 1) list a number of studies finding relative prices significant and note an increasing use of these in the latest versions of the Cambridge Growth Project, Her Majesty's Treasury and the London Business School's macroeconomic forecasting models. Given the flexibility inherent in user cost specifications is coupled with the growing evidence that this methodology is increasingly being found relevant, it is difficult to argue that this theory can be ignored. This is especially the case in a long run model such as that at the heart of the present research which is a putty-putty regime in contrast to other empirical applications and therefore testing substitution elasticities becomes irrelevant.

In summary the user cost of capital theory represents the optimal vehicle for our model as it best facilitates the isolation of the investment implications of taxation, inflation and risk. This is particularly the case in a long run model although it is difficult to reject the theory over shorter time periods on the basis of historical empirical evidence as this can be critisised on the grounds that they do not measure the user cost of capital accurately enough to provide valid tests. Utilising this approach is also consistent with the increasing use of the user cost of capital theory in contemporary economic literature.

1.3. Multisector Models of Resource Allocation.

We have indicated that it is our intention to construct a general equilibrium model of resource allocation. In the present Section we review various theoretical and empirical models which are utilised to explore this matter. This Section therefore forms the methodological grounding for the model presented in Chapter 2.

Research carried out in order to expose the implications of inflation, taxation and risk between different sectors in the economy has, so far, all related to the U.S. economy (Hendershott and Hu, 1980, 1981a, 1983; Feldstein, 1982; Ebrill and Possen, 1982; Kau and Keenan, 1983; Gahvari, 1984; Fullerton and Henderson 1987; Hendershott, 1987; Berkovec and Fullerton, 1989). Such papers typically include the corporate sector and owner occupied housing, although, in some cases, the models include other sectors or disaggregate to various assets within sectors (for example, real assets, structures, plant and machinery and inventories or financial assets, bonds or equities). With the exception of Berkovec and Fullerton (1989), all of these papers confirm the resource allocation bias towards investment in owner occupied housing as a result of the interaction of tax rules and inflation. All of the studies share the belief that productivity could be improved if a more "optimal" asset allocation split were achieved.

The lack of U.K. research in this area may result from the actual U.K. experience commented on by Matthews (1982, pp. 314), "In the U.K., many of the relevant tax provisions are broadly similar, but, whether because of front loading or some other reason, residential investment has fallen, not risen, as the rate of inflation has increased...". The possibility of front loading (the tilt phenomenon described in Section 1.4.10.4.) constraining investment in owner occupied housing is described in Hendershott (1983, pp. 5) and HH (pp. 810). As Matthews (1982) alludes to this, it may not, however, be the only factor influencing his observation.

The combination of capital market rationing coupled with inflation may have offset the bias towards owner occupation. Observing a period of low and relatively stable inflation such as 1966 to 1969 when inflation rose by 13.6%, over the period (Source: Thompson, 1990, pp. 55) deposits in Building Societies earned a positive return (Source: Thompson, 1990, pp. 66) and average earnings (key to mortgage advances, see Section 1.4.4.1.) rose by 24.3 % (Source: Monthly Digest of Statistics, various issues). All of these factors provided a good basis for investment in housing. In contrast, a period of rising inflation such as 1973 to 1977 saw real earnings fall slightly (inflation rose by 92 % and average earnings by 90 %) at a time when the real return from Building Society deposits was negative. Over this period, the loan to income multiple for new buyers fell from 2.24 to 1.17 and for existing buyers from 2.01 to 1.64, Building Society advances rose by only 45 % (Source, BSA, 1984, pp.11). The evidence therefore suggests that rationing played some part in shaping mortgage demand. If this hypothesis is correct, then a study of the effects of inflation and taxation is useful in the U.K., particularly one which can explicitly incorporate capital markets. Any sectoral misallocation is unlikely to wholly explain the U.K.'s productivity performance but may provide some evidence to the jigsaw.

HH (pp. 796) state that between 1965 and 1978, the real increase in non-residential capital stock in the U.S. was 70 % while that of the residential stock was 47 %. Official figures for the U.K. show that comparable increases of 73 % and 75 %, respectively were experienced in the U.K. (Source, see Sections 3.2.1.2. and 3.2.1.3.). Furthermore, whereas the value of the housing capital stock is relatively straight forward to calculate, several authors (Smith, 1986; Wadhwani and Wall, 1986; Callen and Convey, 1988; Driver, 1989) have questioned the accuracy of the manufacturing capital stock data. Using estimates provided in Wadhwani and Wall (1986, pp. 51, measure ii) the real increase in the manufacturing capital stock would be only 51 %.

The figures presented above represent the outcome given the taxation regimes, inflation shocks and capital market conditions actually prevalent at that time. The only way to isolate the influence of these factors is to model the environment and perform the appropriate comparative static analysis.

Ebrill and Possen (1982) is a typical example of the relative price, asset allocation work carried out in the U.S. They construct user costs of capital for two sectors (equity in owner occupied housing and equity in corporates) and then shock these with different rates of inflation. More specifically, the framework they used was short run where the stock of capital is held constant. This is, effectively, a long run solution without growth implications (ie. no income effects are included). The main result from the study was that as the rate of inflation increased, housing took a greater share of asset allocation. This result is typical of most studies in this area, although Berkovec and Fullerton (1989) argue that inflation does not raise the cost of corporate capital because of interest deductability at a corporation tax rate of 46 % (this is specific to the 1983 tax regime).

Hendershott and Hu (1980) calculate user cost of capital series for six categories of investment including owner occupied and rental housing and corporates. Tax regimes between 1964 to 1965 and 1976 to 1977 were modelled. Productivity losses were calculated (a geometric formulation is described in Page 350 with the relevant mathematics on Page 351) by taking the divergence of user cost from a mean and inferring the misallocation of capital stock and consequent welfare loss.

A similar methodology is applied in Hendershott (1987) to analyse the effects on different assets and investor types of the 1985 U.S. tax reforms. This research was rather more disaggregated, involving the estimation of thirteen user cost series. The model assumes a fixed capital stock and allows relative prices to determine asset shares much like Ebrill and Possen's (1982) work. More specifically, a value of wealth is set and specific asset size is determined by dividing wealth by each user cost and simultaneously solving these to obtain an equilibrium asset split. Whilst Hendershott and Hu (1980) utilised detailed user costs, they extended these in a subsequent paper (Hendershott and Hu, 1981a) by introducing a more rigorous exposition of taxation, depreciation and financing rates. Own product user costs were specified. That is, each series incorporated its own assets expected inflation figure (equivalent to expected capital gain) and consequent real price changes.

A comparative international study (the U.S., Japan and W. Germany) based on Hendershott and Hu's (1980) methodology has been carried out by Nakamura (1981). The user costs were constructed for each country's tax system in the fiscal year 1976 to 1977. His conclusions were that across the countries, the lowest user cost was for owner occupied housing in the U.S., costing one half of similar investments in the other countries. The average equilibrium user cost was lowest in the U.S. followed by Japan and W. Germany. Inefficiency (productivity losses) were greatest in the U.S., small in W. Germany and negligible in Japan.

The central thrust of the studies outlined above is the calculation of a series of relative prices which can be shocked with varying rates of inflation. Results are then reported in terms of relative price ratios or, taking the analysis one step further, by solving to infer portfolio asset allocation.

The use of relative prices to compare asset allocation has also been utilised in small two sector models of the economy (Feldstein, 1982; HH; Fullerton and Henderson, 1987). The most straight forward model is that of Feldstein (1982) whose analysis is strictly theoretical like Kau and Keenan (1983) and Gahvari (1984). A production function relates output to the industrial capital stock and all corporate investment is financed by debt issued by the private sector. A similar set of equations are expressed for the owner occupied sector, for example, the demand for housing services is included where constant proportionality is assumed between housing services and the housing capital stock. The demand for money is also included which allows inflation to enter the model and provide cash balances as an alternative asset. Further equations define real government expenditure, consumption and savings.

Using the framework above, the equilibrium effects of changing inflation are simulated. The model predicts the typical outcome described above namely, inflation reduced the real return from corporate investment while reducing the owner occupied user cost and consequently, resulted in a lower equilibrium level of corporate capital and reduced productivity. The reallocation towards housing also reduces income per capita. Feldstein (1982, pp. 309) concludes that, "It is ironic that an easy money policy aimed at stimulating investment in plant and equipment is likely to have just the opposite effect: reducing the long-run capital intensity of production".

It is interesting to note that these results contrast with those presented in an earlier paper (Feldstein, 1981, pp. 29-30, 33) where the author found (theoretically and econometrically) that the marginal and average propensity to accumulate housing capital was less than actually observed. This study did not incorporate the effects of taxation.

A more complex study is presented by Fullerton and Henderson (1987). They utilise a simultaneous general equilibrium model in order to compare the merits of the 1984 U.S. Treasury Department tax plan with that prepared by the President in 1985. Hall-Jorgensen user cost methodology is employed incorporating detailed modelling of the relevant tax structures paying particular attention to the rate of investment incentives. The model is very disaggregated with twelve income-differentiated households which allocate investment across four sectors (corporate, non-corporate, business and owner occupation). Consumption expenditure is divided into fifteen consumer goods and eighteen industries constitute national output. The investment incentives are used as inputs to a general equilibrium model developed by Fullerton and Henderson (1986) while the consumption side of the model discussed in Ballard *et al.* (1985).

One simulation constituted six equilibria which, in total, culminated in a simulation interval of fifty years. Simulations of the two tax proposals were carried out, both were found to add neutrality to post tax returns between assets, although the Treasury Department's plan increased inter-sectoral and inter-temporal distortions. Detailed asset and sector results are reported in pages 429-31 and for industries, on page 431.

A model which falls in between Feldstein (1982) and Fullerton and Henderson (1987) in terms of complexity is provided by HH. The model is two sector (housing and non-residential) which incorporates a production function and demand equations for the two sectors assets. The demand functions incorporate disposable income and profits respectively along with the relevant user cost of capital series. Within these sectors, individuals allocate between four assets, corporate bonds, corporate and housing equity and mortgage debt (a negative asset). Two types of household are specified - wealthy and non-wealthy - the former lend to the latter and the corporate sector to enable them to finance their expenditure decisions.

An interesting twist to the model is its ability to endogenously incorporate risk premium attached to the assets. This means that, assuming the investor is rational and risk averse, an asset increasing as a proportion of the total portfolio suffers a rising risk premium. Tax structures are also comprehensive and clearly relate to the personal sector, that is, the corporate user cost includes not only corporate taxes but any further taxes which affect the returns to the individual from corporates. The need to incorporate all layers of taxation facing the ultimate investor is emphasised by Summers (1981, pp. 7). Equations representing household and corporate tax payments, retained earnings and disposable income are also included.

Again, the model is of a simultaneous general equilibrium nature and in its basic form, solves for fourteen variables. An initial simulation was run with values set at levels roughly equivalent to those in 1965. The model was shocked for real growth actually experienced over the period and future simulations were expressed as divergents from this initial run.

The second simulation consisted of shocking the model by the rise in inflation experienced over the period. This was followed by introducing relative price changes and finally, mortgage rationing. Both the general and relative price shocks disproportionately reduced the relative real user cost of housing and increased its share of total wealth. Capital market effects neutralised this bias, although it increased the wealth differential in favour of wealthy households. This capital market result is contrary to the view expressed by Hendershott (1983). The ability of the model to facilitate capital markets is unique among the studies outlined above.

1.3.1. Conclusion.

The above discussion suggests that a U.K. model using a similar approach to those presented would be of interest. From this we may gain insight into how the asset allocation process developed in the U.K. which would enable us to test the hypothesis, how did inflation, risk and taxation under the classical and imputation periods affect resource allocation? Would the U.K. model support or refute the role of mortgage rationing as found in HH and argued in Meen (1988; 1989; 1990) Using the comparative work of Nakamura (1981), we may tentatively suggest where the U.K. would feature in the welfare loss analysis and finally, we may test some alternative fiscal regimes for both sectors in order to compare the allocative impacts as well as the effects on sectoral revenue flows which are also of great importance.

In order to test the hypothesis outlined above, the model presented by HH has several distinct advantages. For example Feldstein's (1982) paper is purely theoretical and possesses no explicit treatment of risk, multiple financing or capital market effects. HH does all of this within an empirical framework which aids result interpretation. On the other hand, the detail of Fullerton and Henderson's (1987) work is impressive, but its results depend on at least two other large modelling exercises and would represent overkill in terms of the above hypothesis.

HH's paper is the culmination of previous detailed work (Hendershott, 1980; 1981; Hendershott and Hu, 1980, 1981a, 1981b; Hendershott and Slemrod, 1982) and is complex enough to produce surprises and simple enough to enable the origin of such results to be traced. For some tax policies, the effect on real cash flows may be just as important as the user costs. Incorporation of risk, capital markets, cost of finance in a long-run model where a closed or open economy can be imposed should represent a good starting point for an analysis of the U.K. The choice of time period, 1965 to 1979 has three main motivating factors: there are two distinct tax regimes to compare - the period was one with a consistent mortgage rationing policy and the base model will afford some comparison with the U.S. experience reported in HH.

1.4. Owner Occupied Housing and Manufacturing Capital as Alternative Assets.

Having discussed the investment process and multisector models of resource allocation it is necessary to set in context the sectors which will be modelled and indicate areas where these sectors impinge on the economy as a whole. The following Section crystallises why owner occupied housing and manufacturing have been identified as key sectors of the economy. In doing this we highlight important influences and main debating areas regarding each sector such as net cash withdrawal, labour market rigidity and productivity performance. This Section also provides an opportunity to describe and discuss the tax regimes of both sectors and asset classes within them, this will form a basis which links directly into our model. Comparison of the classical and imputation system along with the interaction of the two sectors when shocked with inflation and different mortgage market regimes within our model framework will be discussed in Chapter 4. Finally this Section includes a review of policy issues relating to the sectors which directly feeds into policy simulations presented in Chapter 5.

1.4.1. Housing Investment.

Investment in the housing sector is important to the performance of the U.K. economy for a multitude of reasons. Various factors have made owner occupation both the dominant form of housing tenure and a key asset to the private sector, yet a major difference with manufacturing is that it cannot replicate itself or vary its output mix. A similar position to the U.K. has arisen in the U.S. (see Congdon (1988, pp. 173-174) and Hallett (1988)) which is contrasted with a higher rented proportion in countries such as Germany and the Netherlands (Hallett, 1988). This has resulted in a powerful political interest in supporting owner occupiers both fiscally and in terms of funding via a dedicated capital market. Despite this, little work has been carried out regarding the interaction of the housing sector with other areas of the economy. One noticeable consequence of this neglect has been poor econometric forecasting in the 1980's, chiefly resulting from a failure to incorporate significant wealth effects originating from the sector.

1.4.2. Development of the Owner Occupied Sector.

As a form of tenure, between 1965 and 1979 owner occupation has risen from 46 % to 54.7 % and in 1989 (the latest available data) stood at 66.5 % (Source: Housing and Construction Statistics). This is the highest proportion as a form of tenure of the major European countries and is comparable to the United States of America (Hallett, 1988, pp. 5). Moreover using our capital stock data for 1976 and table 3 in Nakamura (1981, pp. 69) housing as a proportion of the housing and corporate capital stock represented 55% in the UK, 32% in the USA, 25% in W. Germany and 30% in Japan. During this period house prices rose by around 2.75 % per annum in real terms (ie. relative to the retail price index) although for the 1970's decade, Dicks (1980, pp. 4) estimates this figure at around 3 % per annum (an index of real house price changes are provided in BSA (1987, pp. 21, Table 1)). The capital stock rose from just under £27 bn to over £200 bn, an increase of 75 % in real terms (Source: see Section 3.2.1.3.).

This was by no means an isolated period in the growth of owner occupation. At the beginning of the century, owner occupation, as a form of tenure, was small, at around 10 %. Since 1914, (Ball, 1983, pp. 2, Table 1.1.) a sharp rise in this form of tenure occurred, particularly during in the inter-war period, boosted by demographics, a pool of available labour to the construction industry, government grants to builders and a cheap money policy. Broadberry (1987) provides an econometric analysis of these factors and concludes that the "cheap" money policy accounted for around half of this investment. Post the Second World War, a major problem facing the government was a shortage of housing, made worse by the poor quality in many areas. Flemming and Nellis (1982) point out that in 1951 (the year of the first post war census) there was a crude shortage of around 600,000 houses. Slum clearance represented the major loss of privately owned housing stock during this period, although this diminished greatly in the late 1960's, affecting less than 20,000 dwellings per annum (Drayson, 1985, pp. 85). Other isolated problems remained (or emerged as, for example, crumbling housing schemes), however, the status of housing provision in the period after the mid 1960's was not so pressing. There was no further round of government policy to actively stimulate the owner occupied sector, yet the figures quoted above suggest that, for whatever reason, that is exactly what occurred.

1.4.3. Politics and the Investment Environment.

A major area of interaction between government policy and the private sector's asset allocation decision is taxation, (Section 1.2.4.1.3.), a key area of our model. General aspects of tax policy making in the UK are presented in Levacic (1987, pp. 99-105). We shall not seek to discuss specific aspects of housing fiscal policy until Section 1.4.10.1., but instead, we will seek to explain why owner occupation in particular is a politically sensitive subject and suggest that a key result of this is policy inertia, or worse, a policy "ratchet" effect in favour of the sector. A similar argument as been attributed to the U.S. by Hendershott (1983, pp. 6). Whilst we do not seek to model political factors this influence does have a bearing on the choice of policy simulations carried out in Chapter 5.

Particularly in terms of housing policy, the tendency for economists not to discuss political factors as an additional step is unfortunate. Without this consideration, even the best of intended economist's work is likely to be discarded as a mere aphorism. An interesting political analysis is contained in Hettich and Winer (1984) who develop a partial equilibrium model where tax payers make both economic and political responses which affect the government's use of policy instruments (Kydland and Prescott (1980) also make similar assumptions). The rational government's objective is to maximise its votes subject to the factors outlined above. As a result, it is tempted to tax as many economic activities as possible in order to equalise the marginal political cost to each tax payer. It is for this reason that complexity is a common feature of most modern tax systems.

Given the owner occupied sectors' voting power (by definition of age), coupled with the relatively large size housing expenditure represents to the individual and the transparency between that expenditure and government fiscal policy, it is not surprising that owner occupation has been a sensitive issue for politicians. Franklin (1990) econometrically explores the importance of mortgage rates and voting intentions finding that both the mortgage rate and house price inflation are significant. Contrasting this with manufacturing (we are not arguing that this is a weak political force), it will be the case that the number of people in full time employment in this sector is less than the number of owner occupiers. Moreover, even transparency of government policy is clouded (management are employed to deal with such matters) and the overall perceived effect on well being will be less given that for most people, the investment in a house is their largest capital commitment.

Taking the political analysis one stage further from a Marxist point of view, owner occupation plays a central role in the ideological incorporation of the working class into the dominant ideology of capitalism. When discussing the relative tax advantage to owner occupation, Buckley and Ermisch (1982, pp. 295) argue that this was not the intention of legislation. Boleat (1982) argues that the fiscal position of the building societies (crucial to the owner occupation sector as a source of funds) arose from a series of independent and sporadic policy measures rather than as part of a coherent fiscal strategy. For example, tax on imputed rent (Schedule A) was abolished in 1963, a time of low inflation and interest rates when the tax was of little consequence.

Whether a favourable fiscal regime was intended or not, it is easy to see how gains in popularity can be achieved by benefiting the sector and quickly reversed if anything threatens the owner occupiers position (Ball, 1988). In this sense, policy follows a ratchet type of progress which protects any benefits received. The most recent example occurred in 1988 when the U.K. government failed to charge VAT on new housing, a decision which would have been in line with a European court ruling, but was "exempt" for "social" reasons. (see Lloyds Bank Economic Bulletin (1988) and Taylor *et al.* (1988)).

1.4.4. Building Societies as a Dedicated Source of Finance.

Building societies form a unique aspect of the owner occupied sector in that they provide a dedicated source of funding for investors in the sector. Although building society behaviour is not a matter for this research, the crucial role they play (especially before 1980) in facilitating house purchase means that they cannot be ignored (other lenders existed but these were marginal, see Gough, 1975, pp. 219). Many economists have attempted to model building society behaviour, a summary of such models is given in Anderson and Hendry (1984, pp. 186). Indeed, the mortgage demand function in our model differs from that of HH's because of the building societies' need to ration funds resulting from a favourable fiscal treatment of the societies' funding operation and their ability to operate an effective cartel.

1.4.4.1. Taxation of Building Societies and Mortgage Rationing.

Building society depositors received income net of the "composite rate of tax". This rate was less than the standard income tax rate which made the net return to tax paying depositors from building societies relatively attractive. (For a detailed explanation of the reasons for and calculation of the "composite rate" see Boleat (1982), Chapter 13). Given that mortgage borrowers received lower funding rates than the market-clearing rate (some of which was passed onto borrowers) and mortgage interest relief at source (MIRAS) on interest repayments, this resulted in a high demand for mortgage funding and consequently, continual mortgage rationing (see Buckley and Ermisch, 1982, pp. 284-285). Over the period of interest it is therefore crucial that our model deals with this.

An additional twist to this situation was the effective cartel (primarily administered by the Building Societies Association) which operated on both sides of their balance sheet. Successive governments were willing to tolerate and sometimes encourage the cartel (which included excluding clearing banks from the mortgage market) because it helped to maintain mortgage rates below market clearing rates whilst adding stability to the housing market. Indeed, in the early 1970's, the Labour Government set up the "Guideline System" which provided a forum for it and the societies to discuss these matters. During this period the government used mortgage rationing as an important facet of policy (for example see Spencer, 1987b, pp. 16). Although the cartel's powers effectively diminished in the mid 1970's with the advent of term share deposits, it was not until the 1980's that abolishing of the cartel and tax advantages were seriously recommended by the Wilson Committee (Wilson (1980), Committee to Review the Functioning of Financial Institutions, Chairman, H. Wilson. Final Report Cmnd. 7937, HMSO : London).

The building societies achieved mortgage rationing through various non-price techniques (for an overview, see Dicks (1990, pp. 6-8)), for example, the imposition of a loan to valuation ratio at a figure less than unity or a loan to income multiple.

Loans may be limited to larger depositors or established customers and queues created. Rationing was significant, for example King (1980, pp. 156-157) found that 30 % of households wishing to enter the owner-occupied sector were rationed out and that "...the admission probability into the owner-occupied sector is an increasing function of income, a phenomenon which reflects constraints in the capital market and the criteria used by building societies to ration mortgages". This finding is supported by Lomax (1991, pp. 61).

The building societies reasons for choosing this method were straightforward. If each borrower's capacity to default is different through time and unobservable, it is impossible for lenders to identify defaulters *a priori*. Detailed screening by the societies would help, but only to a degree, whilst being costly particularly as existing mortgage turnover was increasing (BSA, 1980, pp. 94). In a situation where the propensity for nominal house prices to fall was low, the societies could concentrate on making sure that interest payments were met which were, of course, achieved through current income. Thus, it was optimal for building societies to lend mortgages subject to the income of the borrower.

1.4.4.2. Liberalisation of the Mortgage Market.

In 1986, "Big Bang", the liberation of stock exchange investment practices received much publicity from the media in general. The gradual deregulation of the mortgage market has been a much lower key affair, yet its effect on the economy as a whole and individual households are arguably greater. The transition to a liberal mortgage market began to occur in the late 1970's. However 1979 represents a good proxy for the cut off point when the Thatcher government was elected. Meen (1989) and Davis and Saville (1982) estimate that mortgage rationing had effectively disappeared by the early 1980's. The facility to unration our model in a realistic manner is a powerful option necessary when looking at contemporary issues.

In 1979, the Building Society Guidance System was scrapped, closely followed by the abolition of the corset in 1980, which enabled banks to compete in the mortgage market (see Artis and Lewis (1981), Chapter 6). Bank advances for mortgage purposes rose from £0.1 bn in 1977 to £2.5 bn in 1981, and almost £11 bn in 1988 (Source, Financial Statistics, Central Statistics Office, HMSO, various). In this environment it became impossible for the building society cartel to survive and its role diminished until it was abandoned in 1984. The preferred tax treatment given to the industry was effectively withdrawn in 1985, while in 1986, the Building Societies Act (briefly described in Boleat (1988), Kleinwort Grieveson Securities (1988) and BSA (1988a)) widened both the scope of businesses (see Cumming,

1989) and sources of funds (see Hudson, 1989) which building societies could utilise (For a description of the major building societies and their options for future development under liberalisation see Wriglesworth (1989a,b)).

Naturally, the convergence of business areas between banks and building societies ended the rationing described above although income is still used as a basis for mortgage allocation. Deregulation should result in a "one off" move to a new debt to income ratio among households, a greater tendency for price to clear the mortgage market and a larger impact on the housing market from housing fiscal policy changes (the implications of the switch in regimes along these lines is further discussed in Meen, 1988, 1989, 1990). Once this is attained, mortgage credit growth should increase more in line with income growth. Indeed, Smith *et al.* (1988, pp. 53) rightly warned that when analysing the housing market it would be wrong to solely concentrate on rationing at the expense of ignoring other fundamental long-run determinants such as incomes, real rates of interest and prices. In this sense, our model does not rely on one specific housing formation determinant.

1.4.5. Owner Occupied Wealth and the Rest of the Economy.

It has been argued that housing has been fiscally privileged especially as a result of owner occupiers political influence and that building societies were important in providing a stable and dedicated source of funds. These conditions resulted in owner occupied housing being an important source of wealth to the private sector. Given the relative importance of this sector any rise in wealth is likely to affect individual consumption and saving decision as well as the structure of individuals' asset portfolios. These influences should be larger in the 1980's than in the 1960's although this is not without complications (see Section 1.4.5.2.). The potential for large portfolio shifts is of particular interest to this research.

1.4.5.1. Labour Market Efficiency.

An important suggested area of interaction between owner occupation and the economy is the efficiency of the labour market (Bover *et al.* 1988, Hendry, 1985; Meen, 1988; Minford *et al.* 1987; Muellbauer, 1986b, 1988b,d, 1990c; Muellbauer and Murphy, 1989). Essentially, this a domestic inflation spiral where rising house prices feed wage growth and wages feed house prices. Bover *et al.* (1988) argue that house prices and wages are "co-integrated" and, whilst in the long-run both have consistently outperformed the RPI, house prices and inflation are not related in this way. The diversity of house prices on a regional basis can also affect labour mobility (and, consequently, unemployment) because regions which are booming will tend to pay higher wages in order to attract staff which, in turn, leads to higher house prices representing an additional hurdle for workers (possibly unemployed) in other regions to fill vacancies (recent data regarding regional house prices can be found in BSA (1987, pp. 22-23)). This theory suggests that the housing market crucially impinges on the efficiency of the labour market. Work carried out by Egginton (1988) on the other hand rejects this thesis arguing that the variability of regional unemployment has been greater than regional earnings and that regional earnings are highly correlated with national growth rates of hourly earnings of those industries which dominated employment in a particular region.

Another factor which adds to this mobility problem is the probability of a link between tenure and socio-economic groups (Munro, 1986). Minford *et al.* (1987) argue that in many instances, there are strong incentives not to move even for employment reasons because of rigidities in the council house system and protected tenancies. A lack of good accommodation is also problematic. In attempting to explain what factors may push people away from rented tenancies, Gordon *et al.* (1987, pp. 248) stress the moral hazard problem associated with rental contracts. That is, tenants have little incentive to take care of the property and landlords have little incentive to allow tenants to alter the property. The moral hazard theory does have the problem that people still have to live in the house although low maintenance of landlords may be an important factor. Furthermore, Champion *et al.* (1986, pp. 4) provide evidence from the National Dwelling and Household Survey which indicates that only 22 % of household moves were for employment reasons, whereas 41 % moved for housing related reasons. Ball (1983, pp. 324, Table 11.1) provides a list of reasons why existing owner occupation moved in 1981 carried out by the Nationwide Building Society which supports the findings of the Household Survey.

The outcome of this theory is similar to that of the one expounded by those concentrating on the fiscal differentials, namely an increase in the NAIRU (Non accelerating inflation rate of unemployment). These are not necessarily competing theories. If the direct link between wages and house prices is likely to be a function of the favourable tax treatment of housing, then consequently, this becomes a necessary condition of the theory described above. Our model is a national aggregate model and does not, therefore, shed any light on the regional issue, although if parameterised correctly, it could produce results at a regional level. The model does however have important implications for the house price, wage growth, inflation spiral if it is clear that fiscal rules lubricate this spiral.

1.4.5.2. Effectiveness of Economic Policy.

The accumulation of wealth in housing has also had important effects on monetary policy. This arises primarily from the effect on money supply as individuals borrow to buy a house or as they increase their credit facilities, given that housing equity represents security to the lender. Financial deregulation coupled with a vigorous housing market was clearly at odds with the Conservative Government's Medium Term Financial Strategy in the 1980's (Johnston, 1983). Having gone through much of the deregulation adjustment, monetary policy should be more effective as people's financial gearing levels are closer to market clearing equilibrium they will, by definition, be more sensitive to fluctuation in the rate of interest (Meen 1988, pp. 1). Ironically, this may be diluted again owing to the growing trend towards annual review mortgages (Anderson, 1989). Such mortgages isolate individuals from the short-run effects of changes in interest rates which push the burden of monetary policy into a smaller sub-sector of the housing market. Davis (1988) argues that as wealth in housing increases, individuals' marginal propensity to consume from income is reduced. These trends are likely to add to instability and possible policy mismatches as monetary policy will display a greater than anticipated inertia.

1.4.5.3. Net Cash Withdrawal.

Financial deregulation has also highlighted the phenomenon of net cash withdrawal, sometimes called "equity withdrawal", as an important influence in the economy (this is also being increasingly recognised in the U.S.A., see Canner and Tuckett (1989) and Canner *et al.* (1990)). This is defined as the net increase in house purchase loans less the private sector's net expenditure on housing. Spencer (1987b, pp. 23) correctly indicates that the term "equity withdrawal" is a misnomer since the borrower retains full title to the property. Detailed analysis of net cash withdrawals are provided in Drayson (1985), Holmans (1986), and Lowe (1990). In response to the 1986 Building Society Act, the Bank of England withdrew the Mortgage Lending Guidance stating that since societies could now make unsecured consumer loans, achieving this by means of a mortgage would only increase the security of the loan (Bank of England, 1986b).

If people regard the rise in the equity value of their home as a store of wealth, this will engender less saving, and indeed, this has been the trend during the 1980's (see Franklin *et al.* 1989 or Milne, 1990, pp. 4). Lomax (1991, p. 64) notes that countries with the least developed housing finance systems have the highest household savings ratio. On the other hand, Ermisch (1988) indicates that rising house prices transfer wealth from the young to the old who have a higher propensity to save and this tempers the general effect. Similarly, most inheritance estimated to be currently over £7 bn per annum and reaching £13 bn by the end of the century (Morgan, Grenfell, 1987), falls to people in their fifties who have a higher propensity to save. In general increased consumption from net cash withdrawal will have negative implications for the balance of payments (Lyons, 1988; Miles, 1990).

1.4.5.4. Crowing-in and Crowding-out of Alternative Investments.

That owner occupied housing has represented an especially attractive investment vehicle and has effectively "crowded out" alternative investments is a possible outcome given the correct facilitating conditions. "Crowding out" is used here in a general sense rather than the more traditional reduction in private sector investment owing to high rates of interest caused by government expenditure (summarised in Levacic and Rebman (1982) and Goodhart (1975)). Under such circumstances, the potential for the economy to evolve towards a second stage of evolution, "crowding in" is clear (although not directly demonstrated) from the methodology of our model. If conditions were conducive, individuals could re-finance housing equity and diversify their portfolios towards more attractive assets, assuming a deregulated capital market. This outcome is supported by Morgan Grenfell (1987) who argue that financial assets in particular will benefit from this process. From the present situation of high relative levels of housing wealth in the South of England, this process would further concentrate economic power in that region.

Such an outcome could arise if housing becomes a less attractive investment in the 1990's as the end of the deregulation process reduces expected house price gains (thus increasing the user cost of housing capital). Furthermore, the demographics of household formation (Ermisch, 1990, Chapter 6) suggest that the demand for housing should fall significantly, although some of this will be tempered by a rise in the headship rate (the ratio of households to population). A similar conclusion is reached by Hokenson (1990) with respect to the U.S. housing market. Further discussion regarding demographics and the headship rate is found in Buckley and Ermisch (1982) and Dicks (1988) and for the U.S. economy in Hendershott (1987, 1988a, 1988b). For these reasons, individuals may be forced to seek out other investments therefore fiscal measures could play an important factor in both the speed and direction of any "crowding in".

1.4.5.5. Macroeconomic Forecasts.

We have argued above that the housing market has significant direct and indirect effects on the U.K. economy and acts as a transmission mechanism for many macroeconomic shocks. Given this, the large amount of policy advice seems disproportionate compared to the level of theoretical and empirical knowledge especially with respect to housing's interaction with other sectors of the economy. One consequence of this neglect is that many of the larger U.K. macroeconomic forecasting models do not (or did not until the late 1980's) incorporate the housing sector explicitly. For example, Meen (1988, pp. 4) notes that the wealth component of consumers expenditure is usually restricted to financial assets. Recently, treasury forecasts have consistently (especially since 1985) underestimated the strength of consumer spending and much of this has been attributed to neglect of the housing market. This situation has begun to reverse and many more forecasting models incorporate the effects of wealth and net cash withdrawal in consumption functions. This inclusion is difficult since the period probably represents a structural break (Pindyck and Rubinfeld, 1981, pp. 123-127) in the housing market. Ericsson and Henry (1984, pp. 20-21) for example point out that house price data derived from building societies will be biased in the early 1980's.

1.4.6. Manufacturing Investment.

Having discussed aspects of the importance of the owner occupied sector we can turn to the discussion of the manufacturing sector and present the reasons for its inclusion as a sector of particular importance. The size of the manufacturing capital stock, defined by the CSO as plant and machinery, buildings and vehicles, ships and aircraft, has increased from £27 bn in 1965 to £177 bn in 1979, or 73 % in real terms. By 1988, had reached £263 bn (Source CSO). Moreover, in 1989, manufacturing accounted for 21 % of the U.K's GDP, employed 23 % of the workforce (services accounted for 18 % of employment) and provided 80 % of merchandise exports (Freeman, 1991, pp. 6).

1.4.7. Importance of Manufacturing Investment.

Despite the continual reduction in the proportion of manufacturing output as a percentage of GDP (Economic Progress Report, 1985; Freeman, 1991, pp. 9), manufacturing continues to play a disproportionately important role in the economy. Studies which have singled out in manufacturing as a key sector in the economy are Malkiel (1979), Stafford (1981), O'Shaughnessy (1987, 1988, 1989a,b), Brown (1988), Wells (1989), Haskel and Kay (1990), Freeman (1991), Martin (1991) and Skeoch and Hacche (1991). By comparing investment in housing and manufacturing, it is not the aim of this research to argue that the latter is necessarily more important than other areas of activities such as services, but to provide a framework in which to analyse two important sectors of the economy. Indeed, a recent study by Hague (1991) argues that international specialisation tells us that the U.K.'s future lies in the service sector rather than manufacturing.

There are, however, a number of arguments which suggests that manufacturing does deserve particular attention. Unlike housing capital, manufacturing can duplicate itself as well as produce consumer goods. It is the former ability, through the resource allocation and investment process, which increases future output and creates wealth. Jorgenson *et al.* (1987) finds that the unprecedented growth in economic activity in the U.S. between 1948 and 1979 originates mainly from investment in capital stock. In many ways, the stock of fixed capital plays an important role in determining the nation's unemployment and inflation trade off (the internal balance) and the balance of payments (the external balance).

1.4.8. Productivity.

The purpose of the following sector is to outline the importance of productivity growth to the economy. Low capital investment as a result of a bias of resources away from manufacturing is one thesis which could explain the productivity slowdown witnessed in the U.K. in the 1970's. This is one hypothesis of many and in Section 1.4.8.1. other, not necessarily exclusive, hypothesis are discussed in order to place the inflation and taxation bias analysed in the present research in context. Capital intensity, or the capital to labour ratio, is an important element in a country's productivity performance (output per man hour), although caution is required when interpreting this derived statistic (Steiner, 1950; Hildred, 1984). Greater productivity helps extend production and hence, it is used in wage bargaining and contributes to international competitiveness by lowering unit labour costs. Since the turn of the century, a productivity trend of around 2 % per annum was normal in the U.K. (manufacturing productivity is displayed graphically in Muellbauer, 1986a, pp. 3 and Oulton, 1988, pp. 66). In the 1960's, this rose to around 3.75 %, only to fall in the 1970's to no growth at all. Spencer (1987a, pp. 7) argues that the underlying productivity trend is between 2.5 to 3.5%. The 1980's witnessed a sharp revival, sometimes exceeding 5 % per annum (for a summary, see Maynard, 1988, pp 90-92). The performance of the 1980's has been used to herald the success of Thatcher supply-side policies (for a discussion see Kilpatrick and Naisbitt, 1984; Budd, 1988; Wolf, 1988 and Godley, 1991, pp. 33) although Mendis and Muellbauer (1983) correctly caution against the danger of short-run cyclical movements compared to long-run trends when interpreting productivity data. Boosting the performance of manufacturing industry is clearly a priority of the current Labour Party (Smith, 1990). Although productivity growth is not only a function of the growth in the capital stock it is one of the more influential variables and the route which our model feeds into the overall picture.

1.4.8.1. Productivity Slowdown.

Wren-Lewis (1989) provides an international analysis of productivity trends finding that U.K productivity growth was comparable to other nations in the 1960's. However, during the general growth slowdown in the 1970's, the U.K. did not perform well. A general summary of the U.K. experience can be found in Muellbauer (1986a) and Oulton (1990). Much work has been carried out by economists in an attempt to explain this slowdown. It is unlikely that any one theory holds the entire answer but a lack of investment owing to a "crowding out" effect from more attractive assets could arguably form a piece of the jigsaw. Below we shall outline some of the competing explanations thus setting the above proposition in context.

One of the main theories to emerge as an explanation for the manufacturing productivity slowdown in the 1970's is the relative price thesis. This has been expounded in various forms. For example, the oil price, and other commodities shock may have resulted in projects being assigned higher risk profiles or large scale mispricing may have occurred. Similarly, such price rises may have rendered energy intensive capital goods uncommercial. In order to test this, Bruno (1982) extended the conventional two factor production function by introducing purchased materials or intermediate goods as a third input. Utilising econometric evidence across several countries, he found that, "On average, raw materials explain about 60 % of the slowdown, with the demand squeeze explaining the remaining 40 %" (Bruno, 1982, pp. 89). Muellbauer (1986a, pp. 14) contributes to this theory by suggesting that low investment and scrapping may have induced a switch to older vintages of capital designed for the relatively higher energy prices of the 1950's and 1960's. Similarly, Darby and Wren-Lewis (1988) and Oulton (1990) also find relative prices to be of some significance whilst Nadiri and Schankerman (1981) working in the U.S., stress the fall in demand.

Although often presented as a thesis to describe the high productivity gains of the 1980's induced by a labour "shake out", the Labour hoarding hypothesis can be used to explain the performance in the 1970's. Details of the labour hoarding hypothesis can be found in Bowers *et al.* (1982) and a shorter summary in Oulton (1990). The theory suggests that firms find it more cost effective to even out their employment paths over the economic cycle owing to the costs incurred when hiring and firing. Labour hoarding was also rationalised by the advent of implicit contract theory (see Grossman, 1981; McDonald and Solow, 1981 and for a summary, Stevenson *et al.*

1988, pp. 111-125). By introducing the exchange of an incomplete insurance policy in the labour market, to some extent, wages and employment could be stabilised, relative to the outcome produced from a short-run myopic spot market.

A further employment stabilising theory is expounded by Darby and Wren-Lewis (1988) who argue that during the 1970's, firms displayed "over-optimistic expectations" regarding output (demand) and consequently, maintained higher than average levels of employment. Whether the main reason in the 1970's for stable employment was a result of labour hoarding and/or implicit contracts or "over-optimistic expectations", these strengthen the procyclical nature of productivity (referred to as Okun's Law). In fact, these theories are likely to be complementary in that labour hoarding or implicit contracts to fully explain the productivity path in the 1970's would require demand to be lower than firms anticipated.

The role of trade unions has been presented as a cause of higher than optimal employment levels and inefficiency, owing to restrictive work practices (for a summary, see Stafford, 1981, pp. 14 and 74). Oulton (1990) carries out a disaggregated analysis and finds that industries with a higher degree of unionism displayed lower productivity growth. On the other hand, recent work carried out using corporate data (Nickell *et al.* 1989; Wadhwani and Wall, 1989; Wadhwani, 1989) rejects the hypothesis that unions adversely influence productivity growth or investment. Work carried by Christiansen and Haveman (1981) emphasise the effects on productivity of interventions to the market process as a result of public regulations, while Bishop (1989) emphasises the decline in the rate of growth of human capital using academic records data.

1.4.9. Manufacturing Investment and Economic Growth.

We have argued so far that, whilst cautioning against over-emphasis of manufacturing, the size and productivity growth of the sector is of particular importance to a country's economic development. While economywide shocks may weigh more heavily in destabilizing investment than changing tax parameters (Chirinko, 1988) these can only be reacted to. The emphasis of this research is to discuss the impact of inflation, taxation and capital markets on investment in competing sectors. This is important not only because it affects manufacturing capacity, but through the rate at which technology is introduced into the capital stock.

