Empirical Studies in Consumption, House Prices and the Accuracy of European Growth and Inflation Forecasts

Bharat Barot

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Abstract

BAROT, Bharat, This Ph.D. thesis, Empirical Studies in Consumption, House Prices and the Accuracy of European Growth and Inflation Forecasts contains four self-contained chapters:

Chapter I gives a brief introduction to the topic of the thesis and summarizes the main results.

Chapter II an aggregated consumption function based on the life cycle hypothesis using the error correction methodology is estimated for Sweden. Wealth in its disaggregated form (financial and housing wealth) is incorporated in the consumption function, along with basic standard explanatory variables including the unemployment variable. Applying Hendry's general to specific modelling strategy one final model is deduced. The study finds that each of the primary components of wealth has an equal role for consumer's expenditure. In addition the study finds significant effects from employment and interest rates.

Chapter III a stock-flow model serves as the theoretical basis for the fundamental determinants of real estate construction and prices. A housing market model for Sweden has been estimated on semi-annual data for 1970-1998 by separately modelling the demand and the supply sides, specified in error correction form. The supply side is based on Tobin's q-index. The results indicate that even in a turbulent period, Swedish house prices and housing investment are tracked quite well with this specification. The importance of the simulations and their usefulness to Swedish policy makers is discussed. Both *ex post* and *ex ante* forecasts using the model gives reasonable results.

Chapter IV (with Zan Yang), we estimate quarterly dynamic housing demand and investment supply models for Sweden and the UK for the sample period 1970-1998, using an Error Correction Method (ECM). In order to facilitate comparisons of results between Sweden and the UK we model both countries similarly using comparable exogenous variables. The long run income elasticity for Sweden and the UK are both constrained to be equal to one. The long run semi-elasticity for interest rate is 2.1 for Sweden and 0.9 for the UK. The speed of adjustment on the demand side is 12% and 23% for Sweden and the UK, respectively, while on the supply side it is 6% and 48%. Tobin's q Granger causes housing investment.

Chapter V (with Lars-Erik Öller), evaluates the one-year ahead forecasts by the OECD and by national institutes of GDP growth and inflation in 13 European countries. *RMSE* was large 1.9% for growth and 1.6% for inflation. Six (11) OECD and ten (7) institute growth forecasts records were significantly better than an average growth forecast (the current year forecast). All full record-length inflation forecasts were significantly better than both naive alternatives. There were no significant differences in accuracy between the forecasts of the OECD and the institutes. Two forecasts were found to be biased and one had auto-correlated errors.

CONTENTS

Acknowledgements

The main part of this dissertation was written during my time as economist at the National Institute of Economic Research (NIER), whose hospitality is gratefully acknowledged. Even a cursory look at the contents of this thesis should suffice for the reader to gather that I have been deeply influenced by the stimulating atmosphere and trends at NIER. In the initial period of my employment at NIER, I devoted a great deal of my time to studies of private consumption in Sweden, which resulted into an NIER Working paper "On Determinants of Private Consumption in Sweden" in 1993, co-authored with Alfred Kanis. In this study quarterly and semi-annual functions for total private consumption expenditures, cars, semi & other durables, and nondurable consumption where estimated using Error Correction models (ECM). This study was supported by the Economic Council of the National Institute of Economic Research (1992-1993).

At that time I was enrolled on the doctoral program at the Department of Economics at Stockholm University. My supervisor then was Göran Eriksson who unfortunately passed away in 1994. I immediately took contact with Prof. Peter Englund than at Uppsala University to be my supervisor for my Licentiate Degree in Economics awarded to me 1995 writing the paper "The Role of Wealth in the Aggregate Consumption Function using an Error Correction Approach: Swedish evidence from the years 1970 – 1993".

The major econometric models both for Sweden and UK do now incorporate housing wealth alongside with financial wealth in their consumption functions, see Hendry et al. (1981), Berg (1993), Kanis and Barot (1993) and Barot (1995). This makes it more important to have an econometric model which increases our understanding of the determinants of house prices and of effects on house prices of both fiscal and monetary policies. This obviously made me transmit into issues related to house prices and real estate economics. In 1997 the Department of Real Estate and Construction Management Royal Institute of Technology arranged a graduate course in real estate economics given by Professors John Quigley and Nancy Wallace from the University of Berkeley. With guidance from Professors John Quigley, Nancy Wallace and finally Alfred Kanis, I was able to write my second paper in this dissertation "A Full Fledged Demand-Supply Econometric Model for Swedish Private Housing (1970-2000)". Thanks to both Professors Peter Englund and Roland Andersson and the staff at the Department of Real Estate and Construction Management for supporting my financial my trip to attend the AREUEA conference in Maui, Hawai during the year 1999. A recent paper on "The Stock-Flow Model for Sweden and the United Kingdom: Econometric Analysis for the period 1970-1998", has been written in collaboration with Dr. Zan Yang formerly at the (Department. of Building and Real Estate Economics, Department of Infrastructure, Royal Institute of Technology (KTH), Sweden, but now at Institute for Housing and Urban Research, Uppsala University, Gävle, Sweden.

During the year 1998 Svante Öberg was appointed the new director of the National Institute of Economic Research. He was very interested on the issue of the accuracy of NIER forecasts. I was in the initial stage requested to check the accuracy of NIER's GDP forecasts. This project was then extended to cover the accuracy of both the European GDP and inflation forecasts. This was joint work with Professor Lars-Erik Öller who has been the head of the Research Department (1993-2001). This led to publication of two working paper in the NIER's Working Paper Series and also to the publication in the International Journal of Forecasting 16, (2000) 293-315.

I would like to thank both of my supervisors Professor Bengt Turner and Professor Thomas Lindh who have given me this opportunity in pursuing this thesis. Their help kindness and concern is highly appreciated. Constructive and critical comments by Mats Wilhelmsson, my opponent at my final seminar held at Uppsala University on 27th of September 2002 are also highly appreciated. I also would like to thank Niklas Ahlgren for reading all the four papers and coming up with valuable suggestions on each paper. Jukka Nybloms comments on one of the papers are highly appreciated too. Thanks to Dr. Robert D Campbell willing to be my discussant. The anonymous referees for the European Journal of Housing Policy, Review of Urban & Regional Development Studies, and finally the International Journal of Forecasting have also come with critical comments which have also helped to improve the quality of the published papers.

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It is the God of small things that matter in life.