Freeman (1991, pp. 6-7) argues that about 40 % of the growth in GDP in the U.K. can be attributed to technical progress and that manufacturing is responsible for around 85% of investment in research and development. Thus, despite the constant reduction in the proportion of output of manufacturing as a percentage of GDP (Economic Progress report, 1985; Freeman, 1991, pp. 9) manufacturing continues to play an important role in wealth creation. Indeed, if Aurther's (1990) vision of increasing returns to scale from the new "micro chip" industries is correct, the secular decline of manufacturing may soon reverse.

The importance of investment and scrapping of equipment is emphasised by Mendis and Muellbauer (1983), Muellbauer (1986a), Oulton (1988, 1989) and O'Shaughnessy (1987, 1988, 1989a, b). This can be discussed in terms of a vintage approach where allowance is made for reductions in efficiency as capital ages. In this way, technology, investment and the capital stock are related. Better methods or technology which can be applied to the existing capital stock (disembodied technical change) are usually not as significant as technology introduced with new investment (embodied technical change). Testing this theory is difficult owing to data problems (Muellbauer, 1986a, pp. 3), but it could be argued (Oulton, 1988) that the 1970's slow-down was a result of low investment, whereas the 1980's pick up was a result of scrapping.

The work of O'Shaughnessy (1987; 1989a, b) argues that manufacturing capacity has been a significant constraint on macroeconomic performance in the U.K. Consequently, any policy to expand employment (policy alternatives are discussed in O'Shaughnessy, 1988) would require to be accompanied by an increase in manufacturing investment. The author argues that the trade-off between the external balance and the internal balance has worsened over the years, in particular the late 1960's to early 1970's, between 1973 and 1974 and from 1980 to 1984. Common to all of these periods is a fall, not only of output, but of manufacturing capacity. O'Shaughnessy emphasises the "stop-go" cycle as an important discouragement to investment because entrepreneurs, anticipating policy responses in these phases, tend not to invest in capacity necessary to meet higher demand, preferring instead to increase prices and not hold levels of capacity which would be inappropriate for the anticipated downturn as policy tightens.

This response, over time, leads to a smaller manufacturing base than optimal, a higher inflation propensity and reliance on imports to support the demand at the top half of the cycle. This is crucial to the balance of payments given manufacturing output accounted for around 80 % of merchandise exports in 1989 (Freeman, 1991). Even if manufacturing in the 1980's is more competitive in foreign markets, as proposed by Haskel and Kay (1990) and Ray (1990), the actual size of the sector has been argued to be too small (O'Shaughnessy 1987; 1989a, b; Wells, 1989, 1991; Muellbauer and Murphy, 1989).

Although the work of O'Shaughnessy is carried out in a non-neoclassical framework which ignores the problem of relative prices (O'Shaughnessy; 1988, pp. 16) the emphasis of his work is not, in principal, contrasting to the present study where the the structure of the tax system and capital markets is emphasised in determining capacity and productivity growth (discussed in Section 1.3.). Indeed, if manufacturing is starved of investment whilst at the same time, individual's wealth is increasing owing to house price rises, then the trade-off problem becomes more critical. The argument can be extended further in that in an unrationed mortgage market environment investors wishing to "sit out" the "stop-go" cycle may be attracted to housing as an alternative investment. This logic can lead to a spiral where increasing demand coupled with low capacity creates inflationary bottlenecks and balance of payments crisis which are precisely the conditions which make housing investment attractive. If this analysis is even partially correct, then those authors concentrating solely on labour market rigidities as the only obstacle to full employment, are being unnecessarily myopic.

1.4.10. Fiscal Structures and Policy Debate.

It is now appropriate to outline the relevant fiscal structures of each sector which are modelled in Chapter 2. We also discuss the policy debates which mainly centre around these issues and form the basis of the work presented in Chapter 5.

1.4.10.1. Housing Fiscal Structure.

Before reviewing the arguments for and against various aspects of the housing fiscal structure, we can state what these were in the period of interest and comment on the major changes post this period. Prior to 1969, interest payments on all personal borrowing were tax exempt, after this date only mortgages remained. The amount of MIRAS received by an individual is a function of the mortgage rate, house prices, the individual's income tax rate, and the ceiling for relief. The last change to the ceiling was in 1983 when it was increased to £30,000 from £25,000 set in 1974. MIRAS has made mortgages the cheapest form of personal sector debt available, although the real value of this has diminished because of the non-indexation of the ceiling. Ironically, a tax cut increases the cost of servicing mortgage debt and therefore acts to neutralise the benefits to highly geared households. MIRAS does not apply to a second home.

Tax on imputed rent was a feature of the U.K. fiscal system until Schedule A was abolished in the 1963 Maulding Budget. Initially, this tax was aimed at private landlords with owner occupiers happening to fall into the same net. Similarly, for a main residence, owner occupiers do not pay CGT on nominal or real returns despite the U.K. having a fully fledged CGT since 1965.

Owner occupiers do pay stamp duty (currently 1 %) if they purchase a residence with a value greater than a specified amount (currently £30,000). Also, during the period of interest rates were abolished. Rates were, in essence, a tax on imputed rent, being a function of the poundage and property valuation set by the relevant local authority. Rates were often criticised, especially on a regional level, for inconsistency among rateable values with actual or potential market rentals and for the lack of revaluations (the last one in England and Wales being in 1973). The Community Charge (Poll Tax) arose from the fourth green paper aimed at reforming the rating system since 1971. Its introduction occurred in Scotland in 1989 and England and Wales in 1990. This tax is not related to property but individuals.

1.4.10.2. Housing Policy Debate.

The importance and complexity of the housing market has led to a disproportionately high number of policy alternatives compared to actual theoretical and empirical analysis. We will briefly indicate some of the policy approaches suggested to reform the housing market and then focus on these which can be incorporated for analysis into our model, namely, fiscal policy and capital market controls. Not all policy suggestions centre on fiscal policy, powerful arguments are also found eminating from alternative directions.

The demise of the private rented sector (figures provided in Dicks (1989, pp. 66-67)) throughout the century has occurred owing to fiscal privileges of the owner occupied sector coupled with restrictive rent acts. King and Atkinson (1980, pp. 12) (and to an extent Muellbauer (1992, pp. 38)) suggest reforming the sector by equating the "cost" of both tenures. Generally, the liberalisation of both sectors is proposed although Hunt (1988) suggests that the effect of this would be to increase rents and not to stimulate the tenure. Studies which link the labour market to migration rigidities (Champion *et al.* 1986; Muellbauer, 1986; Minford *et al.* 1967; Bover et al., 1988) typically propose stimulating the rented sector. The sector is generally emphasised because of low moving costs unlike the owner occupied sector which suffers because of regional house prices (Bover *et al.* 1988, pp. 52-53) and large transactional costs (Ermisch, 1988, pp. 23). Council house tenants are also "sticky movers", Hughes and McCormick (1988) find council house owners least likely to move for job related reasons. This is also argued in Minford *et al.* (1987) who conclude that labour mobility would increase, and unemployment decrease, if rent restrictions were abolished and council house rents were set at market levels.

Restrictive planning and land controls have also been criticised for adding to house price inflation (Brittan, 1988b; Muellbauer, 1990c) and therefore a policy to make more land available has been suggested to ease the problem. Hallet (1988, pp. 205), on the other hand, argues that there is a case for making land available for more housing in "parts of Southern England, but not elsewhere". Muellbauer (1990c, pp. 24) suggests support for the home building industry, whilst Malpas (1986, pp. 237) argues that an improved system of maintenance and improvement grants is required for those on low incomes in order to maintain the standard of the whole housing stock. A comprehensive list of housing policies ranging from the taxation of owner occupation, the reform of local authority and housing associations to housing benefit and improvement grants are contained in Hills (1991, pp. 29-40).

1.4.10.3. Model Specific Housing Policy Debate.

In broad terms, the objective of many economists advocating housing reform is to realign house purchase to match desired housing services and break the link as a speculative investment. Thus, for example, King and Atkinson (1980, pp. 12) state, "Ideally, reform of the tax treatment of housing would be based on an appeal to a fully articulated set of principals. Unfortunately, theoretical principals have played little role in the evolution of the British tax system; and this makes it extremely difficult to propose a systematic plan for reforming the treatment of housing which is consistent with all other aspects of taxation". Many reformers are driven by inequality of taxation between assets, while others envisage the housing market playing a more sinister role in the economy. Arguments for a favorable tax treatment of housing are summarised in De Leeuw and Ozanne (1981, pp. 316-317). These include the benefit to society in general from good housing stock, both aesthetically and socially.

We have already described the theory that regional house prices adds to labour immobility and wage price pressure (Section 1.4.5.1.). Muellbauer (1986b) states that, "The housing market may be the major channel by which the money supply influences inflation directly rather than via interest rates". Other economists take a more sanguine view. Brittan (1988b) argues that house prices are not the cause of inflation, but a symptom and part of the transmission mechanism. Spencer (1987b) also casts doubt on the inflationary stimulus of house prices arguing that they merely react to inflationary expectations faster than labour or goods markets owing to its asset market characteristics (Brittan (1988a) also supports this view). He cautions against full acceptance of the labour rigidity theory because the evidence is not powerful enough to explain the statistical relationship between the two price series. If house prices are an indicator of inflationary expectations, then they may be adopted as an intermediate policy objective in the spirit of Friedman (1975) and discussed in Stevenson *et al.* (1988, pp. 297-299).

Turnbull (1990) also supports Spencers (1987b) proposition arguing that house prices reflect the overall monetary and fiscal stance in the economy. He strongly attacks the tax reformers arguing that the housing market is a disguise for their "hidden agenda", namely, if you can afford a big house then you should pay big taxes.

Whether such doubts are correct or not, the fact remains that there exists a significant body of literature dedicated to the reform of owner occupier taxation. By far, the most common area for reform is MIRAS, on the grounds that it encourages investment from other assets towards housing, particularly those in higher rate tax bands. This relief is also extended to those whose mortgage interest outgoings may represent only a small part of disposable income. MIRAS also helps to protect the owner occupier from the worst effects of inflation, thus supporting the link between expected inflation and house prices, although Meen (1990, pp. 6) argues that mortgage rationing may have broken the theoretical link between inflation, the tax system and real house prices.

1.4.10.4. Abolition of MIRAS.

Atkinson (1989) provides an entire paper devoted to why MIRAS should be abolished. Congdon and Warburton (1987) argue that almost all housing capital gains stem from MIRAS, while Fitzgerald and Davies (1987) feel that abolition would stem leakage from the mortgage sector to consumption and imports. Malpas (1986, pp. 236) and Muellbauer (1986b) propose achieving this over three years of a buyer's life. The Labour Party are reported to be considering a policy which would abolish higher rate relief and restrict the subsidy for the first ten years of an individual entering the owner occupied sector (Stephens, 1989) (higher rate relief was abolished in 1991). Maintaining MIRAS for a certain number of years is a recognition of the "tilt" or "front end loading" problem, that is, mortgage payments represent a much larger part of first time buyer's income and therefore, they are vulnerable to increased interest rates which increases the real burden of debt payments on current cash flow. Both King and Atkinson (1980, pp. 11) and Buckley and Ermisch (1982, pp. 283) argue that the importance of this phenomenon is diluted in the long run.

Abolition through a gradual reduction in the real value of the relief by maintaining the current threshold level has been proposed by King and Atkinson (1980), the Fabian Society (1990) and Hills (1991). Buckley and Ermisch (1982) suggest abolishing MIRAS, but at the same time, introduce a direct subsidy or tax credit arguing that this would break the link with inflation. Similarly, Keating (1986) argues for abolition of MIRAS at higher rates of income tax coupled with a reduction in the level of higher marginal tax rates claiming that this would provide a "rare example of a Pareto-efficient improvement", since it would help reduce regional imbalances, raise no one's tax bill and leave the PSBR (Public Sector Borrowing Requirement) virtually unchanged. Muellbauer (1988a) also suggests removal of higher tax rate relief.

The reason Keating (1986) includes a cut in higher tax thresholds is the fear of "tax capitalisation" invoking a typical asset market response resulting in lower house prices. This phenomenon occurs as prices fall until the post-tax return to the investor is equal to that achieved before the tax increase (change). If this happened, then many households could find the value of their home worth less than the value of the mortgage which, in turn, would add to labour mobility problems.

King and Atkinson (1980), Muellbauer (1986b) and Turnbull (1990) also emphasise the "tax capitalisation" problem. Research carried out by Meen (1988; 1989; 1990) suggests that its significance depends on whether the mortgage market is rationed or not. Following from his conclusions, tax reform of the owner occupied sector would only have affected prices slightly under conditions of rationing, the main effect being to reduce the mortgage queue. A corollary to this conclusion is that the real effect of inflation in the 1960's and 1970's was not to increase real house prices, but to increase the length of mortgage queues (Meen, 1990, pp. 19-20) and by implication, reject the hypothesis that over-investment in housing occurred during this period. This link between taxation, investment and mortgage market conditions should be important for policy makers.

Both Brittan (1988b) and Callender (1990) argue that MIRAS is not the real problem claimed noting that similar subsidies to MIRAS operate in other European countries, often more generous, without displaying similar housing inflation problems.
Although King and Atkinson (1980) and Buckley and Ermisch (1982) propose some reform of MIRAS, they express the view that the real taxation bias lies in the absence of capital gains tax or a tax on imputed income. Like other economists (eg. Hills, 1991) they accept that political expediency makes MIRAS the least cost policy option. Indeed, MIRAS has been reduced in real terms over the past two decades and multiple mortgage tax relief was abolished on the first of August, 1988,

although this had been suggested by the chancellor since 1986 (HMSO, 1986, pp. 27).

1.4.10.5. Taxation of Capital Gains and Imputed Rent.

Many economists feel that conditions in the housing market are so crucial that political misgivings must be put aside and radical reforms introduced. The introduction of capital gains tax has received some support (Muellbauer, 1986b), although for equity, mobility and again, political reasons, this has been in the main ruled out (King and Atkinson, 1980; Fabian Society, 1990; Hills, 1981). The increased research into net cash withdrawal has, however, brought forward proposals to tax such sums at a capital gains tax rate (Spencer, 1990; Spencer and Scott, 1990; Muellbauer, 1990). This policy has been criticised by Anderson (1990) who argues that alternative assets should be made more attractive (for example personal equity plans) in order to fund more productive alternative investments.

A more popular policy is the imposition of a tax on imputed rent. In its basic form, this is a tax on the market value of the property, assuming constant proportionality between imputed income and the capital value. Hallet (1988, pp. 202) argues, like many economists, for the introduction of such a tax on the grounds of neutrality with the private rented sector and with other assets. King and Atkinson (1980, pp. 13) modify this concept by proposing the taxation of imputed income from the equity held by each owner occupier arguing that this would make housing costs independent of the individuals tax rate and the rate of inflation. They propose that MIRAS be retained. One result of this, at least in a deregulated mortgage market, would be an increase in the levels of mortgage debt.

The case for a tax on imputed rent has also been proposed by Muellbauer (1986b) and expanded upon in Muellbauer (1987a, pp. 14-15; 1987b, p. 19-20; 1988b,c) who suggests taxing current capital values at a rate of 3 %. In a postscript to his (1987b) paper, he discusses the alternative of taxing the underlying value of land. This has the advantage of eliminating the disincentive to carry out home improvements prevalent under the standard proposal and encourage the utilisation of vacant land zoned for residential development. Muellbauer (1989b) suggests that a tax of 1 % of the current value of each plot of residential land above some exemption limit be levied. In between these papers (Muellbauer, 1988c) the author does accept that difficulties would occur at a practical level, for example, assessing land values and incorporating land use with planning controls. Given this, Muellbauer (1990c) concludes that one of the above taxes would be better than none.

Hills (1991, pp. 23) explores the effects of imposing income tax on a 3.5 % assumed real return to owner occupiers. He concluded that whilst the average outcome may be desirable, the disaggregated distributional effects were poor. Like capital gains tax, both Hills (1991, pp. 29) and the Fabian Society (1990, pp. 46) reject such a tax on political grounds. Ball (1983) argues that the tax was first introduced in the nineteenth century and was aimed at landlords, not owner occupiers. The tax has immediate problems given capital values may diverge relative to incomes and there is an absence of actual cash flow to tax.

1.4.10.6. Local Taxation.

We discussed rates in Section 1.4.10.1. and indicated that this had been replaced by the community charge. Today's policy debate therefore begins from this basis. Policy alternatives to the community charge are currently difficult to identify. At the moment, the government is reviewing the situation (the council tax being the outcome) while the Labour Party have announced the outlines of two possible schemes (Muellbauer, 1990c). One scheme is based on current capital values, while the other is a function of the square footage or building cost of the property. Some economists (Muellbauer, 1990c) would use a tax on imputed rent, the Social and Liberal Democratic Party favour a local income tax while The Fabian Society (1990, Chapter 11) advocate a mixture of the two.

1.4.10.7. Mortgage Rationing.

The reintroduction of mortgage rationing has been suggested by Potter (1988) and the tightening of banks and building societies' ability to lend has been proposed in Muellbauer (1990a). Potter's (1988) proposal is to ban new mortgages in excess of 60 % of the valuation of any property costing over £100,000. Rationing is not a common policy suggestion because of the nature of today's financial structure (Muellbauer, 1988b) and European integration (Turnbull, 1990, pp. 10). Lenders may tighten controls on loans in response to the new market environment although they may find this most efficiently achieved by fine tuning loan to income multiples rather than introduce a multiple screening process as proposed by Rose (1987).

1.4.10.8. Manufacturing Fiscal Structure.

The fiscal structure for the manufacturing sector is relatively complex. Not only is there a wide variety of taxes and subsidies to deal with, but two taxation systems. Given that we are interested in the taxation of manufacturing capital to the individual, it is necessary to account for the taxation of the corporate entity and any further taxation of returns to the personal sector.

After 1947, corporates, like individuals, paid income tax at a standard rate on profits. Shareholders were regarded as "partners" in the company. When the company paid a dividend, it was entitled to recoup income tax at the standard rate. Corporate profits were then subject to both an income tax and a profits tax. The system was, in effect, though not in legal form, an imputation system. U.K. corporate taxation is summarised in the Institute for Fiscal Studies (1991, Appendix B). The pre 1965 system is described in Voge (1968), Adams and Whalley (1977, pp. 17) or Devereux (1987), while summary statistics of revenues between 1965 and 1985 are presented in Her Majesty's Treasury (1984, part II). For the purposes of this research, we are interested in modelling the classical and imputation Systems of corporate taxation.

1.4.10.8.1. Classical System.

The classical system was introduced in the 1965 Finance Act (for a summary see Adams and Whalley (1977, pp. 50-51) King (1977, pp. 50-51) or James and Nobes (1988, pp. 277-279)). This system also prevailed in the U.S. for the 1965-79 period of interest and is modelled in HH. Under this system, corporation tax was levied at a uniform rate on all profits, whether distributed or not. The corporate was regarded as a separate entity from its owners and consequently, any distribution required the corporate to deduct income tax at the basic rate. Schedule 11 of the act defined distribution widely, including any redeemable share capital issued in the form of bonus or interest paid on any type of security such as convertables. A complex system of surtax was aimed at wealthy individuals. On receipt of distribution, the individual was then automatically subject to income tax at their marginal rate. This "double taxation" of income was the main focus of criticism regarding the classical system.

Both corporates and individuals were subject to CGT on nominal gains. CGT was first introduced in 1962 with the imposition of a speculative gains tax in which individuals' short-term gains (those made in less than one year) were taxed at their marginal rate of income and surtax rates (Prest and Barr, 1985, pp. 198-199). CGT became much more comprehensive from 1965, individuals' long-term gains were taxed at 30 % or their marginal rate depending on which was most favourable. For corporates, the distinction between short and long-term gains was abandoned and all gains were treated as part of corporate profit and taxed as such at the corporation tax rate.

Like individuals, corporates were also charged rates. In this instance, rates were levied on buildings, the land associated with them and on plant and machinery fixed to the buildings or deemed part of the structure. The main area of contention by corporates to this local tax was that unlike domestic rates, no voting rights were attributed to them. More detailed discussion can be found in Kay and King (1980, Chapter 10), and Bennett and Krebs (1987, pp. 25-26; 1988a, pp. 164-165).

Subsidies to business were provided in two broad forms. Firstly, all interest paid on debt finance could be deducted against corporation tax and secondly, a wide range of accelerated depreciation allowances and grants were available. The rules and rates of these fluctuated over the period.

Inflation and the rapid speed of technological change encouraged many businesses to argue that standard depreciation methods were too long resulting in a growing divergence between the true cost of replacing an asset and its historical replacement cost. Although fixed assets appear on the corporates balance sheet at cost less aggregate depreciation to date (net book value) and depreciation is subtracted from the statement of profit and loss, it is nevertheless advantageous to the corporate to write this off as quickly as possible. This is because the balance sheet is not a valuation of the assets worth and as companies are valued over time, reducing current tax liabilities, increases the present value of the firm.

There has been a frequent change of allowances over the years, however, as Auerbach (1981) indicates, the effect of these differ with varying tax rules and inflation. A table of depreciation allowances and grants can be found in James and Nobes (1988, pp. 302). The most common accelerated depreciation method is first year allowances - first introduced in 1945. Under this scheme, a corporate investing in fixed capital could claim a larger percentage of its allowance entitlement in the first year at the expense of subsequent years. The total allowed remained at 100 % of the initial historical cost. If the corporate replaced its capital evenly through time then the date of repayment could be postponed indefinitely. Such allowances can only be utilised if the firm is generating enough profit to be subject to corporation tax. If it does not, then the firm is "tax exhausted" and its user cost of capital will rise (Devereux, 1987).

One hundred percent initial allowances are similar to the first year allowances, but they correct for the inadequacy of historic cost depreciation. A more flexible system is that of "free depreciation", first introduced in 1963. This scheme enabled firms to write-off costs to a timetable chosen by themselves. In some ways, this helped to circumvent the tax exhaustion problems as firms could write off more in years of strong profits. All of these schemes were used periodically and were sometimes targeted at specific assets.

Investment allowances, first introduced in 1954, were akin to a special allowance in a particular year. This took the form of a net addition to the total allowances granted over the life of the equipment. For example, if the investment allowance was 25 %, then the total allowance over the duration of the asset's life would be 125 %.

At various stages, the government also provided cash grants in addition to, or, instead of, the above allowances. Investment grants were used between 1966 and 1970, when they were abolished principally in favour of first year allowances although they returned in 1972 as part of the government's regional policy.

1.4.10.8.2. Imputation System.

The "imputation system" was introduced on 1st April, 1973 (for a summary, see Adams and Whalley (1977, pp. 18-19), King (1977, pp. 51-52) or James and Nobes (1988, pp. 277-287)). The main effect was to end the double taxation of income associated with the classical system. This was achieved by allowing a partial set-off, or imputation, of corporate taxation against personal taxation, which were no longer separate entities.

The system centres around Advanced Corporation Tax (ACT). ACT serves two purposes, it represents a tax credit to individuals which could be used to offset income tax while the corporate could set ACT against its Mainstream Corporation Tax (MCT).

Corporates paid ACT directly to the Inland Revenue of an amount equal to the basic rate of income tax that would be payable on dividends if they were grossed up at the basic rate of income tax, Θ. For example, if a corporate distributes £70 by way of a dividend, then its ACT charge is $(\Theta/1-\Theta)$£70. As far as the Inland Revenue is concerned, the tax charge to the individual is levied on the gross amount ("gross equivalent"), that is Θ (Dnd $(1 + (\Theta/1-\Theta)))$ where Dnd is the distribution of net dividend.

The imputation system also changed the method in which CGT was applied to corporates. Capital gains ("chargeable gains") were still added to the corporates profits to face corporation tax. However, the size of the changeable gains was scaled down such that the effective rate was equivalent to individuals, 30 %. Throughout the imputation system, the corporate tax deductability of interest payments, rates, allowances and grants were maintained.

Significant changes since 1979 include the introduction of Enterprise Zones (see Bennett, 1990), the indexation of capital gains on assets held for more than one year, introduced in 1982 (see Prest and Barr 1985, pp. 338) and the 1984 corporation tax reforms which removed the protection of stock relief and initial allowances (See King and Wookey (1987, pp. 150-152). Independent Personal taxation has more effect on separate taxation of husband and wife than any investment implications. Finally, Personal Equity Plans (PEP's) were introduced in 1987 after being announced in the 1986 Budget. PEP's enabled personal investors to invest directly in equities's tax free (for a discussion, see Brown (1989)). A brief summary of the personal and corporate tax structure in the late 1980's is provided in Adams (1988, Chapter 2).

1.4.10.9. Manufacturing Policy Debate.

As can be observed from the previous Section, there have been far more changes to the taxation of manufacturing than housing. We have already indicated in Section 1.2.4.1.4. that some form of inflation accounting has been a popular policy proposal. King and Wookey (1987, pp. 60-61) discuss the merits of a cash flow tax which taxes total receipts resulting from the sale of real (as opposed to financial) goods and services. The authors point out that this would be difficult to apply to service-based industries.

Recently, Griffiths (1989) reports that three prominent engineering organisations submitting a joint Budget proposal suggest the introduction of a number of investment incentives. These included full tax allowance for investment expenditure at the time of incurring the expense and an improvement in depreciation allowances for plant and machinery from 25 % to at least 40 % per year.

More recently, a study by the Institute of Fiscal Studies (1991) has proposed a restructuring of corporation tax. They call this the ACE system (Allowance for Company Equity) and as the name suggests, the proposal is to allow the cost of equity against the corporation tax liability in a similar way that relief is extended to interest payments. Such a system is aimed at achieving neutrality between sources of finance and choice of asset.

1.5. Conclusion.

The role of this Chapter has been to provide the background to the importance of investment direction in the economy with particular reference to two key sectors, manufacturing and owner occupied housing. Important concepts of investment were discussed followed by a review of investment theory which enabled the identification of general rules which our model could appeal to. A review of asset allocation models which stressed the user cost of capital theory was provided and we concluded that the work of HH represented the most fruitful starting point for a U.K. study. Following from this we identified owner occupied housing and manufacturing as important sectors in the evolution of the U.K. economy which could be modelled. Examples of areas which these sectors impinge on economic activity were discussed in order to set in context the results of the model presented in Chapter 4 and 5. This was followed by a summary of the actual fiscal structures of the period which directly link the model described in Chapter 2 and the results of Chapter 4. Finally a discussion of various policy proposals was given which forms the basis of the simulations presented in Chapter 5.

2. A GENERAL EQUILIBRIUM MODEL FOR THE U.K.

2.1. Introduction.

In this Chapter we present the basic general equilibrium simulation model which we shall use as a suitable paradigm to analyse the questions contained in Section 1.3.1. of Chapter 1. The model is in real terms and consists of two sectors, manufacturing (or corporate) and housing (owner occupied) and five assets, short and long-term corporate debt, mortgage debt, corporate and housing equity. The basic model has the risk-free rate of interest determined exogenously. User cost of capital measures are central to the allocative process and these have been comprehensively specified. The model uses the tax system's prevalent between 1965 and 1979. Risk premiums and the ability to ration mortgages are also incorporated. The economy is closed, although it is possible to exogenously fix the risk free interest rate as if it were set at levels determined in international markets. Below we shall outline some of the main assumptions underlying the model and then discuss areas where the model theoretically diverges from Hendershott and Hu (1983) (denoted HH). Following this, the basic model is presented in detail in order to expose microeconomic foundations often only partially presented in many studies. This also enables us to expose many of the assumptions implicitly made in similar research.

2.2. Main Assumptions.

This Section outlines the main assumptions of the simulation model. The basic model is presented in Section 2.4. which contains further assumptions more efficiently exposed within the model itself. The model is embedded in a neoclassical long-run general equilibrium framework. Equilibrium is used in the traditional sense (Chiang, 1983, pp. 35; Hendry, 1985, pp. 223), namely, a state where no inherent tendency to change exists. The model is aggregate in nature and therefore abstracts from the heterogeneous aspects of the housing market (see O'Sullivan, 1985) and specific individual situations such as age and income (see Hendershott, 1988a). Perfect competition prevails and all markets clear. Relative factor prices matter and capital is allocated according to the marginal productivity theory of income distribution. As adjustment costs are ignored there are no dynamics, we are only interested in steady state solutions and therefore, the model sheds no light on adjustment paths between them. We shall assume that individuals own all net wealth (see Section 1.2.2.) and allocate resources according to the marginalist principal outlined above. There is no explicit government sector, although the government sets taxes and subsidies, it has no expenditure function or explicit control over money supply or interest rates.

In order to maintain consistency and ease of interpretation, we will ignore many of the less significant tax changes, concentrating on the main structure of the U.K. taxation environment throughout the period of interest. This simplification is not unusual in a long-run model and is similar to, for example, King and Wookey (1987).

Ermisch (1988, pp. 17) criticises the assumption that individuals allocate resources from a single tax base. The author bases his argument correctly on the basis that individuals enjoy other favourable tax vehicles for investing such as pension funds (this would also include life assurance and PEP's) which may affect some of the bias found in the U.S. studies. Indeed Feldstein and Jun (1987, pp. 104) suggest modelling with all taxes and then excluding personal taxes on the premiss that changes in the return to pension funds will, through portfolio substitution, affect the return to other investors. A study by the Bank of England (1986a, pp. 546) argues that life assurance and pension funds have become major vehicles for personal sector saving (for more technical detail relating to pension funds, see Blake (1986b)). In 1984, investment in these areas represented two thirds of all personal sector saving. In 1965, total assets of life assurance and pension funds was about £12.5bn (Bank of England 1986a, pp. 547) compared to our value for the manufacturing sector that year of £27bn (source: see Section 3.2.1.1.) which suggests that significant funding was being channelled from other sources, particularly as the funds typically also invest in government debt and in overseas markets.

For the purpose of the base model, we maintain that it is important to model the basic tax structure as a starting point. The existence of tax free investment vehicles, which invest mainly in corporate property, debt and equity (of which manufacturing is a sub sector) will result in our model slightly over-estimating the manufacturing user cost and consequently, understating the sector's share in the balance sheet. The model's inherent flexibility enables simulations to be carried out assuming any proportion of tax free investment in this sector.

2.2.1. Consequences of the Long-Run Assumption.

Given that all markets clear, the most obvious consequence of the long-run nature of the model is the irrelevance of the supply side. That is, the model focus is on quantity effects. In the long-run, capital supplies are infinitely elastic and therefore, an increase in demand will meet with no real price feedbacks. This implies that in our model $d\pi^{eh}/d\pi^e = d\pi^{ek}/d\pi^e = 1$, where π^e is the expected rate of inflation and π^{eh} and π^{ek} are the expected price increases (capital gains) of housing and manufacturing capital respectively. All models discussed in Chapter 1, Section 1.3.

also ignore supply side complexities either by the route used here or by analysing the short-run and assuming the supply of capital is fixed (eg. Ebrill and Possen, 1982).

These assumptions enable the models to remain relatively simple, thus easing the interpretation of changes in complex tax systems. The assumption of a vertical or horizontal supply curve is particularly common in studies of housing issues (which is arguably a bigger assumption than for manufacturing) in the U.K. (eg. Buckley and Ermisch, 1982; Meen, 1988, 1989, 1990) and the U.S. (eg. Poterba, 1984; Shear *et al.* 1988). When econometrically modelling U.K. house prices, Hendry (1984, pp. 219) assumed a horizontal supply curve arguing that, "An upward sloping supply curve would not materially change the analysis..".

Apart from adding to the complexity of the analysis by the incorporation of the construction industry (see Turner, 1987) or planning policies (see Ellson and McDermott, 1987) introducing a supply side would make the exclusion of complex dynamic lag structures more difficult to justify. This would make matters particularly difficult for the housing side of the model where empirical knowledge regarding the supply side is sparse. The supply of owner occupied housing can be augmented not only by construction activity (both from the construction industry and private house or extension building) but as a result of the transfer from other sectors.

A discussion of housing supply elasticities is contained in Hughes (1988b, pp. 34-37), Bartlett (1989 pp. 1-2, 49) and Spencer (1989, pp. 19-20). In his survey Bartlett (1989) finds that the best available estimates of the long-run supply elasticity of housing services in the U.K. is 5.5. This is lower than the U.S., which he reports as being around 11.5. Topel and Rosen (1988, pp. 719) also find that in the U.S. most of the difference between the short- and long-run supply erodes within one year.

The relative price implication of this assumption has, to some extent, been addressed by HH. Hendershott (1980, pp. 431) comments that "The model was not extended to incorporate feedback effects because no relatively straightforward extension seemed useful. The most obvious extension would be to make the relative price of housing endogenous" (this work was a precursor to HH). He further justifies this by arguing that his "..treatment has implicitly assumed that the rise in the real price is largely exogenous to housing demand and irrelevant to builder's supply" (page 432). In HH, the introduction of relative prices is achieved with the introduction of a supply elasticity (set at 4), the method used to incorporate this is unusual and is not extended to non-residential capital. Parameterisation of the productivity parameters (pp. 806, Equations 4'' and 19) is complex and duplicating with any conviction for the U.K. would be difficult. Our basic model is general enough to allow for a simple feedback in the form of relative price changes. In many ways, this adds to the model's appeal by using a basis which has clear implications rather than being dependent on matching the correct relative supply elasticities. Given the model's aim of exposing the long-run allocative implications of taxation, risk and inflation, short-run implications are a secondary issue.

In conclusion, our interest lies in quantity rather than price effects. Although empirical evidence supporting the long-run assumption of infinitely elastic supply is more powerful in the U.S., an empirical case can still be made for the U.K. All of the other arguments outlined above favour retention of the assumption in the basic model.

2.3. Main Departures from HH's Model.

The main departures from HH's model are outlined and discussed below. Where necessary, these shall be expanded further in the model derivation. The main areas are as follows:-

1. The assumption of an homogeneous personal sector.

2. The incorporation of the classical and imputation systems of corporate taxation.

3. The incorporation of a specific mortgage demand equation utilising a loan to income multiple along with a user cost of mortgages which facilitates switching between rationed and not-rationed states.

4. The treatment of tax depreciation and investment grants.

5. The assumptions that corporates fund debt of both long and short duration. Short-term debt only is assumed risk-free, while long-term debt attracts a risk premium.

6. The explicit introduction of MIRAS.

7. The introduction of a mortgage risk premium which does not follow the mean-variance approach.

2.3.1. Discussion.

Before expanding on the departures highlighted above, it is useful to remind the reader of the key aspects of HH's model. The model contains two sectors (housing and non-residential) which incorporate a production function and demand equations for the two sectors assets. The demand functions incorporate disposable income and profits respectively, along with the relevant user cost of capital series. Within these sectors, individuals allocate between four assets, corporate bonds (not separated by duration), equity and mortgage debt (a negative asset). Two types of household are specified - wealthy and non-wealthy - the former lend to the latter and the corporate sector to enable them to finance their expenditure decisions.

An interesting twist to the model is its ability to endogenously incorporate risk premium attached to the assets. This means that, assuming the investor is rational and risk averse, an asset increasing as a proportion of the total portfolio suffers a rising risk premium. Tax structures are also comprehensive and clearly relate to the personal sector, that is, the corporate user cost includes not only corporate taxes but any further taxes which affect the returns to the individual from corporates. The need to incorporate all layers of taxation facing the ultimate investor is emphasised by Summers (1981, pp. 7). Equations representing household and corporate tax payments, retained earnings and disposable income are also included.

The model is of a simultaneous general equilibrium nature and in its basic form, solves for fourteen variables. An initial simulation was run with values set at levels roughly equivalent to those in 1965. The ability of the model to facilitate binding capital markets is unique among the studies outlined above.

2.3.1.1. Homogeneous Personal Sector.

We have not differentiated between wealthy and non-wealthy individuals, as HH did, principally because the question of wealth splits is not directly related to the objectives of this research. Moreover, having carefully attempted to parameterise their model for a specific period, HH then apply an arbitrary equal split between the sectors. Although this results in one additional user cost and balance sheet, their model does not split out real cash flows of the two sectors.

The advantage which HH best exploit is the ability to show wealthy households lending mortgage funds to the less wealthy. In our model, we assume that such funds are exogenously provided by financial institutions (eg. building societies) which operate through some form of bank multiplier. All individuals have access to mortgage debt. This is advantageous because, given the favourable tax treatment of mortgage debt, it will be optimal for all individuals to hold some amount of mortgage debt. This is impossible in the HH model. Although the amount of mortgage debt does not alter the size of wealth directly, it features in the balance sheet and plays a crucial role in the model by influencing the loan to valuation ratio, MIRAS and risk premiums.

2.3.1.2. Tax Systems.

Over the period studied by HH, the U.S. system was classical in nature unlike the U.K. which replaced this with the imputation system during the period (Section 1.4.10.8.). The U.K. model, therefore, requires us to model both systems. This is relatively straightforward, involving the respecification of taxation in the model and the introduction of a switching facility in the model solution programme. Throughout both systems we have incorporated corporate CGT, HH only apply CGT to the personal sector.

2.3.1.3. Tax Depreciation.

HH do account for the treatment of tax depreciation and grants through the parameter t_1. A time series for t_1 is derived and presented in an earlier paper, Hendershott and Hu (1981b, pp. 94). The disadvantage in this procedure is that whilst the value of t_1 may be correct, the effect on the user cost is that these allowances change in value only if the corporation tax rate changes. The present research utilises a more conventional method of incorporating these allowances (see Section 2.4.6.1.2.) which expands the range of influences which the allowances operate through.

HH's parameter t_2 acknowledges the use of historic rather than replacement cost and is based on work carried out in Hendershott (1981) and Hendershott and Hu (1981b). Like t_1, we ignore this parameter and follow a more conventional user cost approach (see Section 2.4.6.1.2.). Using the methodology contained in the above papers, it is possible to calculate t_2 for the U.K. However, the assumptions necessary to do this and the data availability make it an unattractive proposition.

Given this, we do not utilise equation 12 in HH (pp. 799) which represents their vehicle for incorporating the effect of investment allowances and the use of historic cost accounting.

2.3.1.4. Corporate Debt.

Corporate debt has been divided between long and short-term financing. This has the effect of introducing a further asset to the individual's portfolio and requires the specification of a risk premium on long-term debt. This change results in a more realistic model without unduly adding to its complexity. It is arguably more consistent to assume short-term debt (rather than all corporate debt) is risk-free, particularly when the model attributes an albeit small risk premium to housing equity.

2.3.1.5. MIRAS.

There are several reasons for explicitly introducing MIRAS as an endogenous variable. Section 1.4.4.1. described the significance of MIRAS to individuals, its importance to government as an uncontrollable area of marginal expenditure while Section 1.4.10.4. describes its high profile as a policy issue in the U.K. The effect of the MIRAS ceiling is also accounted for in order not to over estimate its influence by incorporating a scaling factor which represents the threshold limit imposed.

2.3.1.6. Effective Mortgage Demand and Rationing.

Effective mortgage demand is assumed to be the minimum of the actual supply or demand existing in the market. We have defined mortgage supply to be a function of income and a loan to income multiple. This is a result of the variable rate mortgage regime prevalent in the U.K. (which differs from fixed rate mortgages in the U.S.) and the use of the loan to income multiple as an optimal screening method in assessing applicants' ability to service loans (see Section 1.4.4.1.). On the other hand mortgage demand is assumed to be a function of individuals income and the real mortgage user cost.

HH (p. 800) specify a mark up paid by borrowers which is determined by a quadratic function which progressively bites as the loan to valuation ratio rises above a specified level. Below this level no mark up is paid. The authors do not provide any sources pertaining to theory or parameterisation and as such, suggests an instrumentalist approach to the problem (concepts of instrumentalist methodology are discussed in Blaug (1980, pp. 105-107) and Wible (1984)). Whilst this is an interesting method of incorporating risk which the authors argue reflects differences in commitment rates for level payment fixed rate mortgages, it cannot be said to be representative of the U.K. market. The variable rate mortgages in the U.K. charge individuals' the same mortgage rate independent of their particular gearing levels. The mortgage rate charged was greater than the risk-free rate, the margin fluctuating depending on building society costs over time and the lenders' ability to generate funds.

Clearly, the loan to income and the loan to valuation ratios are directly related (see Mathematics Appendix, Section A) if mortgage supply is less than mortgage demand. The loan to income ratio allows us to switch between regulated and deregulated regimes and the model to compute the effect on the loan to valuation ratio. HH (p. 809-810) also use income along with housing costs to provide a form of rationing. Their methodology, whilst straight-forward, is more complex than that actually used by lenders although both achieve the same result. Obtaining an empirical parameter for non-utility housing costs (HC in HH) would also have been difficult for the U.K. with scope for errors. Our model stresses the role of quantity in a disequilibrium framework to represent the U.K. mortgage market. We make the distinction between individuals facing a binding constraint because of their perceived ability to finance a mortgage by lenders, and individuals being rationed out of the market by lenders imposing a lower loan to income multiple than they otherwise would in a competitive environment. This is an important distinction not often emphasised. Thus, in a deregulated mortgage market if notional demand for mortgages is greater than actual supply, we define this as individuals facing a binding constraint as lenders believe that to provide greater loans would result in them facing the unacceptable risk that borrowers income flow could not cover interest payments. We define mortgage rationing as the setting of the loan to income ratio at levels below that which would pertain in a competitive market. If notional demand is less than potential supply under any mortgage market environment individuals demand is naturally fully satisfied. By changing the value of the loan to income multiple the effects of a shift in the mortgage market may be analysed.

2.3.1.7. Mortgage Premium.

The premium paid for mortgage debt does not conform to the standard mean-variance approach. That is, lenders do not (at the moment) generally charge different rates to borrowers depending on their exposure to a mortgage. More to the point, the margin between the risk-free rate and, for example, building societies' ordinary deposit rate tends to be a function of expense ratios rather than a risk premium for uncertainty of returns. Building societies which paid a return subject to the composite rate would also, for this reason, not require to fund from wholesale markets (see Building Societies Association, 1988a, pp. 21). When borrowers enter into a mortgage agreement they endure the theoretical risk that lenders could increase the mortgage rate substantially at will. This would result in borrowers dissatisfaction and potentially bad debts would occur. It is however possible to imagine that an implicit contract exists between the parties which results in borrowers accepting the above risk while the lenders agree to maintain a stable mortgage premium. Moreover, given the sensitivity of the mortgage user cost to changes in its components, large fluctuations in the mortgage premium would be required in order to equilibriate the mortgage market.