Bharat Barot

Chapter I

Introduction to the thesis

This thesis consists of four separate chapters on Empirical studies in Consumption, House Prices and the Accuracy of European Growth and Inflation Forecasts. The first three chapters in some respects have the same theme and essentially about problems related to consumption. An aggregated consumption function relates total consumption to the level of income and wealth and perhaps other variables. Consumption functions are sometimes defined for individual households, but their major role is determining total national consumption in a macro economic model. The relationship was first defined by J. M. Keynes (1936) and it is a major element in his model of income determination. One characteristic of the consumption function, the marginal propensity to consume, is an important determinant of the stability of the economy in simple models of the multiplier type. The consumption function was widely used until the early 1950s when more data and improved statistical techniques demonstrated its inadequacy. In attempting to quantify the relationship, it was observed that there is often considerable short-run variation in consumption which is not accounted for by changes in income, but that when income and consumption are measured in longer run averages, there is a close relationship. The failure of variation in income in accounting for variation in consumption suggested that other influences, such as the value of wealth would be important.

The first chapter deals with the issue of the role of wealth in the aggregated consumption function for Sweden using the Error correction Model (ECM). The results indicate that both components of wealth (financial and housing) have an equal role. One dominant theme to arise from this assessment of the adequacy of the previously dominant consumption functions has been the role of wealth, and in some cases more particularly housing wealth, in an explanation of aggregated expenditure. The concept of an Error Correction Model dates back at least to the paper by Sargan (1964), on wages and prices in the UK. However the current popularity of these models owes much to their association with the work of Hendry (1980) and his promotion of the general-to-specific approach to econometric modelling. The major econometric models both of the UK and Sweden do now incorporate housing wealth along with financial wealth in their consumption functions. This makes it all more important to have an econometric model which increases our understanding of the determinants of house prices.

The second chapter is connected to the first in the sense that we endogenize house prices applying the stock-flow model. Muth (1960) developed a stock-adjustment framework that has long served as the basic framework in which to model housing markets In a stock-adjustment model, differences between desired or optimal demand and the and the existing stock lead to an adjustment process that, in the end, equates the two. The stock-adjustment model is demand-oriented; investment in new housing is derived from shifts in demand rather than from explicit profit maximisation by building companies. Poterba (1984) develops an asset-market model. On the demand side consumers equate discounted marginal benefits from housing services to marginal user cost. On the supply side Poterba does not make any explicit assumption about the objectives of the building firms, but he specifies a cost function in which the level of investment is a function of a number of cost variables. To close the system, he specifies how stocks relate to flows in the model.

To analyse the aggregate effects of changes in house prices upon the value of total stock of housing we need to model how such changes affects total demand for housing and we also need to specify how the supply of private homes is determined. Simply written we are trying to sort out the mechanism in the housing market for private homes in Sweden, distinguishing between cause and effect; between exogenous and endogenous factors- is crucial if we are to understand the economics of housing. We derive a reduced form for the stock-flow model for Sweden. The reduced form approach specifies separate housing demand and supply equations and then equates the two to derive a price equation. In addition we conduct both *ex post* and *ex ante* forecasts for private house prices for Sweden. The *ex ante* forecasts compared to the outcomes look promising. Private house prices for Sweden can be *ex post* and *ex ante* forecasted.

The third chapter is a continuation of the theme from the second chapter but with an international perspective. International comparisons of house price and housing trends have been dogged by data problems. In the third paper we estimate dynamic housing demand and investment supply models for Sweden and the UK for the sample period 1970-1998, using an Error Correction Method (ECM). In order to facilitate comparisons of results between Sweden and the UK we model both countries similarly using comparable exogenous variables. We compare the short and the long-term point estimates, elasticities and the error correction speed of adjustment coefficients. The secondary objective is to investigate if changes in house prices and housing investment can be *ex post* forecasted? The results indicate many similarities and a few differences. *Ex post* forecasts look promising.

The fifth chapter is autonomous. Considerable intellectual activity within the economics profession is devoted to the production, interpretation and analysis of forecasts of major economic variables. The main purpose of most macroeconomic forecast is as an aid to the rational discussion of economic policy making. Forecasts of economic variables are important because governments plan budgets and set macroeconomic policies based on forecasts of future economic activity e.g. money, stock and foreign exchange markets consumption and investment. There are many reasons for studying the accuracy of the economic forecasts, including the need to: (1) identify the sources and thereby the causes of major mistakes, in order to learn from them (2) form a rational basis for assessing what kind of policy the accuracy typically permits policy makers to make (3) be able to recognize in advance the occasion when there is a conjunction of the sort of circumstances that typically lead to large forecasting errors (see Chatfield (2001)).

The analysis in the fifth chapter indicates that the one year ahead forecasts both by the OECD and by national institutes of GDP growth and inflation in 13 European countries that the Root mean square error was large: 1.9% for growth and 1.6% for inflation. There was no significant difference in accuracy between the forecasts of the OECD and the national institutes. Positively biased revisions reveal large errors in data.

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Chapter II

The Role of Wealth in the Aggregated Consumption Function Using An Error Correction Approach: Swedish Evidence for the years 1970 – 1993

1. Introduction

The study of consumer's expenditure is of interest to economists, government authorities, policy makers and the business sector. Consumption is seen as the main objective of the economic system, because of its close connection with economic welfare. Aggregate private consumption accounts for a large share of national income (54% in Sweden), and thus the fluctuations in consumption behaviour have crucial consequences for output, employment, and the business cycle. The relationship between consumption and income has played a dominating role since Keynes wrote his General Theory in 1936. A further reason for studying consumption is that it is impossible to understand the transmission of economic fluctuations, or the way in which fluctuations can be moderated, without an understanding of the determinants of aggregate consumption[1].

Recently there has been considerable interest in comparing wealth effects from the stock market versus those from the housing market on aggregated consumption. Case et al. (2001) examines consumer behaviour at the USA state level from 1982 to 1999, and found that the wealth effect from housing wealth was both statistically significant and twice as large as the stock effect. On average a 10% rise in house prices resulted in a rise in consumption of roughly by 0.6% where as a 10% increase in stock market wealth raised consumption by only to 0.3%. For the USA the marginal propensity to consume is about 0.04% out of stock wealth and somewhat higher out of housing wealth (see Boone et al. (1998)). When the study examined data for 14 countries, including USA, they found an even larger housing wealth- with no discernible equity wealth effect at all.

This study is in vein in analysing wealth effects. However the contribution of this study is in presenting nested versions of aggregated consumption functions, where the role of financial contra housing wealth is analysed with particular importance for house prices, interest rates and the unemployment variable. One dominant theme to arise from this assessment of the adequacy of the previously dominant consumption function has been the role of wealth, and in some cases more particularly housing wealth, in an explanation of expenditure on aggregated consumption.