2.4. Basic Model.

2.4.1. Output.

We assume an economy with two goods, owner-occupied housing services and manufacturing output. The manufacturing good is produced by labour and manufacturing capital via a Cobb-Douglas production function. Constant returns to scale are assumed (the function homogeneous of degree one), that is an equiproportional increase in inputs results in an equiproportional increase in output such that,

$$Y = Ç_k K^{\alpha_k} L^{1-\alpha_k} , \qquad (2.1)$$

where Y is real manufacturing output, $Ç_k$ is an efficiency parameter representing the state of technology, K and L are real capital and labour inputs respectively and α_k is a production coefficient.

By assuming the Cobb-Douglas to be linearly homogeneous and assuming that each input is paid by the amount of its marginal product, then the relative share of total product (profit) accruing to capital is α_k. Similarly, the wage share paid to labour is represented by $1-\alpha_k$ (See Mathematics Appendix B, Section B or Chiang (1984, pp. 416)).

We assume that $Ç_k$ and L are constant, such that $Ç_k L^{1-\alpha_k} = Ç_{kl}$ and Equation (2.1) becomes,

$$Y = Ç_{kl} K^{\alpha_k} . \qquad (2.2)$$

2.4.2. Demand for Manufacturing Capital.

Equation (2.1) is subject to the constraint $Y \leq f(K)$ where f, in this case, represents the Cobb-Douglas production function. Firms are assumed to be profit maximisers and hence never produce where $Y < f(K)$, the function becomes an equality. In the long-run, the demand curve facing the corporate for its output is,

$$P_W = P_W(Y), \qquad (2.3)$$

where P_W is the price of manufacturing output. Given the production function equality, we can express the firm's total revenue, TR, as,

$$TR(Y) = TR\big[f(K)\big]. \qquad (2.4)$$

This result enables us to determine the corporate's cost and revenue with its input and therefore corporate output need not appear explicitly in its profit maximisation function.

Assuming that corporate activity is funded by retained earnings and investment from the personal sector (and therefore personal taxation has a bearing on financing) the corporate's objective can be written,

$$\max_k TR\big[f(K)\big] - UC_{ka}(K)_t, \qquad (2.5)$$

where UC_{ka} is the real user cost of manufacturing capital where the terms are real in the sense intended in equation (3) in Kelly and Owen (1985, pp. 4). Assuming that $K > O$ (equation (2.5)) implies that,

$$TR' \cdot f'_k - UC_{ka} = O, \qquad (2.6)$$

where $TR' = dTR/dY$ is the corporates marginal revenue (MR) and $f'_k = dY/dK$ is the marginal physical product of capital (MPP_k). The corporate's marginal revenue product (MRP_k) therefore is $TR' \cdot f'_k$ which equals dTR/dK. Equation (2.6) represents the standard text book equilibrium condition, namely, the corporate will pay for an extra unit of capital input up to the point where the user cost of capital (rental cost) equals MRP_k. Rearranging equation (2.6) we obtain,

$$MR \cdot MPP_k = UC_{ka}. \qquad (2.7)$$

We know by the product rule (Chiang, 1984, pp. 161-162) that,

$$MR = dP_W/dY \cdot Y + P_W. \qquad (2.8)$$

Under the conditions of perfect competition, the condition $dP_W/dY = O$ holds (ie. the demand curve facing each individual firm is horizontal) and therefore equation (2.8) simplifies to,

$$MR = P_W. \tag{2.9}$$

In turn, this allows us to write equation (2.7) as,

$$P_W MPP_k = UC_{ka}. \tag{2.10}$$

Noting that the corporate's marginal cost (MC) equals UC_{ka}/MPP_k then dividing both sides of equation (2.7) by MPP_k provides the condition marginal revenue equals marginal cost.

Given equations (2.7) and (2.9) and dividing both sides by P_W, we obtain the equilibrium relation (assuming P_W equals unity),

$$MPP_k = UC_{ka}. \tag{2.11}$$

Note that this solution is not inconsistent with equation (2.5) as the user cost in (2.11) is real with respect to corporate cash flows and the terms in the user cost function become nominal. This methodology is explained and demonstrated in Kelly and Owen (1985, pp. 4-5).

Solving equation (2.2) for the MPP_k, we find (see Mathematics Appendix, Section C)

$$f'_k = \alpha_k Y/K, \tag{2.12}$$

applying the equilibrium equation (2.11) and solving for K we obtain,

$$K = \alpha_k Y/UC_{ka}. \tag{2.13}$$

Thus, demand for real manufacturing capital depends on the sector's profit share of real output and the user cost of capital.

2.4.2.1. Demand for Housing and Mortgage Capital.

All households are assumed to have identical tastes. The housing production function is assumed to employ capital only to produce housing services and we egnore the effect of land as an input. This assumption is tantamount to imposing constant proportionality between the housing capital stock and its service flow. This assumption is common in the housing literature, utilised for example by Buckley and Ermisch (1982, pp. 278), Gahvari (1984, pp. 213) and Poterba (1984, pp. 731). Housing services are derived from non-Cobb-Douglas technology such that the demand for housing capital takes the form,

$$H = \alpha_h(D)^{\epsilon}(UC_{ha})^{-n}, \tag{2.14}$$

where H is the real stock of housing capital, α_h is a constant, D represents real personal disposable housing income while ϵ is the elasticity of housing demand with respect to income, UC_{ha} is the real user cost of housing capital and n is its elasticity. The assumption of a log linear demand function rather than a strictly linear one allows the use of constant elasticities over time (Ripley and Seddighi, 1988, pp. 15-18) and thus taking logarithms we obtain,

$$\ln H = \ln\alpha_h + \epsilon\ln D - n\ln UC_{ha}, \tag{2.15}$$

where ln specifies a natural logarithm.

The specification of a demand for mortgages is complicated by the implications of rationing and liberalisation. The supply of mortgages as determined by lenders in any environment (H^{ms}) is assumed to be a function of the personal sectors gross income (α_k represents the income share split between capital and labour, see Section 2.4.1) and a loan to income multiple, Γ, (Section 2.3.1.6.) and therefore,

$$H^{ms} = \Gamma\big[(1-\alpha_k)Y\big]. \tag{2.16}$$

Our mortgage supply equation takes this form because of lenders' use of income as a least cost screening method (see Section 1.4.4.1.). In a liberalized market, the value of Γ is likely to rise. Making this the only mortgage market equation in the model is theoretically weak as one could envisage the situation where housing costs rose and individuals' optimal mortgage stock was less than the funds potentially made available to them by lenders. Under these conditions it is desirable to model a separate mortgage demand equation incorporating the user cost of mortgages, UC_m, such that following the methodology of equation (2.14) and (2.15), we may write mortgage demand H^{md} as,

$$\ln H^{md} = \ln\alpha_m + \epsilon\ln\big[(1-\alpha_k)Y\big] - n\ln UC_m, \tag{2.16'}$$

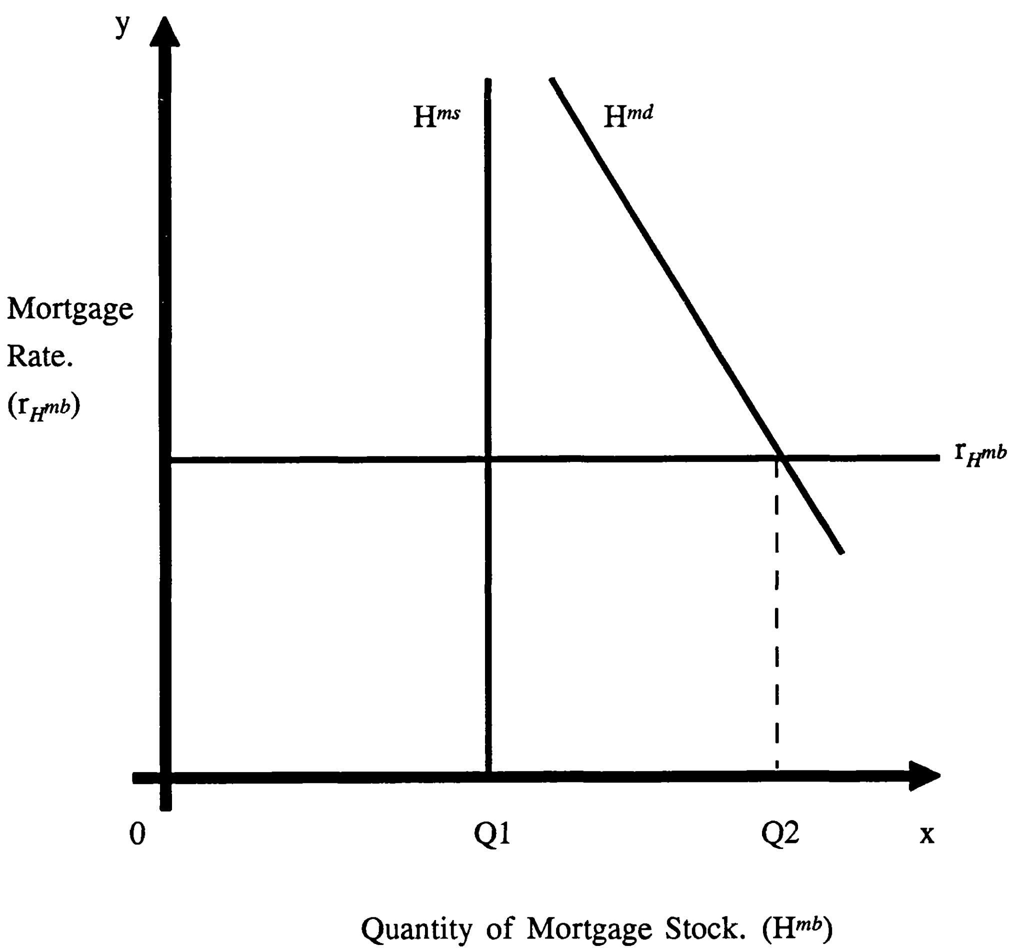
where UC_m is the user cost of housing capital financed purely by mortgage debt. We assume that the relavent income definition is at the pre-tax level which results in mortgage demand being less volotile than overall housing demand given the increased potential influences on disposable income (see equation 2.63). In addition, for simplicity, we assume similar elasticities across both demand functions.

Effective equilibrium mortgage demand, H^{mb}, would be the minimum of the two. Thus, $H^{mb} = \min(H^{md}, H^{ms})$. This methodology is similar to that outlined by Hall *et al.* (1987, pp. 30) in their model of the labour market. Further methods which have been employed in models to effect mortgage rationing are described in Meen (1988, pp. 9-10).

The mortgage market in our model is described in Graph 2.1. Given our definitions contained in Section 2.3.1.6. individuals receive their desired stock of mortgages when $H^{mb} = H^{md} < H^{ms}$ at the given mortgage rate. If H^{ms} crossed the horizontal line $r_{H^{mb}}$ at a point to the right of Q2 then the effective mortgage stock would continue to be Q2. If the market is liberalized and $H^{mb} = H^{ms} < H^{md}$ then individuals face a binding constraint as income is too low to finance the desired mortgage stock. In Graph 2.1 this constraint would be the difference, Q2 - Q1. On the other hand if Γ was lower than its deregulated level and $H^{ms} < H^{md}$ the same picture would emerge as in Graph 2.1 but the difference between Q2 and Q1 would contain an element of (or be totally) mortgage rationing. Even in an unrationed market, asymmetry exists as excess supply has no effect on the market. If we assume that Graph 2.1 is constructed in a rationed environment then deregulation would shift H^{ms} vertically to the right. A rise in income, under any conditions, shifts both H^{ms} and H^{md} to the right. An increase in the mortgage rate narrows the gap between Q1 and Q2.

The asymmetry noted above is in part a result of the tie between the mortgage rate and base rates which may at some point in the future weaken. If we, as an alternative, were to assume that lenders supply of mortgages was a function of the deposit rate, (which they set) this would involve not only modelling this component of saving behaviour, but doing so under both regulated and deregulated environments (the latter of which we do not possess a significant history). The mortgage market presented here represents a reasonable simplification and is consistent within our model framework.

Graph 2.1. Mortgage Market.



2.4.3. Wealth and the Personal Sector Balance Sheet.

We assume that individuals are the ultimate wealth holders in the economy and that they costlessly allocate resources between the manufacturing and owner occupied housing sectors. The real stock of wealth (Wr) consists of the capital stock of the sectors described above thus,

$$Wr = K + H. \qquad (2.17)$$

In order to introduce relative price effects (through asset markets), we can write the total value of wealth (W) as,

$$W = qK + pH, \qquad (2.18)$$

where q is the ratio of the market value of manufacturing capital to its replacement cost (Tobin's Q) and p is the ratio of the price of housing to the price of non-housing goods. When no relative price movements occur (basic simulations) $p = q = 1$ and $Wr = W$.

The personal sector balance sheet includes both short and long dated corporate debt (Sb and Lb respectively), equities (E) and the total housing stock, some of which is financed by mortgaged debt. The balance sheet is,

$$Sb + Lb + E + H^{ml} + H = W + H^{mb}, \qquad (2.19)$$

where H^{ml} is the mortgage stock lent and by definition, $H^{mb} \equiv H^{ml}$. Housing stock which is paid up and represents equity (H^{pd}) is equivalent to $H - H^{ml}$. Total corporate debt (B) is split into its two components by a ratio, z, such that, $Sb = zB$ and $Lb = (1-z)B$. The portfolio is a simplification as individuals would have the option of holding a wide range of alternative assets such as cash, precious metals, art or a range of financial derivatives such as options or warrants.

The two sectors combine to form net or "outside" wealth (Goodhart 1975, pp. 202-203; Stevenson *et al.* 1988, pp. 19-20). That is, there is no net liability (debt) outstanding which finances W itself. The asset H^{ml} is exactly offset by H^{mb} and as described in Section 2.3.1.1. and therefore H represents "outside wealth".

2.4.4. Risk Premium and the Demand for Risky Assets.

All the assets on the left hand side of equation (2.19) except Sb are regarded as risky by individual investors. Given a current portfolio, if individuals' expectations altered with respect to prospective asset yields then they will attempt to reallocate the proportions of assets across the portfolio so as to maximise return subject to risk. This process is encapsulated in the von Neumann-Morgenstern choice under uncertainty framework. A background and brief outline of the theory of portfolio demand for risky assets is provided in Stevenson *et al.* (1988, pp. 150-154). This methodology does not apply to mortgage stock although it is attributed a risk premium (discussed in Section 2.4.6.2.) and is assumed to be a component of wealth in the individuals portfolio.

Utilising mean-variance portfolio analysis (see Green, 1978, pp. 242-247) we assume homogeneity of expectations and a frictionless capital market (infinitely devisable assets and zero transactions cost). In equilibrium, the market price of risk - the ratio of the expected risk premium on risky assets to the variance of return on those assets - equals the market value of all risky assets multiplied by a function of each individual's measure of absolute risk aversion, R_A (local risk aversion or risk aversion in the small, Pratt (1964)).

If U(W) represents the individual's utility function, with respect to wealth, we can assume that more wealth is preferred to less, thus the marginal utility of wealth is positive, $dU/dW = U'(W) > O$ and assuming individuals are risk averse, then $U''(W) < O$ (producing a concave utility function). Absolute risk aversion is defined as, $-U''(W)/U'(W)$ and relative risk aversion, R, (local proportional risk aversion, Pratt (1964)) as $- W \cdot U''(W)/U'(W)$. R represents the wealth elasticity of the marginal utility of wealth (slope of the investors' utility function), that is, it is a measure of aversion to risk as a proportion of assets (see Green, 1978, pp. 268).

The traditional Arrow-Pratt analysis suggests that as wealth rises, investor's R_A falls or remains constant, while R rises (Friend and Blume, 1975, pp. 901; Bhattacharyya, 1979, pp. 423; Kihlstrom and Laffont, 1983, pp. 160-161; Molana, 1990, pp. 4). Recently, however, there has been a growing body of work which either empirically challenges (Friend and Blume, 1975) the traditional assumption for R finding that it is constant and those who assume it is constant in their analysis (Grossman and Shiller, 1981, pp. 224; HH, pp. 802; Nickell and Wadhwani, 1989, pp. 13). Friend and Blume (1975, pp. 915) conclude that, "Perhaps the most accurate single statement is: if there is any tendency for increasing or decreasing proportional risk aversion, the tendency is so slight that for many purposes the assumption of constant proportional risk aversion is not a bad first approximation". This assumption of a constant R, the elasticity of substitution between assets is constant regardless of wealth, is equivalent to equation 6.2 in Molana (1990; pp. 2) where gamma is constant. This assumption is utilised in the present study.

Following the methodology of Friend and Blume (1975, pp. 902) and aggregating individual investors, we can write the equilibrium market price of risk as,

$$E^*(r_m - i) / \sigma^2_m = J_s\left[\Sigma E^*(1 / R_A)\right]^{-1}, \tag{2.20}$$

where E^* denotes mathematical expectation and the subscript m represents the market portfolio, J_s is the market value of all appropriate risky assets ($J_s = \Sigma J = Lb + E + H^{pd}$) and σ^2_m is the variance on the return of the portfolio. The wealth conservation equation is,

$$W_{t+dt} = W_t\Big[1 + [i + (J_s/W)E^*(r_m - i)]dt +$$

$$(J_s/W)\sigma_m y(t)\sqrt{dt}\Big], \tag{2.21}$$

where σ_m is the standard deviation of the returns of the portfolio of risky assets and y(t) is a standardised normal random variate. Equation (2.21) simply states that future wealth is a function of current wealth plus or minus the expected risk adjusted return (the $\pm$ term is dropped because of y(t)).

The proportion of the risk-free asset can be written as the residual $1 - (J_s + H^{ml} / W)$. This is incorporated, for example, as part of the financial sector of the London Business School model (LBS) in Keating (1985, pp. 90-91). The LBS model also assumes that all non-risky assets are perfect substitutes and therefore must have the same yield. Given the small part short dated bonds play in the total portfolio (around 6 %) we shall assume this forms part of W in the interests of model simplicity (HH also make this assumption regarding total bond debt).

By expanding $U(W_{t+dt})$ about W_t, in Equation (2.21), taking expected values and dropping terms involving dt to the power of two or more (these fractions become infinitely small) we find,

$$E^*\left[U(W_{t+dt})\right] = U(W_t) +$$

$$U'(W_t)W_t\left[i + (J_s/W)E^*(r_m - i)\right]dt$$

$$+ 0.5\ U''(W_t)W^2_t(J_s/W)^2\sigma^2_m dt. \qquad (2.22)$$

By differentiation, we can optimise the proportion of risky assets in the portfolio by setting $dE^*(U) / dW$ equal to zero,

$$U'(W_t)E^*(r_m - i) + U''(W_t)W_t(J_s/W)\sigma^2_m = 0. \qquad (2.23)$$

Recalling Pratt's definition of R, and implicitly including expectations and taxation, we can rewrite equation (2.22) in terms of the proportion of wealth invested in risky assets as (see Mathematics Appendix, Section D),

$$J_s/W = (r_m - i) / R\sigma^2_m. \qquad (2.24)$$

We assume that the return from bonds (and therefore the risk-free asset) are untaxed. This arises because of the widespread use of a legal loophole which enabled "bond washing". Simply, individuals who held bonds but were subject to income tax on interest could sell bonds to tax exempt institutions (such as pension funds) a number of days prior to the coupon being paid and purchase them again after a specified time period. A similar assumption is used by Thompson (1990, pp. 62) when calculating bond returns.

Equation (2.23) can be transformed to relate to an individual asset in the portfolio by substituting J for J_s and j for m (see HH, pp. 798). We define the after tax expected risk premium from the jth asset as p, where,

$$p_j = R\sigma^2_j(J/W), \qquad (2.25)$$

and,

$$r_{ja} = i + p_j. \qquad (2.26)$$

2.4.5. Market Clearing Equations.

The following equations (2.27) to (2.31) represent the demand for each asset in the individuals portfolio, and stem from the demand for manufacturing and owner occupied housing stock. The debt to equity split is determined by b, and the debt component is split by duration depending on the appropriate ratio of short dated to long dated debt, z. The loan to valuation ratio, v, which shows the split between paid up and mortgaged housing stock, is determined endogenously in the model. The equations are as follows,

$$Sb = zbqK, \tag{2.27}$$

$$Lb = (1\text{-}z)bqK, \tag{2.28}$$

$$E = (1\text{-}b)qK, \tag{2.29}$$

and

$$H^{mb} = vpH, \tag{2.30}$$

We impose the conditions $0 \leq z,b,v \leq 1$. By definition, we can write that part of housing equity that is fully paid for as,

$$H^{pd} = (1\text{-}v)pH. \tag{2.31}$$

The model has already defined H^{mb} (equation (2.17)) and equation (2.30) can be rearranged such that the model determines v,

$$v = H^{mb}/pH. \tag{2.32}$$

2.4.6. Real User Costs of Capital.

We have discussed the concept of the user cost of capital in Section 1.2.5.1. and shown that this plays a crucial role in the asset allocation models outlined in Section 1.3. When incorporating the user costs into our model they have been specified comprehensively in order to reflect the parameters impinging on the allocation decision. This detail should pervade throughout the model.

We shall define real user costs for the housing and manufacturing sectors which includes modelling the relevant tax treatment of the sectors. Complementary to this, the cost of capital for both sectors is included along with expected capital gains and risk premiums.

2.4.6.1. Real User Cost of Manufacturing Capital.

We have demonstrated the relevance of the user cost of capital to the capital stock (eg. equation 2.14) and are now in a position to specify it. Abstracting from labour input in the production function and following the methodology of Jorgenson (1963) the capital stock at time t is,

$$K_t = \int_{-\infty}^{t} e^{-\delta_k (t-s)} I_s ds. \tag{2.33}$$

Capital services decay exponentially at a rate δ_k, that is, a unit of capital aged t is equivalent to $e^{-\delta_{kt}}$. I_s is investment at time s with, $s \leq t$. Differentiating (2.33) with respect to t obtains the result equivalent to equation (1.4).

In equation (2.5) we stated the firms objective function in terms of cash flow. Under the competitive conditions assumed in the present model, this is equivalent to assuming that the firms maximise the total value of wealth, W, (Hall and Jorgenson, 1967, pp. 392; Gravelle and Rees, 1981, pp. 412-414) which we can write as,

$$W = \int_{0}^{\infty} e^{-r_{kt}} [P_{Wt} f(K_t) - P_{It} I_t] dt. \tag{2.34}$$

This implies that the firm should invest in units of capital up to the point where the NPV of the marginal additional unit is zero. Substituting for K_t in equation (2.34) with equation (2.33) and differentiating with respect to I_t, we obtain this result,

$$P_I = \int_{t}^{\infty} e^{-r_{k(s-t)}} P_{Ws} f'_{ks} e^{-\delta_{k(s-t)}} ds. \tag{2.35}$$

The familiar user cost of capital expression can be obtained by substituting for I_t in equation (2.34), then using equation (1.4) and solving with respect to K_t. Optimisation allows the Euler condition to hold (see Chiang, 1984, pp. 413) and we obtain an expansion of equation (2.11),

$$f'_{kt} = UC_{kat} = (P_{It}/P_{Wt})(r_t + \delta_{kt} - \pi_t). \tag{2.36}$$

This methodology can also be found in Auerbach (1983, pp. 913) or Kelly and

Owen (1985, pp. 4).

2.4.6.1.1. Economic Depreciation.

We have discussed the nature of depreciation in Chapter 1, Section 1.2.2. Incorporation into the user cost is usually concurrent with the assumption that depreciation occurs at a constant exponential rate (this is confirmed in Jorgenson (1973, pp. 1128-1129)). This assumption is generally made because it simplifies the user cost considerably. Feldstein and Foot (1971, pp. 57) express reservations regarding this assumption whilst conceding that constant proportionality has some justification in the long run. This sentiment is also echoed by Hendry (1984, pp. 223). Empirical studies, however, may introduce an incompatibility if they utilise capital stock data which is constructed by assuming finite lives and non-geometric depreciation. In the U.K. this latter technique is used by the CSO to construct estimates of the gross capital stock of manufacturing (Griffin, 1976, pp. 130-131, and pp. 137-140) in the form of a perpetual inventory method with finite lives.

The implications of this inconsistency are investigated in Downs (1986) who concludes that significant margins of error may arise which results in the violation of the equilibrium assumption of marginal zero NPV. Comparing a theoretically and empirically consistent user cost series with one suffering from this inconsistency, he found them to be different by a margin of 6.5 % (Downs, 1986, pp. 300) which would have resulted in the corporate investing in projects with negative NPV's. Of greater pertinence to the present research the margins of error multiplied when the user costs were used in comparative studies. The author concludes that, "A researcher estimating elasticities of substitution or analysing the distortional impact of government tax policy on resource allocation may have significantly different results if he or she were to switch from a Hall-Jorgenson type user cost to a user cost consistent with the capital stock", (Page 301-302). Researchers can overcome this problem by modifying the theoretical exposition of the user cost in order to account for fixed asset lives (by using the formula provided in Downs (1986, pp. 299, equation 5) or utilise depreciation data which is consistent with finite life capital stock. Naturally, either of these routes should produce identical results. This research employs the latter option (see Chapter 3, Section 3.2.5.9.) to maintain model consistency.

2.4.6.1.2. Corporation Tax, Investment Allowances and Grants.

Although there was a change of taxation systems during our period of interest (See Chapter 1, Section 1.5.3.), in its basic form corporation tax has featured in both systems. This is also the case for investment allowances and grants, although the present study incorporates these in a different manner to the work of HH (see Section 2.3.1.4.).

We follow the conventional route of deducting the present value of depreciation allowances and grants from the purchase price of the asset. This methodology is also a feature of Auerbach (1983) and Kelly and Owen (1985).

The post grant cost of a unit of capital is, $P_{It}(1\text{-}g)I_t$, where g is the rate at which grants are applied. We denote the depreciation allowances given on a unit of capital, M1, and equation (2.34) becomes (See Auerbach, 1983, pp. 915),

$$W = \int_0^\infty e^{-r_{kt}}\Big[(1-\tau)P_{Wt}f(K_t) - P_{It}(1-g)I_t$$

$$+ \tau \int_{-\infty}^{t} P_{Is}I_sM1^{t-s}ds\Big]dt. \qquad (2.37)$$

We can see that τ is applied to cash flow followed by the effect of grants and finally depreciation allowances.

Simplifying (2.37),

$$W = \int_0^\infty e^{-r_{kt}}\big[(1 - \tau)P_{Wt}f(K_t) - P_{It}(1 - g - \tau M)I_t\big]dt +$$

$$\tau \int_0^\infty e^{-r_{kt}}M1^{-s}ds, \qquad (2.38)$$

where $M = \int_0^\infty e^{-r_{kt}}M1^{t}dt.$

Setting (g - τM) = A we can multiply equation (2.36) by (1-A)/(1-τ) to incorporate investment allowances and corporation tax.

2.4.6.1.3. Own Product User Cost.

We have already commented on the expectational nature of investment in Chapter 1, Section 1.2.2. The explicit incorporation of real prices, P_I and P_W and expected capital gains for manufacturing, π^{ek}, means that the user costs relate directly to the specific sector whilst adding flexibility to the model. Own product user costs are crucial to the incorporation of relative price changes in such models. The construction of an own product user cost series is clearly outlined in Kelly and Owen (1985, pp. 3-7 and 16-18). It is also stressed as a key user cost component by Dougherty and Van Order (1982) and Kollintzas and Rowley (1985). The former authors clarify the rationale for expected capital gains, "It is expected future inflation that matters, as that is what enters the hypothetical landlord's maximisation calculations. Actual inflation is not directly relevant", (Page 157).

2.4.6.1.4. Local Authority Rates.

The inclusion of domestic rates in the user cost of housing capital is common (eg. King and Atkinson, 1980; Spencer, 1987b; Hughes, 1988a,b; Shear *et al.* 1988). This contrasts with the exclusion of rates in manufacturing user costs (eg. Kelly and Owen's (1985) comprehensive study). The manufacturing sector does pay rates which are levied against structures and certain fixed plant and machinery. Explanations for this omission may lie in the difficulty of parameterisation or the likelihood of rates being of little importance to the overall user cost. King and Fullerton (1984, pp. 51-52), Bennett and Fearnehough (1987) and Bennett (1987) do discuss non-domestic rates as part of a user cost framework. HH include rates for both sectors. For model consistency and theoretical rigour, we include rates in both our user costs.

Manufacturing rates (Φ_k) enter the user cost with the prepositive 1^* which is defined as (1-τ)/(1-A) because rates can be offset against MCT (Bennett, 1987, pp. 68-69) and rateable values are not a function of the post tax allowances and grants price of capital goods, but are set by applying a rental equivalent. Rates become further detached from the post allowance price when the rate poundage applied to the rental equivalent is set by each local authority. This latter complication was eliminated when the rate poundage was centralised with the introduction of the "uniform business tax" (Bennett and Fearnehough, 1987).

We are now in a position to write a general user cost for manufacturing capital. Letting $n = P_I/P_w$, dropping the time subscript and allowing for corporation tax, taxation allowances and non-domestic rates, equation (2.36) becomes,

$$UC_k = (1-A)/(1-\tau)n(r_k + \delta_k - \pi^{ek} + 1^*\Phi_k). \qquad (2.39)$$

The term 1^* naturally drops out of the equation when multiplying through by (1-A)/(1-τ).

2.4.6.1.5. Cost of Finance.

In Section 2.4.5., we described the corporate's ability to fund through capital markets in terms of short and long term debt and equity. We also defined the corporate's post tax cost of capital from the jth asset in equation (2.26). Combining these allows us, by aggregation, to define r_k and r_{ka} (which split into profit plus capital gains) as the corporate's overall pre and post tax cost of capital where the required rate of return from each funding source is weighted according to the market clearing equations.

This also requires the incorporation of the effect which capital market valuation may have on the user cost to the individual. Whilst the term n provides a corporate user cost which is real with respect to the price of capital good inputs, the existence of capital markets which effectively lie between the physical cost of manufacturing capital and the individual requires to be modelled. Multiplying the user cost by q (defined in Section 2.4.3.) introduces this concept into the model. For the purposes of the user cost, we are interested in the post tax required returns from each asset which are best described within the context of the appropriate tax system.

2.4.6.2. Classical System.

We assume that the return to the personal sector from corporate bonds do not suffer income or capital gains tax, thus $r_B=r_{Ba}$. The concept of bond washing which allowed the investor to avoid paying income tax on interest is described in Section 2.4.4. Capital gains could also be easily offset by purchasing bonds which were priced greater than par and would automatically generate capital losses.

Using equations (2.25) and (2.26), we can write,

$$r_{Lb} = i + R\sigma^2{}_{Lb}qLb/W. \qquad (2.40)$$

We have already defined $r_{Sb} = i$ in Section 2.4.4. and therefore, we can write (Section 2.4.3.),

$$r_B = i + (1-z)R\sigma^2{}_{Lb}qLb/W. \qquad (2.41)$$

The nominal equity rate paid by corporates, r_{Ec} (the subscript c denotes classical system) differs from the after tax equity rate received by shareholders, r_{Eac} by taxes at the personal level on dividend income and increases in share values as a result of inflation and retained earnings (capital gains). The relationship between r_{Ec} and r_{Eac} is given by,

$$r_{Eac} = \phi(1-\Theta)(r_{Ec}-\pi^{ek}) +$$

$$(1-\mu_p)\left[(1-\phi)(r_{Ec}-\pi^{ek}) + \pi^{ek}\right], \qquad (2.42)$$

where ϕ denotes the dividend payout ratio, Θ is the personal income tax rate and μ_p is the rate at which capital gains are taxed to the personal sector. Effectively, equation (2.42) splits the return into dividends, retained earnings and capital gains. Simplifying (2.42) and letting $x = \phi\Theta + (1-\phi)\mu_p$ then (See Mathematics Appendix, Section E),

$$r_{Eac} = (1-x)r_{Ec} + \phi(\Theta-\mu_p)\pi^{ek}. \qquad (2.42')$$

Using the same methodology which derived equation (2.40) and simplifying in terms of r_{Ec} (See Mathematics Appendix, Section F) we can write,

$$r_{Ec} = \left[i - \phi(\Theta-\mu_p)\pi^{ek} + R\sigma^2{}_{E}qE/W\right] / (1-x). \qquad (2.43)$$

Substituting r_B (there is no need for a c subscript as the tax treatment was uniform over the two systems) and r_{Ec} into r_k in equation (2.39) whilst incorporating q, allowing for the tax deductability of corporate debt interest and including corporate capital gains tax (μ_k) we obtain from equation (2.39),

$$UC_{kac} = qn\left[(1-A)br_B + \frac{(1-A)(1-b)r_{Ec}}{(1-\tau)}\right.$$

$$\left. + \frac{(1-A)\delta_k}{(1-\tau)} - \frac{(1-A)(1-\mu_k)\pi^{ek}}{(1-\tau)} + \Phi_k\right]. \qquad (2.44)$$

Theoretically capital gains (chargeable gains) are taxed as part of the corporation tax bill (Saunders, 1982, pp. 24). We now introduce μ_{ke} in order to maintain flexibility within the model because the effective CGT rate may deviate from τ. Substituting for r_B and r_{Ec} in equation (2.44.) and collecting in terms of i, p_j, π^{ek} and others, we can write the fully tax adjusted real user cost of manufacturing capital, under the classical system as,

$$UC_{kac} = qn\left[\alpha_{c1}i + \alpha_{c2}qK/W - \alpha_{c3}\pi^{ek} + \alpha_{c4}\right], \tag{2.45}$$

where,

$$\alpha_{c1} = (1-A)b + \left[(1-A)(1-b)/(1-x)(1-\tau)\right],$$

$$\alpha_{c2} = (1-A)(1-z)bR\sigma^2_{Lb} + \left[(1-A)(1-b)R\sigma^2_E \ / \ (1-x)(1-\tau)\right],$$

$$\alpha_{c3} = \left[(1-A)(1-\mu_{ke}) + \phi(1-A)(1-b)(\Theta-\mu_p) \ / \ (1-x)\right] \ / \ (1-\tau),$$

$$\alpha_{c4} = (1-A)/(1-\tau)\delta_k + \Phi_k.$$

2.4.6.3. Imputation System.

We shall maintain the methodology of the above Section and all assumptions, unless otherwise stated, in order to write a user cost under the imputation system. The imputation system is discussed in Section 1.3.9.2. The main change from the above Section is the scaling down of capital gains tax to the corporate in order to make the official rate 30 %, equivalent to that paid by individuals. The double taxation of income is also avoided.

Individuals receive a tax credit along with any distribution thus avoiding the double taxation of income. Equation (2.42) can be rewritten as,

$$r_{Eai} = \phi(r_{Ei}-\pi^{ek}) + (1-\mu_p)\left[(1-\phi)(r_{Ei}-\pi^{ek}) + \pi^{ek}\right], \tag{2.46}$$

where the i subscript denotes imputation system. Simplifying (2.46) and letting y =

$\mu_p(1-\phi)$, we obtain,

$$r_{Eai} = (1-y)r_{Ei} - \mu_p\phi\pi^{ek}. \qquad (2.46')$$

Note that the term $-\mu_p\phi\pi^{ek}$ is not saying that any capital gain is detracting from r_{Ei} because capital gains are a part of r_E. Following the same methodology used to obtain equation (2.43) we can write,

$$r_{Ei} = \left[i + \mu_p\phi\pi^{ek} + R\sigma^2{}_E qE/W\right] / (1-y). \qquad (2.47)$$

Substituting r_{Ei} and μ_{ke} into Equation (2.44), we obtain the fully tax adjusted real user cost of manufacturing capital under the imputation system as,

$$UC_{kai} = qn\left[\alpha_{i1}i + \alpha_{i2}qK/W - \alpha_{i3}\pi^{ek} + \alpha_{i4}\right], \qquad (2.48)$$

where,

$$\alpha_{i1} = (1-A)b + \left[(1-A)(1-b) / (1-y)(1-\tau)\right],$$

$$\alpha_{i2} = (1-A)(1-z)bR\sigma^2{}_{Lb}$$

$$+ \left[(1-A)(1-b)R\sigma^2{}_E / (1-y)(1-\tau)\right]$$

$$\alpha_{i3} = \left[(1-A)(1-\mu_{ke}) - \phi(1-A)(1-b)\mu_p / (1-y)\right]$$

$$/(1-\tau),$$

$$\alpha_{i4} = (1-A)/(1-\tau)\delta_k + \Phi_k.$$

We have now developed user costs of capital for manufacturing for the classical and imputation systems and we can now progress to develop user costs for the housing sector.

2.4.6.4. Real User Cost of Housing Capital.

In terms of the user cost of capital for investment allocation purposes, we can treat housing in a similar manner to manufacturing. The returns to housing do not occur in actual cash terms, but take the form of imputed rent and capital gains net of depreciation. Following from the assumptions made in Section 2.4.6., then from equation (2.39), we can write the user cost of housing capital as,

$$UC_h = p(r_h + \delta_h - \pi^{eh} + \Phi_h), \qquad (2.49)$$

where the subscript h denotes housing and Φ_h is domestic rates. Given that there is no secondary market between the personal sector and housing capital any real house price changes will be incorporated into the term p.

The term r_h consists of a financing cost in the form of the mortgage rate and an opportunity cost to that proportion of the capital stock which is owned outright. We must split r_h into its component parts because mortgages attract mortgage interest relief. The rate at which the opportunity cost is applied varies widely between studies. Fry and Pashardes (1986, pp. 62) assume this to be the return on housing equity (which we assume) while Hughes (1988b, pp. 54-55) uses the yield from index-linked gilts and Buckley and Ermisch (1982, pp. 279) assume that the opportunity cost is equal to the nominal borrowing rate. Miles (1992, pp. 74) argues that the relevant risk premium should be equal to that of the stock market which contrasts to the more conventional low risk comparison.

We can write the required rate of return from the housing stock as,

$$r_h = v r_{H^{mb}} + (1-v) r_{H^{pd}}. \qquad (2.50)$$

There are no tax implications for $r_{H^{pd}}$, but the difference between the mortgage rate and the mortgage rate actually paid by the personal sector lies in the MIRAS subsidy, thus,

$$r_{H^{mba}} = r_{H^{mb}} \,/\, (1-\Theta ç), \qquad (2.51)$$

where ç scales down the relief because of the imposition of ceiling above which the full interest cost is borne.

While this method of including the ceiling is the most appropriate for the present model, other authors have varied the method of incorporation. In a more simplistic form, the mortgage rate (i+mp), where mp is a mark up, would be reduced by the common marginal personal income tax rate, giving, (i+mp)(1-Θ). This is assumed by Feldstein (1982) and Dougherty and Van Order (1982). Ermisch (1988) also utilised this specification, but switches Θ = 0 for any mortgage debt greater than the imposed ceiling. Hendershott and Shilling (1982), Fry and Pashardes (1986) and

Shear *et al.* (1988) also deploy this technique. Spencer (1987b) uses a net interest cost, which he calculates by dividing the total value of the net of tax relief interest payments and divides this by the outstanding mortgage stock. This empirical methodology is similar to that used in the present study and can also be found in Breedon and Joyce (1992, pp. 179).

Owing to the nature of the mortgage market, like Sb, we do not apply the mean-variance analysis to mortgages. While there is a risk of bankruptcy or default such that the mortgage rate should be at a premium to the risk-free rate, the premium is not derived by conventional portfolio theory. The mortgage rate may be more determined by precautionary motives, lenders' expense ratios and the building society cartel when it existed. Even under the deregulated market, this relatively constant premium has been maintained and has not been visibly affected by portfolio risk. It may well be the case that in years to come, one of the longer term consequences of a liberalized mortgage market is that the risk premium complies to that specified in equation (2.25) (this is discussed in Section 6.3.). For the present study, it is optimal to write the required return from mortgage stock as,

$$r_{H^{mb}} = (i+mp)(1-\Theta ç) \qquad (2.52)$$

and,

$$r_{H^{pd}} = i + R\sigma^2_{H^{pd}} pH^{pd}/W. \qquad (2.52')$$

Incorporating these equations into equation (2.50) and simplifying, we obtain,

$$r_{ha} = (1-v\Theta ç)i + vmp(1-\Theta ç) + (1-v)R\sigma^2_{H^{Pd}} H^{Pd} / W. \qquad (2.53)$$

Collecting in terms of i plus mp, and pH/W and others, we obtain the fully tax adjusted real user cost of housing capital as,

$$UC_{ha} = p\left[ß_1 i + ß_2 mp + ß_3 pH/W + ß_4\right], \qquad (2.54)$$

where,

$$ß_1 = (1-vç\Theta),$$

$$ß_2 = v(1-\Theta ç),$$

$$ß_3 = (1-v)R\sigma^2_{H^{Pd}},$$

$$\beta_4 = \delta_h - \pi^{eh} + \Phi_h.$$

Finally, we can specify the user cost of housing capital financed purely by mortgages, which is used in equation (2.16') as,

$$UC_m = p\left[(i+mp)(1-\Theta ç) + \delta_h - \pi^{eh} + \Phi_h\right]. \qquad (2.16'')$$

2.4.7. Real Cash Flows.

The following Section of the model represents various tax and subsidy real cash flows as well as corporate retained earnings and personal sector disposable income. These functions follow directly from the model specification above and represent an integral part of the overall working model. As such, it is vital that the specification of the equations is fully consistent with the tax structures modelled above. Real cash flows of interest are MIRAS, corporate and household net tax payments, corporate retained earnings and individuals disposable income.

2.4.7.1. MIRAS.

The MIRAS subsidy is discussed in Section 1.3.8. and 1.3.8.2.1. and is clearly regarded as an important factor in reducing the user cost and as a form of government expenditure. For these reasons, MIRAS is endogenous to the model. MIRAS is a function of the mortgage rate, the personal tax rate, the outstanding mortgage stock and a scaling factor which allows for the MIRAS ceiling,

$$MIRAS = r_{H^{mb}} \Theta ç H^{mb}. \qquad (2.55)$$

2.4.7.2. Manufacturing Sectors Real Tax Flows.

2.4.7.2.1. Classical System.

From the assumptions above, we can write the tax paid by manufacturing industry during the classical system, TX_{kc}, as,

$$TX_{kc} = \tau\left[\alpha_k Y - (\delta_k + br_B - (1-\tau)\Phi_k + \Omega A)K\right]$$

$$+ \mu_{ke}\pi^{ek}K, \qquad (2.56)$$

where Ω is the proportion of new investment which received the investment grants and allowances. That is, allowances are not continually provided on the entire manufacturing capital stock. Under the classical system, all profits are taxed at the corporation tax rate less depreciation, debt interest payments and allowances plus capital gains tax and rates. Again, we have allowed for the possibility that capital gains may not be taxed at a rate equal to τ (specifically $\mu_{ke} = 0.5\tau$). Where we do not specify a subscript c or i, after an equation (eg. TX_k or TX_h) then these can be implicitly assumed depending on the time period specified.

2.4.7.2.2. Imputation System.

From the corporate perspective, taxation paid differed from the classical system because τ was scaled down by a factor such that the effective rate of tax on capital gains became 30 % and implicitly because corporation tax is split into ACT and MCT. Our model recognises this by the reduction of μ_{ke} such that $\mu_{ke} = \mu_p$. We can therefore write tax paid under the imputation system, TX_{ki}, as,

$$TX_{ki} = \tau\Big[\alpha_k Y - (\delta_k + br_B - (1\text{-}\tau)\Phi_k + \Omega A)K\Big] + \mu_p \pi^{ek} K. \tag{2.57}$$

We briefly commented on the problem of tax exhaustion in Section 1.4.10.8.1., further explanation is provided in Devereux (1987) and James and Nobes (1988, pp. 289-290). Normally, a corporate paying a dividend will be able to offset the corresponding ACT against its MCT. This may not be the case if the dividend paid is large in proportion to profits, or, if profits themselves are negative. In this instance, unrelieved or "surplus" ACT is created. Such problems do not arise in this steady state growth model as we fix ϕ and α_k such that $0 \leq \phi, \alpha_k \leq 1$, thus profits rise consistently through time.

2.4.7.3. Personal Sector Real Tax Flows.

2.4.7.3.1. Classical System.

We have assumed that all personal sector income is taxed at a rate Θ. Returns to households from the corporate sector (dividends) are distributed after economic depreciation, corporate tax and retained earnings. The former subtraction takes account of the long-run steady state nature of the model by changing the gross capital stock into a net one. Households are also subject to CGT, rates and the MIRAS subsidy. We ignore personal allowances and therefore specify tax paid by the personal sector under the classical system, TX_{hc}, as,

$$TX_{hc} = \Theta(Y - \delta_k K - TX_k - RE) - MIRAS$$

$$+\mu_p(RE + \pi^{ek}qE) + \Phi_h pH, \qquad (2.58)$$

where RE represent corporate retained earnings.

2.4.7.3.2. Imputation System.

Specification of the personal sector tax flow under the imputation system, TX_{hi}, differs only from equation (2.58) by the incorporation of the tax credit associated with corporate dividend distribution. This is achieved by specifying the dividend, Dnd, and allowing it to be multiplied by the personal income tax rate,

$$TX_{hi} = \Theta(Y - \delta_k K - TX_k - RE - Dnd)$$

$$- MIRAS + \mu_p(RE + \pi^{ek}qE) + \Phi_h pH. \qquad (2.59)$$

This eliminates the double taxation of income.

We define Dnd as,

$$Dnd = \phi\left[\alpha_k Y - TX_k - (\delta_k + br_B - b\pi^{ek})qK\right], \qquad (2.60)$$

where $b\pi^{ek}qK$ represents the addition to real earnings from the erosion of the real value of corporate debt. Dnd simplifies to $\phi\left[EAT + b\pi^{ek}qK\right]$ where EAT represents real corporate earnings after tax, $(\alpha_k Y - (\delta_k + br_B)K - TX_k)$.

Having specified corporate and personal sector tax flows, it is possible to combine these in order to obtain a government balance, GB,

$$GB = TX_k + TX_h. \qquad (2.61)$$

This equation is of limited use as the government's role in the model is the setting of tax systems not controlling money supply, issuing bonds or injecting expenditure. Comparing values of GB will allow us to assess the net effect on the real government balance of any taxation changes.

2.4.7.4. Retained Earnings.

Corporate retained earnings consist of earnings after tax (EAT) plus the erosion of the real value of corporate debt less dividends paid. Thus, retained earnings can be written as,

$$RE = (1-\phi)\Big[\alpha_k Y - TX_k - (\delta_k + br_B$$

$$- b\pi^{ek})qK\Big]. \qquad (2.62)$$

2.4.7.5. Personal Disposable Income.

Real personal disposable income, D, is the sum of all factor payments received less all taxes paid, plus all subsidies, thus:

$$D = Y - \delta_k K - TX_k - RE - TX_h. \qquad (2.63)$$

2.5. Conclusion.

This Chapter has outlined the main assumptions of the U.K. model and indicated the key theoretical divergences from HH model. The result of these assumptions and changes have been discussed. The basic U.K. model was then presented in full which represents a closer representation of the U.K. economy than any other model of its kind and offers greater detail in many areas than HHs' model, for example our treatment of MIRAS. Key areas were discussed from their theoretical groundings up to the working equations. Although some components may have been ignored, the level of detail provides several key benefits, such as an emphasis on model consistency, a clearer understanding of model interaction and the exposure of further subtle assumptions.

Asset allocation between the respective sectors, the user costs of capital, the loan to valuation ratio and real cash flows are key outputs of the model. The basic model can easily be adapted to allow for endogenizing the risk-free interest rate if desired and switching to an unrationed mortgage market. Before presenting the results from the model it is necessary to parameterise it by either generating the required data or appealing to empirical evidence from relevant economic literature. This is presented in Chapter 3 along with detail regarding the model solving technique. Following this we may discuss the model output which is presented in Chapter 4.

Mathematical Appendix.

Section A.

Rearranging and solving equations (2.16) and (2.32), we can see that,

$$v = \Gamma\left[(1-\alpha_k)Y\right]/pH.$$

Section B.

Using equation (2.1), capitals relative share is defined as,

$$\frac{K(dY/dK)}{Y} = \frac{KÇ_k\alpha_k(K/L)^{\alpha_{k-1}}}{LÇ_k(K/L)^{\alpha_k}}$$

$$= \alpha_k.$$

and labour's relative share is,

$$\frac{L(dY/dL)}{Y} = \frac{LÇ_k(1-\alpha_k)(K/L)^{\alpha_k}}{LÇ_k(K/L)^{\alpha_k}}$$

$$= 1-\alpha_k.$$

Section C.

From equation (2.2), differentiation gives,

$$f'_k = Ç_{kl}\alpha_k K^{\alpha_{k-1}},$$

expanding, we obtain,

$$f'_k = Ç_{kl}\alpha_k K^{\alpha_k} K^{-1},$$

and simplifying,

$$\frac{\alpha_k \varsigma_{kl} K^{\alpha_k}}{K},$$

which using equation (2.2) simplifies to the standard result,

$$f'_k = \alpha_k Y/K.$$

Section D.

From equation (2.23), we can take $E^*(r_j\text{-}i)$ to the right hand side while multiplying both sides by -1,

$$\frac{-U''(W_t)W_t(J_s/W)\sigma^2{}_j}{U'(W_t)} = E^*(r_m\text{-}i).$$

From Pratt (1964), we have defined R as $-W_tU''(W_t)/U'(W_t)$, therefore,

$$R(J_s/W)\sigma^2{}_m = E^*(r_m\text{-}i).$$

Dividing both sides by R and $\sigma^2{}_m$ and implicitly including expectations, we derive equation (2.24).

Section E.

Simplifying equation (2.42) by expansion, we obtain,

$$r_{Eac} = r_{Ec}\left[1\text{-}\phi\Theta\text{-}\mu_p(1+\phi)\right]+\pi^{ek}\phi(\Theta\text{-}\mu_p),$$

setting $x = \phi\Theta\text{-}\mu_p(1+\phi)$.

Section F.

Setting equation (2.42') equal to the equilibrium condition implied by equations (2.25) and (2.26), then,

$$(1\text{-}x)r_{Ec}+\phi(\Theta\text{-}\mu_p)\pi^{ek} = i+R\sigma^2{}_E qE/W.$$

Taking $\phi(\Theta-\mu_p)\pi^{ek}$ to the other side and multiplying both sides by 1/(1-x), we obtain equation (2.43).

3. IMPLEMENTATION.

3.1. Introduction.

The purpose of the following Chapter is to present and discuss the data utilised in the model derived in Chapter 2 and to describe details of the model solution technique.

3.2. Data.

The basic model requires initial values for Y, K and H, along with 24 further parameters. Given the different tax systems which were effective over our period of interest, we have specified the model such that it could run with any of the following options:

Period 1 covering the classical system,

Period 2 covering the imputation system and,

Period 3 covering both systems.

Each parameter specified in the model therefore contains a maximum of three possible inputs which depend on the time period specified. This detailed treatment of the data is complementary to the thrust of Chapter 2 and allows the model to elucidate differences between the two systems. Many parameters are averages over the specified period. Simulations for period 3 run the classical model for the appropriate number of periods and then switches the relevant equations to run the imputation system automatically. Although the imputation system becomes effective in the fiscal year, 1973/4, we assume that it occurred at the beginning of the calendar year, 1973. Period 3 data, in many instances, is therefore a weighted average of Period 1 and Period 2 data.

3.2.1. Output and Capital Stock.

Initial values for Y, K and H are provided as a means of fixing a term of reference and to provide initial asset holdings and cash flows. For this reason, it is advantageous to set Y = K = H.

Averaging also eliminates the problem of the model displaying sensitivity to the starting values. For example, we may obtain a different distribution of Y, K and H by choosing 1966 just because of relative effects of the business cycle. The starting value in 1965 for Period 1 and Period 3 is the same and therefore, we require two separate figures, an initial value for the classical system and one for the imputation system. The following sections contain the actual values while we present the average figures in Section 3.2.1.3.

3.2.1.1. Manufacturing Output.

GDP for the manufacturing sector was obtained from United Kingdom National Accounts Table 3.2., various issues. This provided figures of £11,040m for 1965 and £20,920 for 1973.

3.2.1.2. Manufacturing Capital Stock.

The gross stock of manufacturing capital was obtained from unpublished data provided by the CSO. This utilises the perpetual inventory method (see Giffin, 1976; United Kingdom National Accounts: Sources and Methods, 1985, pp. 199-203) and, consequently, assumes finite asset lives. The quality of data produced by the CSO has been generally criticised (eg. Mayes, 1984) and as such alternative estimates have been produced by independent sources (see Section 1.3.). Despite this, the official data was used as other methods also have their estimation problems although it would be a straight forward matter to use an alternative series for K. This would not affect the starting values presented here, but some of the parameters which are proportional to K.

The data provided a figure of £27,120m for 1965 and £64,257m in 1973. Averages used are as reported in Section 3.2.1.3.

3.2.1.3. Owner Occupied Capital Stock.

The stock of owner occupied housing is the product of the Department of the Environment mix-adjusted house price series (see Flemming and Nellis (1985) or Nellis *et al.* (1989) for a discussion of alternative price series) and the number of owner occupied dwellings. The data series was kindly provided by Andrew Scott of the London Business School. Both of these series can be found in various issues of Housing and Construction Statistics: Great Britain, HMSO.

For the year 1965, a figure of £29,089m was obtained and for 1973, this was £107,145m. Averaging the data over Y, K and H, initial capital stocks were,

Period 1 = Period 3 = £22,500m; Period 2 = £64,000m.

In terms of the actual results, the aggregate starting values are not critical, but by setting them close to the actual values, nothing is lost. Clearly, the variation of values is greater in 1973 than in 1965, making the latter values more representative.

3.2.2. Taxation.

3.2.2.1. Personal Rate of Income Tax: Θ.

The average basic marginal rate of personal income tax was obtained from Thompson (1990, pp. 68). We ignore the effects of personal allowances and higher rates as there inclusion would multiply the complexity of the model. In our model we assume that,

Period 1 = 40.62 %; Period 2 = 33.17 %; Period 3 = 37.15 %.

3.2.2.2. Personal Capital Gains Tax: μ_p.

The rate of personal capital gains tax has been 30 % throughout the whole time period (Prest and Barr, 1985, pp. 198-9; James and Nobes, 1988, pp. 178). Net receipts from this tax are provided in the Inland Revenue Statistics. (1988, pp. 10).

King (1977, pp. 65-71, 86) argues that empirical studies employing this figure will overstate the tax actually paid owing to allowances, loss offsets and other forms of avoidance. He suggests multiplying the tax rate by a coefficient of 0.5 in order to derive an "effective" rate. This methodology has been followed by subsequent empirical studies such as Buckley and Ermisch (1982, pp. 281) and Nickell and Wadhwani (1987, pp. 21). Consequently, we assume,

Period 1 = Period 2 = Period 3 = 15 %.

3.2.2.3. Domestic Rates: Φ_h.

Domestic rates as a proportion of H was calculated by dividing a total rates series by the capital stock described in Section 3.2.1.3. Unfortunately, a published rates series for the owner occupied sector is not directly available and therefore, unpublished data provided by the CSO was used. This series was a disaggregated version of rent, rates and water charges which form part of consumer's expenditure (eg. Economic Trends, 1990, pp. 42). The rates series was gross rates less rebates (CSO mnemonic CCGB). This figure was then scaled down by multiplying the percentage of households in the owner occupied sector, thus avoiding the assumption that the total rates bill was borne by the sector. The split of owner occupiers as a form of tenure is provided in various issues of Housing and Construction statistics, HMSO. The result is an approximate Φ_h. This is because we would expect rateable values to be higher, on average, in the owner occupied sector than other tenures and because the proportion of rebates to the sector is also likely to be proportionally lower.

Few user cost studies incorporate rates (eg. Buckley and Ermisch, 1982; Fry and Pashardes, 1986) perhaps as a result of data difficulties or the small overall impact rates may have in the user cost. A property tax is included in HH's study. Spencer (1987b, pp. 8) provides rates as a percentage of the owner occupied housing stock which are generally twice the size of those reported below. This arises because in his study he scales down the value of private residential buildings (Table S2, Financial Statistics, 1987) in order to estimate the value of the owner occupied housing stock and takes the rates, sewerage and water charges from the Family Expenditure Survey. The actual aggregate rate probably lies somewhere between these figures, for the present model we estimate that,

Period 1 = 1.1 %; Period 2 = 0.9 %; Period 3 = 1 %.

3.2.2.4. Rate of Corporation Tax: τ.

The marginal rate of corporation tax was obtained from Inland Revenue Statistics (1988, pp. 120) and various other issues. We ignore the smaller companies rate and overseas tax liability effects. Corporation tax for each period is,

Period 1 = 41.25 %; Period 2 = 52 %; Period 3 = 46.27 %.

3.2.2.5. Manufacturing Effective Capital Gains Tax: μ_{kc}.

Officially, corporates were charged a capital gains tax rate equal to the rate of corporation tax under the classical system. This was scaled down under the imputation system to produce a rate of 30 %, equivalent to the personal sector.

Imposing this in the model would, again, overestimate the influence of the tax. Corporates could employ accountants to minimise this bill at little cost. For example, capital gains could theoretically be postponed indefinitely by utilising "roll-over" relief. That is, when replacing an asset, any gain made on the old one can be deducted against the cost of the new asset. Other benefits such as loss relief are explained in Sinclair and Silke (1982, Chapters 2 and 4) and James and Nobes (1988, pp. 309-313).

Given the above evidence, we will also apply a coefficient of 0.5 to the manufacturing sector throughout both systems. The effective rates of capital gains tax are,

Period 1 = 20.625 %; Period 2 = 15 %.

In period 3 the rate is split at 23.14 % for 8 terms and 15 % in the remaining 7 terms.

3.2.2.6. Manufacturing Rates: Φ_k.

Deriving the rates paid by the corporate sector as a proportion of the manufacturing capital stock suffered the same data limitations as described for Φ_h. King and Fullerton (1984, pp. 52) obtain the yield from non-domestic rates in 1980/81 provided by the Chartered Institute of Public Finance and Accountancy and divided this by the net capital stock in buildings other than dwellings to give an average corporate wealth tax on buildings of 2.46 %. This institute did not have any figures for manufacturing or even a time series of rates yields.

Bennett and Krebs (1988a, pp. 167) provide a series of effective tax rates on buildings between 1960 and 1986 for industry. The series was calculated using the net stock of buildings. A series of rate yields was obtained by multiplying the Bennett and Kreb's series by the stock of buildings (Source: National Income and Expenditure Blue Book, various issues). The resulting rate yields series was divided by K to obtain Φ_k. Our figures for manufacturing rates are smaller than both papers cited above as their series is a proportion of the net stock of buildings, whereas our data is a proportion of the total capital stock. We assume that the industry sector endures a similar rates environment as manufacturing. Manufacturing rates enter the model as,

Period 1 = 0.5 %; Period 2 = 0.63 %; Period 3 = 0.56 %.

3.2.2.7. Present Value of Investment Allowances and Grants to Manufacturing: A.

The present value of depreciation and investment grants is based on the work of King and Fullerton (1984, pp. 42-50). A series for A was kindly provided by Dr C.M. Kelly of Her Majesty's Treasury which was utilised in Kelly and Owen (1985) and relates to manufacturing. Oulton (1981, pp. 190) also provides estimates for A, choosing a central rate of 0.33. Data utilised in the present study are,

Period 1 = 0.39; Period 2 = 0.41; Period 3 = 0.4.

3.2.3. Risk.

Levels of risk are inherently difficult to measure. This is especially so given that investors' attitudes to and experience of risk varies through time. Assuming constant risk parameters is necessary within the framework of the present model although these parameters can be altered. This assumption would be of greater significance in a short-run forecasting model. All variance figures displayed below were calculated using a standard population variance calculation described in Mendenhall (1979, pp. 44).

3.2.3.1. Common Risk Aversion Term: R.

The common risk aversion term relates to the individual and not specific assets. The equivalent parameter was assigned a value of 3 in HH study and was based on econometric work carried out by Friend and Blume (1975) in the U.S. Similar estimates in the U.K have been carried out by Bhattacharyya (1979) who finds estimates of between 2 to 3.3 depending on the estimation technique. Utilising evidence from the U.S. and the U.K., we also set R = 3 although we accept that this figure is subject to a degree of uncertainty. We therefore set R in the basic model,

Period 1 = Period 2 = Period 3 = 3.

3.2.3.2. Post Tax Manufacturing Equity Variance: σ^2_E.

Data used to calculate the post tax variance of manufacturing equity was obtained from Thompson (1990, pp. 66). This equity return series includes net income reinvested. Although this data represents the total equity market rather than the manufacturing subsector, we assume that any divergence in relative volatility is minimal.

The methodology described above was also applied to the U.S. Standard and Poor's Composite index (unpublished data, kindly provided by Mr Bryan Allworthy at Barclays de Zoete Wedd) which produce a figure of 0.03. This compares to 0.04 reported in HH. Figures calculated for the U.K. were,

Period 1 = 0.062; Period 2 = 0.360; Period 3 = 0.20.

These figures are a clear example that risk fluctuates through time. The high figure in period 2 reflects the economic chaos of the first oil shock. Stock market returns were extremely volatile falling by 51 % in 1974 and recovering 145 % in 1975. These figures could have been smoothed, however, given the limited analysis of Period 2, it was felt that actual figures should apply. The more heavily used period 3 is more representative although still high compared to the long run standard deviation produced in Seigel and Kaplan (1989, Table 12) which suggests period 1 as being more representative.

3.2.3.3. Post Tax Manufacturing Long Bond Variance: σ^2_{Lb}.

Data for the post tax long bond variance was derived from Thompson (1990, pp. 64). The actual series was annual returns on gilts with gross income reinvested. This is consistent with our assumption of bond washing. Although corporate bonds provide higher yields than gilts, we assume that the effect of this on the variance of returns is minimal. The Period 3 figure is consistent with the work of Seigal and Kaplan (1989, Table 12) and Brown and Seigel (1990, Table 1). Data used in the model are,

Period 1 = 0.008; Period 2 = 0.041; Period 3 = 0.024.

3.2.3.4. Post Tax Paid Up Housing Variance: $\sigma^2_{H^{pd}}$.

In order to calculate the post tax paid up housing variance, it was necessary to calculate a total return series such as that used in Sections 3.2.3.2. and 3.2.3.3. This was achieved by finding a capital gain derived from the house price index used in Section 3.2.1.3. and adding imputed income from the rent of owner occupied dwellings obtained in various issues of National Accounts (eg. National Accounts, 1980, pp. 30). This calculation was made more straight forward by the lack of tax on housing returns. Values for the paid up housing variance were,

Period 1 = 0.002 Period 2 = 0.037 Period 3 = 0.019.

3.2.3.5. Mortgage Mark Up: mp.

The mortgage mark up premium, mp, was calculated by taking the difference in the risk free rate and the actual mortgage rate charged over the period of interest. The source for the risk free rate is that described in Section 3.2.4.4. and for the mortgage rate is that described in Section 3.2.5.4.

Performing this calculation produced a figure of one and minus one per cent for the periods 1 and 2 respectively. The negative result in period 2 arose as the building society cartel kept the mortgage rates as relatively low as possible in the volatile inflation and interest rate environment of the mid 1970's in order to prevent a large repossessions problem. Despite this, properties taken into possession rose from 0.025 % in 1973 to a peak of 0.093 % in 1976 (BSA, 1985, pp. 198). In the long-run, a negative premium could not be sustained and in the period 1980 to 1986, the premium averaged 1.2 %. It would be rational to expect that in a deregulated mortgage market, premiums will be on average, positive.

Given the long-run nature of the model, we set mp at 1 % which should be treated with some caution. Thus,

Period 1 = Period 2 = Period 3 = 1 %.

3.2.4. Prices and Interest Rates.

We have explained in Chapter 2, Section 2.2.1. that one of the main consequences of assuming a long-run state is that relative prices do not change. In some simulations we shall relax this assumption by allowing supply side feedback in the limited form of relative price movements. Data described below is, therefore, somewhat sterile with respect to initial simulations. When relative prices are altered, the magnitude of these shall be reported along with the simulation and the justification for these magnitudes lies in the data sources described below.

3.2.4.1. Real Price of Manufacturing Input: n.

The real price of manufacturing input is a series derived such that $n = P_I/P_W$. An index of manufacturing input prices, P_I, effectively the rate of inflation of capital goods, was calculated by dividing the series gross fixed investment in manufacturing at current prices by the same series based on 1985 constant prices. Both series were extracted from Economic Trends (1990, pp. 68).

The index of manufacturing output prices, P_W, was calculated using the same procedure. Today, the basis for this is called the producer price index. This series was introduced in 1980 and only calculated retrospectively to 1974 (see Economic Trends 1984, pp. 211). Given this, the present study utilised the old wholesale price index for output (which the new series replaced) for all manufacturing products home sales. This series was obtained from Economic Trends (1983, Table, 114) and covered the entire period of interest.

The output price series was then rebased such that 1985=100 and values for n were obtained by division. During runs of the basic model, we set n equal to one. As we allow relative prices to deviate, n will rise or fall accordingly.

3.2.4.2. Ratio of the Market Value to Replacement Cost of Manufacturing Capital: q.

The ratio of the market value to replacement cost of manufacturing capital was obtained from various sources. This series is calculated in Oulton (1981, pp. 193) between 1960Q4 and 1977Q2 for industrial and commercial companies. Unpublished data for this sector was also kindly provided by Dr John Lomax at the Bank of England which spanned the time period 1966Q4 to 1989Q4. Finally, data specific to the manufacturing sector was kindly provided by Professor Sean Holly of the London Business School which covered the 1971Q1 to 1986Q4 period. Utilising industrial and commercial data requires a similar assumption regarding the relative performances of the sectors which we made in Section 3.2.3.2. None of the above data sets were suitable candidates for splicing.

Movements in q were sensitive to the quarter or year taken as the starting or end date. Over period 3, q fell substantially with the bulk of the fall occurring in the turbulent second period. Using Oulton's (1981) data, q fell by about 41 % or just under 2.5 % per annum (all compound figures were calculated using Table 29 in Kmietowicz and Yannoules (1980, pp. 45-46)). HH report a fall of 30 % over a similar period for the U.S. Data between 1952Q1 and 1976Q4 of q in the U.S. is reported in Von Furstenburg (1977, pp. 351-355).

As with n, in our basic model we set q = 1 over all time periods.

3.2.4.3. Ratio of the Price of Housing to non-Housing Goods: p.

The real change in the price of housing was calculated using the following method. The house price series reported in Section 3.2.1.3. was transformed into an index based on 1987=100. This does not result in any inconsistency with indices reported in Section 3.2.4.1. as no indices were mixed with different bases, and, for example, inputs n or p are then independent of base dates used. The following calculation was carried out:

$$\frac{\text{RPI - (House price component x weight in the RPI),}}{\text{1 - weight in the RPI}}$$

where RPI is the retail price index obtained in Economic Trends (1990, pp. 128) and rebased appropriately. This methodology is implicitly used to obtain our results in Fry and Pashardes (1986, pp. 50). The house price series and its weight in the RPI were obtained from the Department of Employment (1987). The result of this calculation is to produce an RPI which excludes the effect of house prices in the index. Real house price movements were then derived by taking the ratio of the house price index to the RPI ex housing. This parameter is separate from mortgage costs, which are also a component of the RPI (see Johnson, 1987; BSA, 1988b).

Over period 3, the ratio rose by 42 %, or 2.75 % per annum. Hughes (1988b, pp. 6) states that over the long-term, real house prices have risen between 1.5 % and 3 % per annum, although Hendry (1985, pp. 241-5) demonstrates this is not monotonic. This figure would be lower on a hedonic basis (Dicks, 1989, pp. 70), that is, adjusting for the effects of quality improvement through time (see Goodman, 1978; Fleming and Nellis, 1984, 1985; Fry and Pashardes, 1986). This concept is an index problem which may apply to any capital stock price series where technological and innovative progress occurs. Thus, more specifically, Hughes (1988b, pp. 54) states that between 1970 and 1985, real house prices increased by about 2.5 % per annum, but assumes for his empirical work that on a hedonistic basis, this falls to 1 %.

Like q and n, we set p = 1 in our basic model.

3.2.4.4. Expected Inflation and Capital Gains: π^e,π^{ek},π^{eh}.

The general rate of expected inflation, π^e, was not obtained from the RPI index described in Section 3.2.4.2. The basic model requires a starting value equivalent to the actual rate experienced in 1965 and 1973. This assumption enables the model to explore the effects of altering π^e from its base level. Thus, for π^e, Period 1 = Period 3 = 4.7 %; Period 2 = 9.0 %.

Expected capital gains for the manufacturing sector, π^{ek}, were kindly provided by Dr C.M. Kelly of Her Majesty's Treasury and represent the data series discussed in Kelly and Owen (1985, pp.7). This term is the inflation rate of manufacturing capital (P_I in our study) adjusted by a coefficient of 0.5 in order to restrict the capital gains term. The authors argue that this "inevitably arbitrary" scaling should be applied in order to take account of the absence of developed and efficient markets for second hand capital goods. For example, the problem of asymmetric information between buyer and seller, Lemons Law (see Akerlof, 1970), would ensure that firms could not fully liquidate installed capital at replacement cost. An alternative series for π^{ek} has been generated by Kilpatrick and Naisbitt (1984, pp. 28-29) who regressed the inflation rate of capital goods prices on lagged values of itself and other exogenous variables. The best equation was identified and used to generate predictions which form an expected rate with rational expectations origins.

The series was not displayed and the authors were unable to provide it. This is unfortunate only for comparative purposes as the methodology applied to the data actually used is closer to the methodology applied in the rest of the model.

Work carried out in order to estimate house price movements has ranged from simple moving averages (Dicks, 1988, pp. 22-23) to more complex econometric estimations such as Hendry's (1984, pp. 228) "sensible expectations" which utilises lagged values of house prices, interest rates, earnings and flows of mortgage loans. Maintaining model consistency expected housing capital gains in our model, π^{eh}, were based on the data for π^e and the real house price gains discussed in Section 3.2.4.3. We therefore assume that any expected real gain is added to π^e to form π^{eh}. In the basic model, we restrict $\pi^{ek} = \pi^{eh} = \pi^e$. Where expected capital gains do occur it is assumed that the reasons for this are exogenous to the model.

3.2.4.5. The Risk Free Rate of Interest: i.

The risk free rate of interest is assumed to be equivalent to the U.K. Government Treasury bill yield. Yields over the relevant period were obtained from Economic Trends Annual Supplement (1990, pp. 213). The yield for the year 1965 was 5.6 % and in 1973, this was 12.82 %. Therefore,

Period 1 = Period 3 = 5.6 %; Period 2 = 12.8 %.

3.2.5. Miscellaneous Parameters.

3.2.5.1. Elasticity of the Demand for Housing Services with Respect to Income: ϵ.

The housing income elasticity was assumed to equal 0.8. This figure was presented in King (1980, pp. 155) and is also used in Hughes (1988b, pp. 28). The figure used by HH (pp. 802) was 0.85. Further details of U.K. estimates can be found in King (1980, pp. 154). We assume this figure throughout, therefore,

Period 1 = Period 2 = Period 3 = 0.8.

3.2.5.2. Elasticity of the Demand for Housing Services with Respect to the User Cost of Capital: *n*.

The housing user cost elasticity assumed is -0.7. This compares to a figure of -0.5 used in HH (pp. 802). This figure is consistent with that found in King (1980, pp.156) and utilised in Hughes (1988b), although Hughes (1988a, pp. 115) incorporated the marginally higher figure of -0.75. These figures are to the upper end of the Green Paper, "Paying for Local Government", (Cmnd, 9714, January, 1988) which provides a range of possible elasticities between -0.5 and -0.8 (reported in Spencer (1988, pp. 15)). Again, this figure is assumed throughout and consequently,

Period 1 = Period 2 = Period 3 = -0.7.

3.2.5.3. Aggregate Loan to Income Multiple: Γ.

The principal of the user costs of capital is to achieve the most realistic environment facing the investor making a marginal investment. As a result of this, we estimate the whole economy's portfolio structure and real cash flows. In the case of the loan to income multiple which is used to determine total mortgage debt for the whole economy, an aggregate must be used.

The loan to income multiple was calculated by dividing the actual total mortgage stock outstanding (Source: Financial Statistics (1987, July, pp. 150) and various others) by the total number of owner occupied housing units (Source: see Section 3.2.1.3.) to obtain an average mortgage per house. This figure was then divided by a measure of U.K. average incomes (Source: Donald and Phauge (1990, pp. 22)) to obtain a series for Γ between 1965 and 1988. Results for periods 1 and 2 were close at 0.78 and 0.74 respectively. The latter figure fell as incomes rose strongly in the post oil price hike. It was decided to consolidate a rationed loan to income multiple as 0.75 for all periods, thus,

Period 1 = Period 2 = Period 3 = 0.75.

We have discussed the process of mortgage market liberalisation in Section 1.4.4.2. and argued that this culminated with the 1986 Building Societies Act. Between 1986 and 1988, the average Γ was 0.9. Given that all individuals may not have fully adjusted to the new deregulated environment in the short-run, we decided to set Γ at 1 to represent our best estimate for a deregulated market. Given the lack of data and adjustment lags, we accept that this estimate should be used with caution.

3.2.5.4. MIRAS Scaling Factor: ç.

MIRAS is defined in Chapter 2, this equation (2.55) can easily be solved for ç. The resulting equation was calculated using annual data to estimate ç over the period. Sources for Θ are as in Section 3.2.2.1., H^{mb} as in Section 3.2.5.3., actual MIRAS figures were obtained from Inland Revenue Statistics (1988, pp. 44) and the average annual mortgage rate obtained from the Building Societies Association (1984, pp. 6) earlier figures being obtained from the Building Societies Association directly. Using this methodology, we set ç as,

Period 1 = 0.709; Period 2 = 0.887; Period 3 = 0.792.

3.2.5.5. Manufacturing Debt to Equity Ratio: b.

The manufacturing debt to equity ratio is defined as the market value of debentures, plus loan stock plus net bank borrowing divided by the market value of total ordinary plus preference shares. Net bank borrowing is defined as bank advances less liquid assets.

Values for b were calculated from unpublished data kindly provided by the Bank of England. The data pertained to non-financial companies and originated in 1967. More disaggregated data was unavailable and we therefore assume that the manufacturing industry was not significantly detached from the rest of the sector. A slightly older version of the Bank of England data between 1975 and 1980 is presented in King and Fullerton (1984, pp. 65). Over this period, and using this table, the debt to equity ratio was 0.24. Using the latest available data and the methodology outlined above, we find that the debt to equity ratio for the model is, Period 1 = 0.1846; Period 2 = 0.3349; Period 3 = 0.2547.

3.2.5.6. Manufacturing Short-Term to Long-Term Debt Ratio: z.

Data for the manufacturing debt structure forms a part of the debt to equity ratio calculation and therefore, the source and assumptions discussed in Section 3.2.5.5. apply to this Section. The calculation applied was to divide short-term debt by the total debt outstanding. This provided the following input,

Period 1 = 0.331; Period 2 = 0.684; Period 3 = 0.496.

King and Fullerton (1984, pp. 64) argue that the increased inflation volatility experienced during the 1970's resulted in firms becoming reluctant to lock themselves into long-term interest rates. This may explain the dramatic rise in the proportion of short-term debt in Period 2.

3.2.5.7. Investment Scaling Factor: Ω.

The investment scaling factor was calculated by dividing total gross fixed investment in manufacturing (Source: Economic Trends Annual Supplement (1990, pp. 68)) by the gross manufacturing capital stock described in Section 3.2.1.2. Input to the model for Ω was,

Period 1 = 0.049; Period 2 = 0.036; Period 3 = 0.043.

3.2.5.8. Manufacturing Dividend Payout Ratio: ϕ.

The divided payout ratio is defined as dividends per share divided by earnings per share where earnings are defined as profit after tax less interest on borrowings and preference shares (Rutterford, 1983, pp. 140). Data was only available to the level of the industrial and commercial companies sector. The following data was obtained from Economic Trends Annual Supplement (1990, pp. 189), profit, tax paid, interest paid on all borrowing while dividend payments were obtained from various issues of Financial Statistics (eg. 1984, June, pp. 86) under the title "Payments of Dividends on Ordinary Shares". The following figures were found for the model,

Period 1 = 0.44; Period 2 = 0.34; Period 3 = 0.39.

3.2.5.9. Depreciation Rate of Manufacturing Capital Stock: δ_k.

We have discussed the importance of using a rate of depreciation that is consistent with assumed asset lives used in the calculation of the capital stock in Section 2.4.6.1.1. Work carried out by King and Fullerton (1984) utilises CSO assumed asset lives to produce a figure for manufacturing depreciation which is consistent with the theoretical work of Downs (1986). Kelly and Owen (1985, pp. 12-13) also use the methodology described by King and Fullerton (1984, pp. 29).

We assume a constant rate of depreciation over our time periods and utilise the figure calculated by King and Fullerton (1984, pp. 47) of 7.9 %. Therefore,

Period 1 = Period 2 = Period 3 = 7.9 %.

3.2.5.10. Depreciation Rate of the Housing Capital Stock: δ_h.

Given the methodology described in Section 3.2.5.9., we assume that owner occupied housing have an expected life of one hundred years. This is similar to Hendry (1985, pp. 32) who finds the mean life of a house to be 95 years. The Central Statistics Office assumes that commercial property has a life of eighty years and industrial property of sixty years (Central Statistics Office, 1985, pp. 199-203). Using the formula derived in King and Fullerton (1984, pp. 29) we have 2/100, which provides a rate of depreciation of 2 %. This figure compares with 1 % assumed by Dicks (1988, pp. 22), although the author also added 1 % for maintenance and 2.5 % for the U.S. assumed in HH (pp. 802). Thus, we input,

Period 1 = Period 2 = Period 3 = 2 %.

3.3. Model Solution.

The model described in Chapter 2 is nonlinear simultaneous general equilibrium in nature. We shall explain how and why the model was solved computationally, outlining some of the key procedures and concepts involved. Solutions to the model could be obtained by finding the derivatives of the implicit functions (see Chiang, 1984, pp. 210-214) however given the size of the model in terms of the number of endogenous variables (the feedback block) and the objective of analysing subsequent changes to parameter values and model structure alterations, this manual technique would be slow and cumbersome. The usefulness of partial derivatives is limited as there is a functional relationship between the independent variables. The model was, therefore, written in TURBO Pascal and solved using the Gauss-Seidel method.

The basic model determines 18 endogenous variables and utilises the three predetermined variables outlined in Section 3.2.1. along with 24 parameters and 11 initialised parameters (eg. α_k, αc_1). A number of post-recursive variables were also calculated, for example, GB, E and risk premiums which are outlined further in Chapter 4. The endogenous variables are (Y), (H), (K), (W), (Wr), (UC_{ka}), (v), ($ß_1$), ($ß_2$), ($ß_3$), (H^{mb}), (UC_{ha}), (TX_k), (RE), (MIRAS), (TX_h), (D) and (Dnd). The technical progress parameter ($Ç_{kl}$) was shocked for the desired rate of growth to create the simulation.

3.3.1. Initialisation.

The purpose of the initialisation process is to produce starting values for the model by logically using the equations, parameters and predetermined variables. The starting values being variables or parameters not directly specified, such as H^{mb}, TX_h α_k, α_{1c}, etc. To enable the model to achieve this, the sequence in which the equations are solved is of crucial importance.

As an example, the basic model for period 1 solved its initialisation using the following ordering (from left to right):

(W), (Wr), (x), (α_{c1}), (α_{c2}), (α_{c3}), (α_{c4}), (UC_{kac}), (UC_m), (H^{ms}), (H^{md}), (H^{mb}), (v) (MIRAS), ($ß_1$), ($ß_2$), ($ß_3$), ($ß_4$), (UC_{ha}), (TX_k), (RE), (TX_h), (D),

The parameters α_k, α_h, α_m and $Ç_{kl}$ were obtained in this way and subsequently had there values fixed for further simulations.

If the period 2 was initiated, then an If - then statement (see Findlay and Watt, 1981, pp. 52-55) built into the initialisation run would switch equations specifically devoted as being of the classical system to those pertaining to the imputation system, for example equations (TX_{kc}) and (TX_{hc}) would switch for (TX_{ki}), (TX_{hi}) and introduce a calculation of (Dnd). If the model ran for period 3, then after eight years, a further initialisation procedure was performed which reset and substituted the user cost parameters for the imputation system in the order outlined above. Changes required for the initialisation procedure were minimal for non-basic model solutions and are specified when appropriate in Chapter 4.

3.3.2. Solution Algorithm.

In order to solve the non-linear system, an iterative or numerical procedure must be used such as Gauss-Seidel or Newton methods. Hughes Hallett and Fisher (1990), favour the Gauss-Seidel method for computational efficiency and this solution is used in the present study (also discussed in Nash (1979, Chapter 17) and Challen and Hagger (1983, pp. 33)). Ripley and Seddighi (1988, pp. 185-195) provide an application to a personal computer using Basic language.

Having obtained starting values for the model, iterations occur until a solution condition specified is obtained. The first iteration consists of passing through the entire model and solving for each of the endogenous variables, given the starting values. The second iteration proceeds along the same path using values for the endogenous variables derived in the first iteration. This process continues until the absolute change of,

$$\left| EV_{t,n} - EV_{t,n-1} \right| < \text{crit} \tag{3.1}$$

or the absolute proportionate change is such that,

$$\left| (EV_{t,n} - EV_{t,n-1})/EV_{t,n-1} \right| < \text{crit} \tag{3.2}$$

where EV is the estimated value of the endogenous variable, t denotes the time period, n represents the iteration number and crit is the specified tolerance limit or critical value. If, for example, the tolerance limit was 1 %, then the model would solve for a particular time period when the absolute change in all endogenous variables from the last iteration is less than 1 %. The value for crit in the model was set at 0.0001 %, or one thousandth of a percent.

This technique has been followed such that the algorithm becomes a two part iteration with only the feedback set of variables requiring the tolerance test.

3.4. Conclusion.

This Chapter is complementary to Chapter 2. Having discussed the data used in the model and the various aspects of solving the model, we are now in a position to test and obtain results for analysis. Any structural changes to the model should be consistent with the model described in Chapter 2 and the data and model solution described in the present Chapter. We are now in a position to generate and analyse the models output and this is contained in Chapter 4.

4. BASIC MODEL SIMULATIONS.

4.1. Introduction.

The purpose of the present Chapter is to explore the results generated when carrying out various simulations using the model effectively contained in Chapters 2 and 3. Our principal interest being the resultant asset allocations between our portfolio constituents and the effect on the real user costs of capital. Utilising these, and other variables, we will be in a position to highlight key influences on these sectors of the economy between 1965 and 1979. Comparisons with similar studies conducted in the U.S.A. will be of interest. In particular whether inflation, coupled with taxation, channels resources towards owner occupation.