2. Review of earlier studies

Two seminal papers have contributed to a significant amount of empirical research on the aggregate consumption function. The first is Hall (1978), a paper on stochastic implications of forward looking behaviour, one in a series of works on consumption that may be said to have started with Modligliani and Brumberg (1954), and Friedman (1957). At almost the same time, Davidson, Hendry, Srba and Yeo (DHYS) (1978) developed an econometric model of consumer expenditure in the U.K., built on the Error Correction Mechanism (ECM).

[1] See Deaton (1992).

In the Scandinavian context, studies with ECM methodology are the Norwegian study of Brodin and Nymoen (1989)[2], where they estimate a vector autoregressive system (VAR), that by Magnussen and Skjerpen (1992), presenting a model for demand for durables and non-durables, and Skjerpen and Swensen (1992), where a linear expenditure system is modelled for Finland, Lehmussari (1990) studies the savings dynamics in the Nordic countries using annual data, and Koskela and Viren (1987) study the international differences in saving rates between countries, applying the life cycle hypothesis.

Earlier Swedish empirical studies have been based both on the permanent income and the life cycle hypothesis. Matthiessen (1972) estimated a consumption function based on Friedman's theory using yearly data for the period 1950-1969. This study was followed by Ettlin (1976) and Lybeck (1976), which were based on a modification of the life cycle hypothesis, and by Palmer and Markowski (1977) in Friedman's tradition.

In the Swedish context, consumption studies with ECM methodology are Berg (1989), Berg and Bergström (B and B) (1991) B and B (1993)[3], Nordblom (1993), Kanis and Barot (1993), Markowski (1994) and finally Johnsson et al. (1999). Kanis and Barot's study presents a quarterly as well as a semi-annual consumption function, used at the National Institute of Economic Research (NIER). All these estimated functions are models in annual change as most forecasts are conducted on annual basis.

This study is organized in the following sections. In section 3, the main objective of the study is outlined. Section 4 deals with economic theory, model derivation and the steady state wealth model using the life cycle theory. In section 5 the explanatory variables are discussed and motivated with a brief note on the data set. Section 6 is on econometric methods, followed by section 6.1 on the ECM methodology. In Sections 6.2 and 6.3 we deal with the tests of integration and co-integration as a part and parcel of the ECM approach. Section 6.4 discusses the methodological considerations of general to specific modelling and presents the specific model under scrutinization. Section 7 is on the forecasting performance of the wealth contra no-wealth model. Sections 7.1 up to 7.5 present the tests of model adequacy, where the stability of the equilibrium elasticities, based on recursive estimates are depicted in Figures 3- 4. This is followed by a Lagrange multiplier test of misspecification and test for exogeneity. The Akaike and the Bayesian information criteria are tested on the restricted, unrestricted and the no wealth model. Finally the test for weak exogeneity is presented. Section 7.6, presents the results from this study and compares them to the results in Berg and Bergström. In Section 8 comparative statics, dynamic simulations, and the steady state properties of the model are presented. Finally, Section 9 concludes with the main results and contributions of this study in the light of earlier studies. Appendix 1 is on the calibration of the real saving rate. Appendix 2 presents the dynamic simulations (Figures 4 to 11). Appendix 3 contains plots (Figures 12 to 18), of the consumption data set. Lastly a variable list is presented with the basic variables of this study and a detailed description of the data set used in this study.

3. The main objective of this study

Previous empirical studies using Swedish data have indicated that the relationship between consumption and disposable income is stable. Does this empirical finding hold for the last decade? The deregulation of financial markets at the end of 1985 perhaps facilitated a debt financed increase in buying. In addition, as a result of capital gains both on real and financial assets, consumption demand on goods might have been stimulated. This structural shift might

[2] See Brodin and Nymoen (1989).
[3] B and B henceforth Berg and Bergström.

have affected the ratio between consumption and savings. While investigating these issues, the study also contributes to the development of the consumption function in KOSMOS, a semi-annual Keynesian model, developed at NIER and still in use at the Ministry of Finance, Sweden. An important step in this direction is to incorporate the wealth variable, linking the real and financial blocks of the economy. In an even longer perspective the aim is to disaggregate financial wealth, and analyse the effect of household portfolios on the consumption/saving ratio.

In contrast to B and B (1991, 1993), this study is based on a consecutive semi-annual difference model and contains the interest rate, where as B and B encounters no significant interest rate effects on quarterly total consumption expenditures. B and B (1993) conclude that the change in household debt is an important determinant of short - run consumer behaviour, indicating that households have been credit constrained.This variable is supposed to capture the effects of the two crucial variables: the financial deregulation and the 1991 tax reform.

Also, in contrast to Kanis and Barot (1993), and B and B (1993), this study takes into consideration the employment rate (E), or implicitly the unemployment rate (1- E), as an additional explanatory variable to explain consumption / savings decisions of Swedish households. While the above mentioned studies often present the results of various diagnostic or specification tests, none provides a really systematic application of diagnostic testing as carried out in this study.

In order to facilitate comparisons with B and B, four models are estimated:

(1). A model without a wealth variable (no - wealth model).

(2). A model with wealth split into net financial wealth and real assets, with restrictions on the long-run coefficients (the restricted wealth model).

(3). A model without restrictions (the unrestricted wealth model).

(4). A model with total wealth, i.e. an aggregation of financial and real assets.

All four aggregated consumption functions are estimated in ECM form. Another related empirical issue, which is examined, is which interest rate to apply, the short term, three months treasury discount notes or the long run government bond rate. The above mentioned specifications are evaluated both from the theoretical and the forecasting point of view, keeping in mind that the ultimate goal of empirical testing in econometrics is to determine how well a theoretical model corresponds to the reality of an economic situation[4].

The Root Mean Square Error (RMSE), Mean Absolute Error (MAE), the Theil's Inequality Coefficient (TIC) and the Mean percentage Error (MPE) are used to evaluate the predictive accuracy of the empirical models. The forecasting performance is also compared with the no-wealth model and a naive model. In addition, an out of sample forecast is carried out for the period 1990 - 1993. The final econometric model is diagnostically checked by the Breusch-Godfrey Lagrange Multiplier test, White test for absence of residual heteroscedasticity and recursive estimates for stability. The Akaike and the Bayesian information criteria are applied in the model selection procedure. Simulations are carried out in order to check for the dynamic multipliers and dynamic responses of a change in the basic exogenous variables in the aggregated consumption function. Lastly we check a hypothesis of unchanged structure 1986-1993 compared with 1970 - 1985 using the Chow test.