More specifically we concentrate on exploring the effects of the period 1 and period 2 environments on our model. We describe the methodology used in this comparative static analysis and indicate some extensions to the reported results. When comparing period 1 and 2 attributes a selection of parameter shocks are discussed in Section 4.3. which also serves to describe various aspects of model interpretation. Given our particular interest in inflation, risk, taxation and capital markets these areas are focussed on in particular. Following this we simulate the model combining both periods using the parameters presented in Chapter 3. At this stage the model is altered so that the cumulative effects of growth, inflation, relative inflation and rationing can be analysed. This involves the endogenisation of the risk free rate and the exogenisation of real wealth. The final objective of this Chapter is to provide and analyse a long run model based mainly on period 3 which will provide a vehicle capable of being used in Chapter 5 for the comparison of various taxation policy regimes.

4.2. Results Analysis and Model Stability.

The objective of the present Section is to present the methodology which is used to achieve consistency in our comparative static analysis (Section 4.2.1.). We explain the complexities involved in assessing the implications of our CGT assumptions and stress the comparative static nature of the results. In Section 4.2.2. we outline the format of the results presented in the Results Appendix, Sections B and C which forms the basis for our discussion in Section 4.3. Finally, before our results analysis we comment on the models stability in Section 4.2.3.

4.2.1. Methodology.

Our Methodology Section outlines those aspects of the model which require to be consistently treated among specific sets of simulations (Section 4.2.1.1.). Before interpreting our results the implications of our alternative influences on corporate capital gains is discussed which explains why there is no individual simulation focusing solely on this parameter (Section 4.2.1.2.). Finally, we stress that the usefulness of the results lie in relative comparisons, either between periods or within a period (Section 4.2.1.3.).

4.2.1.1. Model Consistency.

We can now outline those factors maintained constant within a group of simulations which is crucial in facilitating the comparative analysis presented in the following Chapter. In order to compare the effects of a change in either an existing parameter or a change in model structure on the variable output it is necessary to maintain consistency all in other areas. Values for the constant parameters determined in the initialisation run for each period are reported in the Results Appendix Section A, these parameters remained fixed during all simulations unless a sensitivity analysis was being performed on one of them. The parameter α_m was calculated assuming that the mortgage market was initially in equilibrium such that $H^{ms} = H^{md} = H^{mb}$ and $\Gamma = 1$. That is, α_m was initialised in an unrationed environment. The technology term ($Ç_{kl}$) was increased in order to produce a growth rate described in Section 4.4.3. and the size of the increase was not altered during the results reported in the present Chapter or Chapter 5. Similar consistency is applied to Wr when it is endogenised in Section 4.4.4., that is, we always apply a constant growth rate of real wealth within relevant simulation sets.

4.2.1.2. Corporate CGT.

Interpretation of the results of changes in the corporate CGT rate is complicated by the parameters equivalence with other separate tax rates in each period. Consequently it is of use to outline the implications of this before the model results are interpreted. The effect of a reduction in each parameter of one percent is indicated above the appropriate simulation in the Results Appendix. The changes are mirrored between period one and two however it is worth stressing the effects of the CGT changes between the periods. In period one the CGT was levied at the same rate as the rate of corporation tax and was independent of the personal CGT rate. For this reason in period one we simulate an independent reduction in the rate of personal CGT (μ_p). When we simulate a cut in the corporation tax rate this implicitly reduces the rate of CGT to the corporate and therefor this simulation produces the effects of the taxes being cut in unison. This is in effect what would happen under this system. The introduction of the imputation system switched the above relationship in that manufacturing CGT was concomitant to the rate of personal CGT. Consequently when we reduce μ_p we automatically assume a reduction in μ_{ke}. It follows that the parameter μ_{ke} does not explicitly appear in the simulations reported in Section B or C of the Results Appendix because of its fixed relationship with other taxes although the associated effects are incorporated.

4.2.1.3. Comparative Analysis.

The interest in the results generated by our model lie in their comparative nature. Failure to comply with this restriction would however result in the possibility of over interpreting the data. This Section briefly outlines the importance of this condition. The result of, for example, a tax increase in our model should increase the variable GB although we have indicated that the government does not play on explicit role in the model (Section 2.2. and 2.4.7.3.2.). This may present a difficulty typical in assessing tax policy changes, the "*ceteris paribus problem*" (See Prest and Barr, 1985, pp. 32-34, Section 1.2.4.1.3.). Simply stated a reduction in a tax, with government expenditure remaining constant should reduce the governments budget balance which consequently would effect the level of money income and expenditure. If we assume the stock of money to remain constant then the deterioration in the budget may result in higher interest rates.

For these reasons the results reported should be thought of as comparative tax effects rather than the effects of a single tax change considered in isolation.

4.2.2. Reporting of Results.

The purpose of the present Section is to equip the reader with the rationale for those results reported in the Results Appendix. The term N/C is inserted when the specific simulation result is unchanged from that reported in the previous column. Each column in Section B and C represents one simulation and is split into five sections. These are the individuals balance sheet (£m), real user costs of capital, user cost of capital parameters, the loan to valuation ratio and real cash flows (£m). The variables Sb, Lb, E and H^{pd} are post recursive in nature and stem from the variables K and H. Appropriate addition of the balance sheet produces K, H and W. UC_m is fixed on initialisation but is presented mainly to show the effect changes in parameters have on it and because it is a relatively long manual calculation to perform. The real user cost of housing and manufacturing capital parameters are reported for the same reason although β_1 to β_3 are endogenous variables. This affords a more detailed analysis of the results following a change in the levels of tax or risk associated parameters which is central to the study. β_4 is included for consistency and the other variables are self explanatory. A calculation of Dnd is not required for the classical system and is therefore not reported but it is under the imputation system and thus Section C contains this variable. Actual figures are presented, often with many decimal places (eg. user costs), in order to expose variable responses to relatively small parameter changes. For this reason there is a cost in using sensitivity results to analyse differences between systems in that these are, in many cases, only exposed after many decimal places.

4.2.3. Sensitivity Analysis.

Sections B and C of the Results Appendix represent the majority of the simulations carried out for sensitivity analysis purposes. The role of sensitivity analysis is to assess the models robustness in the face of parameter changes. For example, it would be undesirable if a small change in a particular parameter caused large movements in the model output. It also provides results in terms of insights into the model and the significance of various parameters which allows us to introduce our convention for presenting elasticities.

In total there are sixty four simulations and two sets of initial values reported between the two periods. The results show the effect of a one percent reduction in each parameter for periods 1 and 2. One percent changes were applied in order to ensure responses were mainly linear in the limit. Elasticities can easily be calculated, for example, if we take the reduction in income tax in period 1 (Section 4.3.2.) then we can see that compared to base the reduction in Θ results in a 0.4 % reduction in H^{ml}. This is equivalent to $(dH^{ml}/d\Theta)(\Theta/H^{ml})$ which we shall denote as $\epsilon_{1,H^{ml},\Theta}$ which reads, the elasticity of H^{ml} with respect to Θ in period 1.

Simulations have also been reported which shift R to 2.5 and 3.5 as the range of possible values for the common risk aversion term was wide (see Section 3.2.3.1.). In order to quickly expose some of the effects of inflation this has been reduced to zero while the real rate of interest has been kept constant. These results are reported at the end of Sections B and C.

Increases of one percent for each parameter were also simulated although the results have not been reported in the interest of consiseness and clarity. Given that thirty two columns of results were reported for each period if we included period three and reported a one percent rise in each parameter we would have to report one hundred and eighty individual sets of results. Although the model is nonlinear this did not cause any notable divergence from symmetric results when an equiproportional increase or decrease in a parameter was simulated.

When altering parameters significantly, as can be observed from our risk aversion and inflation examples this did not engender any model stability problems. In conclusion the model presented stable characteristics throughout its range of parameters.

4.3. Analysis of Period 1 and Period 2 Systems.

The purpose of this Section is to draw out some of the differences between the results generated in period 1 and 2 models which form the basis for our period 3 model. The main differences lie in the change from the classical to the imputation system of taxation and contrasting parameter values. Many parameters, particularly corporation tax, income tax, asset variance and corporate debt funding ratios, reflect the change from a stable growing economy to one of rapid change in the wake of the oil price shock and associated inflation and uncertainty. It would be unreasonable to discuss every result in turn and therefore some of the more interesting parameter changes will be focussed on with particular reference to taxation, inflation, risk and capital markets. All results reported in this Section assume unrationed mortgage market ($\Gamma = 1$). The results reported in the Results Appendix can be thought of as a core set of results. Utilising these results along with the relevant equations described in Chapter 2 and the parameters described in Chapter 3 it is possible to calculate further variables. Examples are, risk premia, pre and post tax required returns and components of cash flow. There are many such configurations and in this Section our objective is to indicate when required the possibility of extrapolating from the core set of results.

4.3.1. Base Run Simulations.

The purpose of this Section is to introduce the base run simulations of the period 1 and 2 models. This Section also forms an appropriate vehicle to contrast the effect of the economic conditions of each period on our model. Following this we can discuss the effects of the growth simulation in greater detail. The portfolio split of individuals is significantly different between the two periods. Under the economic conditions prevailing in period 2 the proportion of bonds in the portfolio (16.7 %) is much higher than under period 1 (9.2%). Within this there is a switch in period 2 towards short dated bonds from long bonds which rise from less than half in period 1 to more than double the amount of long bonds in period 2. Corporate equity falls from 40.8 % to 33.2 %. While the total proportion of housing investment remains fixed at 50 %, within this there is a dramatic shift in the proportion which is funded by a mortgage which falls from 39 % in period 1 to 17.6 % in period 2.

An appropriate additional variable to discuss is the relative risk premia which the portfolio asset allocation implies. The portfolio in the Results Appendix effectively provides us with J (a specific risky asset) and W (by addition), coupled with equation (2.25) and the appropriate parameters R and $\sigma^2{}_j$ from Chapter 3 we can obtain risk premia. At the end of period 1 we find that p_{Lb}, p_E and $p_{H^{pd}}$ are 0.149%, 7.628% and 0.066% respectively. Given that we have argued that paid up housing represents the safest asset (Section 1.2.4.2.5.) which is consistent with our findings of variance data for all periods, that is $\sigma^2{}_{H^{pd}} < \sigma^2{}_{Lb} < \sigma^2{}_E$, and we find $p_E > p_{Lb} > p_{H^{pd}}$. While the above variance condition holds for all periods this does not constrain the risk premia to conform also. In period 2 for example we find $p_{H^{pd}} > p_{Lb}$ because paid up housing is relatively a much larger component of the portfolio.

All user cost of capital figures rise in period 2 compared to period 1. If we impose equal tax rates, interest rate, inflation and risk premiums the imputation systems' manufacturing user cost is lower than the classical system as expected. The higher user cost observed under the imputation system is a result of a combination of a higher real rate of interest, a higher corporation tax rate and, most significantly an almost six fold increase in the corporate equity variance. The subsequent rise in the risk premia manifested in a dramatic increase in α_{2i} over α_{2c}.

The user cost of housing and mortgages also increases in period 2, though not by such a large factor. The latter movement arises mainly from the 2.82 % increase in the real rate of interest although this is tempered to some extent by a lower rates burden and a higher proportion of mortgages eligible for MIRAS. The period 2 housing user cost suffers principally from the higher real interest rate and a higher paid up risk premium (3.6 % compared to 0.23 %) owing to the increase in $\sigma^2{}_{H^{pd}}$ and the much larger proportion of the individuals portfolio invested in paid up housing under the period 2 environment.

The switch from mortgages to paid up housing in period 2 is reflected in the fall in the loan to valuation ratio but results principally from the rise in the profits share parameter α_k which is fixed at initialization to equal the real user cost of manufacturing capital (see equation (2.13) and note that Y = K and see Section 3.3.1.). This effectively means that for every pound of national product only 35 % is distributed to labour compared with 78 % in period 1 and consequently represents a dramatic fall in labour's income share which restricts households ability to service mortgage debt (equation's 2.16 and 2.16'). The low housing user cost makes it an attractive investment but individuals can not rely on mortgage funding to the extent witnessed in period 1. While the mortgage user costs are similar there is an almost three fold increase in the housing user cost when we move into period 2 which arises as a result of the eighteen and a half times increase in the variance of paid up housing, a higher real interest rate and the far smaller loan to valuation ratio.

In a similar manner to risk premia above we can extend the user cost analysis when desired to isolate required returns from assets. We know that the pre-tax cost of short dated corporated debt (r_{sb}) is the risk free rate of interest. It follows from equation (2.40) that the pre tax cost of long corporate debt in period 1 is 5.749% compared to 13.457% in period 2. As the corporate can offset interest payments against corporation tax the effective post tax interest rate paid on long debt for example is $(1-\tau)r_{Lb}$ which is 3.378% for period 1 and 6.459% in period 2. Given that our assumed inflation rates for the periods are 4.7% and 9% respectively the ability to offset interest payments (τ is 10.75 % higher in period 2) results in the real post tax cost of funding long term debt falling from -1.322% in period 1 to -2.541% in period 2, despite the real pre tax funding cost being 3.408% higher in period 2. In a similar way we could calculate to total (weighted) cost of corporate debt (pre or post-tax) by using equation (2.41). These figures represent the cost of finance as discussed in Section 1.2.4.2.1.

Although more cumbersome we can calculate the post tax expected return from corporate equity by using equations (2.42') and (2.46') and multiplying these by $(1-A)/(1-\tau)$. The individual receives a return in the form of a risk free rate, the risk premium and any capital gains, all after tax at the manufacturing and personal level. Utilising the variables E and W along with the appropriate parameters, and calculating x, ($\phi\Theta + (1-\phi)\mu_p = 0.2348$) and y, ($\mu_p\ (1-\phi) = 0.099$) we obtain a required return of 16% in period 1 compared to 56.6% in period 2.

Similar calculations can be obtained for the housing sector. The mortgage rate is equal to i + mp which is 6.6% in period 1 and 13.8% in period 2 while the aggregate post subsidy rate is given by equation (2.52) which is 4.699 % and 9.739 % respectively. Again, the real rate is lower in period 2. An individual with a mortgage at or under the MIRAS ceiling would effectively pay $(i + mp)\ (1 - \Theta)$ or 3.9% in period 1 and 9.2% in period 2. The opportunity cost of paid up housing is given by equation (2.52') and is 5.7% in period 1 and 16.4% in period 2. When $r_{H^{mb}} < r_{H^{pd}}$, any change which reduces the loan to valuation ratio (eg. a reduction in Γ) will increase UC_{ha} and result in a shift away from housing. We may also calculate mortgage interest payments as a proportion of gross or disposable income. For example the former can be obtained by calculating $r_{H^{mb}}H^{mb}/(1-\alpha_k)Y$ and represents 4.6 % at the end of period 1 and doubles to 9.5 % at the end of period 2.

Real income flows are also greatly affected by the profits share parameter. Manufacturing's increased profit share results in the sector paying a higher tax bill which is reflected in the ratio TX_h/TX_k which falls from 7.34 in period 1 to 0.58 in period 2. Similarly as a percentage of output disposable income falls from 47.8 % to 30.6 % while MIRAS as a percentage of output remains constant at around 1.5 %. The residual of Government expenditure and revenue is given by equation (2.61) and is £9,508m (39.2 % of output) at the end of period 1 and £32,128m (43.1 % of output) at the end of period 2. As an additional source of information it is possible to identify the contribution to any cash flow by isolating the respective term. For example we can identify the contribution to Government revenue resulting from domestic rates using equation (2.58), that, is $\Phi_h pH$ which equals £263m and £652m at the end of each respective period.

We can now discuss in more detail the results of applying economic growth to the model. Each model was run for eight periods to provide a consistent base simulation, a summary of the key results are contained in Table 4.1. In both periods all asset classes rose in absolute terms as did real cash flows. Manufacturing's higher income elasticity resulted in a general switch towards bonds and manufacturing equity therefore the risk premium on manufacturing equity increased relative to housing and thus the user cost of manufacturing capital rose while the user cost of housing capital remained lower than the initial values for both periods. The Tables presented in this Section display at a glance the absolute and relative changes in asset allocation and the user costs of capital (the relative user costs represent the ratios UC_{ka}/UC_{ha} and UC_{ka}/UC_m). Table 4.1. represents the base run movements compared to the initial values, while the other Tables represent the end result of a parameter change compared to the variables positions at the end of the base run. The term N/C denotes no change.

The loan to valuation ratio fell during both periods although this fall was larger in period 2 (a fall of 0.211 % compared to 0.007 %). In both periods the demand for mortgages was lower than the potential supply owing to the assumption of a mortgage demand income elasticity of less than unity (equation 2.16'). In order to

Table 4.1. Movement of Key Variables.

Base Run.

	Period 1		Period 2	
	Absolute	Relative	Absolute	Relative
Sb	increase	increase	increase	increase
Lb	increase	increase	increase	increase
E	increase	increase	increase	increase
H^{nl}	increase	decrease	increase	decrease
H^{pd}	increase	decrease	increase	decrease
UC_{ka}	increase	-	increase	-
UC_{ha}	decrease	increase	decrease	increase
UC_{m}	N/C	increase	N/C	increase

expose the relative changes in the loan to income ratio over these simulations we need to examine the functions controlling the demand for mortgages and the total demand for housing. If we look at the fall in the housing user cost we find this is much higher in period 2 as opposed to period 1 (-0.03 % compared to -0.006 %) which should boast housing demand in period 2 relative to period 1. A similar result is obtained when we note that disposable income as a percentage of total output actually fell slightly in period 1 while rising in period 2. These factors together with the mortgage market analysis above explain the relative falls in the loan to valuation ratio witnessed between both periods (particularly in period 2).

An important capital market result can also be observed. Our base model generates the result $H^{md} < H^{ms}$ and consequently the simulation which reduces Γ to 0.99 has no effect on the model as the above inequality continues to hold. That is Γ plays no role in the model if equation (2.16') represents the mortgage market. This is also the case in period 2. If $H^{ms} < H^{md}$ then a reduction in Γ would reduce total wealth and output while reducing v. The latter effect increases UC_{ha} if $r_{H^{pd}} > r_{H^{mb}}$ and a general reduction in housing demand would occur. All real cash flows rise and, apart from disposable income, initial distributions do not change significantly. We are now in a position to present a comparative analysis of each period for an equivalent percentage change in each parameter.

4.3.2. Reduction in Income Tax.

The main results of this simulation are presented in Table 4.2. Focusing initially on period 1 the reduction in income tax compared to the base run simulation increases wealth among all asset classes except the stock of mortgages. The user cost of manufacturing falls as corporates and individuals face a reduced tax burden on distributed income while on the other hand both the general user cost of housing and of mortgages rise as the value of MIRAS falls.

Building societies would be willing to supply £18,896m worth of mortgages but the marginal increase in cost reduces demand from £18,610m in the base run to £18,536m in the present simulation. This reduces the loan to valuation ratio to below initial and base run levels. The user cost of housing parameters react typically, as Θ falls the benefit of MIRAS falls while as v falls a greater proportion of the user cost is borne by paid up stock. β_1 rises as Θ falls where as β_2 falls principally as v falls. These directions are a function of the greater proportion the fall in Θ plays in β_1 compared to v and the opposite phenomenon occurring in β_2. The net effect is that the aggregate subsidised mortgage rate rises from 4.699 % in the base run to 4.718 %.

Table 4.2. Movement of Key Variables.

Reduction in Income Tax.

	Period 1		Period 2	
	Absolute	Relative	Absolute	Relative
Sb	increase	increase	decrease	increase
Lb	increase	increase	decrease	increase
E	increase	increase	decrease	increase
H^{ml}	decrease	decrease	decrease	decrease
H^{pd}	increase	increase	increase	increase
UC_{ka}	decrease	-	increase	-
UC_{ha}	increase	decrease	increase	decrease
UC_{m}	increase	decrease	increase	decrease

The effect of the reduction of Θ on the manufacturing user cost is demonstrated by the reduction in the parameters α_{1c} to α_{3c}, α_{4c} consists of depreciation and rates and is therefore uneffected by changes in Θ.

Real output rises while tax paid by individuals and corporates falls which increases disposable income thus boosting housing demand despite the falling MIRAS contribution. Corporate taxes fall only marginally in absolute terms as manufacturing output, and consequently profits, rise. That is, the general portfolio switch towards manufacturing as a result of lowering Θ in period 1 does not significantly reduce the net tax paid by the sector. Indeed, the total government balance ,GB, declines by less than 1 %.

The period 2 simulation is rather different, principally as a result of the unchanged marginal cost of investing in manufacturing which results from the imputation system. The absence of the double taxation of income is clearly indicated in the parameters α_{1i} to α_{3i} which remain constant. Thus in period 1, $\epsilon_{1,E,\Theta} = -0.17$ while in period two the equivalent measure is 0.02, smaller in magnitude but a different sign. As a result only paid up housing rises over the simulation, the other assets fall marginally apart from the stock of mortgages which falls significantly ($\epsilon_{2,H^{mb},\Theta} = 2.58$). As a proportion of the individuals portfolio's all manufacturing assets remain fixed while the ratio of mortgages to paid up housing falls from 0.54 to 0.52.

In conclusion the reduction in Θ results in a portfolio switch away from housing towards manufacturing. In both periods this occurs as the user cost of housing increases as a result of the consequent reduction in MIRAS. The portfolio switch is reinforced in period 1 as the user cost of manufacturing falls owing to the lower tax on distributed income. There is no additional reduction in the marginal investment hurdle in period 2 because the imputation system has already eliminated this hurdle and the relative switch to manufacturing assets raises the user cost marginally. The greater cost of mortgages resulted in a reduction in v in both periods. In terms of cash flows there was a two way pull in period 1 of lower income tax on dividends and earned income but a lower MIRAS contribution while the situation was similar in period 2 with the treatment of dividends being the exception. The net result was a reduction in household tax and an increase in manufacturing tax as a proportion output although the net change in GB was slight in both cases.

4.3.3. Reduction in Corporation Tax.

Analysing a change in the corporation tax is interesting for many reasons. It is a typical policy move (straightforward to carry out), it impacts CGT under the classical system and not the imputation system and it results in both the manufacturing and housing user costs falling.

The overall effects are broadly similar between period 1 and 2 in terms of directional responses as can be observed from Table 4.3. Compared to initial levels and the base run simulations all asset values rise (asset elasticities are all positive). Portfolio's are biased away from housing assets towards manufacturing in both periods. Real output rises while the proportion of tax paid by corporates falls and disposable income rises. In period 1 the elasticity $\epsilon_{1,(TX_h/TX_k),\tau}$ = -1.9 while the same elasticity in period 2 is -1.4. Both show a switch in the emphasis of tax revenue base from corporate to households. The switch is greater under period 1 because although corporation tax is greater in period 2 (see Section 3.2.2.4), and therefore a one percent fall is larger in absolute terms the rate of CGT is also effectively cut in the classical system.

In both periods the user cost of manufacturing capital falls as a result of the reduction in the corporation tax, demonstrated by both periods manufacturing user cost parameters falling. The user cost of mortgages is unchanged, however the user cost of housing in both periods falls because the switch away from paid up housing reduces the required risk premium. For example in period 1, compared to the base simulation the risk premium on paid up housing falls from 0.0658 % to 0.0656 % ($\epsilon_{2,p_{Hpd},\tau}$ = 0.3). Conversely the risk premium of corporate equity rises from 7.62 % to 7.63 % ($\epsilon_{1,p_E,\tau}$ = -0.4).

In conclusion the reduction in τ produces the anticipated effects of increasing the relative size of the stock of manufactured capital while at the same time reducing the overall corporate tax bill. The later effect is greater in period 1 (causing an absolute fall) as CGT are also reduced.

4.3.4. Reduction in Manufacturing Capital Gains.

By analysing corporate capital gains we will expose the effects of a change in expectations on one user cost and by following this Section with a reduction in housing capital gains this will enable us to compare these Sections with each other

Table 4.3. Movement of Key Variables.

Reduction in Corporation Tax.

	Period 1		Period 2	
	Absolute	Relative	Absolute	Relative
Sb	increase	increase	increase	increase
Lb	increase	increase	increase	increase
E	increase	increase	increase	increase
H^{ml}	increase	decrease	increase	decrease
H^{pd}	increase	decrease	increase	decrease
UC_{ka}	decrease	-	decrease	-
UC_{ha}	decrease	decrease	decrease	decrease
UC_{m}	N/C	decrease	N/C	decrease

as well as with the initial and base results. The key results are summarised in Table 4.4. The present simulation also enables us to expose some of the factors influencing retained earnings.

Like the Section above the reduction in expected corporate capital gains has had similar effects on the portfolio split, user costs and real cash flows between both periods. Specifically, the reduction raises the user cost of manufacturing capital although, naturally, none of the user cost parameters are effected. For both periods there is a relative switch away from all manufacturing assets towards all housing assets. Asset values fall in absolute terms across the portfolio with the exception of paid up housing in period 1 which holds up because the fall in disposable income is slight, reflecting a relatively larger saving in the CGT payment in this period. That is, because the GCT rate is higher under the period 1 environment the reduction in actual gains cuts the tax paid under the period 1 system by more that in period 2. Again the rise in the housing user cost is principally a result of a switch towards housing and the resultant increase in the paid up housing risk premium.

The only real cash flow which moves in opposite directions between each period is retained earnings which rises in period 1 as a proportion of output and falls in period 2. The elasticity, $\epsilon_{1,\mathrm{RE},\pi^{ek}}$ = -8.67 while in period 2 this falls to 0.2. The key factors influencing this result are the relative fall in corporate profits, corporate taxation and the real gain made by corporates owing to the reduction in corporate debt. The elasticity of corporate profits $\epsilon_{1,\alpha_k \mathrm{Y},\pi^{ek}} = 0.045$ in period 1 compared to 0.148 in period 2 which demonstrates the reduced ability of corporates to pay dividends in the latter period. We have already indicated that the effect on corporate tax is that although the fall in tax paid is slightly greater under the period 2 system (a fall of 0.178 % compared to 0.175 %) as a proportion of corporate profits it is greater under period 1 (unsurprising as CGT is greater in period 1) which biases retained earnings towards period 1.

Finally, the greater proportion of bonds held during period 2 (b is higher, see Section 3.2.5.5.) means that the real gains made at the expense of lenders by holding debt during a period of inflation is reduced by 4.6 % in period 2 and only 3.9 % in period 1. These factors combine to favour retained earnings in period 1 if capital gains fall.

Table 4.4. Movement of Key Variables.

Reduction in Manufacturing Capital Gains.

	Period 1		Period 2	
	Absolute	Relative	Absolute	Relative
Sb	decrease	decrease	decrease	decrease
Lb	decrease	decrease	decrease	decrease
E	decrease	decrease	decrease	decrease
H^{ml}	decrease	increase	decrease	increase
H^{pd}	increase	increase	decrease	increase
UC_{ka}	increase	-	increase	-
UC_{ha}	increase	increase	increase	increase
UC_{m}	N/C	increase	N/C	increase

4.3.5. Reduction in Housing Capital Gains.

Compared to our base simulations the reduction in housing capital gains produces symmetric directional movements between both periods with the exception of paid up housing as can be seen in Table 4.5. Throughout both periods all asset values fall in real terms along with real output and the loan to valuation ratio. There is a general shift towards manufacturing debt and equity although in period 2 the large fall in the stock of mortgages means that this is the only asset class to fall as a share of the portfolio. The proportion of household and corporate tax, along with retained earnings rise while MIRAS and disposable income fall.

All user costs of capital rise, the explanation for the relative movements of paid up housing and the mortgage stock lie in the relative user cost movements and this presents us with an opportunity to discuss these in further detail. As we would expect the housing related user costs are generally larger under period 2 as a result of a higher real interest rate and a higher risk premium (see Section 4.3.1.). Once the implications of MIRAS and the different loan to valuation levels observed between the periods are introduced matters are distorted some what. In its basic form the MIRAS benefit, $(1 - \Theta ç)$ reduces the user cost slightly more under the period 2 environment which reduces the impact of the higher real rate of interest. The lower proportion of mortgage debt in period 2 negates this benefit as can be seen from the generally higher levels of $ß_l$ in period 2 simulations. Total housing demand is of course influenced directly by UC_{ha} which in period 1 is more sensitive to changes in capital gains than in period 2 ($\epsilon_{1,UC_{ha},\pi^{eh}}$ = -1.4 compared to -1.2 in period 2).

The results of this are straight forward but important for asset allocation impacts. In period 1 π^{eh} represents 140 % of UC_{ha} and 150 % of UC_m, both should react in a similar manner to a change in π^{eh}. In period 2 however the figures are 100 % and 256 % respectively thus when π^{eh} is reduced this has a large impact on UC_m in period 2 relative to UC_{ha} which reduces mortgage demand substantially. The share of mortgages in period 2 fell by 1.2 % compared to a fall of only 0.5 % in period 1. This was at a time when the general housing user cost did not rise substantially thus promoting outright ownership.

Comparing these results with the equivalent fall in manufacturing price expectations we find the effect on housing user costs are greater as they are more sensitive to price expectation changes than corporate capital, thus the magnitude of any asset allocation changes was greater during these simulations. Generally a reduction in

Table 4.5. Movement of Key Variables.

Reduction in Housing Capital Gains.

	Period 1		Period 2	
	Absolute	Relative	Absolute	Relative
Sb	decrease	increase	decrease	increase
Lb	decrease	increase	decrease	increase
E	decrease	increase	decrease	increase
H^{ml}	decrease	decrease	decrease	decrease
H^{pd}	decrease	decrease	decrease	increase
UC_{ka}	increase	-	increase	-
UC_{ha}	increase	decrease	increase	decrease
UC_{m}	increase	decrease	increase	decrease

either price expectation shifted asset allocation away from the particular sector or an asset within that sector. In absolute terms a fall in either price expectation resulted in a deflationary environment where investment hurdles rose.

The area of most significant contrast lies in the path of real cash flows. When housing price expectations fell, as a proportion of total output, both household and corporate tax payments rose while MIRAS and disposable income fell. The opposite cash flow changes occur when manufacturing price expectations fall. This is principally because corporate capital gains impact on manufacturing and households, and while these are falling, MIRAS is rising as households increase their housing weighting. When housing capital gains fall this switches assets towards manufacturing which increases the sectors tax payable while MIRAS payments fall.

In conclusion, the reduction in housing capital gains produce relatively consistent results in both periods although this significantly affected the demand for mortgages in period 2. In both periods all user costs rose and there was a switch towards manufacturing assets. Compared to the reduction in manufacturing capital gains the magnitude of change induced was greater because of the absence of housing CGT, while overall the portfolio and cash flow effects mirrored each other. These effects are also reinforced by the results of the simulation where we assume that there is no inflation in the economy. In both periods there is a portfolio switch towards manufacturing assets and all user costs rise. In period 2 paid up housing increases along with retained earnings and disposable income, in period 1 the corporate's tax bill falls as the benefit of zero capital gains outweighs the rise in profits subject to corporation tax where as the opposite occurs in period 2.

4.3.6. Reduction in Manufacturing Equity Variance.

Compared to the relevant base simulation the reduction in the manufacturing equity variance has reduced manufacturing user cost hurdles and consequently increased the size of all assets and cash flows in both periods. In general there has been a relative shift towards assets in the manufacturing sector as reported in Table 4.6. The fall in equity variance is reflected in the parameter α_2 and both the user cost of manufacturing and housing capital fall while the user cost of mortgages is unaffected. Real output rises in both periods while all proportionate real cash flows fall.

The reduction has a slightly greater effect in period 2 where the elasticity, $\epsilon_{2,UC_{ka},\sigma^2 E} = 0.5$ compared to 0.4 in period 1. Compared to the base simulation the risk premium required from manufacturing equity actually increased (using period

Table 4.6. Movement of Key Variables.

Reduction of Manufacturing Equity Variance.

	Period 1		Period 2	
	Absolute	Relative	Absolute	Relative
Sb	increase	increase	increase	increase
Lb	increase	increase	increase	increase
E	increase	increase	increase	increase
H^{ml}	increase	decrease	increase	decrease
H^{pd}	increase	decrease	increase	decrease
UC_{ka}	decrease	-	decrease	-
UC_{ha}	decrease	decrease	decrease	decrease
UC_{m}	N/C	decrease	N/C	decrease

1 figures for example) rising to 7.645 % from 7.628 % and for long debt to 0.1494 % against 0.1491 %. This occurred as a result of the combination of a lower manufacturing user cost of capital and a higher income elasticity raising the proportion of all manufacturing assets in the portfolio. The corollary to this is a lower paid up housing risk premium (0.0658 % against 0.0656 %). Effects have tended to be greater in period 2 owing to the dominance of the parameter in the user cost at that time and the effect would have been even greater if the debt to equity ratio had not risen by almost two fold in this period. Elsewhere in the system the change has had little effect.

The purpose of the current Section has been to outline some of the issues surrounding the model methodology along with the rationale for the presentation of the Results Appendix and to follow this with a discussion of a selection of pertinent parameter shocks. Consequently, different areas of the model have been explored and alternative methods of analysing an area have been utilised when appropriate. The comparison of period 1 and 2 environments produces valuable insights in itself and by following this route we have obtained an efficient method of introducing the workings of the model while presenting analytical techniques which may be used on other reported results.

4.4. Basic Model Simulations: Period 3 Data.

The following Section will discuss the impacts of cumulative growth, general inflation, relative price inflation and mortgage rationing on the basic model, period 3 data. Prior to this a short introduction to the layout of results presented in Section D is provided. This Section represents the model's closest reflection of investment conditions for the relevant sectors in the U.K. economy between 1965 and 1979 and enables us to isolate the effect exerted by influences such as general and real price inflation and mortgage rationing.

4.4.1. Rationale for Reported Results.

The results reported for the present Section are chiefly in the form of percentages or ratios. The changes imposed in each run mean that generally one does not have to operate to several decimal places which was the case in Section 4.3. The main reason for this form of presentation is to further facilitate the comparative nature of the results rather than become fixed on actual values, although the results reported will facilitate conversion to actual values when required as we provide actual figures in the discussion of the initial values. The user cost of manufacturing parameters are presented in Section 4.4.2. and are not reported in the Results Appendix as there are no taxation or risk parameter changes in this Section.

4.4.2. Initial Values.

The initial values represent the economy as at 1965 with parameters taken over period 3 but with the classical system of taxation in place. The initial balance sheet of the two sectors is presented in Figure 4.1. and the individuals portfolio asset split is provided in Figure 4.2. From this it can be seen that total wealth owned by individuals is £45,000m.

The user cost of manufacturing capital is 44.94 % and its parameters are, α_1 = 1.246, α_2 = 0.661, α_3 = 0.955 and α_4 = 0.094 while the tax parameter x is 0.2386. The user cost of housing capital is 4.66 % (the parameters are reported in the Results Section) while the user cost of mortgages is 2.96 %.

Real output is of course £22,500m, tax paid by the personal sector is £5,889m and by the corporate sector £3,584m making an initial government balance of £9,483m. Retained earnings are £2,756m and the MIRAS subsidy is £241m while disposable income is £8482m. Risk premiums are 22.4 % for manufacturing equity, 0.46 % for long bonds and 1.3 % for paid up housing. The post tax cost of short debt to manufacturing is 3.01 % and for long dated debt this is 3.26 %. The post MIRAS cost of mortgage debt in the model is 4.66 %.

4.4.3. Economic Growth.

We are now in a position to look at the effect economic growth has on the model with the existing parameters and tax structure. Real growth in manufacturing output rose sixteen percent in real terms over the period 1965 to 1979, a poor performance which reflects a fall in real output between 1973 and 1979. The more stable period 1965-73 (and more representative of a long run environment) produced a real growth rate of 18.5 %, or 2 % per annum and we therefore increase $Ç_{kl}$ such that we simulate economic growth of 2 % per annum. This figure remains fixed throughout all simulations in Chapter 4 and 5.

The risk free rate of interest and the rate of inflation remain as they were in 1965. Manufacturing output grows to £30,348m or by around 35 % and there is a general shift towards manufacturing assets, again, the assumed higher manufacturing income

Figure 4.1. Initial Balance Sheets (£m) of the Period 3 Model.

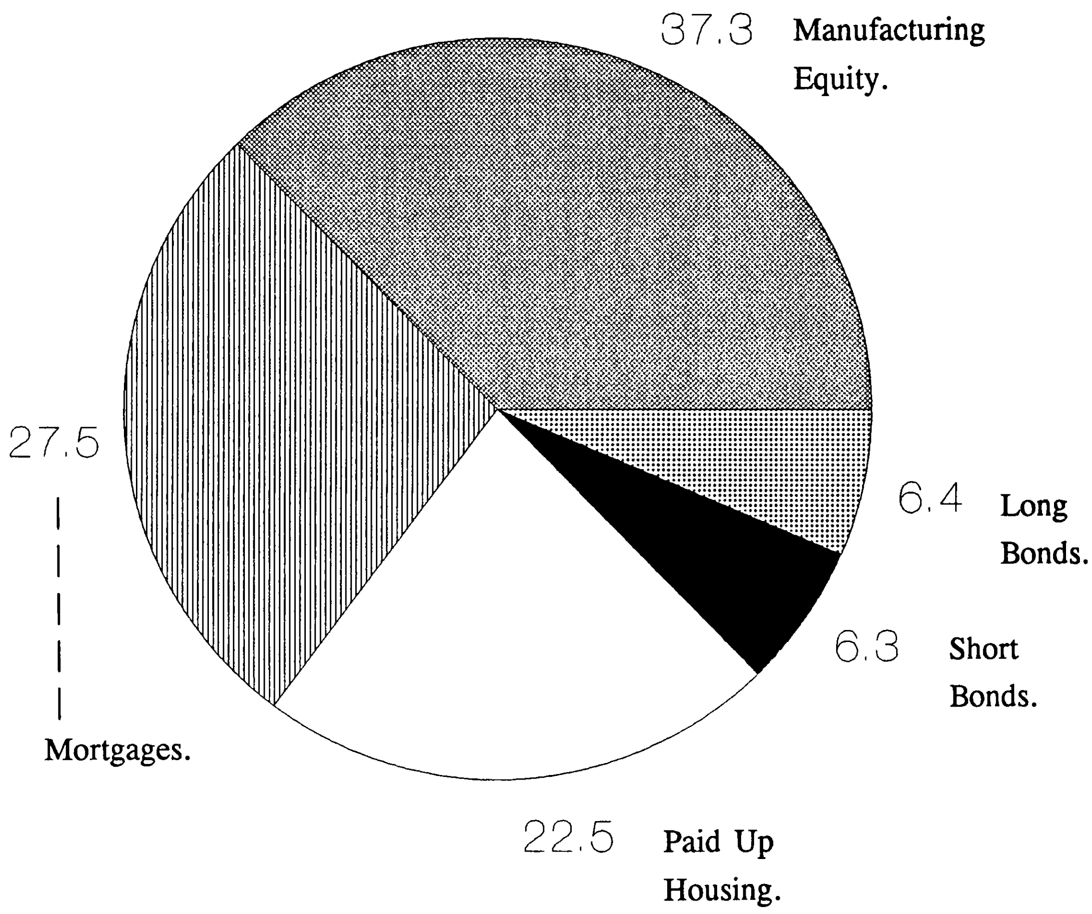
Individuals

Short bonds	2,842	Wealth	45,000
Long bonds	2,889	Mortgages	12,388
Equity	16,769		
Housing	22,500		
Mortgages	12,388		

Corporates

Capital	22,500	Short bonds	2,842
		Long bonds	2,889
		Equity	16,769

Figure 4.2. Initial Portfolio Asset Allocation.
Period 3 Model.



shift towards manufacturing assets, again, the assumed higher manufacturing income elasticity exerts prevalence. The real user cost of manufacturing capital falls to 40.41 %, an unusual reaction given our analysis contained in Section 4.3. The proportionate switch towards the manufacturing sector results, as expected, in a continually rising manufacturing user cost owing to rising risk premia. The final user cost is lower than the initial figure reported owing to the one off fall when the model changes from the relatively heavily taxed classical system to the imputation system. Thus the user cost begins at 44.94 % and rises to 45.18 % as a result of the increased risk premium, however the change to the imputation system causes an instant fall of 4.94 % from which level the path continues its upward momentum, ending at 40.41 %. The regime switch results in the tax parameter y becoming equal to 0.09, and compared to the user cost parameters prevalent under the classical system (reported in Section 4.4.2.) these are now lower with $\alpha_1 = 1.067$, $\alpha_2 = 0.554$, $\alpha_3 = 0.894$ and α_4 remaining unchanged.

Conversely, the real user cost of housing capital rises in absolute terms by 0.04 %, despite the housing share in the portfolio diminishing throughout the simulation. The user cost rises to a high of 4.7 % in order to equilibrate the market when the manufacturing tax change takes place, the final result culminates in the ratio reported to the user cost of manufacturing capital falling to 8.6. This reduction in the ratio is principally a result of the sharp decline in the manufacturing user cost which is also reflected against the user cost of mortgages. The mortgage market is not rationed although H^{ms}/W equals 24.6 % indicating that demand for mortgages can not rise much further without hitting this binding constraint. The loan to valuation ratio falls from around 55 % to 52 % which can be attributed to the relative fall in incomes compared to disposable income which rises as a percentage of output from 37.7 % to 40.7 %.

Tax paid by both the personal and corporate sector as a proportion of output fall, retained earnings remain constant and this results in the switch to disposable income reported above (equation (2.62)). The fall in the tax take arises because of the introduction of the imputation system with the biggest movement being the reduction of the personal tax bill owing to the dividend tax credit (see Section 1.10.8.2.). The reduction in the corporate tax bill arises from the assumption that under the classical system $\mu_{ke} = 0.5\tau$ which falls to $\mu_{ke} = \mu_p$, (an effective fall from 23 % to 15 %).