4. The steady state wealth model and the life cycle theory

In a model with aggregate wealth, the relationship is now commonly expressed in constant elasticity form, disregarding stochastic terms:

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[4] According to Hendry and Richard (1983), a model should be data-coherent i.e. the model should be able to explain adequately existing data.

$$C_t = A \cdot Y_t^{\alpha} \cdot W_t^{\beta} \; ; 0 < \alpha < 1 \tag{1}$$

where
C_t denotes private consumption.
Y_t denotes real disposable income.
W_t denotes household net worth at the beginning of the period.
A is a constant scale term and t is the time index.
The homogeneity constraint for (1) is

$$\alpha + \beta = 1 \tag{2}$$

and is imposed to ensure that C_t is homogenous of degree one in (Y_t, W_t), i.e. an equal proportional change in both Y_t and W_t should lead to the same proportional change in C_t in the long run. In addition it is postulated that while both income and wealth effects are positive, the income effect is the dominant one[5].
The homogeneity constraint can be tested. Since the respective elasticities sum to unity, introducing savings (S), the consumption and total saving ratios using (1) are:

$$1 - \frac{S_t}{Y_t} = \frac{C_t}{Y_t} = A \cdot \left(\frac{W_t}{Y_t}\right)^{\beta} \tag{1'}$$

The test involves introducing Y_t as an additional term in (1') and testing whether its elasticity is zero. If this is the case then in the hypothetical steady state, income, consumption, savings and wealth would grow at the same rate.
It must be pointed out that the elasticities with respect to the different components of wealth would not be equal as they are weighted by their shares in total wealth. Below, total wealth, W_t is essentially a geometric weighted average of net financial wealth and housing wealth, implying a unit elasticity of substitution[6]. Introducing a model with disaggregated wealth, i.e. total wealth decomposed into household net financial wealth (WF) and real assets (AH), we have an analogous relationship:

$$C_t = A \cdot Y_t^{\alpha} \cdot WF_t^{\beta_1} \cdot AH_t^{\beta_2} \tag{3}$$

where $W = WF + AH$.
The homogeneity constraint for (3) would be $\alpha + \beta_1 + \beta_2 = 1$. Introducing savings again, as a consequence of the homogeneity constraint, the consumption and saving ratios are

$$1 - \frac{S_t}{Y_t} = \frac{C_t}{Y_t} = A \cdot \left(\frac{WF_t}{Y_t}\right)^{\beta_1} \cdot \left(\frac{AH_t}{Y_t}\right)^{\beta_2} \tag{3'}$$

[5] See Molana (1987).
[6] Barnett and Fisher and Serletis (1992).

The homogeneity test is now analogous to (1').

A further disaggregation of real assets (AH) into real house prices ($\frac{PH}{P}$), where H is the housing stock, can be expressed as

$$C_t = A \cdot Y_t^{\alpha} \cdot WF_t^{\beta_1} \cdot H_t^{\beta_{21}} \cdot \left(\frac{PH_t}{P_t}\right)^{\beta_{22}} \qquad (4)$$

The homogeneity constraint for (4) would be $\alpha + \beta_1 + \beta_{21} = 1$. The homogeneity constraint can be tested again as in (1).

Analogously the consumption and saving ratios are:

$$1 - \frac{S_t}{Y_t} = \frac{C_t}{Y_t} = A \cdot \left(\frac{WF_t}{Y_t}\right)^{\beta_1} \cdot \left(\frac{H_t}{Y_t}\right)^{\beta_{21}} \cdot \left(\frac{PH_t}{P_t}\right)^{\beta_{22}} \qquad (4')$$

(Note that $AH = H \cdot (\frac{PH}{P})$, and dividing through by Y implies that one merely divides H by Y to keep it neat). The homogeneity test analogously involves introducing ln (Y_t) as an additional term in (4') and checking whether its elasticity is zero. In case $\beta_{21} = \beta_{22} = \beta_2$, the implication is that (4) is equal to (3).
The steady state constancy in all ratios requires compositional constancy in wealth and a constant wealth / income ratio. Real assets / income or (housing assets / income) are constant for constant real home prices, which may be regarded as proportional to a Tobin's Q of unity (the consumption and housing investments deflators move in close step over long periods). A third way of writing (4) is obtained by replacing real housing prices by real assets using the identity.

$AH = H \cdot (\frac{PH}{P})$ is:

$$C_t = A \cdot Y_t^{\alpha} \cdot WF_t^{\beta_1} \cdot H_t^{(\beta_{21} - \beta_{22})} \cdot AH_t^{\beta_{22}} \qquad (5)$$

The homogeneity constraint is identical as in case (4), which can be tested in (5') below, by introducing Y_t as an additional term in (5') and checking on whether its elasticity is zero.

$$1 - \frac{S_t}{Y_t} = \frac{C_t}{Y_t} = A \cdot \left(\frac{WF_t}{Y_t}\right)^{\beta_1} \cdot \left(\frac{H_t}{Y_t}\right)^{(\beta_{21} - \beta_{22})} \cdot \left(\frac{AH_t}{Y_t}\right)^{\beta_{22}} \qquad (5')$$

A fourth nested equivalent form to (4) and (5) using the same identity is:

$$C_t = A \cdot Y_t^{\alpha} \cdot WF_t^{\beta_1} \cdot AH_t^{\beta_{21}} \cdot \left(\frac{PH_t}{P_t}\right)^{(\beta_{22} - \beta_{21})} \quad (6)$$

The homogeneity condition is identical as before and can be tested in the same manner as before. Analogously the consumption and saving ratios are:

$$1 - \frac{S_t}{Y_t} = \frac{C_t}{Y_t} = A \cdot \left(\frac{WF_t}{Y_t}\right)^{\beta_1} \cdot \left(\frac{AH_t}{Y_t}\right)^{\beta_{21}} \cdot \left(\frac{PH_t}{P_t}\right)^{(\beta_{22} - \beta_{21})} \quad (6')$$

Equation (4), (5) and (6) in fact are the long term relations within the ECM term of the dynamic nested models. The two alternative forms see equations (4 and 4') and (5 and 5') distinguish between the role of housing price and stock and housing assets and stock, respectively. If the elasticities of stock and price diverge in (4'), then there is an additional housing stock effect on consumption beyond the housing assets effect in (5'), in the version used in estimation (see Kanis and Barot (1993)).

In case $\beta_{21} = \beta_{22}$ we have B and B's (1993) model. For $\beta_{21} \neq \beta_{22}$, the implication is that the housing stock influences consumption not only via housing assets but also directly. The extra stock effect can also be interpreted as the separate house price effect (see equations (5) and (6)). Muelbauer and Lattimore (1994) interpret this effect as indicating that those households not possessing a house would save more when real house price rise, in their aspiration to acquire a home. Their saving would also depend on the size of the required deposit as a proportion of the price of a house when obtaining a mortgage. The justification for specifications (4 and 4'), (5 and 5') and (6 and 6') is that one should not expect a priori the elasticities for the components of wealth to be identical, as there is a possibility that they can differ. Assuming that the consumer deflator and house prices tend to move together over long periods has thus the implication that the long run ratio of house prices (or deflator for housing investment in small homes) to the consumer deflator would be proportional to Tobin's Q. The transitory character of relative prices in the short run, departing from the long term constancy, suggests that the volume and price components have different implications for real assets and by that for the consumption plans of households. Analogously to the supply side there is a Tobin's q operating on the demand side working via the ratio of house prices to the consumer deflator (often defined as capital gains or losses). Nevertheless, it may also be the case that the extra housing stock effect (or the separate house price effect) could just be a proxy for some omitted wealth variable, e.g. social security or net government debt)[7].

5. Explanatory variables

5.1 Disposable income

Aggregate disposable income is considered to be one of the most important factors that determine the consumption and saving decisions of the household. A typical household will receive income from a variety of sources and depending upon a variety of factors. This 'measured income' may typically include a large component of labour income (73.9% of disposable income in 1993 in Sweden), that depends upon wage rates, salary scales, the amount of overtime, transfers, various taxes, social security, and pension contributions that are deducted at source. Secondly, measured income may include sums accruing from the ownership of various forms of wealth, especially net

[7] Kanis and Barot (1993).

interest payments. Finally, measured income of a typical household may, in any period, include a variety of transitory components of the 'windfall' variety - e.g. unexpected gifts, gambling winnings, or tax repayments. In this study, of a household's total demand for all goods, real income, i.e. effective purchasing power, becomes one of the main determinants, with relative prices determining the composition, rather than the total. A change in the relative price of one good may change the household's total demand, but this effect arises because the price change results in a new real income - the household's money income can buy more of all goods if the price of one good falls. Current disposable income is therefore the main determinants of a household's private consumption. The a priori sign is positive.

5.2 Inflation

There are several reasons for including the price variable: According to Deaton[8] (1977) and the misperception hypothesis, economic agents do not possess sufficient information to distinguish between relative and general price movements when both are changing simultaneously. Under these circumstances, unanticipated inflation is misinterpreted as a rise in the relative prices of good agents are currently buying, so that real saving may increase. However, the main reason and motivation is to capture the effect of income uncertainty, as a household's recorded real income would deviate from what it anticipated. An 'anomaly' in many empirical estimates of the time series consumption function is that although inflation is not an argument of the theoretical consumption function, it is statistically significant when added to the empirical function. Three explanations have been offered for this phenomenon by Batchelor and Dua (1992):

(1). It reflects the confusion between relative and general price movements,

(2). It is proxying for the effect of inflation uncertainty[9], and

(3). It is proxying for inflation induced losses on assets which are not appropriately incorporated in national income measures[10].

5.3 The real after tax interest rate

The real rate of interest is a potentially important explanatory variable, affecting both long and short run variations in consumption and saving. As is well known the effect of an increase in the interest rate can be divided into a substitution and an income effect. The substitution effect is always negative because today's consumption becomes more costly and there is a substitution towards tomorrow's consumption. The income effect for a given level of wealth implies that consumption increases in both periods. For the economy as a whole, the total effect can be either positive or negative, depending on which effect dominates. Berg (1982) was the first to include an after-tax real interest rate using Swedish data.

5.4 Wealth

In addition to depending on income, consumption is assumed to depend on the real value of the stock of assets held in the economy. The greater is the stock of wealth, the higher is consumption[11]. Wealth was in fact mentioned as a possible determinant of consumption in the original Keynesian specification, and in recent years the inclusion of wealth has been associated with the quantity theory of money. In contemporary discussion, the estimation of the effect of liquid assets, rather than that of total wealth has become popular for two reasons: (a) they can be more reliably measured than total wealth, and (b) they are a more relevant element of wealth[12].

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[8] See Deaton (1977) and Blinder and Deaton (1985).
[9] See Gylfason (1985).
[10] See HUS (1981).
[11] See Laidler (1972).
[12] See Wallis (1973).

Studies by Zellner, Huang and Chau (1965) had included a real balance effect in the consumption function. Any imbalance in the consumer's liquid assets position is postulated to affect the consumer's behavior. The interpretation is that if liquid assets are sufficient with respect to some desired position, consumption plans will be carried out, but if they are insufficient, expenditures will be reduced. For a recent study on the real balance effect, (see Markowski (1994). Pesaran and Evans (1984) and Patterson (1984), make a distinction between liquid and illiquid assets). In contemporary discussion emphasis has been put on the role of housing wealth but these studies leave some doubt about whether each of the primary components of wealth has an equal role. A recent study by Case et al. indicates that the wealth effect from housing was both statistically significant and twice as large as the stock market effect. On average a 10% rise in house prices resulted in a 0.6% rise in consumption, whereas a 10% increase in stock market wealth pushed consumption by only 0.3%. The wealth variable in this study is split into financial wealth (WF), and real assets (AH). The real assets are further disaggregated into the housing stock component (H) and the house price component (PH/P). Total wealth is the sum of the sub-aggregates; financial wealth and real wealth.

5.5 House prices

The reason for including house prices is that they have a vital impact on the wealth holdings of individuals, the composition of their portfolios and the interpersonal distribution of wealth (i.e. the redistribution of wealth between young and old households). In addition the changes in house prices result into short - term fluctuations in real assets as capital gains and losses. According to Muellbauer and Lattimore (1994), the real price of owner-occupied houses have two effects on non- housing consumption: a positive wealth effect for owner-occupiers and a negative income / substitution effect for everyone whose price of housing services is affected by the market price of owner occupied housing. This in turn implies two different types of saving and spending behaviour among consumers. In recent studies on consumption there has been emphasis on different effects of housing wealth and house price increases. For the importance of dynamics of house prices see Englund (1994). For a recent study on the crisis in the Swedish housing market see Jaffee (1994).