In conclusion, economic growth results in a general switch towards manufacturing assets, the ratio K/H rises from unity to 1.12 mainly as a result of manufacturing's higher assumed income elasticity and the switch to the imputation system of taxation.

4.4.4. General Inflation.

The results reported under the heading general inflation are the product of both economic growth and an increase in the general rate of prices throughout the economy from 4.7 % to 9 %, the average annual rise over the period. In this simulation we fix Wr to grow by 42 %, the rate of growth experienced in the previous simulation which enables the model to determine the risk free rate of interest, rather than Wr.

The model changes which occur are as follows, we rearrange equation (2.13) such that,

$$K = Wr - H, \qquad (4.1)$$

whilst it remains in the recursive block. An equation to determine the risk free rate of interest, i, is introduced which is a weighted average of the increase necessary to leave the respective real user costs of capital constant. That is, we force the risk free rate of interest to neutralise any effect on the real user cost of capital which otherwise would result from a change in inflation. For example, in the case of manufacturing we can write,

$$\alpha_1 i = \alpha_3 \pi^{ek} - UC_{ka}. \qquad (4.2)$$

Assuming that UC_{ka} is fixed then we can write the relationship between the risk free rate and inflation as,

$$i = (\alpha_3/\alpha_1)\pi^{ek}. \qquad (4.3)$$

The implicit user cost of capital elasticity for manufacturing is unity and for housing is n, thus we can weight the effects between the sectors such that,

$$i = i_s + \left[\frac{1}{1+n} \frac{\alpha_3}{\alpha_1} \dot{\pi}^{ek} + \frac{n}{1+n} \frac{\dot{\pi}^{eh}}{\beta_1} \right], \qquad (4.4)$$

where $\dot{\pi}^{ek}$ and $\dot{\pi}^{eh}$ represent the change in expected inflation and i_s represents the initial risk free rate (5.6 %).

We have effectively introduced to the model the possibility that, as a result of taxation, the Fisharian conclusion that $di/d\pi$ is equal to unity may not hold. Real interest rates may now vary, although Holland (1984) indicates that taxation is only one of many potential factors in the determination of real interest rates. The potential role of taxation on real interest rates is discussed further in Feldstein (1976) who criticises growth models in general for not allowing taxes to alter the cost of capital and for not exposing the effects on interest rates of inflation and taxation. Our model should therefore shed light on these issues, in particular how this affects capital intensity.

The parameters i_s and the change in inflation (an increase of 4.3 %) require to be introduced to the model and equation (4.4) is incorporated into the initialisation procedure between α_4 and UC_{ka}.

The results show that an increase in the general level of inflation encourages individuals to switch their portfolio allocation away from manufacturing assets towards housing which supports the general hypothesis (eg. Feldstein, 1982, pp. 305). The effect of inflation tends to reduce real interest rates through manufacturing taxation, $di/d\pi^{ek} = 0.77$ during the classical system and 0.84 in the imputation system. This contrasts with the work of HH (pp. 804) where they found $di/d\pi^{ek} = 1.25$, the difference arises from the much higher value for α_3 found in their model which results from their assumption of a 4 % CGT rate and our different treatment of investment allowances. On the other hand $di/d\pi^{eh} = 1.18$. The net effect on the real interest rate is that it falls by 0.25 % in the classical system and by only 0.1 % under the imputation system. This is marginal and conforms, despite theoretical logic, to Poterba's (1984, pp. 735) finding that empirical investigation frequently discovers that $di/d\pi \leq 1$.

General inflation results in $\epsilon_{3,K,\pi^e} = -0.08$ and $\epsilon_{3,H,\pi^e} = 0.07$ the difference principally arising because all capital gains resulting from increased inflation flow straight through to the user cost of housing and mortgages as no CGT has to be paid (also see Section 4.3.5.). While the reduction in the real interest rate reduces the value of the MIRAS subsidy it also reduces the manufacturers ability to offset interest payments against corporation tax thus the ratio UC_{ka}/UC_{ha} rises, consequently we find that $\epsilon_{3,(UC_{ka}/UC_{ha}),\pi^e} > 0$ which is consistent with the result $d(r_k/r_h)/d\pi^e < 0$ as argued in Ebrill and Possen (1982, pp. 37).

The loan to valuation ratio falls from 52 % to 50 %. The increase in general inflation feeds through to a reduction in the user cost of mortgages to a greater extent than housing because of the factors outlined in Section 4.3.5. and this is reflected in the user cost ratios. The effect of this is to increase H^{md} above H^{ms} and hence mortgage lenders are extending credit to the maximum (effectively mortgage demand faces the income binding constraint for the first time) given current income leading to a greater reliance on ownership of housing stock.

The effect on real cash flows is negligible although the relative reduction in manufacturing capital does cause output to fall slightly to £29,446m. Clearly CGT payments by both sectors rise but this is more than offset at the household level by the dramatic rise in MIRAS payments from 1 % to 1.7 % of total output caused by the interest rate increase. This feature is not incorporated in HH (see Section 2.3.1.5.).

Again these results, in part, differ from the model used by HH. For example, while corporate taxes fall in absolute terms owing to reduced profits this is by no means as substantial because of CGT. Indeed, the increase in inflation results in the corporates share of the tax burden rising proportionally. Retained earnings fall in absolute terms as a portion of the real gains made by companies at the expense of debtors is paid out and profits are reduced but this is negligible as a proportion to output. Unlike HH the absolute (and proportionate) movement of personal taxes is downwards not up because in our model individuals are not taxed on interest from bonds, the effects of the imputation system and our inclusion of MIRAS in cash flow calculations.

In conclusion, the effect of a rise in general inflation has been to shift capital resources towards the formation of housing, the majority of this has originated in paid up housing increasing as mortgage supply binds individuals demand. The net effect on real interest rates has been negligible and on the user cost of manufacturing capital to cut it slightly to 39.30 % while the user cost of housing fell by a greater proportion. In the model presented by Buckley and Ermisch (1982, pp. 281) they argued that a rise in the general rate of inflation would (with the stock of housing fixed) result in a disproportionately greater rise in house prices, our findings complement this by holding real prices constant and letting stock levels change, $\epsilon_{3,H^{pd},\pi^e}$ is positive and has a larger effect on portfolio asset allocation than the user cost of mortgages despite $\epsilon_{3,p_{H^{pd}},\pi^e} > 0$ because of the binding constraint. The inflationary environment encouraged households to borrow as much in the way of mortgage stock as lenders would supply at the given price. The ratio of K/H falls back to unity and clearly the general argument that taxation and inflation bias resource allocation towards housing (see Section 1.3.) is supported by our model.

4.4.5. Relative Price Inflation.

We stressed in Chapter 2 that one of the aims while constructing the model was to make it flexible, especially in terms of relative price effects which may play a part in a long run model if the cause is exogenous to the system (this issue is discussed in Section 2.2.1.). Moreover, real house price gains have been prevalent in the owner occupied sector and it would therefore seem appropriate to present results under such an environment. In the present simulation we increase the expected house price parameter to 10.75 %. That is, house prices are expected to rise by 1.75 % per annum in real terms. Expected price changes of corporate capital remain equal to the general rate of inflation. The actual real house price rise experienced over the period was 2.75 % per annum and consequently we increase the value of p (the real price of housing) by this figure. The real price of manufacturing output rose by 0.25 % per annum over the period and, like p, n is increased at this rate. We retain q at unity.

We discussed in Section 3.2.4.2. the actual rise in house prices over the period of interest and presented some evidence regarding real house price expectations produced by other authors. Increasing π^{eh} by 2.75 % per annum, the rise that actually occurred is probably overestimating expectations for two main reasons. The first is the hedonic (quality) issue discussed in the Section above and the second is the likelihood that the large gains over a few years in the 1970's would not be fully built into individuals long term expectations. Taking account of these points we have incorporated a figure in the lower range of Hughes (1988b, pp. 6) estimates but higher than his 1 % estimate (pp. 54). On the other hand p is increased by the full amount as this is what actually occurred and the change in n is incorporated for the same reason.

The data for expected manufacturing capital gains discussed in Section 3.2.4.3. was calculated over the period 1966 to 1979. Using the input price index as calculated in Section 3.2.4.1. we find that the average annual rise in P_I was 12.8 %. Utilising Kelly and Owen's (1985) methodology we scale this figure down to place it between the actual and Kelly and Owen's (1985) estimate of 5.3 %. We impose $\pi^{ek} = \pi^{e} = 9$ %, effectively a scaling factor of 30 % rather than the 50 % used by Kelly and Owen's (1985). This assumption, in some ways, side steps the debate of which is the relevant scaling factor.

We have stated that q fell substantially over the period (Section 3.2.4.2.) however HH (pp. 807) correctly point out that when introducing a fall in q in this type of model the reason for that fall is crucial. The main causes may be a result of inflation and taxation or because of market valuation errors, which would have a similar effect, or, events which reduce the productivity of existing capital such as an unanticipated change in factor prices and/or government intervention. Evidence regarding productivity changes are numerous (see Section 1.4.8.1.) and the difficulty in identifying the cause of the fall in q, or separating it from inflation and taxation factors is a weakness of the model. The effect of a reduction in q would be to reduce the user cost of manufacturing capital and/or reduce the real value of the stock of manufacturing capital. We follow the conclusion reached by HH (pp. 808) "Given the uncertainties regarding how the decline in q should be implemented and even its directional impact on capital allocation no simulation with this change has been run".

HH carry out further model alterations at this point (HH, equations 4" and 19, pp. 806) in order to introduce relative price effects. Their equations introduce the complexity of incorporating a housing supply elasticity (discussed in Section 2.2.1) and manufacturing and housing construction productivity parameters (a Table of productivity increases between manufacturing, construction and the whole economy for the U.K. is presented in Dickens *et al.* (1985, pp. 88)). Pursuing the changes made by HH has been rejected for the present study on the basis that the increased model complexity is unjustifiable especially when coupled with uncertainty regarding the quality of measurement of the necessary extra parameters.

In summary, expected house price inflation becomes positive in real terms, the real price of housing and manufacturing capital also rise while expected manufacturing prices remain constant along with q. The model structure remains unchanged from the previous simulation.

The results show a further increased swing towards housing assets, the ratio K/H becomes equal to 0.87 and $\epsilon_{3,(K/H),\pi^{eh}} < 0$. Again, the housing investment is directed towards paid up housing as lenders extend loan books as far as possible. For the first time $H^{pd} > H^{ml}$ and consequently the loan to valuation ratio drops to 41.5 % and the risk premium attached to paid up housing increases to 1.8 %. The real price rises have resulted in the total value of wealth increasing by 70.5 %. Ironically if we accept that consumption is to some extent influenced by wealth levels (Section 1.4.5.3.) then the present increase in wealth will boost consumption at a time when the ability of the economy to produce is diminished. A deterioration in the balance of payments is the obvious outcome of this scenario.

The rise in π^{eh} has resulted in an increase of just under 1 % in the risk free rate of interest under the classical system and by slightly less under the imputation system - effectively a reduction in the real rate of interest. While there has been a slight rise in the manufacturing real user cost of capital to 39.59 % (still marginally lower than the base run) this has been a result of the increase in the real price of inputs and the higher risk free rate. Countering this to some extent is the reduced risk premia attached to long bonds and equities.

While the increase in the risk free rate of interest increases UC_m this is more than compensated for by the increased price expectations, as a result UC_m falls as can be seen from the increase in the ratio UC_{ka}/UC_m. Similarly, the ratio UC_{ka}/UC_{ha} falls as the rise in the real price of housing input feeds through, (on a bigger number than UC_m) coupled with an increase in the risk free rate and a shift towards paid up housing which results in an increased risk premium, therefore the increased capital gains which reduces β_4 does not produce a reduced user cost of housing. The user cost of housing rises to 5.27 % despite the benefit of the increased inflation. Of course the real stock of the housing benefits from the rise in p.

In absolute terms the value of all assets increase, hence the wealth increase mentioned above. Total manufacturing output also rises to £30,974m and all real cash flows rise in absolute terms. Tax paid by households rises as the rates bill increases while taxes paid by corporates fall and MIRAS rises only slightly. The net effect is that disposable income falls slightly. Tax paid by corporates falls as the equity risk premium is reduced and bond interest offset against corporation tax increases.

4.4.6 Mortgage Rationing.

In order to complete the environment of the 1965 to 1979 period in our model it is necessary to introduce the effects of mortgage rationing. We have discussed the nature of mortgage rationing in Section 1.4.4.1., our incorporation of this within the model structure in Section 2.3.1.6. and 2.4.2.1. and parameterisation of Γ in Section 3.2.5.3. The introduction of mortgage rationing therefore only requires the reduction in Γ from 1 to 0.75.

Mortgage rationing tilts the individuals portfolio towards manufacturing capital, the ratio K/H becomes 0.94 while the total value of wealth falls to £76,121m and in absolute terms the value of all assets fall except paid up housing. The biggest portfolio shift has been away from mortgages, a fall of around 5 % and towards paid up housing, a rise of around 3 %. Individual and corporate balance sheets are presented in Figure 4.3 and the portfolio asset split of individuals in Figure 4.4. This simulation provides an opportunity to explore the mortgage market in greater detail. If we examine the individuals demand for mortgage stock as represented by equation (2.16') we find that the user cost of mortgages has fallen to such a low level (as a result of house price inflation and MIRAS) that demand is £55,225m, or 72.5 % of total wealth. Interest payments would equate to 26 % of the individuals pre tax income ($r_{H^{mb}}H^{mb}/(1-\alpha_k)Y$), which compares to a figure of just under 4 % at the end of the base run. Clearly lenders would be uneasy with aggregate debt levels so high. In a deregulated mortgage market they would supply (given pre tax incomes) £17,394m worth of mortgage stock (by equation (2.16)) or 22.8 % of total wealth. Imposing rationing by reducing the loan to income multiple in equation (2.16) (effectively a lengthening of the mortgage queue) takes the actual mortgage stock to £13,046m or 17.1 % of total wealth. Whilst rationing is significant, reducing the mortgage stock that would otherwise have been lent by one quarter, the largest discontinuity between mortgage demand and supply occurs as a result of the building societies optimal lending limits.

We can now broaden the results of this analysis by examining the effects of rationing on the whole model. Without any changes in taxation or inflation, economic growth results in the ratio K/H of 1.12, our relative price environment takes this ratio to 0.87 while rationing has offset this to a position closer to the values of 1965 (on a sector basis). Rationing has reduced a 29 % portfolio shift towards housing to one of a 19 % shift, in other words our model suggests that rationing offset about one third of the taxation and inflation bias during the period 1965-1979.

Compared to the previous simulation the user cost of housing rises relative to the user cost of manufacturing (which itself rises to 40.89 % principally resulting from higher risk premiums). The rise in the housing user cost results from the increased reliance of paid up housing whose risk premium is greater than the mortgage mark up (hence the large rise in β_1). More generally, the reduction in v as a result of rationing may directly increase or decrease the housing user cost depending on whether the mortgage mark up is greater or less than the paid up housing risk premium. The risk free rate is reduced slightly as β_1 rises in response to the reduction in the loan to valuation ratio which falls once again, this time reaching 33 %.

Figure 4.3. Final Balance Sheets (£m) of the Period 3 Model.

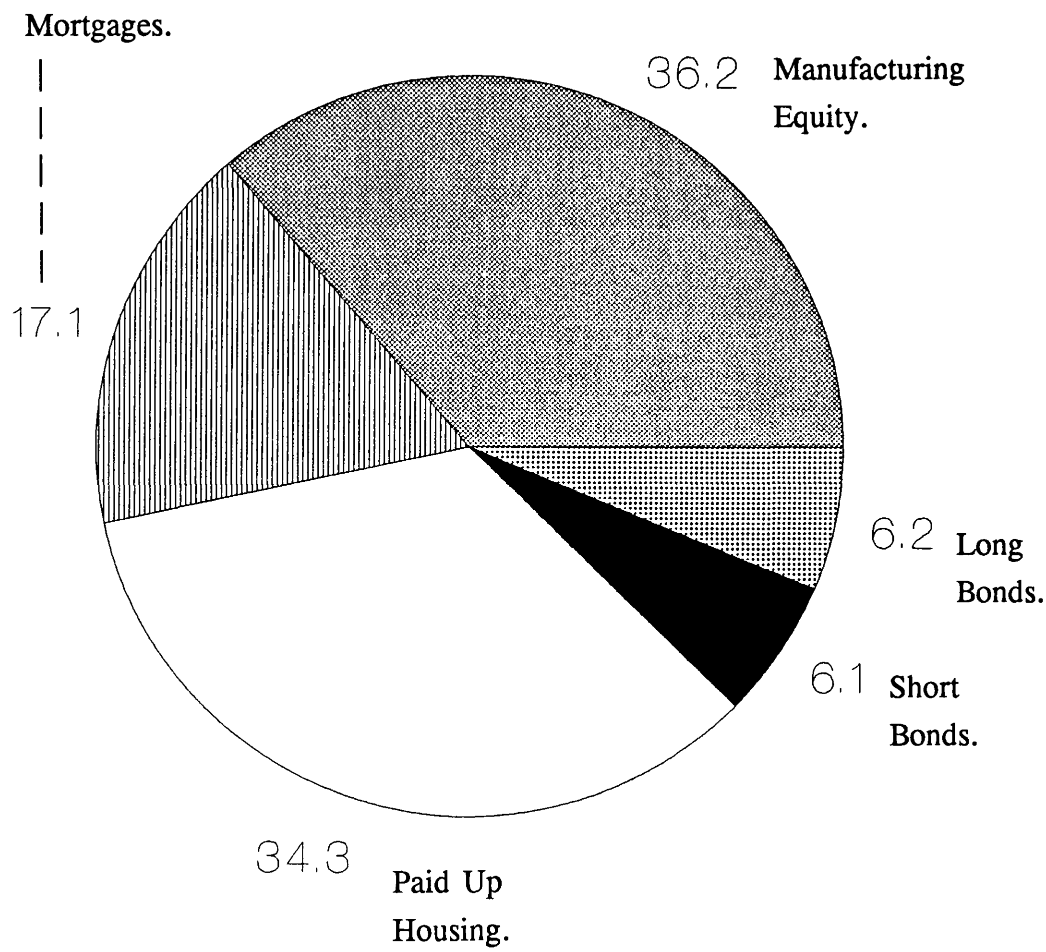
Individuals

Short bonds	4,674	Wealth	76,122
Long bonds	4,749	Mortgages	13,009
Equity	27,572		
Housing	39,127		
Mortgages	13,046		

Corporates

Capital	36,995	Short bonds	4,674
		Long bonds	4,749
		Equity	27,572

Figure 4.4. Final Portfolio Asset Allocation.
Period 3 Model.



Manufacturing output rises slightly to £31,502m and all real cash flows rise in absolute terms with the exception of MIRAS. The reduction in the quantity of mortgage loan stock and the mortgage rate reduces MIRAS significantly. In relative terms this falls from 1.9 % to 1.4 % and results in households paying relatively more tax than the previous simulation.

Compared to the growth simulation (Section 4.4.3.) the impact of relative price movements and mortgage rationing has been to engender a relative portfolio switch away from all assets towards paid up housing while at the same time the total value of real wealth has increased. The real user cost of housing has risen relatively owing to a higher housing risk premium and the lower loan to valuation ratio. On the other hand the user cost of mortgages has reduced in absolute and relative terms although this has had no effect on the stock of mortgages owing to rationing. All real cash flows have risen and as a proportion of output although these variables have remained remarkably constant in relation to each other although MIRAS has risen significantly.

Finally, we can compare some key variables to actuals over the period utilising data discussed in Chapter 3. During period 3 manufacturing capital stock rose by 73 % and for housing by just over 75 %. That is the ratio of K/H in reality was 0.97, in our model as we indicated above the ratio was 0.95. Over the period the average loan to valuation ratio was 24 % with the figure being 22 % in 1979. Our final figure of 33 % is close but suggest the model understated slightly the reduction in the proportionate stock of mortgages.

4.5. Adjusted Basic Model Simulations.

The present Section seeks to report results generated from a long run model which can be more fruitfully utilised in the analysis of policy simulations reported in Chapter 5. This is achieved by utilising the period 3 model and data as above but incorporating three key alterations. These are, fixing the risk free rate of interest, reducing the manufacturing equity variance to a more realistic level, and reducing real house price gains. Thus we are progressing from Section 4.4. where the objective was to produce results from a long run model parameterised to reflect that period. The results from the current Section therefore represent benchmarks for comparison with those discussed in Chapter 5 and are reported in Section E of the Results Appendix and follow a similar rationale to that described in Section 4.4.1. Given the similarity of these results to those reported in Section 4.4. it is unnecessary to describe each result to the same degree, but rather to expose the main differences and re-emphasise the general trends.

4.5.1. Model and Parameter Adjustments.

While the effect of maintaining the real user costs of capital constant in the face of altered inflation expectations provided an insight into the interest rate pressures resulting from taxation and inflation this mechanism has been replaced. Principally, this decision stems from the premise that international flows of funds increasingly dominate domestic interest rates throughout the world. In order to compare policy simulations, which should be forward looking, it will be easier to expose these by ensuring the real risk free interest rate is constant.

Over the period 1965 to 1979 the real risk free rate fluctuated greatly and was negative overall in real terms. This is not consistent with long run equilibria and we therefore impose a real rate of 0.9 %, the figure as at 1965, thus when general inflation rises to 9 % the risk free rate is 9.9 %. During our relative price simulations it is no longer necessary to weight the expected price series as the real user costs are not being kept constant. We therefore take the average of π^{ek} and π^{eh} which is 9.9 % and thus the risk free rate of interest is fixed at 10.8 %. The model changes consist of taking i out of the recursive block and to fixing it like any other parameter, determining i in the initialisation is also unnecessary.

We noted in Section 3.2.3.2. that the turbulent economic conditions during the 1970's had resulted in an unusually high manufacturing equity variance measure. Utilising this as a representation of the period is justifiable but this becomes difficult in a long run model. The long run figure found by Siegel and Kaplan (1989) (who utilise the same data source as the present study for $\sigma^2{}_E$) was 0.07, closer to our period 1 figure. This figure represents a more accurate long run measure and is used in the following simulations.

Following the same reasoning, we allowed the real value of the housing stock to rise by 2.75 % p.a. in the unadjusted model. Again this could be argued to be exceptional and therefore in the relative price simulations we reduce this increase to 1.75 % p.a., concomitant with house price inflation expectations.

Having introduced these alterations at the appropriate times in the initialisation procedure the model specific parameters, α_k, α_h, α_m and $Ç_{kl}$, were found and are reported in the Results Appendix Section E. The model was shocked such that the increase in output (Y) was equivalent to that reported in Section 4.4.3. Again, all parameters remained constant unless otherwise stated.

4.5.2. Summary of Results.

For comparison we present the initial balance sheet values in Figure 4.5. and the individuals portfolio asset split in Figure 4.6. The user cost of manufacturing capital has fallen to 23.62 %, solely as a result of the reduction in $\sigma^2{}_E$. This is reflected in the fall of α_2 to 0.235 in the classic system and 0.198 in the imputation system, the other parameters remain as reported in Section 4.4.2. More specifically, the risk premium required from manufacturing equity has fallen from 22.4 % to 10.5 %, a more realistic long run rate. The user cost of housing capital is 3.85 % and for mortgages is 2.96 %. Tax paid by the personal sector is £6,932m, while the manufacturing sector pays £1,366m. Retained earnings are £1,210m and MIRAS is £334m while disposable income is £11,214m.

The main difference in the model is the reduction in the real user cost of manufacturing capital, this also reduces the value of manufacturing's income share α_k. The indirect effect of this is to increase the loan to valuation ratio as individuals incomes rise. Naturally this shifts the proportion of tax paid further towards households although MIRAS rises by 39 %. These general shifts are maintained throughout the simulations, thus for example, although the loan to valuation ratio falls in all simulations its low is 49.6 % compared to 33.2 % in the unadjusted rationed run.

The extent of portfolio shifts (apart from the housing split) are similar and we find ϵ_{3,K,π^e} = -0.12 while ϵ_{3,H,π^e} rises to 0.12. The effect of fixing the real rate of interest is marginal, the largest divergence occurring in the rationed simulation. Similarly, the reduction in the rate of growth of the real value of the stock of housing has made little difference to asset allocation, primarily as the real user cost of housing capital rises less. We find that the elasticity $\epsilon_3(UC_{ka}/UC_{ha})/d\pi^e$ remains positive. Clearly the greater income share enjoyed by individuals has caused a significant increase in the ratio of net taxes paid by individuals compared to manufacturing. A similar effect is evident in all other real cash flows although directions of change match the unadjusted period. Figure 4.7. and 4.8. show the individuals balance sheet and portfolio asset split for the final simulation of the adjusted base model.

The key result of the model alterations is the reduction in α_k and the subsequent increase in all variables which are a function of individual income. The user cost of manufacturing is less sensitive to the cost of equity and the user cost ratio's generally fall. The ratio K/H becomes 0.97 in the final rationed simulation. As

Figure 4.5. Initial Balance Sheet (£m) of the Adjusted Period 3 Model.

Individuals

Short bonds	2,843	Wealth	45,000
Long bonds	2,888	Mortgages	11,214
Equity	16,769		
Housing	22,500		
Mortgages	11,214		

Corporates

Capital	22,500	Short bonds	2,843
		Long bonds	2,888
		Equity	16,769

Figure 4.6. Initial Portfolio Asset Allocation.
Adjusted Period 3 Model.

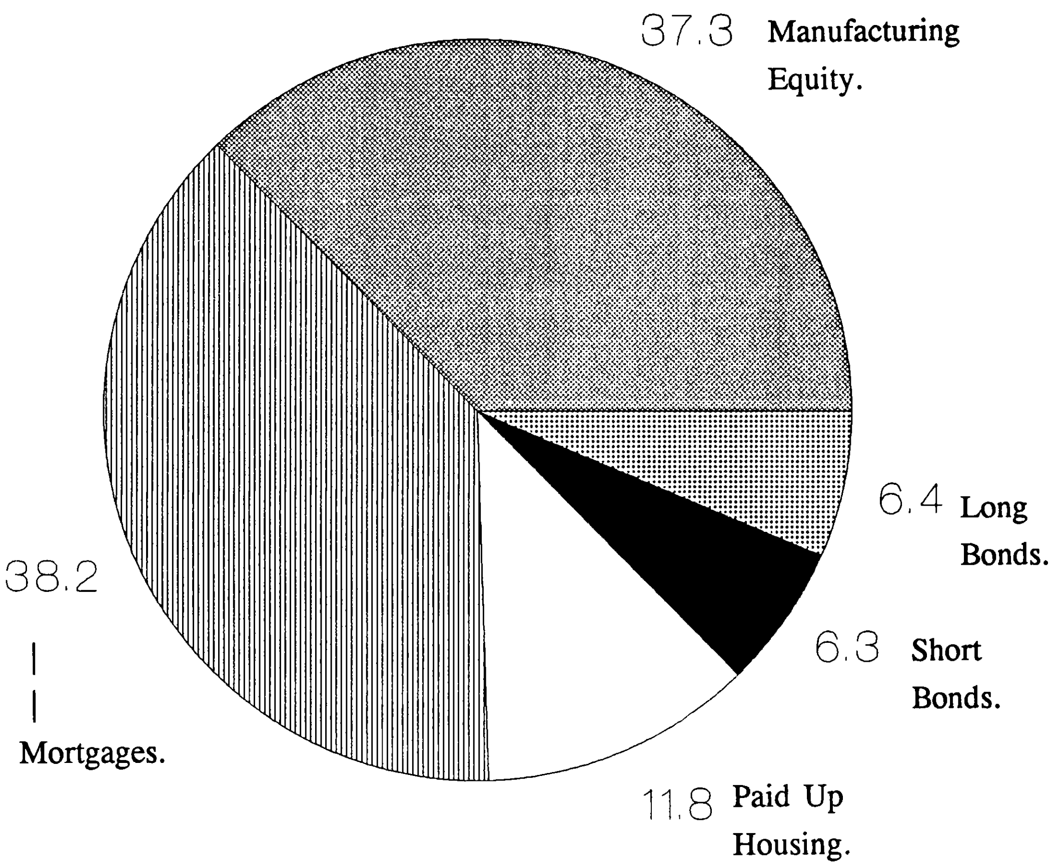


Figure 4.7. Final Balance Sheet (£m) of the Adjusted Period 3 Model.

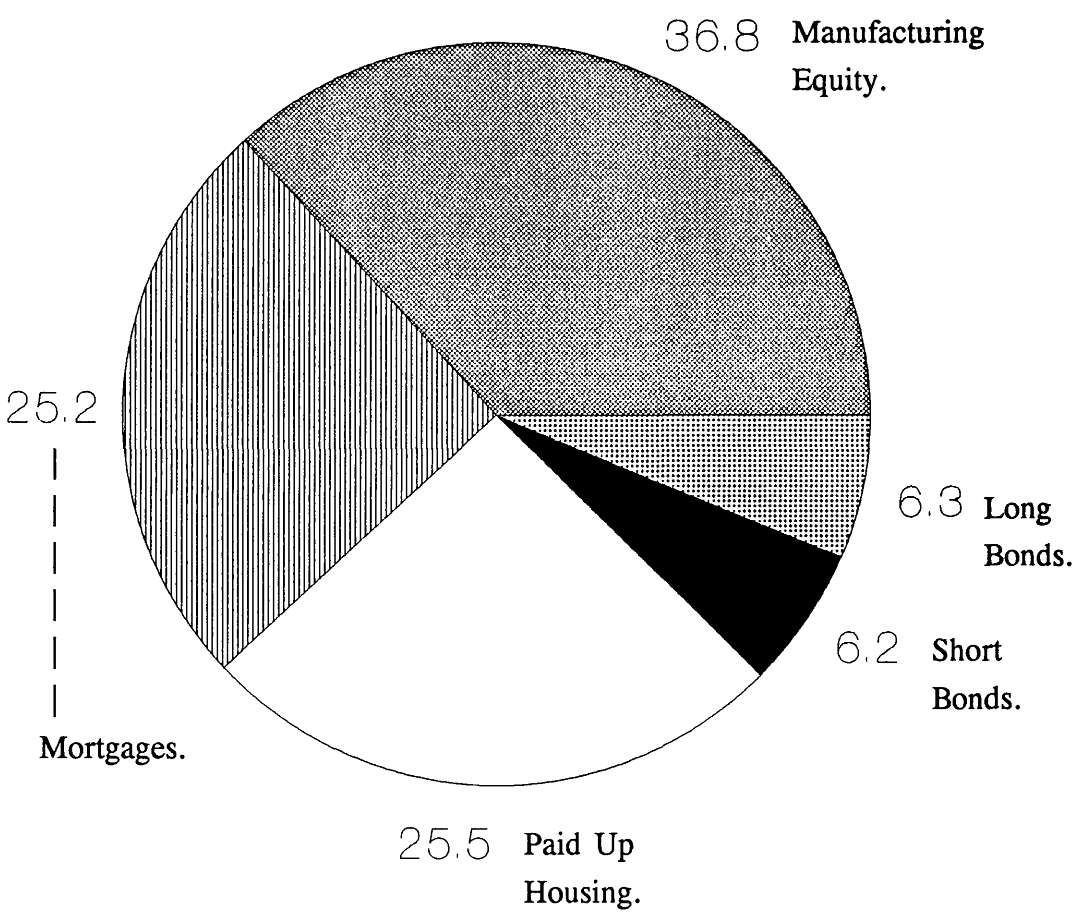
Individuals

Short bonds	4,339	Wealth	69,648
Long bonds	4,409	Mortgages	17,519
Equity	25,598		
Housing	35,302		
Mortgages	17,519		

Corporates

Capital	34,346	Short bonds	4,339
		Long bonds	4,409
		Equity	25,598

Figure 4.8. Final Portfolio Asset Allocation.
Adjusted Period 3 Model.



with the unadjusted model, we find that the elasticity $\epsilon_{3,(K/H),\pi^e}$, $\epsilon_{3,(K/H),\pi^{eh}}$ and $\epsilon_{3,(K/H),\Gamma}$ are all negative in both models. Greater familiarity with these results will occur as comparisons in Chapter 5 unfold.

4.6. Conclusion.

In the present Chapter we have discussed the methodology utilised in order to run comparative simulations with the basic model. The rationale for all results reported in the Results Appendix was provided and these were then utilised to explain the characteristics of the model. A selection of results were discussed which comparedsimulations to a base growth simulation as well as the differences arising from the period 1 and 2 environments. The selection of these results focussed on taxation, inflation, risk and capital markets. While comparing the results various methods of analysing the model were discussed when appropriate. The completion of this Section left us in a position to explore the simulations of the base model for period 3.

During period 3 simulations the model was cumulatively altered to demonstrate the effects of economic growth, general inflation, relative price inflation and mortgage rationing. The results were a general switch towards manufacturing followed by two successive portfolio switches towards housing with rationing correcting around one third of the bias. Anecdotal evidence in the form of actual real sector growth supports this assertion (Section 4.4.6.). In all simulations there was a reduction in the loan to valuation ratio, that is, paid up housing played an increasing part in individuals portfolio's, in particular, while the response of individuals to rationing was to increase K/H they also invested in housing increasingly by outright purchase (or by not reallocating gains made because of inflation). The real user cost of housing and manufacturing rose while the user cost of mortgages fell. Real cash flows tended to rise and remain relatively stable as a proportion of real output. Without rationing the allocative bias towards owner occupied housing would clearly have been worse, but even so there is a case for arguing that portfolio asset allocation could have contributed to the productivity slowdown (Section 1.4.8.1.). Indeed if we look back from the rationed to the unrationed state this is representative of the main change between the present model and one representative of the 1980's, taking the ratio K/H from 0.94 to 0.87, a trend witnessed in the 1980's.

The final set of results reported represent the basic period 3 model adjusted in order to provide a base which more accurately forms an environment with which to model and compare policy simulations in Chapter 5. Having explored the characteristics of the adjusted model we are now in a position to discuss and implement policy simulations centering around our discussions in Section 1.4.10.

5. POLICY SIMULATIONS.

5.1. Introduction.

The objective of the present Chapter is to utilise the model framework established in Section 4.5. in order to assess the main implications of a selection of alternative taxation policy reforms. The selection of such reforms is based on the discussion regarding the policy debate in each sector presented in Chapter 1 (Sections, 1.3.8.1. and 1.3.9.1.) and are designed to favour investment in the manufacturing sector and hopefully obtain a degree of fiscal neutrality across economic environments. In order to demonstrate the model's flexibility, while keeping the results reported manageable, a selection of four taxation reforms are presented. Prior to describing these, a discussion of the results format and model methodology is provided. We also describe various policy options which are not tax reform specific but give examples of alternative modelling ideas. We then present each of the four options modelled in turn, including the necessary model alterations. The policies actually modelled represent an eclectic mixture of plausible housing reforms and an example of reform of the taxation of manufacturing returns at both the personal and corporate level. The results are discussed for each set of simulations together in order to better facilitate comparative analysis. Finally, a discussion of the conclusions is presented.

5.2. Methodology.

The purpose of this Section is to outline the results format which relates to this Chapter and discuss some of the restrictions typically found when introducing policy switches into simulation models.

5.2.1. Results Format.

As described in Section 4.2.1.1. the model specific parameters (eg. α_k and α_h) remain constant throughout all policy simulations. The parameters are those derived from the adjusted model and are contained in Section E of the Results Appendix. The initial values of each policy simulation are presented in the first page of Section F of the Results Appendix to aid comparison and these are followed by the results of each policy simulation. The results follow a similar methodology to those used in Section D and E of the Results Appendix, described in Section 4.4.1. with the only addition being the inclusion of the real user cost of manufacturing parameters as these change if the manufacturing tax structure changes.

5.2.2. Limitations of Simulation Results.

We have argued that the model specification outlined in Chapter 2 and extended in Chapter 4 is relatively comprehensive and flexible, the results of which can be analysed in reasonable detail. As with any economic or econometric model our model does have limitations which qualify our results . The limitations of a computational simultaneous solution model such as the one presented in this research is touched on by Fullerton and Henderson (1987, pp. 426). Principally, the model accounts for the effect of policy changes on two sectors and five assets, but not the economy as a whole. We therefore omit the possibility of feedback from other areas of the economy such the as consumer sector. Like all models, in order to trace the origin of results a degree of simplification is required. Thus for example, a change in taxation policy which neutralised the corporates incentive to raise finance from debt (eg. the ACE system described in Section 5.3.4.) may result in the corporates debt to equity ratio (b) adjusting. Given this is not a model variable we cannot simulate any possible movement in b although we could impose a 'likely change' exogenously, but choose not to do so as institutional factors such as those discussed in Section 1.2.4.1.2. may well continue to exert a greater influence than purely tax efficiency. All of our policy simulations follow the growth, inflation and rationing paths of the base runs presented in Chapter 4. To maintain the comparative nature of the model we do not, for example, reduce the real house price gains in the face of a housing tax although this could easily be achieved. Finally, the policy changes implemented are not necessarily presented on the grounds of "fairness" or "simplicity" and may even represent extreme cases where a more pragmatic solution would achieve a result between the policy results as presented and the base case.

Other than the tax reforms presented the model runs are treated in the same way as the effective base simulations (discussed in Section 4.5.). The policy simulations are therefore conducted in a comparative manner with all changes clearly indicated.

5.3. Policy Options.

The object of the following Section is to outline the methodology of those policy options incorporated in this Chapter. The model's flexibility allows us to simulate most of the aggregate fiscal reforms for each sector discussed in Section's 1.4.10.3. and 1.4.10.9. Each policy reform could also be analysed with varying economic environments, for example, the low inflation, high real interest rate scenario typical of members of the Exchange Rate Mechanism in the late 1980's and early 1990's. For comparative reasons however we maintain the economic environment presented in Section 4.5. An obvious simulation may have been to look at the effects of the

Community Charge which not only reduces the user cost of housing, but would increase the general rate of inflation as a result of its inclusion in the retail price index as a non revenue neutral substitute for domestic rates (see Roseman, 1989). The transitory nature of this reform however precludes it from being of major interest. For the purposes of the present research four policy reforms have been chosen, two specific to the owner occupied sector and two relating to manufacturing. The subsequent discussion outlines in more detail the rationale underlying the reforms modelled and presents all structural model alterations and, if necessary, any parameter changes. The results are discussed in Section 5.4.

5.3.1. Abolition of MIRAS.

The key points to the debate regarding the abolition of MIRAS are contained in Section 1.3.8.2.1. This reform is of interest because MIRAS has been attributed by those expounding the reform of owner occupied taxation as a central problem of the fiscal treatment of housing, particularly when mixed with high inflation. It is also a practical policy option at the aggregate level (although some help for new entrants to the housing market may be justified) and one which is already taking effect as the real value of the relief diminishes thus avoiding the dichotomy between economic theory and political reality (see Section 1.4.3.). For simplicity and ease of comparison we have not assumed any reduction in the rate of income tax (the value of which would currently allow a reduction in the basic rate of income tax of 2.75 pence, Dilnot and Johnson (1992)) or the more preferable option of a direct subsidy or tax credit (Buckley and Ermisch, 1982, pp. 296).

The implications of applying this reform to our model are straightforward, equation (2.50) becomes,

$$r_{H^{mba}} = r_{H^{mb}}, \tag{5.1}$$

and therefore equation (2.51) can be written as,

$$r_{H^{mb}} = i + mp. \tag{5.2}$$

Substituting equation (5.2) into equation (2.49), after simplification, provides the required return from owner occupied housing as,

$$r_h = i + vmp + (1\text{-}v)R\sigma^2_{H^{pd}}H^{pd}/W. \tag{5.3}$$

Consequently the housing user cost parameters which enter directly into equation (2.53) become,

$$\beta_1 = 1,$$

$$\beta_2 = v,$$

$$\beta_3 = (1-v)R\sigma^2{}_{Hpd},$$

$$\beta_4 = \delta_h - \pi^{eh} + \Phi_h.$$

The user cost of mortgage stock also increases as a result of the exclusion of MIRAS, equation (2.17'') becomes,

$$UC_m = p\left[i + mp + \delta_h - \pi^{eh} + \Phi_h\right]. \tag{5.4}$$

The real taxation cash flow equations require to be altered to reflect the change in the taxation system. This involves the removal of the MIRAS term in the household tax equations, (2.56) and (2.57).

Other complementary changes to the model are the removal of the MIRAS equation (2.54), its initialisation and its presence in the recursive block. The model effectively determines one less variable and possesses one less equation.

5.3.2. Abolition of MIRAS and Tax Paid Up Housing.

The introduction of a tax on the value of a property or the associated land value has been discussed in Section 1.3.8.2.2. This option is regarded as more practical than the taxation of capital gains although less so than abolishing MIRAS because of the lack of actual cash flow. The flexibility of our model allows us to modify this in the manner suggested by King and Atkinson (1980, pp. 13), namely, to tax the imputed income from the non debt funded proportion of the house. This differs from most commentators who generally suggest taxing the imputed income from the entire market value of the house regardless of the households funding situation. Our simulation differs from King and Atkinson's (1980) proposal however in that we continue the abolition of MIRAS because maintaining MIRAS while taxing imputed income on the proportion of the house which is not financed by debt would further distort the choice of funding towards debt. As it is, our policy is effectively providing tax relief on that part of the housing stock which would otherwise be subject to income tax. Such a system would break the link between housing investment (particularly through debt), inflation and taxation while providing some help to those who are highly geared (many of whom will be at early stages of the housing ladder).

Maintaining rates which are also a function of a house's market value does not represent an inconsistency as tenants in the rental sector were also subject to this tax (King and Atkinson, 1980, pp, 13). We assume that imputed income is 4 % of the value of the paid up house which is slightly higher than the typical policy figures quoted in Section 1.3.8.2.2. as a consequence of the debt/paid up polarisation which effectively reduces the tax base.

The impact of this policy on the model is as follows. Equations (5.1) and (5.2) continue to hold as in Section 5.3.1. We introduce a new parameter, IY, which represents that proportion of the imputed income which is assumed to arise from fully paid up housing stock (IY is assumed to equal 4 % as discussed above). The difference between the post ($r_{H^{pda}}$) and pre tax return from paid up housing can be written as,

$$r_{H^{pda}} = (1-\Theta IY)r_{H^{pd}}. \tag{5.5}$$

Thus equation (2.51') becomes,

$$r_{H^{pd}} = \left[i + R\sigma^2_{H^{pd}}\, H^{pd}/W\right]/(1-\Theta IY). \tag{5.6}$$

Incorporating equations (5.6) and (5.2) into the total required return from housing, (equation (2.52)) and simplifying we obtain the new user cost parameters,

$$\beta_1 = v + (1-v)/(1-\Theta IY),$$

$$\beta_2 = v,$$

$$\beta_3 = \left[(1-v)R\sigma^2_{H^{pd}}\right]/(1-\Theta IY),$$

$$\beta_4 = \delta_h - \pi^{eh} + \Phi_h.$$

The user cost of mortgage stock remains equal to equation (5.4). Again the real cash flow equations to be affected are those defining household taxation. This additional tax takes the form (1-v)ΘIYpH and with MIRAS excluded we can show the changes under the classical system, for example, by rewriting equation (2.56) as,

$$TX_{hc} = \Theta(Y - \delta_k K - TX_k - RE)$$

$$+ \mu_p(RE + \pi^{ek}qE) + (\Phi_h + (1\text{-}v)\ \Theta IY)pH, \qquad (5.7)$$

the same changes are made to TX_{hi}. Changes to the model are the same as those discussed in Section 5.3.1. with the alteration of the relevant equations and declaration of IY representing the only additional modifications.

5.3.3. Super Personal Equity Plan

We now move to the taxation of manufacturing returns, in this case focusing on the taxation of the individual. The Super Personal Equity Plan (PEP) is a method of abolishing taxes paid by the personal sector on manufacturing investment returns. We have already assumed that the return from bonds are tax free (Section 2.4.6.2.) and thus we concentrate on equities. The regime is closer to the imputation system than the classical system but capital gains are not taxed twice. An other way of looking at this policy is that we utilise the user cost of manufacturing capital to the corporate, UC_k.

This simulation is also of particular interest as it effectively models the investment allocation decisions of tax free investment vehicles such as pension or life assurance funds. This taxation regime therefore is of interest given the possibility of alternative tax bases, pointed out by Ermisch (1988) (see Section 2.2.2.). Finally, it would also be simple to incorporate the assumption that only a proportion of individuals returns from manufacturing are tax free (the actual position of PEP's at the moment) although this is not incorporated in the present study and therefore the current and base simulations offer boundary limits to contemporary policy.

The absence of taxation at the personal sector level on manufacturing equity means that

$$r_{Ea} = r_E. \qquad (5.8)$$

Although UC_k is represented by equation (2.39), this requires to be modified to allow for the tax deductability of corporate interest payments and the split between short and long dated debt and equity. We therefore continue to utilise equation (2.45), given that $UC_{ka} = UC_k$, the required return from the manufacturing capital, $b(r_B) + (1\text{-}b)r_E$ becomes,

$$r_k = i + \left[b(1\text{-}z)R\sigma^2{}_{Lb} + (1\text{-}b)R\sigma^2{}_E\right] qK/W. \qquad (5.9)$$

Substituting (5.9) into (2.45) provides corporate user cost parameters of,

$$\alpha_1 = (1\text{-A})b + (1\text{-A})(1\text{-b})/(1\text{-}\tau),$$

$$\alpha_2 = \left[b(1\text{-z})R\sigma^2{}_{Lb} + (1\text{-b})\ R\sigma^2{}_E\right]\ (1\text{-A})/(1\text{-}\tau),$$

$$\alpha_3 = \left[(1\text{-A})\ (1\text{-}\mu_{ke})\right]/(1\text{-}\tau),$$

$$\alpha_4 = (1\text{-A})/(1\text{-}\tau)\delta_k + \Phi_k.$$

We maintain the classical system assumption that $\mu_{ke} = (0.5)\tau$ rather than μ_p on the basis that the government is likely to be less generous in the taxation of corporates in order to recover some revenue. This rationale could extend to a reduction in A although this is not assumed in the present simulations.

Taxation paid by corporates in cash flow terms is equivalent to equation (2.55). Again, as the changes are at the personal sector level we require to respecify the taxation cash flow paid by households which is reduced by the inclusion of tax free dividends and the exclusion of capital gains payments, thus,

$$TX_h = \Theta(Y\text{-}\delta_k K - TX_k - RE - Dnd)$$

$$- MIRAS + \Phi pH. \qquad (5.10)$$

Apart from the above model changes, the other major difference is that there is no change of taxation regime during the simulation.

5.3.4. Allowance for Corporate Equity.

The Allowance for Corporate Equity (ACE) system is based on a proposal by the Capital Taxes Group of the Institute for Fiscal Studies (IFS). The complete system is reported in IFS (1991) and the following regime represents a simplification of one of the main taxation outcomes of the study. As the name suggests, the central concept is to put corporate equity on a similar footing with debt in that an allowance set against corporation tax can be made for the cost of equity finance. The result is that the corporate becomes unconcerned as to its source of finance. The IFS argue (IFS, 1991, pp. 4) that this removes the need for the imputation of corporation tax to the owners of that capital. In reality, the actual user cost of capital may rise or fall depending on any changes in the rules regarding investment allowances and capital gains tax.

The present modelling exercise focuses on the taxation of the corporate rather than the personal sector. Although this modification could be carried out in a PEP environment (see IFS, 1991, pp. 6) we shall assume that the classical system remains thus adding to the comparative nature of the results. We also assume that capital gains allowances against corporation tax are withdrawn and consequently $\mu_k = \tau$. This assumption does not induce us to impose the relationship b = 0.5 because of the capital market information problems discussed in Section 1.2.4.1.1.

The concept and practicalities of the allowance are such that companies can deduct the opportunity cost to the shareholders of the capital invested in the company just as if it had been lent to it. In practical terms this means calculating notional interest payments made at the real interest rate on the current value of shareholders funds. The matter is not therefore as straight forward as to allow the total cost, r_E, to be offset against corporation tax, not least as the market value of the firm can differ substantially from the capital invested in it as represented by shareholders funds and accumulated retained earnings.

As a practical solution, the IFS (1991, pp. 27) suggest that the equity allowance be measured by a suitable proxy, a medium-term gilt. We define the return obtained from such a gilt, r_G, as,

$$r_G = i + gp, \tag{5.11}$$

where gp represents the premium over the risk free rate required from a gilt edged security. We shall assume that the gilt premium is equal to the corporate long debt premium in 1965, thus

$$gp = b(1-z)R\sigma^2{}_{Lb}(K/W), \tag{5.12}$$

which equals 0.5 %. That gp < mp is supported by inspection of the mortgage rate and the yield on 20 year gilts (see Economic Trends, 1990, pp. 213).

In the model the required return from equity becomes r_E - r_G. The difference between r_E and r_{Ea} remains that of the classical system and we can therefore re-write r_E by utilising equation (2.43) and introducing r_G, thus,

$$r_E = \left[i-\phi(\Theta-\mu_p)\pi^{ek}+R\sigma^2{}_E qE/W\right]/(1-x) - r_G. \tag{5.13}$$

Substituting (5.13) into equation (2.44) (ignoring the classical subscript as this becomes irrelevant) then we find that the user cost parameters become,

$$\alpha_1 = (1\text{-}A)b + \left[(1\text{-}A)(1\text{-}b)/(1\text{-}x)(1\text{-}\tau)\right]$$

$$- (1\text{-}A)(1\text{-}b)/(1\text{-}\tau),$$

$$\alpha_2 = (1\text{-}A)(1\text{-}z)bR\sigma^2{}_{Lb} +$$

$$\left[(1\text{-}A)(1\text{-}b)R\sigma^2{}_{E}/(1\text{-}x)(1\text{-}\tau)\right],$$

$$\alpha_3 = \left[(1\text{-}A)(1\text{-}\mu_k) + \phi(1\text{-}A)(1\text{-}b)(\Theta\text{-}\mu_p)/\right.$$

$$\left.(1\text{-}x)\right]/(1\text{-}\tau),$$

$$\alpha_4 = (1\text{-}A)(1\text{-}\tau)\delta_k + \Phi_k - (1\text{-}A)(1\text{-}b)gp/(1\text{-}\tau).$$

On this occasion it is the manufacturing taxation cash flow which requires to be altered. Manufacturing tax payments are reduced by offsetting r_G against corporation tax. The corporate tax payment becomes,

$$TX_k = \tau\left[\alpha_k Y\text{-}(\delta_k + br_B + (1\text{-}b)r_G\right.$$

$$\left.\text{-}(1\text{-}\tau)\Phi_k + \Omega A)K\right] + \mu_k \pi^{ek} K. \qquad (5.14)$$

As with equation (2.55) Dnd has no representation as this is similar to the classical system.

In summary, the required model changes include the equation respecifications displayed above, the declaration of gp and its parameterisation. The CGT rate is also increased and like the Super PEP simulation, one corporate tax system exists throughout the simulation.

5.4. Results Format.

The results of each simulation in this Chapter can stand alone in comparison with the base run (the adjusted model presented in Section 4.5.). However, it is more fruitful to analyse these as competing policies. To facilitate this we shall compare the results of the four policy regimes using a natural division of the results. The first Section is perhaps the main one of the study, namely the portfolio asset allocations. Following this, we shall interpret and compare the real user costs, the user cost parameters, and finally the real cash flow outcomes of the policies.

5.4.1. Portfolio Asset Allocation.

At the sectoral level each policy should result in a shift of resources towards manufacturing away from owner occupied housing compared to the base run. It is possible to obtain the opposite allocative shift, but in the present framework we would not expect the relative housing share to increase as each policy is designed to favour such a shift. Table 5.1 complements the portfolio asset results by providing the sector split K/H for each simulation under the separate policy regimes. As we would expect, the condition $K/H_{base}/K/H_{ps} \leq 1$ holds (where the subscript ps represents a policy simulation).

In relative terms the largest sectoral re-allocation occurs when MIRAS is excluded and imputed housing income is taxed, although excluding MIRAS alone has an almost equally powerful effect. Under these conditions the higher taxation (lack of subsidy) of housing, the higher income elasticity of manufacturing and a constant real rate of interest reduce the attractiveness of housing as an investment, even under inflationary conditions. Consequently we find $\epsilon_{3,H^{ml},\pi^e}$ and $\epsilon_{3,H^{pd},\pi^e} < 0$, a change of sign from the base model. The bias in favour of housing owing to the combination of taxation and inflation has been reversed. Factors such as the real gain made by manufacturing at the expense of debt holders now have more effect in helping manufacturing investment when inflation rises. Rationing under both housing taxation policies had no effect on the results as $H^{md} < H^{ms}$ throughout all economic environments.

The exclusion of MIRAS has resulted in a voluntary fall in v, that is a switch away from the mortgage asset towards all other assets. This naturally increases the risk premium attached to other assets. For example p_E rises from 8.32 % in the growth simulation of the adjusted model to 9.09 % and $p_{H^{pd}}$ similarly rises by 0.12 % to 0.79 %. By the final run of the respective simulations, p_E has risen to 9.28 % compared to 7.71 % in the base run while $p_{H^{pd}}$ has fallen from 1.46 % to 1.04 % reflecting manufacturing's increased dominance as inflation rises. When imputed income is taxed the switch is completely towards manufacturing assets and v rises as we would expect. Again, a similar pattern of risk premia responses is evident, though slightly magnified. At the base level, the growth environment p_E becomes equal to 9.11 % while $p_{H^{pd}}$ is 0.76 % and these figures diverge at the final run, becoming 9.4 % and 1 % respectively. Although v is higher under the relative inflation simulation compared to the base rationed case, this is because the demand for paid up housing is lowered in this policy simulation. Finally, the ratio of mortgages to paid up housing is relatively unchanged across the base, Super PEP and ACE simulations.

Table 5.1. K/H Matrix.

	Growth	General Inflation	Relative Inflation	Rationing
Base run	1.13	0.91	0.82	0.97
Exclude MIRAS	1.38	1.65	1.46	-
Tax imputed income and exclude MIRAS	1.40	1.67	1.49	-
Super PEP	1.17	0.92	0.82	0.97
ACE System	1.20	0.93	0.83	0.99

The relative effects of the Super PEP and ACE systems also encouraged greater investment in manufacturing, particularly the ACE system. The magnitude of this swing is reduced as inflation is introduced into the system (we have increased manufacturing CGT particularly in the ACE system). We find the elasticity ϵ_{3,H,π^e} becomes positive again and the boost to manufacturing investment is therefore dependent on a low and stable inflation environment. That is, there has not been a total offset of the link between inflation and housing investment and therefore these policies, while promoting manufacturing investment under low and stable inflationary conditions, cannot compete with the favorable taxation of housing as inflation rises. There are two further points which should be noted when analysing the allocative impact of the manufacturing policies. Generally, the change in allocation would have been greater if the classical system of taxation had been prevalent throughout. As it is, there is no boost to manufacturing investment during the period which the introduction of the imputation system gave in the base runs. More specific to each policy, while the Super PEP reduces tax to the personal sector there is no reduction in the CGT rate from 23.36 % to 15 % for manufacturing as with the base run. Similarly, we utilised the ACE system to equate the taxation of income and capital gains at the corporate level, thus CGT paid rose significantly, being levied at 46.27 % over the entire period. For example, this latter effect would have increased manufacturing CGT paid in the final simulation of the base run from £428m to £1,321m (using, $\mu_k \pi^{ek} K$), a three fold increase. Had CGT in both systems not been made more restrictive, the allocative impact of inflation towards housing would not have been so large, and may have been reversed under the ACE system.

Each asset elasticity with respect to the general rate of inflation changes sign compared to the same base run simulation in the first two policy switches. For example, in the exclusion of MIRAS simulation ϵ_{3,E,π^e} becomes 0.08 compared to -0.12 and $\epsilon_{3,H^{ml},\pi^e}$ falls to -0.12 compared to 0.04. General inflation also changes the sign of ϵ_{3,V,π^e} from negative in the base run to slightly positive and results from the user cost of mortgages falling slightly faster than the general housing user cost. When imputed income is also taxed, the signs remain the same as the simulation excluding MIRAS. The magnitudes also remain similar with the obvious change being the increase of $\epsilon_{3,H^{pd},\pi^e}$ from -0.13 to -0.14 when imputed income is taxed. The advantage conferred to manufacturing equities of the latter two policy switches is ineffectual under conditions of general inflation and real housing inflation. Indeed in the ACE system ϵ_{3,E,π^e} rises to -0.14 from -0.12 principally as a result of our CGT assumptions which explains the higher than base K/H at the growth simulation which becomes almost equal to the base simulation by the time rationing is introduced.

Under the manufacturing policy regimes rationing, like the base run, constrains the equilibrium mortgage stock. The final simulation produces an almost exact match between the base portfolio and the Super PEP portfolio. The ACE system is also similar although the distribution between H^{pd} and manufacturing assets is skewed towards manufacturing.

5.4.2. Real User Costs of Capital.

Throughout all of our policy simulations we find that $UC_{ka} > UC_{ha}$ and $UC_{ka} > UC_m$. We can therefore assume that if a taxation regime reduces either or both ratio's UC_{ka}/UC_{ha} and UC_{ka}/UC_m then the tax system is reducing the allocative bias towards housing. Whether it is optimal for this ratio to converge as a result of UC_{ka} falling, UC_{ha} or UC_m rising, or both, is a separate issue.

As expected the ratios are lower, for equivalent shocks, in all policy regimes compared to the base simulation and in general the ratio's move together. Table 5.2 is presented in order to clearly demonstrate the effect of alternative policies on the user cost of capital, particularly as inflation rises. The main divergence from the base simulation occurs during the housing policy simulations when the user cost of mortgages does not fall when inflation rises as in the base runs because the MIRAS subsidy is excluded and the real rate of interest is constant. The mortgage rate rises from 4.7 % in the growth simulation base run to 6.6 % when MIRAS is excluded. UC_{ha} rises by 1.5 % while UC_m follows a similar pattern, rising by 1.9 %. Very little separates UC_{ha} and UC_m under these conditions, the only important change being that $p_{H^{pd}} >$ mp (ie. β_3pH/W $>$ $\beta_2$mp). This margin widens again as the taxation of imputed income is introduced and produces the smallest ratios of UC_{ka}/UC_{ha} despite the rise in p_E. The effect of taxing imputed income is to increase the required return from paid up housing under the growth simulation from 6.27 % to 6.46 % (using equations (5.52') and (5.57)).

Introducing general inflation we find, unsurprisingly, that $\epsilon_{3,(UC_{ka}/UC_{ha}),\pi^e} > 0$ and $\epsilon_{3,(UC_{ka}/UC_{ha}),(\pi^{eh}-\pi^e)} < 0$ over all simulations. The same signs are prevalent during the base, Super PEP and ACE simulations although $\epsilon_{3,(UC_{ka}/UC_m),(\pi^{eh}-\pi^e)}$ looks relatively large at over 7 in the base, Super PEP and ACE simulations the user cost of mortgages is actually ineffectual in the model, as individuals face a binding constraint and consequently using this elasticity would be misleading. This latter trend is not reflected in the housing policy simulations although the elasticity with respect to π^e is positive it is significantly smaller at 0.08 for the excluding MIRAS simulation compared to 0.79 for the base simulation. Similarly, the elasticity of the ratio UC_{ka}/UC_m with respect to real house prices becomes equal to -

Table 5.2. Real User Cost Paths (%).

	Growth	General Inflation	Relative Inflation	Rationing
Base run				
UC_{ka}	21.66	21.35	22.54	23.41
UC_{ha}	3.86	3.26	3.64	4.18
UC_{m}	2.96	1.69	0.74	N/C
Exclude MIRAS				
UC_{ka}	22.64	24.21	25.45	N/C
UC_{ha}	5.35	5.27	5.92	N/C
UC_{m}	4.90	N/C	5.16	N/C
Tax imputed income and exclude MIRAS				
UC_{ka}	22.67	24.29	25.57	N/C
UC_{ha}	5.38	5.32	6.00	N/C
UC_{m}	4.90	N/C	5.16	N/C
Super PEP				
UC_{ka}	20.89	20.28	21.39	22.20
UC_{ha}	3.85	3.25	3.63	4.17
UC_{m}	2.96	1.69	0.74	N/C
ACE System				
UC_{ka}	20.82	18.14	18.48	19.51
UC_{ha}	3.82	3.22	3.60	4.13
UC_{m}	2.96	1.69	0.74	N/C

0.01 during the abolition of MIRAS simulation as opposed to -0.2 in the base period. This highlights the importance MIRAS played in determining UC_m and consequently the significant effects which can be achieved if the MIRAS subsidy is eliminated. On the other hand the advantages of the ACE system over the Super PEP as inflation rises are clear. The ratio UC_{ka}/UC_{ha} are greater under the ACE system at the initial and growth simulation stage but as inflation increases this trend reverses.

5.4.3. Real User Cost of Capital Parameters

The purpose of this Section is to utilise the user cost of capital parameters to further elucidate the effect the tax reforms have on the real user costs. β_1 to β_3 inclusive are of course variables in the model where as β_4 and α_1 to α_4 are parameters. Naturally changes in the taxation of owner occupied housing will not effect α_1 to α_4 and changes in manufacturing tax will not effect β_4 while any effect on β_1 to β_3 should be slight.

The main determinant in any changes of β_1 to β_3 derives as a result of a movement in the loan to valuation ratio. As v falls (its typical trend in the present simulations) β_1 rises along with β_3 while β_2 falls. As we would expect the elimination of MIRAS raises β_1 to β_3 over all simulations, the latter rising not because of any direct tax implications but as a result of the subsequent fall in v. Additionally, taxing imputed income results in β_1 to β_3 rising even further. In this case, although v actually rises relative to the MIRAS exclusion simulation (which would tend to reduce β_3) the tax on imputed income is enough to result in a rise in β_3. None of the taxation reforms effects depreciation, capital gains or rates and therefore β_4 remains unchanged for tax reasons compared to base over all policy simulations.

Turning to the effects of the reforms of manufacturing taxation. The effects on β_1 to β_4 are minimal for both the Super PEP and the ACE reforms. Under the Super PEP case all α's except α_4 fall and under the ACE system all fall with the exception of α_2. Taking the Super PEP case, the exclusion of personal taxation of manufacturing returns effects the structure of α_1 and α_2 and the CGT term in α_3. We can tell from the fall in α_3 that the effective rise in μ_{ke} has a greater bearing than the elimination of personal CGT (which would increase α_3) for this particular parameter. The proportionate reduction in the user cost as a result of the elimination of capital gains to the individual is around 11 % of the base figure. On the other hand the reductions in α_1 and α_2 are more than double this number. The net effect is a small reduction in the user cost of manufacturing capital in absolute terms (just over 1 % in most simulations).

The effect of the ACE system is slightly greater than the Super PEP albeit in different areas. The largest change is the almost two thirds reduction in α_1 and the slightly less substantial fall of α_4. The latter term falls as the gilt premium enters this equation. Like the Super PEP, the fall in α_3 as a result of an increase in CGT to the corporate acts to increase the user cost. Manufacturing CGT is most severe in this reform and as the structure of α_3 does not change its fall is solely a result of the effective CGT increase. The equality of corporation and CGT makes the firm indifferent to making returns in the form of capital gains or income and is complementary to an allowance for corporate equity. The split between manufacturing and housing would be more in favour of the former if the policy towards CGT remained unchanged and α_3 would be equivalent to the base run. The ACE system, despite this, lowers the user cost below that achieved under the Super PEP regime.

5.4.4. Real Cash Flows.

The most noticeable cash flow offset across the policy reforms is the absence of MIRAS in the first two sets of policy. This reduces the elasticity of household tax with respect to inflation from a base measure of -0.05 to 0.02. When imputed income is also taxed the elasticity rises marginally. The elasticity with respect to real house prices is positive and almost equal with the base run. As a result of the exclusion of MIRAS and the taxation of imputed income individuals disposable income falls by between one and two percent in real terms depending on the economic conditions.

The effect on manufacturing policy displays the essence of the tax incidence of the Super PEP and ACE system. As we would expect the proportion of household taxation paid falls with the introduction of the Super PEP but as the size of manufacturing capital stock rises, tax paid by this sector also increases. Although the government balance falls in absolute terms there is a clear shift of incidence towards corporates, a pattern which is reversed when corporates can offset the cost of equity. We should note that the rationing which occurs in both of these simulations restrains the incidence shift. MIRAS remains constant throughout as a proportion of income for both of these policies. While the Super PEP is more favourable with respect to individual disposable income, both regimes result in this falling compared to the base run.

An important result is contained in the relative cash flow movements in the face of general inflation during the manufacturing tax policies. If we compare the base elasticity, $\epsilon_{3,(TX_h/TX_k),\pi^e}$, which is -0.15 to the same elasticity under the Super

PEP this becomes -1.11. Under the ACE system however this falls back to -0.23 and would be closer to zero but for the high corporate CGT. With the ACE system we can identify a policy which, although it does not subsidise corporate cash flow as inflation rises, it at least allows some cash flow offset compared to the Super PEP. Retained earnings are also much higher under the ACE system. This result is significant in a state where MIRAS must exist in some form, if MIRAS were abolished then the addition of a policy such as the Super PEP would be more complementary and the tax incidence become more favorable to manufacturing.

5.5. Conclusion.

The results reported above represent a fraction of possible tax reforms which could be imposed in our model. Within these further alterations could be made, for example under the ACE system where the bias to financing through debt or equity is eliminated we may have imposed b = 0.5. Similarly, under the Super PEP case where the individual becomes indifferent between returns in the form of capital gains or income we may have wished to impose $\phi = 0.5$.

Having parameterised the model for the period covering the late 1960's and 1970's this allows us to present comparative static (or "what if ?") conclusions. Owing to the multiple corporation tax systems, and the obvious importance of this period in terms of the sectors relative performance, coupled with the varied economic environment, this period is particularly fruitful for assessing taxation systems. The results are not strictly time specific as general features of each regime will, under various inflation or rationing environments, perform similarly today. Only the rates component of housing taxation has changed and while there have been various changes to the taxation of corporate returns (eg. the 1984 reforms, see King and Wookey (1987) and the introduction of PEP's) the principle of the imputation system remains. Therefore the model is relevant to todays policy debate in its general conclusions.

The central conclusion from the results analysis is that the interaction of inflation and MIRAS is extremely powerful. If MIRAS had not existed over the period then the need for mortgage rationing would have been eliminated. Compared to MIRAS the taxation of imputed income, as parameterised in our simulation which includes the exclusion of MIRAS, has a minor effect on portfolio asset allocation. Abolition of MIRAS results in corporate equity being the largest asset class over all simulations. Moreover, the volatility of portfolio asset allocation, user cost of capital ratios and real cash flows is reduced dramatically through each simulation. Such stabilisation should engender other benefits such as a reduction across the range of risk variances, thus reducing housing and manufacturing user costs. Of course the *quid pro quo* to the abolition of MIRAS is the increase in effective household taxation and consequent reduction in disposable income.

The results of the Super PEP and ACE system look, at first glance, unspectacular, however our CGT assumptions are to a large extent the source of this. The results show that while the manufacturing tax policies favour the allocation of assets towards manufacturing the existence of MIRAS negates these benefits in the face of inflation and rationing has an influence on the model results. Manufacturing equity is not always the largest asset class. Given that the Super PEP makes little difference in terms of asset allocation unless inflation is low, the actual PEP policy in existence today (which limits the extent of the tax break per person) is unlikely to have much effect at all and does little to correct imbalances if inflation were to rise. On the other hand the ACE system does have some degree of inflation protection given that as inflation rises the required return from equity (with gilt yields) rises and this can be offset against corporation tax.

From a theoretical view point the stability afforded to the model as well as the allocative implications favour the abolition of MIRAS. Indeed the results suggest that to restructure the taxation of the manufacturing sector while holding housing policy constant would display a degree of ambivalence on behalf of the policy maker. Clearly there are practical problems with this policy (see Section 1.4.3.) in that its abolition would lock in gains made by long standing owner occupiers at the expense of more recent entrants. To this extent abolishing MIRAS after ten years of entering the sector seems attractive and would result in a reduction of ç in our model. If it is accepted that little can be done to housing taxation for political reasons then it would seem important to tax manufacturing returns in such a manner that the system would avoid the relative bias towards housing in the face of inflation. To this extent it would have been more consistent to impose the ACE system (preferably with the CGT rate unchanged or abolished) rather than the PEP regime which has been introduced. Separating policy between housing and manufacturing, individual and corporate acts to clarify policy implications, but this does not mean that policy makers need approach decision making emphasising such bifurcation. The structure of the model makes it clear that the interaction between each sector could be optimised by a mutually reinforcing policy mix which treats the economy as a whole rather than in individual sectors.

6. FINAL DISCUSSION.

6.1. Introduction.

The purpose of this research is to provide a framework with which we may expose the long run implications on asset allocation between the owner occupied and manufacturing sectors. We have argued in Chapter 1 that these sectors have particularly important effects on the performance of the U.K. economy. Our interest focussed on the long run investment implications of the interaction of inflation, taxation, risk and capital markets. The design of our model enabled us to isolate the effects of these influences on the investment process.

In Chapter 1 we discussed the theoretical principles of single project investment rules and reviewed the theoretical and empirical evidence of aggregate investment theories of the firm. This work suggested that the user cost of capital theory represented the optimal vehicle for our long run study. In particular this would aid the isolation of those parameters influencing the relative price of a capital good, the user cost of capital (its purchase price, cost of finance as influenced by the structure of debt to equity, taxation, inflation, risk premia and depreciation) whilst still accounting for the importance of demand. Although there have been no studies of this kind carried out for the U.K. a review of those studies pertaining to the U.S.A. was presented in Section 1.3. which concluded that the work of HH represented the most flexible framework from which a U.K. model could expand upon.

Chapters 2 and 3 represent the construction and parameterisation of the U.K. model. Contrasts with, and extensions of the HH model are discussed along with our parameter assumptions which utilise actual data and appropriate magnitudes obtained from relevant economic literature and the model solution technique. The purpose of Chapter 4 was to provide a framework which would test the stability of the model while enhancing familiarisation with output and parameter influences and compare the effects of the period 1 and 2 environments. In this Chapter we also systematically emulate the growth, inflation and rationing conditions which prevailed between 1965 and 1979. Following this we modified the model in those areas which enhanced its long run appeal and utilised the results from this model as a basis for comparing the policy simulations reported in Chapter 5.

Having obtained and discussed the results presented in Chapters 4 and 5 we shall summarise these below in terms of our original hypothesis and attempt to draw implications in the context of contemporary literature in this field. Following from this we outline an agenda for further work which attempts to improve on inherent deficiencies of the model and suggest areas for broadening the research base.

6.2. Results and Conclusion of the Present Study.

In Section 1.3.1. we presented various hypotheses and objectives with which we aimed to apply our model. The first results analysed in Section 4.3. provided us with an insight into how resource allocation between owner occupied housing and manufacturing investment was affected by inflation, risk, taxation and capital markets under conditions prevalent in the periods of the classical and imputation taxation systems. The effects of inflation are captured in Sections 4.3.4. and 4.3.5. along with the results in Section B and C of the Results Appendix which show the effects of reducing the general rate of inflation to zero. The effects of an increase in the general rate of inflation over the whole period are presented in the Results Appendix in Section's D and E and are discussed in Section 4.4.

The latter result provides us with the most general starting point. Our model supports the hypothesis that inflation biases resource allocation towards investment in owner occupied housing. This is consistent with other U.K. studies in this area, for example, King and Atkinson (1980), Buckley and Ermisch (1982) and Muellbauer (1990c) and the U.S.A. studies quoted in Section 1.3. This arises as housing capital gains represent a greater proportion of the real user cost than the manufacturing equivalent and because there is no taxation to mitigate any of this benefit coupled with the MIRAS subsidy which increased in value as inflation rose. This result is also consistent with that reported by HH (pp. 805), our adjusted model's (Section 4.5) elasticity, $\epsilon_{3,K/H,\pi^e}$ being negative. In the U.S. an increase in the general rate of inflation from 1 % to 7 % results in a fall in the ratio, K/H, from 1.05 to 1.01 which compares to a fall from 1.13 to 0.91 in our adjusted base model. We would concur with Feldstein (1982 pp. 309) that an easy money policy designed to stimulate investment and growth will actually act to reduce the long run productive capital intensity. We would add to this observation that any rise in real wealth as a result of inflation (or relative house price rises) is likely to boost consumption (especially when the mortgage market is deregulated) at a time when the relative ability of the economy to produce is diminished. This evidence is relevant to the work of those economists who argue that manufacturing capacity has been a constraint on the U.K.'s economic performance, for example O'Shaughnessy (1987; 1989a,b).

The effects of an increase in inflation during the period 1 and 2 environments are similar in that investment is channelled towards housing. This was particularly the case in the period 1 environment. There were several reasons for this, obviously the introduction of the imputation system in period 2 helped to relieve some of the allocation bias, particularly as the rate of manufacturing CGT fell. Corporate profits were proportionally lower in period 2 and therefore an increase in capital gains was of greater significance to overall corporate profitability. For similar reasons, given that the ratio of corporate debt to equity was higher in period 2, the real gains made by corporates at the expense of debtors was consequently greater when inflation rose. Risk premiums and the real rate of interest were also larger in period 2 and therefore a proportionate increase in inflation reduced the real user cost of housing by less than in period 1. Of these factors which made the allocative bias towards housing greater in period 1 the government could only directly influence the transition of tax regimes whose net effect was mild - we found that the initial UC_{ka} was actually higher in period 2 than period 1 despite the beneficial tax change.

Although the result that inflation channels resources towards housing is not controversial, this is the first time that an attempt to measure the effect on resource allocation over the long run which contrasts with more popular short run studies which focus on price effects. The comparative analysis between period 1 and period 2 is also unique and provides an idea of the labyrinth of sectoral interaction, apart from the taxation regime, which may influence investment allocation.

Our second hypothesis stems principally from the work of Meen (1988; 1989; 1990) who argues that much, if not all, of the bias towards owner occupied housing during the 1960's and 1970's in the U.K. was effectively offset by mortgage rationing. Our study has disaggregated this process somewhat by differentiating between a binding constraint imposed by lenders under any market environment dependent on individuals income levels and alteration of this multiple as a rationing tool. The effect of the imposition of rationing is a further complication of the mortgage market. Our results suggest that switching mortgage market regimes does have a significant effect on asset allocation. This is also consistent with King (1980) who finds that rationing excluded about 30 % of potential entrants from the owner occupied sector. Using our adjusted model, (Results Appendix, Section E) growth, coupled with relative housing inflation in an unrationed mortgage market takes K/H to 0.82 compared with 1.13 under our growth only simulation. Relative house price inflation in an environment of mortgage rationing increases this ratio to 0.97 which is also closer to the growth case than general inflation. Our results therefore tentatively support Meen's thesis that much of the tax and inflation bias was eliminated as a result of rationing, though our results suggest there was still a significant effect and rejects Meen's (1990 pp. 6) proposition that rationing breaks the theoretical link between inflation, the tax system and real house prices (assuming that the long run results would produce similar price effects in the short run). Our analysis shows that rationing also tends to reduce the loan to valuation ratio and reduce the value of the MIRAS subsidy thus increasing household tax outflows and consequently reducing disposable income.

As a result of specifying the user cost of mortgages, and our breakdown of the factors which determine the loan to valuation ratio, namely, demand, a binding constraint and rationing, we have presented a further level of detail in the determination of the mortgage stock. Quite simply, even before we introduce our mortgage rationing environment there is a shortfall between individuals desired mortgage stock and the actual stock. This occurs because inflation reduces the user cost of mortgages to such a low level that mortgage market institutions have to impose lending limits (the mortgage premium can not rise to clear the market for the reasons explained in Section 2.3.1.7.). Effectively the user cost of mortgages no longer has a bearing on the actual mortgage stock. Thus, when measuring the influence of an imposed reduction in the lenders loan to income multiple it is important to asses what effect on mortgage demand, if any, their equilibrium multiple may be exerting.

Given the conditions prevalent in the 1960's and 1970's our model concurs with Meen's (1989) assertion that the impact on housing demand of an exogenous shock depends on the mortgage market regime. Our model does show, however, that such an impact will not always be dependent on this. More specifically, when the user cost of mortgages is high enough that actual and desired mortgage stock equate then an exogenous shock may have the same effect irrespective of the mortgage finance regime. For example, our abolition of MIRAS simulation provides an environment where mortgage demand is at a relatively low level such that introducing mortgage rationing has no impact on the model. The results of a further exogenous change to the model will not, therefore, be influenced by the state of the mortgage market.

The effects of moving from a regime of rationing to one of non rationing can be observed by moving from right to left of the base simulation in Table 5.1. Without counterbalancing policies this will tend to reduce K/H, this conclusion is also reached by Miles (1990). The results reported in Chapter 5 show that under alternative policy regimes rationing may or may not have an effect on resource allocation depending if the policy increases the mortgage user cost or not. That is, the imposition of rationing may not offset mortgage demand when potential lenders supply is greater than demand, such as our policy simulations which exclude

MIRAS. It is unlikely that a return to mortgage rationing would be politically acceptable and there is little support in other circles, for example Bank of England (1991) states that such a policy would be undesirable and difficult to implement and enforce. The results from our model suggest that, despite the difficulties in doing so, re-introducing rationing as a policy control (suggested by Muellbauer (1990a) and Potter (1988)) would not solve the problems of a distorted tax structure.

In an international context Table 2 in Nakumura (1981, pp. 68) provides real user cost of capital figures for the U.S., Japan and Germany. The highest ratio UC_k/UC_h is that of the U.S.A. who the author finds displays the greatest allocation bias towards owner occupied housing. The results imply a pronounced productivity loss in the U.S. compared to the other countries. Averaging the user cost of corporate structures and equipment, the ratio of manufacturing to housing user costs reported for the U.S.A. is 2.79. This is much lower than our model estimates which suggests that inefficiency in the U.K. is even higher than the U.S.A. and our other main international trade competitors (this conclusion assumes that the respective countries have similar long run supply elasticities).

In an attempt to asses the implications and effectiveness of policies which may neutralise the taxation bias we simulated the effects of alternative tax regimes under similar inflation and rationing conditions. The tax regimes were, exclude MIRAS, tax imputed income, a Super PEP and a simplification of the IFS's ACE system. The model suggests that the most direct way to rectify the allocative bias is to alter the taxation structure of owner occupied housing. Our abolition of MIRAS simulation has beneficial allocative results in the event of rising inflation and engenders a considerable degree of stability to the model. The result supports this as a common policy proposal (for example, see Congdon and Warburton (1987), Fitzgerald and Davies (1987) and Atkinson (1989)). Indeed both housing policies not only engendered a great deal of stability to the results but actually reverse the allocative impact of inflation and erradicated the need for mortgage rationing. It is not possible to compare the effectiveness between abolishing MIRAS and taxing imputed housing income (the latter being proposed by Muellbauer (1986b, 1987a, 1987b, 1988b,c) and Hallet (1988)) without simulating each in isolation. On the other hand it is clear from our results that the Super PEP does little to protect manufacturing investment in periods of high inflation. This supports the conclusions presented in King and Wookey (1987) who demonstrate the present corporation tax systems weakness in an inflationary environment although they propose a cash flow tax base as a solution. Imposing a tax system based on real returns has proved difficult and therefore some account of inflation distortions may be achieved by the ACE system.

In conclusion, resource allocation is a function of many factors the interaction of which is complex leading to the possibility that direction as well as magnitude can change if any one input changes. The main determinants analysed in our model are the rate of inflation, the taxation regime and conditions in the housing finance market. The allocative result of each of these factors depends crucially on the behaviour of the others and it is therefore necessary to formulate policy, not in isolation, but in the context of a wider range of influences. Furthermore it is clearly important to analyse the effects of policy under various possible environments, especially those which governments can find difficult to control such as inflationary shocks. The final result of our adjusted and unadjusted models, a high housing content with a low mortgage debt level, provides just the circumstances where (in a deregulated mortgage market) a change in taxation policy could encourage individuals to raise mortgage debt, as real incomes rise, and invest the funds in more profitable sectors which would crowd out future housing investment. The liberalisation of the mortgage market in the 1980's which resulted in a flow of funds towards housing as a new equilibrium was reached only serves to reinforce this possibility.

Given both political and tax-capitalisation effects it could be argued that an alternative answer to rectifying this issue is not to alter the taxation of housing as suggested by many of the authors in Section 1.4.10. but to make manufacturing a more attractive alternative. This would have to be achieved at a time when government revenue could finance such a policy. In terms of robustness to inflation we have demonstrated that the ACE system would be preferable to PEP's. On the other hand the significance of MIRAS suggest that the policy of not increasing the threshold over time, and effectively reducing ç in our model, is also attractive. Restricting MIRAS to the first ten years of entering the owner occupied housing market would have the same effect of lowering ç and is similar in principle to the policy proposal of Malpas (1986) and Muellbauer (1986b). We have indicated that the biggest winners in the housing market over the past few decades is that cohort which has been in the market the longest, and therefore this policy coupled with something similar to the ACE system would result in an attractive policy combination in the U.K. as it would cap housing investment and encourage productive investment which would increase incomes over time and increase the employment prospects of those who have not gained in the housing market. If this proves politically difficult then the continued reduction in the real value of MIRAS and the ACE system (manufacturing CGT would be less of an issue given our results) would provide a more stable and productive policy mix.

It would seem imprudent to take the view that membership of the Exchange Rate Mechanism of the European Monetary System will result in the U.K. economy permanently being in a situation similar to our low inflation with economic growth simulation. That is to ignore, or attach a high probability that there is now no risk of inflationary shocks and therefore forget the possibility of relieving past experiences and, consequently, fail to tackle the issue of making the taxation structure robust to inflationary shocks, more favorable to risk taking and equitable across generations hardly seems desirable. Unless the issues discussed in this study are constructively addressed then the result of following the discipline imposed by the Exchange Rate Mechanism will seem even more pyrrhic than they presently are. Capacity constraints will bind, even at relatively low levels of growth as we witness greater import penetration and, ironically, a greater tendency to cost push inflation.

6.3. An Agenda for Further Work.

The following Section seeks to discuss possible extensions which would improve on some of the models drawbacks, or increase the range of the models results. Such work could vary in scale but would generally necessitate altering or expanding the simultaneous solution model. Utilising the current model, further combinations of policy regimes could be incorporated in exactly the method described in Chapter 5. For example we could impose the effects of taxing housing capital gains and compare this to the other policy simulations, or at a more simplistic level, it would be possible to alter parameter values given some economic rationale. For example we could alter marginal tax rates on the basis of alternative budget strategies.