5.6 Value added tax

There are two value added tax variables, DVATX, and EDVATX. The dummy EDVATX captures the hoarding effect, i.e. with the announcement of an increase in the value added tax; it is assumed that consumption increases. The dummy DVATX captures any residual reaction in the period of the change[13].

5.7 Other Dummies

To account for the semi-annual seasonal effects to sum to zero over the year, the dummy DS is (1, -1) in the first and second half - years, respectively. In order to account for differences in seasonal pattern before and after 1980 (spliced periods originally with different base - years), each seasonal dummy is multiplied by the period dummy. In order to capture the effects of de-regulation of the financial markets 1986, DREG has been used. It is 0 prior to de-regulation and 1 in the period after.

5.8 Unemployment

The reason for including unemployment in the consumption function, besides the effect of unemployment via the income - expenditure mechanism, is to measure uncertainty, see Markowski and Palmer (1977). According to them, an increase in the unemployment rate can

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[13] See Kanis and Barot (1993).

cause consumers to become generally pessimistic and, hence, as the argument goes; they consume less and save more out of given disposable resources. The expected sign is negative. The issue worth discussing here is if it is the change, and not the level of unemployment rate (or both) that matters. In case it is only the change, it is likely to be a good proxy for uncertainty about labour income, while the level will be correlated with early retirement, and thus with the shifts in the distribution of consumption between the retired and pre-retirement population of households. According to Muellbauer and Lattimore (1994), this is bound to make unique interpretation difficult. The estimates in this study indicate that only the level matters. The interpretation of the employment rate as a proxy for uncertainty can be summarized as the net constellation of many influences:

(1). A minority of relatively newly unemployed may try to save more but may be attached to previous consumption habits or expect re-employment soon. Their savings presumably fall with income, but their incomes are highly insulated by generous unemployment insurance.

(2). A minority of persons in programs have generally been unemployed a longer time in open unemployment in order to qualify for programme, and face termination of unemployment insurance. Some risk occupational extinction, i.e. no reemployment. Such persons have had time to adjust wage and employment expectations, and this would lead to a fall in consumption, and

(3). A majority of persons in households of those remaining in regular employment, or retired, will not be affected. Nevertheless they may fear the 'expected future' believing:

(a). Unemployment will spread to them,

(b). Lower wage increases and less overtime will lower employment income, and

(c). Fiscal reforms associated with budget deficits e.g. higher payroll or income taxes, lower pension entitlements, and eventually lower unemployment benefits.

The influence of all these factors no doubt depends on the relative size of unemployment. There are other important and relevant explanatory variables, for example demographic variables such as life expectancy, retirement age, age distribution, family size and the female participation rate. Public pension schemes, development in financial intermediation and capital markets, and the evolution of public debt also possibly constitute important determinants[14]. However this particular study is limited in its scope to the factors enumerated earlier.

5.9 The data set

In contrast to B and B (1993) who use a quarterly data set for the period 1970 - 1992 (which extends the number of observations), my study uses semi-annual data for the sample period 1970 - 1993. The semi-annual data is aggregated from quarterly data. Among the advantages of working with semi-annual data is that they have smaller measurement errors. Secondly, one would expect lower seasonal variations in semi-annual data compared to quarterly data. Finally it may be mentioned that the data base for the econometric model KOSMOS at NIER which is receving inputs from this present study, was built on semi-annual data. For a detailed description and sources of the data set see List of variables.

6. Econometric methods

The most widely used test and modeling of co-integration is the Engle-Granger (E-G), (1987) two-stage procedure. In the first stage an OLS regression is run on the levels of the variables believed to comprise a cointegrating vector and in the second stage the short-run dynamics are modeled given the long run relationship obtained from the first stage. At the first stage it is

[14] See OECD study (1983).

important to establish that a co-integrating combination has been found. The usual procedure is to check this with an Augmented Dickey-Fuller (ADF) test or some variant there of. Although extensively used, E-G has been criticized for potential biases and inefficiencies in the first-stage regression due to simultaneity and autocorrelation (see Banerjee et al. (1986)). Nevertheless, despite these criticisms, E-G has been widely applied, mainly because of its simplicity, and thus can provide a useful baseline model. In order to test for the number of co- integrating vectors we apply Johanson et al. (1990) test.

In this study the general to specific approach has been applied where both the long-run and short-run parameters are estimated simultaneously, and thus avoids the above mentioned problems[15]. We do not estimate a Vector Error Correction Model (VECM) partly because of problems with degrees of freedom and a small sample size with 50 observations but mainly because, in general, cointegrating vectors are obtained from the reduced form of a VAR system where all the variables are assumed to be jointly endogenous. Consequently, they cannot be interpreted as representing structural equations because, in general, there is no way to go from reduced form back to the structural form (see Rao (1994)). However in a multivariate VAR, it should be possible to give these a structural interpretation by imposing identifying restrictions on the reduced-form parameters (see Bernanke (1986) and Blanchard and Quah (1989)). The Johansen method estimates a vector autoregressive (VAR) model and first determines the number of cointegrating vectors. This approach is in particular a-theoretical. Cointegration is a purely a statistical concept and the cointegrating vectors need not have any economic meaning. That is why Johansen (see Johansen et al. (1994)) distinguishes between three concepts of identification:

(1). Generic identification which is related to a linear statistical model.

(2). Empirical identification which is related to the estimated parameter values.

(3). Economic identification which is related to the economic interpretability of the estimated coefficients of an empirically identified structure.

This study follows the third aspect.Nevertheless it must be pointed out that if there is one co integration relationship, it may be easier to interpret it as a long-run relationship. In Hendry's own work the unit coefficient hypothesis seems to have been the most common defining characteristic of the ECM. Analogously to Hendry (1980), we do impose the unit elasticity restriction. This reparameterisation relate to the parameters of interest from the point of view of economic theory.

6.1 The error-correction method

As a result of the path breaking work of DHSY, the ECM has become widely used to model consumption in the U.K. and elsewhere. A model specification is said to be balanced when the left-hand side and the right-hand side variables are of the same order of integration and the residuals are stationary (see Favero (1993)). Error-correction terms were used by Sargan, Hendry and Andersson (1977), and Davidson et al. (1978) as a way of capturing adjustments in a dependent variable which depended not on the level of some explanatory variable, but on the extent to which an explanatory variable deviated from an equilibrium relationship with the dependent variable.