Related to the above suggestion, the most straightforward work would be to parameterise the model according to the tax regime as it currently stands. While our model is not sterile in the application of its conclusions to todays economy its historical parameterisation could be regarded as a weakness when assessing the effects of policy on current economic conditions. There is little in the way of structural change as the imputation system remains in place although there would be the introduction of the PEP scheme. This work would result principally in a reduction in income tax, the present value of investment allowances (this is a result of the less favourable treatment of depreciation, stock and interest relief, see King and Wookey (1987, pp. 41-42)), corporation tax and the real value of the MIRAS threshold (ç). Domestic rates would drop out of UC_{ha} and we may wish to focus more on simulations which did not include such dramatic real house price rises if the 1990's are to be a period of consolidation (at the current time this is the consensus view point, for example see Roseman (1990) and for the U.S. see Hokenson (1990)). Other parameters may change slightly while those determining risk premiums would be held constant. Of course if we wished to accept the argument that the CSO capital stock estimates are too high, as argued by Smith (1986), Wadhwani and Wall (1986), Callen and Convey (1988) and Driver (1989) then we would have to re-estimate many of the manufacturing parameters presented in Chapter 3 using an adjusted capital stock series. This issue is of increasing relevance when parameterising for periods post the mid 1970's. The benefit of such work is that policy conclusions can be analysed more accurately from todays actual base. For example, while the path of the model variables will be similar, the influence of MIRAS in the face of inflation should be reduced while the absence of domestic rates and the reduction in the value of investment allowances will tend to counter balance this in asset allocation terms.

It would also be possible to introduce a simple supply side to the model, the absence of which could be regarded as a drawback, and its inclusion a useful extension. This could be at the asset or sector level with one equation being required for each supply and the relevant elasticity. The model could then be switched from short to long run, assuming the appropriate elasticities were used. Caution would be required in particular if this route were taken given the uncertainty surrounding supply elasticity measures and care would be required when assessing price effects, although we could utilise the option of assuming instantaneous price adjustment by assuming supply to be fixed (introducing the option of collapsing the model into the short run).

The model is flexible enough to incorporate many changes, this includes the most dramatic change of the 1980's, mortgage rationing, the likely effects of which were not instantly forthcoming. Specifically, it could be argued that the ultimate result of a deregulated mortgage market is that as equilibrium is achieved returns will become more sensitive to general market influences (for example building societies are already increasingly dependent on wholesale money market funds). Such an environment also suggests that as borrowers can obtain higher loan to valuation ratio's than before the probability of defaults rises throughout the economic cycle. Lenders may wish to assess individuals credit standing further and competition in both the funding and loan markets should ensure that returns to lenders will fluctuate more than in the past, this is already occurring. It would be possible to replace our assumed fixed mortgage mark up, mp, with a variable mortgage risk premium which does conform to the mean-variance approach used for other assets.

This would be relatively straightforward to incorporate (and has been implemented, although not reported here) to incorporate, model changes would be to respecify equation (2.51) as,

$$r_{H^{mb}} = \left[i + R\sigma^2{}_{H^{mb}}(pH^{mb}/W)\right](1-\Theta ç). \qquad (6.1)$$

This would result in,

$$ß_1 = (1-\Theta çv),$$

$$ß_2 = v(1-\Theta ç)R\sigma^2{}_{H^{mb}} + (1-v)\ R\sigma^2{}_{H^{pd}},$$

the term $ß_3$ would be equivalent to $ß_4$ in the basic model (Section 2.4.6.2.). The difficulty with this alteration is parameterising $\sigma^2{}_{H^{mb}}$ as we have no stable long run history to appeal to.

Further interesting work could be carried out at a more disaggregate level. For example, it was not the purpose of the present study to differentiate between wealthy households (those individuals who largely owned their house) who provide mortgage funds to non-wealthy households (those with large loan to valuation ratio's). Such work was carried out by HH who incorporated many features specific to the U.S. housing market, such as, the effects of level-payment fixed rate mortgage instruments some of which would be non-assumable (that is the interest rate would be re-struck if the household moved) although HH do not identify separate real cash flows between wealthy and non-wealthy and they split initial wealth arbitrarily in the model. While we do not incorporate any real gain as the value of mortgage debt declines with accelerating inflation as this cancels out across households at the aggregate level this would not be the case if a wealthy, non-wealthy split were introduced. The wealthy, non-wealthy split could be made to represent the difference between new and existing participants in the housing ladder and therefore allow us to simulate our policy suggestion with respect to MIRAS for the first ten years in the mortgage market presented in Section 6.2.

Although more ambitious, it would be possible to model other major countries using the same methodology utilised in our basic model. Rather than study these in isolation the countries could be merged into one simultaneous block in which we would assume freedom of international capital flows, thus assets would be allocated globally. The rationale for this is that international capital flows are of increasing importance regarding the allocation of global resources (even domestic building societies are increasingly sourcing funds from overseas capital markets). This is of relevance to policy makers as well as academics as there is increasing evidence (see Razin and Slemrod, 1990) that domestic taxation regimes play a major role in international resource allocation. Jun (1990) utilises relative net rates of return between the U.S.A. and the rest of the world to demonstrate that U.S.A. domestic tax policy can have a significant effect on direct investment capital flows.

In a similar spirit it would be possible to look within the U.K. at regional asset allocation. Utilising the model described in this research we could provide evidence regarding the effects of regional parameter variations. In particular, parameters such as expected capital gains from either sector, regional grants and investment allowances and the risk premium of regional housing markets (through house prices) would be of interest. Many factors would remain unchanged as they would be at the aggregate level, for example income and corporation tax rates, and the model would therefore expose the effects of a select change in parameters across regions. Obtaining reasonable estimates of the present value of investment allowances and grants at a regional level would represent the most problematic task in such work. While our model does not provide results regarding the workings of the labour market, the labour market thesis discussed in Section 1.4.5.1. is essentially a problem of regional house price differentiation which restricts labour mobility. This problem is complex but our model could shed some light regarding the outcome of a regional taxation policy which may help to alleviate this problem. It is worth noting however that the stability of the model variables when MIRAS is reduced would cut regional housing volatility. If on the other hand Egginton (1988) is correct in arguing that regional earnings are the key to house prices which are dependent on regional industrial growth then regional allowances to industry would be an obvious policy to reduce unemployment which our model could incorporate.

6.4. Conclusion.

Our research demonstrates that manufacturing investment has to some extent been crowded out by housing investment in the 1960's and 1970's. It could be argued that the wealth currently tied up in housing will be refinanced (an increase in mortgage demand) and utilised to crowd in a new more attractive investment vehicle if taxation policy permitted. If the taxation of housing continues to remain politically sensitive our research demonstrates that the taxation of productive alternative investments should be in some ways comparable to housing taxation. In particular, the powerful investment incentive arising from housing taxation and inflation has to be addressed for any policy to be robust over various economic environments.

RESULTS APPENDIX

Section A.

Period 1

α_k = 0.220517
α_h = 1.2472
α_m = 0.62041
$Ç_{kl}$ = 2468.621

Period 2

α_k = 0.647999
α_h = 4.4111
α_m = 0.71786
$Ç_{kl}$ = 49.179

Period 3

α_k = 0.449393
α_h = 1.8940
α_m = 0.56016
$Ç_{kl}$ = 249.083

N/C denotes no change from the previous column result.

Section B: Period 1.

	Initial Values	Base Run	Θ = 0.402138	μ_p = 0.1485
Sb	1,375	1,476	1,479	1,478
Lb	2,779	2,984	2,989	2,987
E	18,346	19,700	19,734	19,722
H^{ml}	17,538	18,610	18,536	18,614
H^{pd}	4,962	5,267	5,374	5,272
UC_{ka}	0.220517	0.221167	0.220878	0.220980
UC_{ha}	0.033640	0.033638	0.033835	0.033639
UC_m	0.030992	N/C	0.031182	0.030992
β_1	0.775512	0.775535	0.778970	0.775578
β_2	0.554995	0.554939	0.554199	0.554832
β_3	0.001323	0.001324	0.001349	0.001324
β_4	-0.016000	N/C	N/C	N/C
α_{1c}	1.260931	N/C	1.258154	1.259624
α_{2c}	0.215397	N/C	0.214880	0.215153
α_{3c}	0.953597	N/C	0.951237	0.954207
α_{4c}	0.087026	N/C	N/C	N/C
v	0.779483	0.779426	0.775250	0.779275
Y	22,500	24,234	24,242	24,239
TX_h	7,766	8,365	8,293	8,364
TX_k	1,058	1,143	1,142	N/C
MIRAS	333	354	349	354
RE	1,151	1,241	1,142	1,241
D	10,748	11,576	11,655	11,582

	$\phi = 0.4356$	$n = 0.693$	$\epsilon = 0.792$	$\tau = 0.408375$
Sb	1,477	1,468	1,449	1,487
Lb	2,986	2,966	2,929	3,005
E	19,716	19,585	19,337	19,843
H^{ml}	18,613	18,144	17,145	18,634
H^{pd}	5,257	5,148	4,928	5,276
UC_{ka}	0.221032	0.222185	0.224395	0.219923
UC_{ha}	0.033633	0.033636	0.033650	0.033637
UC_m	N/C	N/C	N/C	N/C
β_1	0.775441	0.775657	0.776310	0.775550
β_2	0.555170	0.554638	0.553022	0.554888
β_3	0.001322	0.001326	0.001340	0.001324
β_4	N/C	N/C	N/C	N/C
α_{1c}	1.259178	1.260931	N/C	1.252925
α_{2c}	0.215070	0.215397	N/C	0.213907
α_{3c}	0.952170	0.953597	N/C	0.949075
α_{4c}	N/C	N/C	N/C	0.086454
v	0.779751	0.779003	0.776734	0.779355
Y	24,238	24,202	24,135	24,272
TX_h	N/C	8,357	8,339	8,382
TX_k	N/C	1,146	1,153	1,124
MIRAS	N/C	345	326	354
RE	1,251	1,242	1,243	1,249
D	11,570	11,560	11,525	11,595

	mp = 0.0099	π^{ek} = 0.04653	π^{eh} = 0.04653	Φ_k = 0.00495
Sb	1,477	1,473	N/C	1,477
Lb	2,985	2,978	2,976	2,984
E	19,706	19,661	19,652	19,705
H^{ml}	18,641	18,604	18,407	18,611
H^{pd}	5,266	5,269	5,226	5,267
UC_{ka}	0.221115	0.221515	0.221588	0.221035
UC_{ha}	0.033579	0.033640	0.034112	0.033638
UC_m	0.030921	0.030992	0.031462	0.030992
β_1	0.775443	0.775577	0.775693	0.775536
β_2	0.555166	0.554836	0.554547	0.554936
β_3	0.001322	0.001324	0.001327	0.001324
β_4	N/C	N/C	-0.015530	-0.016000
α_{1c}	1.260931	N/C	N/C	N/C
α_{2c}	0.215397	N/C	N/C	N/C
α_{3c}	0.953597	N/C	N/C	N/C
α_{4c}	0.087026	N/C	N/C	0.086976
v	0.779744	0.779281	0.778876	0.779422
Y	24,235	24,223	24,221	24,235
TX_h	8,366	8,360	8,362	8,366
TX_k	1,142	1,141	1,144	1,142
MIRAS	N/C	N/C	350	354
RE	1,241	1,242	1,241	1,242
D	11,576	11,574	11,569	11,576

	$\Phi_h = 0.01089$	$b = 0.182754$	$z = 0.32769$	$\sigma^2{}_E = 0.06138$
Sb	N/C	1,459	1,461	1,484
Lb	2,986	2,950	2,998	2,999
E	19,712	19,717	19,700	19,798
H^{ml}	18,659	18,606	18,610	18,627
H^{pd}	5,280	5,265	5,267	5,270
UC_{ka}	0.221061	0.221408	0.221170	0.220312
UC_{ha}	0.033528	0.033638	0.033638	0.033636
UC_m	0.030882	0.030992	N/C	N/C
β_1	0.775531	N/C	0.775536	0.775526
β_2	0.554949	N/C	0.554936	0.554961
β_3	0.001323	N/C	0.001324	0.001323
β_4	-0.022050	-0.016000	N/C	N/C
α_{1c}	N/C	1.262405	1.260931	N/C
α_{2c}	N/C	0.215862	0.215405	0.213261
α_{3c}	N/C	0.953890	0.953597	N/C
α_{4c}	0.087026	N/C	N/C	N/C
v	0.779441	0.779440	0.779422	0.779456
Y	24,237	24,226	24,234	24,260
TX_h	8,363	8,362	8,365	8,374
TX_k	N/C	1,145	1,143	1,140
MIRAS	355	354	N/C	N/C
RE	1,241	N/C	N/C	1,240
D	11,580	11,572	11,576	11,587

	$\sigma^2_{H^{pd}} = 0.00198$	$\sigma^2_{Lb} = 0.00792$	R = 2.97	A = 0.3861
Sb	1,476	N/C	1,484	1,467
Lb	2,984	N/C	2,999	2,965
E	19,701	N/C	19,800	19,576
H^{ml}	18,610	N/C	18,627	18,589
H^{pd}	N/C	5,266	5,273	5,261
UC_{ka}	0.221162	0.221160	0.220301	0.222265
UC_{ha}	0.033632	0.033638	0.033630	0.033639
UC_{m}	N/C	N/C	N/C	N/C
$ß_1$	0.775560	0.775533	0.775549	0.775536
$ß_2$	0.554877	0.554944	0.554904	0.554937
$ß_3$	0.001311	0.001324	0.001311	0.001324
$ß_4$	N/C	N/C	N/C	N/C
α_{1c}	N/C	N/C	N/C	1.268993
α_{2c}	0.215397	0.215378	0.213243	0.216774
α_{3c}	N/C	N/C	N/C	0.959694
α_{4c}	N/C	N/C	N/C	0.087550
v	0.779338	0.779434	0.779377	0.779423
Y	24,234	N/C	24,260	24,200
TX_h	8,365	N/C	8,374	8,352
TX_k	1,142	1,143	1,140	1,151
MIRAS	N/C	N/C	N/C	353
RE	1,241	N/C	N/C	1,239
D	11,576	N/C	11,587	11,560

	Ω = 0.04851	ç = 0.70191	δ_h = 0.0198	δ_k = 0.07821
Sb	1,476	1,475	1,147	1,482
Lb	2,984	2,981	2,987	2,995
E	19,700	19,683	19,721	19,776
H^{ml}	18,609	18,528	18,699	18,623
H^{pd}	5,265	5,262	5,284	5,272
UC_{ka}	0.221169	0.221316	0.220986	0.220511
UC_{ha}	0.033637	0.033792	0.033436	0.033637
UC_m	N/C	0.031182	0.030792	0.030992
$ß_1$	0.775525	0.777958	0.775466	0.775554
$ß_2$	0.554964	0.556737	0.555108	0.554893
$ß_3$	0.001323	0.001327	0.001322	0.001324
$ß_4$	N/C	N/C	-0.016200	-0.016000
α_{1c}	1.260931	N/C	N/C	N/C
α_{2c}	0.215397	N/C	N/C	N/C
α_{3c}	0.953597	N/C	N/C	N/C
α_{4c}	0.087026	N/C	N/C	0.086205
v	0.779462	0.778801	0.779664	0.779361
Y	24,234	24,229	24,239	24,254
TX_h	8,364	8,366	8,367	8,375
TX_k	1,147	1,143	1,142	1,148
MIRAS	354	349	355	354
RE	N/C	1,241	N/C	1,247
D	11,575	11,570	11,579	11,587

	$i = 0.05544$	$\Gamma = 0.99$	$\alpha_k = 0.2183118$	$\alpha_h = 1.234728$
Sb	1,484	1,476	1,423	1,473
Lb	3,000	2,984	2,876	2,978
E	19,808	19,700	18,989	19,660
H^{ml}	18,798	18,610	18,206	18,604
H^{pd}	5,313	5,267	5,145	5,069
UC_{ka}	0.220228	0.221167	0.220385	0.221518
UC_{ha}	0.033202	0.033638	0.033639	0.033558
UC_m	0.030594	0.030992	N/C	N/C
$ß_1$	0.775475	0.775535	0.775464	0.773683
$ß_2$	0.555087	0.554939	0.555130	0.559518
$ß_3$	0.001322	0.001324	0.001322	0.001285
$ß_4$	N/C	N/C	N/C	N/C
α_{1c}	N/C	N/C	N/C	N/C
α_{2c}	N/C	N/C	N/C	N/C
α_{3c}	N/C	N/C	N/C	N/C
α_{4c}	0.087026	N/C	N/C	N/C
v	0.775475	0.779426	0.779670	0.785857
Y	24,263	24,234	23,511	24,223
TX_h	8,376	8,365	8,128	8,359
TX_k	1,140	1,143	1,094	1,144
MIRAS	N/C	354	346	354
RE	1,241	N/C	1,190	1,241
D	11,585	11,576	11,258	11,573

$\pi^{eh} = \pi^{ek} = 0$

$\alpha_m = 0.614259$ $Ç_{kl} = 2443.935$ $i = 0.009$

Sb	1,476	1,458	1,505
Lb	2,982	2,947	3,043
E	19,692	19,460	20,090
H^{ml}	18,423	18,421	14,491
H^{pd}	5,409	5,213	5,309
UC_{ka}	0.221243	0.221056	0.217814
UC_{ha}	0.033714	0.033638	0.044031
UC_m	N/C	N/C	0.044528
$ß_1$	0.777381	0.775533	0.789234
$ß_2$	0.550375	0.554943	0.521071
$ß_3$	0.001362	0.001324	0.001609
$ß_4$	N/C	N/C	0.031000
α_{1c}	N/C	N/C	N/C
α_{2c}	N/C	N/C	N/C
α_{3c}	N/C	N/C	N/C
α_{4c}	N/C	N/C	N/C
v	0.773015	0.779432	0.731852
Y	24,231	23,927	24,339
TX_h	8,367	8,259	8,498
TX_k	1,143	1,128	979
MIRAS	350	N/C	79
RE	N/C	1,225	1,321
D	11,572	11,429	11,594

	R = 2.5	R = 3.5
Sb	1,614	1,364
Lb	3,261	2,757
E	21,533	18,204
H^{ml}	18,905	18,353
H^{pd}	5,371	5,166
UC_{ka}	0.206454	0.235211
UC_{ha}	0.033516	0.033760
UC_{m}	0.030992	N/C
$ß_{1}$	0.775733	0.775272
$ß_{2}$	0.554448	0.555589
$ß_{3}$	0.001106	0.001538
$ß_{4}$	-0.016000	N/C
α_{1c}	N/C	N/C
α_{2c}	N/C	N/C
α_{3c}	N/C	N/C
α_{4c}	N/C	N/C
v	0.778737	0.780339
Y	24,714	23,815
TX_{h}	8,527	8,224
TX_{k}	1,090	1,183
MIRAS	359	349
RE	1,229	1,249
D	11,781	11,395

Section C: Period 2.

	Initial Values	Base Run	$\Theta = 0.328383$	$\mu_p = 0.1485$
Sb	14,660	16,926	16,922	16,980
Lb	6,773	7,819	7,818	7,845
E	42,566	49,143	49,134	49,302
H^{ml}	22,528	25,431	24,791	25,473
H^{pd}	41,473	46,968	47,582	47,117
UC_{ka}	0.647999	0.653082	0.653125	0.652342
UC_{ha}	0.091371	0.091073	0.091442	0.091091
UC_m	0.035539	N/C	0.035946	0.035539
$ß_1$	0.896244	0.896652	0.898470	0.896752
$ß_2$	0.248436	0.247915	0.247039	0.247676
$ß_3$	0.071928	0.072010	0.072309	0.072047
$ß_4$	-0.062000	N/C	N/C	N/C
α_{1i}	1.104937	N/C	N/C	1.103941
α_{2i}	0.987614	N/C	N/C	0.986538
α_{3i}	0.998517	N/C	N/C	1.000874
α_{4i}	0.103404	N/C	N/C	N/C
v	0.352001	0.351260	0.348566	0.350922
Y	64,000	74,476	74,467	74,631
TX_h	10,170	11,840	11,765	11,837
TX_k	17,405	20,288	20,286	20,315
MIRAS	916	1,034	1,015	1,036
Dnd	6,051	7,047	7,046	7,064
RE	11,746	13,680	13,678	13,713
D	19,622	22,829	22,899	22,908

	ϕ = 0.3366	n = 0.963	ϵ= 0.792	τ = 0.5148
Sb	16,885	16,724	16,056	17,277
Lb	7,801	7,726	7,418	7,982
E	49,026	48,557	46,619	50,164
H^{ml}	25,399	24,689	22,816	25,703
H^{pd}	46,756	46,050	42,543	47,623
UC_{ka}	0.653632	0.655846	0.665316	0.648375
UC_{ha}	0.090990	0.091062	0.090362	0.090994
UC_m	N/C	N/C	N/C	N/C
$ß_1$	0.896431	0.897310	0.897286	0.896866
$ß_2$	0.248445	0.246337	0.246394	0.247402
$ß_3$	0.071926	0.072258	0.072249	0.072091
$ß_4$	N/C	N/C	N/C	N/C
α_{1i}	1.105451	1.104937	N/C	1.095213
α_{2i}	0.988169	0.987614	N/C	0.977111
α_{3i}	0.998954	0.998517	N/C	0.987816
α_{4i}	N/C	N/C	N/C	0.102363
v	0.352012	0.349024	0.349106	0.350534
Y	74,360	73,899	71,974	75,474
TX_h	11,829	11,756	11,453	12,030
TX_k	20,261	20,150	19,686	20,322
MIRAS	1,033	1,004	928	1,045
Dnd	6,966	6,995	6,823	7,204
RE	13,730	13,580	13,245	13,984
D	22,715	22,644	22,050	23,177

	$\pi^{ek} = 0.09009$	$\pi^{eh} = 0.09009$	$\Phi_k = 0.006237$
Sb	16,887	16,823	16,929
Lb	7,802	7,772	7,821
E	49,031	48,845	49,153
H^{ml}	25,400	24,905	25,433
H^{pd}	46,947	46,648	46,975
UC_{ka}	0.653607	0.654483	0.653037
UC_{ha}	0.091114	0.092152	0.091072
UC_m	N/C	0.036449	0.035539
β_1	0.896700	0.897588	0.896655
β_2	0.247801	0.245670	0.247909
β_3	0.072028	0.072363	0.072011
β_4	N/C	-0.061090	-0.062000
α_{1i}	1.104937	N/C	N/C
α_{2i}	0.987614	N/C	N/C
α_{3i}	0.998517	N/C	N/C
α_{4i}	0.103404	N/C	0.103341
v	0.351099	0.348080	0.351253
Y	74,366	74,182	74,485
TX_h	11,818	11,803	11,842
TX_k	20,252	20,218	20,288
MIRAS	1,033	1,013	1,034
Dnd	7,033	7,021	7,049
RE	13,653	13,629	13,683
D	22,817	22,729	22,833

$\Phi_h = 0.00891$ $b = 0.331551$ $mp = 0.0099$

Sb	16,938	16,615	16,931
Lb	7,825	7,676	7,822
E	49,179	48,974	49,157
H^{ml}	25,485	25,319	25,469
H^{pd}	47,016	46,717	46,969
UC_{ka}	0.652915	0.655032	0.653018
UC_{ha}	0.090972	0.091116	0.091022
UC_m	0.035449	0.035539	0.035469
β_1	0.896575	0.896588	0.896549
β_2	0.248100	0.248069	0.248162
β_3	0.071981	0.071986	0.071971
β_4	-0.062090	-0.062000	N/C
α_{1i}	N/C	1.107530	1.104937
α_{2i}	N/C	0.992471	0.987614
α_{3i}	N/C	0.998284	0.998517
α_{4i}	0.103404	N/C	N/C
v	0.351522	0.351479	0.351610
Y	74,511	74,068	74,489
TX_h	11,838	11,765	11,842
TX_k	20,297	20,211	20,292
MIRAS	1,036	1,029	1,035
Dnd	7,050	7,009	7,048
RE	13,686	13,606	13,682
D	22,847	22,696	22,833

	$z = 0.67716$	$\sigma^2{}_E = 0.3564$	$\sigma^2{}_{H^{pd}} = 0.03663$
Sb	16,754	17,176	16,950
Lb	7,988	7,935	1,035
E	49,136	49,871	49,213
H^{ml}	25,429	25,625	25,449
H^{pd}	46,975	47,373	47,150
UC_{ka}	0.653115	0.649711	0.652753
UC_{ha}	0.091080	0.090975	0.090801
UC_m	0.035539	N/C	N/C
β_1	0.896667	0.896717	0.896862
β_2	0.247880	0.247761	0.274130
β_3	0.072150	0.072034	0.071368
β_4	N/C	N/C	N/C
α_{1i}	N/C	N/C	N/C
α_{2i}	0.987780	0.977814	N/C
α_{3i}	N/C	N/C	N/C
α_{4i}	N/C	N/C	N/C
v	0.351211	0.351042	0.350549
Y	74,469	75,188	7,454
TX_h	11,842	11,961	11,853
TX_k	20,281	20,456	20,305
MIRAS	1,034	1,042	1,034
Dnd	7,045	7,109	7,053
RE	13,675	13,802	13,692
D	22,832	23,044	22,848

	σ^2_{Lb} = 0.04059	R = 2.97	A = 0.4059
Sb	16,927	17,202	16,702
Lb	7,820	7,947	7,716
E	49,146	49,946	48,494
H^{ml}	25,432	25,645	25,256
H^{pd}	46,965	47,553	46,601
UC_{ka}	0.653067	0.649369	0.656143
UC_{ha}	0.091069	0.090700	0.091158
UC_m	N/C	N/C	N/C
$ß_1$	0.896646	0.896919	0.896587
$ß_2$	0.247931	0.247276	0.248070
$ß_3$	0.072007	0.071389	0.071985
$ß_4$	N/C	N/C	N/C
α_{1i}	N/C	N/C	1.112615
α_{2i}	N/C	N/C	0.994477
α_{3i}	N/C	N/C	1.005456
α_{4i}	N/C	N/C	0.104079
v	0.351283	0.350355	0.351481
Y	74,479	75,261	73,837
TX_h	11,839	11,973	11,730
TX_k	20,292	20,476	20,148
MIRAS	1,034	1,043	1,027
Dnd	7,048	7,117	6,987
RE	13,681	13,816	13,563
D	22,827	23,061	22,634

	Ω 0.03937	$\varsigma = 0.87813$	$\delta_h = 0.0198$
Sb	16,923	16,894	16,949
Lb	7,819	7,805	7,830
E	49,141	49,052	49,210
H^{ml}	25,430	25,204	25,549
H^{pd}	46,962	46,934	47,040
UC_{ka}	0.653093	0.653511	0.652770
UC_{ha}	0.091070	0.091343	0.090834
UC_m	N/C	0.035946	0.035339
β_1	0.896645	0.898229	0.896442
β_2	0.247932	0.247626	0.248420
β_3	0.072007	0.072217	0.071930
β_4	N/C	N/C	-0.062200
α_{1i}	1.104937	N/C	N/C
α_{2i}	0.987614	N/C	N/C
α_{3i}	0.998517	N/C	N/C
α_{4i}	0.103404	N/C	N/C
v	0.351284	0.349394	0.351976
Y	74,473	74,386	74,541
TX_h	11,838	11,842	11,848
TX_k	20,299	20,267	20,304
MIRAS	1,034	1,014	1,039
Dnd	7,043	7,039	7,053
RE	13,672	13,664	13,691
D	22,826	22,785	22,851

	$\delta_k = 0.07821$	$i = 0.126918$	$\Gamma = 0.99$
Sb	16,976	17,111	16,926
Lb	7,843	7,905	7,819
E	49,291	49,681	49,143
H^{ml}	25,470	26,040	25,431
H^{pd}	47,063	47,472	46,968
UC_{ka}	0.652394	0.650586	0.653082
UC_{ha}	0.091061	0.089748	0.091073
UC_m	0.035539	0.034634	0.035539
β_1	0.896683	0.895776	0.896652
β_2	0.247841	0.250016	0.247915
β_3	0.072021	0.071679	0.072010
β_4	-0.062000	N/C	N/C
α_{1i}	N/C	N/C	N/C
α_{2i}	N/C	N/C	N/C
α_{3i}	N/C	N/C	N/C
α_{4i}	0.102433	0.103404	N/C
v	0.351156	0.354238	0.351260
Y	74,620	75,002	74,476
TX_h	11,867	11,917	11,840
TX_k	20,353	20,430	20,288
MIRAS	1,036	1,049	1,034
Dnd	7,069	7,099	7,047
RE	13,723	13,781	13,680
D	22,879	22,972	22,829

	α_k = 0.641519	α_h = 4.366989	$Ç_{kl}$ = 48.68721	α_m = 0.7106814
Sb	14,011	16,837	16,512	16,902
Lb	6,473	7,779	7,628	7,808
E	40,681	48,886	47,940	49,074
H^{ml}	21,991	25,362	24,905	25,158
H^{pd}	40,340	46,307	45,971	47,046
UC_{ka}	0.643394	0.654289	0.652214	0.653403
UC_{ha}	0.091646	0.090761	0.091125	0.091291
UC_m	N/C	N/C	N/C	N/C
$ß_1$	0.896199	0.895884	0.896614	0.897484
$ß_2$	0.249003	0.249759	0.248007	0.245921
$ß_3$	0.071839	0.071720	0.071995	0.072324
$ß_4$	N/C	N/C	N/C	N/C
α_{1i}	N/C	N/C	N/C	N/C
α_{2i}	N/C	N/C	N/C	N/C
α_{3i}	N/C	N/C	N/C	N/C
α_{4i}	N/C	N/C	N/C	N/C
v	0.352807	0.353873	0.351390	0.348435
Y	61,350	74,223	72,556	74,408
TX_h	9,851	11,793	11,534	11,838
TX_k	16,491	20,228	19,760	20,272
MIRAS	894	1,031	1,012	1,023
Dnd	5,738	7,024	6,864	7,041
RE	11,139	13,636	13,325	13,668
D	19,036	22,758	22,241	22,780

$\pi^{eh} = \pi^{ek} = 0$			
	$i = 0.0372$	$R = 2.5$	$R = 3.5$
Sb	16,356	22,634	13,166
Lb	7,556	10,457	6,082
E	47,490	65,717	38,227
H^{ml}	16,863	29,566	22,275
H^{pd}	48,284	58,424	38,674
UC_{ka}	0.660997	0.589577	0.713464
UC_{ha}	0.104447	0.084832	0.097291
UC_{m}	0.062313	0.035539	N/C
β_1	0.923840	0.901138	0.892472
β_2	0.182696	0.237153	0.257943
β_3	0.082267	0.061419	0.082172
β_4	0.029000	-0.062000	N/C
α_{1i}	N/C	N/C	N/C
α_{2i}	N/C	0.823011	1.152216
α_{3i}	N/C	N/C	N/C
α_{4i}	N/C	N/C	N/C
v	0.258855	0.336013	0.365474
Y	72,842	89,908	63,288
TX_h	11,306	14,482	9,953
TX_k	20,048	23,911	17,562
MIRAS	234	1,202	906
Dnd	6,846	8,413	6,041
RE	13,289	16,331	11,726
D	22,556	27,377	19,504

Section D: Culmulative Base Model Simulations 1965-79.

	Initial Values	Growth	General Inflation
Balance sheet asset split (%)			
Sb	6.3	6.7	6.3
Lb	6.4	6.8	6.4
E	37.3	39.3	36.9
H^{ml}	27.5	24.6	25.4
H^{pd}	22.5	22.6	25.0
Ratio of real user costs			
UC_{ka}/UC_{ha}	9.64	8.60	9.49
UC_{ka}/UC_{m}	15.19	13.66	24.20
Housing user cost parameters			
β_1	0.837996	0.846673	0.851906
β_2	0.388602	0.367788	0.355238
β_3	0.025615	0.027296	0.028310
β_4	-0.017000	N/C	-0.060000
Loan to valuation ratio and risk free rate (%)			
v	55.1	52.1	50.3
i	5.6	N/C	9.8
Real cash flows as a percentage of output (Y)			
TX_h	26.2	23.4	23.3
TX_k	15.9	14.9	15.3
MIRAS	1.1	1.0	1.7
Dnd	8.7	8.2	N/C
RE	12.2	N/C	N/C
D	37.7	40.7	40.6

	Relative Price Inflation	Mortgage Rationing
Sb	5.8	6.1
Lb	5.9	6.2
E	34.5	36.1
H^{ml}	22.3	17.1
H^{pd}	31.5	34.5
UC_{ka}/UC_{ha}	7.51	7.14
UC_{ka}/UC_{m}	66.69	79.10
β_1	0.878150	0.902248
β_2	0.292283	0.234478
β_3	0.033394	0.038062
β_4	-0.077500	N/C
v	41.4	33.1
i	10.6	10.5
TX_h	23.6	24.0
TX_k	14.9	14.8
MIRAS	1.9	1.4
Dnd	8.1	8.0
RE	12.0	N/C
D	40.4	40.0

Section E: Culmulative Adjusted Base Model Simulations 1965-79.

Model derived parameters

α_k = 0.236242
α_h = 1.325900
α_m = 0.598050
ς_{kl} = 2108.706

	Initial Values	Growth	General Inflation
Balance sheet asset split (%)			
Sb	6.3	6.7	6.0
Lb	6.4	6.8	6.1
E	37.3	39.6	35.6
H^{ml}	38.2	35.1	36.4
H^{pd}	11.8	11.8	15.9
Ratio of real user costs			
UC_{ka}/UC_{ha}	6.13	5.61	6.55
UC_{ka}/UC_{m}	7.99	7.32	12.61
Housing user cost parameters			
β_1	0.775281	0.779535	0.794498
β_2	0.539039	0.528834	0.492941
β_3	0.013466	0.014290	0.017189
β_4	-0.017000	N/C	-0.060000
Loan to valuation ratio and risk free rate (%)			
v	76.4	74.9	69.7
i	5.6	N/C	9.9
Real cash flows as a percentage of output (Y)			
TX_h	30.8	29.6	29.1
TX_k	6.1	5.2	5.8
MIRAS	1.5	1.4	2.4
Dnd	3.6	N/C	3.7
RE	5.4	N/C	5.5
D	49.8	51.1	51.6

	Relative Price Inflation	Mortgage Rationing
Sb	5.7	6.2
Lb	5.8	6.3
E	33.6	36.7
H^{ml}	32.6	25.2
H^{pd}	22.3	25.6
UC_{ka}/UC_{ha}	6.19	5.6
UC_{ka}/UC_{m}	30.59	31.76
β_1	0.825489	0.853993
β_2	0.418603	0.350229
β_3	0.023192	0.028714
β_4	-0.077500	N/C
v	59.3	49.6
i	10.8	N/C
TX_h	29.2	29.8
TX_k	5.4	5.1
MIRAS	2.6	2.0
Dnd	3.6	3.4
RE	5.3	5.1
D	N/C	51.0

Section F: Initial Values of Policy Simulations.

	Exclude MIRAS	Tax Imputed Income	Super PEP	ACE System
Balance sheet asset split (%)				
Sb	7.0	7.0	6.7	6.8
Lb	7.1	7.1	6.8	6.9
E	41.0	41.1	39.6	39.9
H^{ml}	31.1	31.1	35.2	35.3
H^{pd}	13.8	13.7	11.7	11.1
Ratio of real user costs				
UC_{ka}/UC_{ha}	4.61	4.59	5.36	5.38
UC_{ka}/UC_{m}	5.06	5.07	6.99	6.96
Housing and manufacturing user cost parameters				
β_1	1	1.004567	0.779115	0.776785
β_2	0.691170	0.697260	0.529842	0.535430
β_3	0.017603	0.017516	0.014209	0.013750
β_4	-0.017000	N/C	N/C	N/C
α_1	1.245902	N/C	0.985092	0.413629
α_2	0.235093	N/C	0.185098	0.235093
α_3	0.955194	N/C	0.858347	0.696847
α_4	0.093829	N/C	N/C	0.089658
Loan to valuation ratio and risk free rate (%)				
v	69.1	69.7	75.1	75.9
i	5.6	N/C	N/C	N/C
Real cash flows as a percentage of output (Y)				
TX_h	32.1	32.4	29.6	31.1
TX_k	6.3	6.3	5.4	4.2
MIRAS	-	-	1.5	1.5
Dnd	6.3	6.4	3.3	3.9
RE	5.5	5.5	5.0	5.7
D	48.6	48.2	51.0	49.9

Exclusion of MIRAS.

	Growth	General Inflation	Relative Inflation	Rationing
Balance sheet asset split (%)				
Sb	7.3	7.9	7.5	N/C
Lb	7.4	8.0	7.6	N/C
E	43.3	46.4	44.2	N/C
H^{ml}	28.2	25.4	22.5	N/C
H^{pd}	13.8	12.3	18.2	N/C
Ratio of real user costs				
UC_{ka}/UC_{ha}	4.32	4.59	4.30	N/C
UC_{ka}/UC_{m}	4.62	4.94	4.93	N/C
Housing and manufacturing user cost parameters				
β_1	1	N/C	N/C	N/C
β_2	0.673092	0.674729	0.553555	N/C
β_3	0.018634	0.018540	0.025447	N/C
β_4	-0.017000	-0.060000	-0.077500	N/C
α_1	1.245902	N/C	N/C	N/C
α_2	0.235093	N/C	N/C	N/C
α_3	0.955194	N/C	N/C	N/C
α_4	0.093829	N/C	N/C	N/C
Loan to valuation ratio and risk free rate (%)				
v	67.3	37.5	55.4	N/C
i	5.6	9.9	10.8	N/C
Real cash flows as a percentage of output (Y)				
TX_h	30.8	31.5	31.7	N/C
TX_k	5.5	4.6	4.3	N/C
MIRAS	-	-	-	-
Dnd	3.7	3.3	3.2	N/C
RE	5.5	5.0	4.8	N/C
D	50.0	49.2	N/C	N/C

Taxation of imputed paid up housing income.

	Growth	General Inflation	Relative Inflation	Rationing
Balance sheet asset split (%)				
Sb	7.4	7.9	7.6	N/C
Lb	7.5	8.0	7.7	N/C
E	43.4	46.7	44.6	N/C
H^{ml}	28.3	25.5	22.6	N/C
H^{pd}	13.4	11.9	17.5	N/C
Ratio of real user costs				
UC_{ka}/UC_{ha}	4.21	4.57	4.27	N/C
UC_{ka}/UC_{m}	4.63	4.96	4.95	N/C
Housing and manufacturing user cost parameters				
β_1	1.015084	N/C	N/C	N/C
β_2	0.679212	0.682388	0.563504	N/C
β_3	0.018561	0.018377	0.032604	N/C
β_4	-0.017000	-0.060000	-0.077500	N/C
α_1	1.245902	N/C	N/C	N/C
α_2	0.235093	N/C	N/C	N/C
α_3	0.955194	N/C	N/C	N/C
α_4	0.093829	N/C	N/C	N/C
Loan to valuation ratio and risk free rate (%)				
v	67.9	68.2	56.4	N/C
i	5.6	9.9	10.9	N/C
Real cash flows as a percentage of output (Y)				
TX_h	31.1	31.8	32.3	N/C
TX_k	5.4	4.5	4.2	N/C
MIRAS	-	-	-	-
Dnd	3.7	3.3	3.2	N/C
RE	5.5	5.0	4.8	N/C
D	49.7	48.9	48.6	N/C

Super PEP.

	Growth	General Inflation	Relative Inflation	Rationing
Balance sheet asset split (%)				
Sb	6.8	6.0	5.7	6.2
Lb	6.9	6.2	5.8	6.3
E	40.3	35.7	33.6	36.8
H^{ml}	34.4	36.4	32.6	25.2
H^{pd}	11.6	15.7	22.3	25.5
Ratio of real user costs				
UC_{ka}/UC_{ha}	5.43	6.24	5.89	5.32
UC_{ka}/UC_{m}	7.06	11.98	29.02	30.12
Housing and manufacturing user cost parameters				
β_1	0.779501	0.794408	0.825166	0.853668
β_2	0.528917	0.493160	0.419379	0.351011
β_3	0.014283	0.017171	0.023130	0.028651
β_4	-0.017000	-0.060000	-0.077500	N/C
α_1	0.985092	N/C	N/C	N/C
α_2	0.185098	N/C	N/C	N/C
α_3	0.858347	N/C	N/C	N/C
α_4	0.093829	N/C	N/C	N/C
Loan to valuation ratio and risk free rate (%)				
v	74.9	69.9	59.4	49.7
i	5.6	9.9	10.8	N/C
Real cash flows as a percentage of output (Y)				
TX_h	29.6	29.0	28.1	29.7
TX_k	5.4	6.5	6.0	5.9
MIRAS	1.4	2.4	2.6	2.0
Dnd	3.4	N/C	3.1	N/C
RE	5.1	4.9	4.7	N/C
D	51.0	51.4	49.6	50.8

ACE System.

	Growth	General Inflation	Relative Inflation	Rationing
Balance sheet asset split (%)				
Sb	6.98	6.1	5.7	6.3
Lb	7.0	6.2	5.8	6.4
E	40.6	36.0	33.8	37.0
H^{ml}	34.5	36.4	21.6	25.2
H^{pd}	11.0	15.3	33.1	25.1
Ratio of real user costs				
UC_{ka}/UC_{ha}	5.46	5.64	5.14	4.72
UC_{ka}/UC_{m}	7.04	10.71	25.07	26.47
Housing and manufacturing user cost parameters				
β_1	0.777130	0.792691	0.823941	0.852572
β_2	0.534603	0.497278	0.422316	0.353640
β_3	0.013824	0.016838	0.022893	0.028439
β_4	-0.017000	-0.060000	-0.077500	N/C
α_1	0.413629	N/C	N/C	N/C
α_2	0.235093	N/C	N/C	N/C
α_3	0.696847	N/C	N/C	N/C
α_4	0.089658	N/C	N/C	N/C
Loan to valuation ratio and risk free rate (%)				
v	75.7	70.4	59.8	50.1
i	5.6	9.9	10.8	N/C
Real cash flows as a percentage of output (Y)				
TX_h	31.1	30.6	30.8	31.4
TX_k	4.2	5.0	4.6	3.8
MIRAS	1.4	2.4	2.6	2.0
Dnd	3.8	2.3	2.4	2.1
RE	5.8	6.0	N/C	5.9
D	49.9	50.4	50.5	50.0

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