Hendry emphasised the importance of general to specific modelling (see Mizon (1977)), and in this context the ECM can be interpreted as a reparameterization of the general 'auto-regressive distributed lag' (ADL) or 'dynamic linear regression' (DLR) models. For a single-equation model with two variables consumption (c_t) and income (y_t) and one lag, the EC representation is:

[15] Wickens and Breusch (1988) argue that one should estimate both the long-run and short-run parameters simultaneously.

$$\Delta c_t = \alpha + \beta \cdot \Delta y_t - \gamma (c - y)_{t-1} + \varepsilon_t ; \ \varepsilon_t \sim N(0, \delta^2) \tag{7}$$

The static long-run when $c_t = c_{t-1} = c$ *and* $y_t = y_{t-1} = y$ is

$$c = \frac{\alpha}{\gamma} + y \tag{8}$$

Davidson et al. (1978) interpret exp ($\frac{\alpha}{\gamma}$) as an estimate of the long run average propensity to consume in a consumption function which postulates proportionality between consumers' expenditure and income. The proportionality aspect of the relationship between consumption and income takes the following form: $C = K \cdot Y$.

The economic justification of a model like (8) follows because many economic theories suggest long-run proportionality, e.g., the permanent income hypothesis and the quantity theory of money. In addition (8) can be derived from a certain kind of optimizing behavior, with agents responding to their past disequilibrium. For instance, the growth in c_t will be greater than β_1 times the growth in y_t if c_{t-1} was less than its long-run desired value. For a comparison with other dynamic specifications, (see Hendry, Pagan, and Sargan (1984)).

As many economic theories have proportional forms in static equilibrium, ECM models might be expected to occur frequently. In addition, as we do not have forward looking data which would imply introducing expectations in the ECM, the ECM models seem appropriate as the dynamics of both short-run (changes) and long-run (levels) adjustment processes are modelled simultaneously. The dynamic model suggested by HUS (1981) and von Ungern-Sternberg (1981) which was a further development upon work of DHSY (1978) takes the following form:

$$c_t = \beta_0 + \beta_1 \cdot \Delta \bar{y}_t + \beta_2 \cdot \ln \left(\frac{c}{\bar{y}}\right)_{t-1} + \beta_3 \cdot \ln \left(\frac{L}{\bar{y}}\right)_{t-1} + \varepsilon_t \tag{9}$$

where L_t denotes the end period stock of net liquid assets of the personal sector and $\bar{y}_t$ is the log of disposable income adjusted for inflation losses on net liquid assets.

The economic interpretation of the ECM is that at each point of time the economic agent observe their position relative to the long-run equilibrium and adjust their consumption accordingly, increasing consumption if its below equilibrium and decreasing if its above equilibrium see[16]. An important feature of this model is that it takes time to reach the desired level of stocks of a particular good. The reason for this adjustment process is the existence of transaction costs which can be a consequence for instancee lack of information or financial problems. These are merely two interpretations of an ECM model. For alternative interpretations of ECM, see Alogoskoufis (1991).

It was in fact Phillips (1954, 1957) who first introduced the terminology of ECM into economics. The idea was embodied in his analysis of feedback control for stabilisation policy.

[16] See Favero (1993).

This study was followed by Sargan (1964) which was basically a study in econometric methodology dealing with various methods of estimating structural equations with auto-correlated errors. Nickell (1985) showed that ECM's can be derived from the optimal behaviour of economic agents faced with a quadratic loss functions.

6.1 Integration

As a preliminary step to cointegration analysis, the order of integration of the house price model data set is to be tested. Several procedures are available (see Dolado et al. (1990), for a survey). The results are presented in Table 1.

Table 1. Testing for integration by using ADF test using equation

Variable	With Constant 5%significance (-2.92)	With Constant & Trend 5% significance (-3.50)	Conclusion
ln (C)	-2.31	-2.38	I (1)
ln (Y)	-1.65	-2.30	I (1)
ln (P)	-1.41	-1.01	I (1)
RS	-2.22	-2.27	I (1)
R	-1.54	-0.09	I (1)
M	-1.07	-2.76	I (1)
ln (C/Y)	-2.27	-2.14	I (1)
ln (WF/Y)	-2.48	-2.03	I (1)
ln (AH/Y)	-2.68	-3.11	I (1)
ln (H/Y)	-2.46	-2.74	I (1)
ln (E)	-1.70	-2.35	I (1)
ln (PH/P)	-2.05	-2.91	I (1)

Note: All variables are in natural logarithms except RS, R and MTRF. See list of variables to the abbreviations. The critical value for 5% significance level is -2.92 for the intercept case, and -3.50 when the intercept and trend are included. The intercept reflects the possibility that, under the alternative of stationarity, the intercept is not zero. A further variation introduces a time trend into the equation to allow the alternative to be trend-stationarity. Maximum number of lags are 2, and 3 for ln (AH/Y), in order to prewhiten the residuals. Critical values for t-tests from Fuller (1976). See List of variables for the definitions.

The Augmented Dickey-Fuller (ADF) integration test is employed to the log level of the respective variables. The Augmented Dickey-Fuller (ADF) test augments the standard Dickey-Fuller (DF) test with lags of the dependent variable in order to account for serial correlation. In order to pre-whiten the residuals ADF tests were conducted with two and up to four lags. A direct way of testing for integration using the (ADF) test is by running the equation:

$$\Delta y_t = \alpha + \delta t + \gamma y_{t-1} + \beta_1 \Delta y_{t-1} + \cdots + \beta_s \Delta y_{t-s} + \varepsilon_t \qquad (10)$$

where y_t is the relevant time series and ε_t is the residual t is a linear deterministic time trend and s is the lag length. The null hypothesis is that of a unit root. This is rejected if it is negative and significantly different from zero. The null and the alternative hypothesis are: $H_0 : \gamma = 0, H_1 = \gamma < 1$ in (10). One can choose whether to include a constant or constant and trend, and the lag length structure. Note that the t-statistic does not have the conventional t-distribution.

A common reference for critical values is a test by Mackinnon (1991).

The ADF test is carried out with a maximum of 2 - 3 lags of the dependent variable are included, to pre-whiten the residuals[17]. A constant, a linear and a quadratic trend can be included while conducting the integration test. To test without a constant has been deemed to be too restrictive for economic time series.

6.3 Cointegration

The basic idea of cointegration is that individual economic time-series variables wander considerably, but certain linear combinations of the series do not move too far apart from each other. Economic forces tend to bring those series into line, e.g., as hypothesized by some economic theory. According to Ericsson and Irons (1994), cointegration links the notion of a long-run relationship between economic variables to a statistical model of these variables. In case a long-run relationship exists, the variables involved are said to be co integrated. Two properties of co-integration should be emphasized. First, E-G shows that co integrated series have an EC representation and that EC mechanisms imply co-integrated variables. Thus, cointegration establishes a firmer statistical and economic basis for empirically successful ECM models. In addition, cointegration brings together short-and long-run information in modeling the data. This unification resolves the debate on whether to use levels or differences, with Box-Jenkins time-series models and classical structural models both being special cases of ECMs. The number of co integration vectors is often of interest but the E-G approach lacks means to estimate the number. The Johansen and Juselius (1990), test is applied to find the number of co integrating vectors. This is a more appropriate test for co integration compared to E-G when one has more than two variables in the long-term part of the model. The results from Johansens test are presented in Table 2.

The long run according to Johansen and Juselius test takes the following form:

$$\begin{aligned} \ln C = &\ 0.38 \cdot \ln(Y) + 0.9 \cdot \ln(WF) + 0.10 \cdot \ln(AH) + 0.43 \cdot \ln\,(H) - 0.52 \cdot (R \cdot (1 - M)) \\ &+ 0.83 \cdot \ln(E) \end{aligned} \tag{11}$$

The long-run coefficients from the Johansen test are larger than one obtained using the general to specific approach in a single equation framework. This is mainly due to the differences in the short-run dynamics. In addition the income affect is dominant.

6.4 The general to specific approach

Hendry emphasized the importance of general to specific modeling (see Mizon (1977)), and in this context the ECM can be interpreted as a re-parameterization of the general 'auto-regressive distributed lag' (ADL) or 'dynamic linear regression' (DLR) models. At the same time, in the field of model specification, Hendry (1980) developed the top down or general to specific approach.

[17] See Charemeza and Deadman (1992).

Table 2. Johansen's cointegration test for the levels of variables

Null hypothesis	Max test	95% critical values	Trace test	95% critical values
r = 0 ꞁ r = 1	68.93**	39.4	124.8**	94.2
r = 1 ꞁ r = 2	27.0	33.5	55.90	68.5
r =2 ꞁ r = 3	17.17	27.1	28.90	47.2
r = 3 ꞁ r = 4	7.81	21.0	11.73	29.7
r = 5 ꞁ r = 6	3.90	14.1	3.92	15.4

Note: The critical values are at 5% and 1% significance level. The asterisks * and ** denote significance at 95% and 99% significance level. The order of the VAR is 1. Variables entered unrestricted are constant and the seasonal. Trend has been used but did not give much different results. The results indicate that there is one co- integrating vector according to the Johansen's test. If there is one co integration relationship, it may be easier to interpret it as a long-run relationship. We do impose the homogeneity condition on the beta matrix but the restriction is rejected according to the Likelihood ratio (LR) test, rank = 1: Chi squared (6) = 36.82 (0.00)**. For the Johansen method, there are two test statistics for the number of cointegrating vectors: the trace and maximum eigenvalue statistics. In the trace test, the null hypothesis is that the number of cointegrating vectors is less than or equal to r, where r is 0, 1 or 2. In each case the null hypothesis is tested against the general alternative. The maximum eigenvalue test is similar, except that the alternative hypothesis is explict. The null hypothesis r = 0 is tested against the alternative that r = 1, r =1 against the alternative r = 2.

This methodology implies that one starts with a general dynamic model, which may be over parameterized and may have more lags than one you would consider necessary. The model is then simplified using statistical tests, while ensuring that the long run steady state properties of the model are reasonable. Hendry's general to specific methodology is applied in this study following "the three golden rules of econometrics: test, test and test". The ECM here estimates the long - run parameters and the short - run dynamics jointly. As the model specification is balanced, one can formulate the general ADL model. The general model is over parameterized with two lags for both consumption and income, and a broad set of explanatory variables (the inflation rate, the acceleration in inflation, the employment rate, capital gains, the value added taxes, de-regulation dummy, the after tax interest rates, seasonal dummies and finally the ECM terms). The general model includes the following explanatory variables:

$$\begin{aligned} D\ln(C) = f\,(& D\ln(C)_{(-1)}, D\ln(C)_{(-2)}, D\ln(Y), D\ln(Y)_{(-1)}, D\ln(Y)_{(-2)}, D\ln(\frac{PH}{P})_{(-1)}, \\ & D\ln(\frac{PH}{P})_{(-2)}, D\ln(WF)_{(-1)}, D\ln(EDVATX), D\ln(EDVATX)_{-1}, \\ & R\cdot(1-M)_{(-1)}, \ln(\frac{C}{Y})_{(-1)}, \ln(\frac{AH}{Y})_{(-1)}, \ln(\frac{WF}{Y})_{(-1)}, \ln(E)_{(-1)}, \ln(\frac{H}{Y})_{(-1)}, \\ & DREG, D\ln(E), \varepsilon_t), DiffA\ln(P), Diff(DiffA\ln(P)), DS, DS\cdot D70S, \varepsilon_t\ ); \end{aligned} \qquad (12)$$

where *DREG* is the credit deregulation dummy = 1 from 1986, otherwise 0, and f is linear[18].

The intermediate steps in the search process, departing from the general model and deducing the specific model are described below. The t-statistic of the coefficients for lags of income and consumption are insignificant, and are dropped. The model is re-estimated and now lags of

[18] See list for variables pp. 57-58.

capital gains, the change in employment rate and value added tax are dropped. Lastly on the basis of the F - statistic and Likelihood ratio test (LR)[19], one tests for the unit elasticity restriction of the income and wealth variables. Recursive estimating is carried out because it gives more information on how well the long run unitary wealth elasticity of consumption holds. For a well specified consumption function for Sweden the sum of elasticities would be 1. For variables in logarithmic form this long-run consistency of consumption and wealth, for a given development of income, is based on the identity $\Delta W = Y_t - C_t$ (where W denotes net financial wealth, Y is income and C is consumption, (see Berg (1993)). Except for the first years of the 1980's the F and LR values of the unit elasticity tests are statistically insignificant, and one accepts the hypothesis of unit elasticities.

The conclusion is that the violation of the homogeneity condition might have to do with the fact that non-human wealth is not homogenous in terms of liquidity or or capital certainity, which may suggest that the effects of its sub-components on consumption may vary. Moreever, the household sector is not homogenous, for example in terms of: (1) total wealth of households and (2) stage of the life cycle. Both of these may affect the portfolio composition of the household and its response to changes in the components of wealth. The results are shown in Table 3 and Table 4. The conclusion we draw is, as the estimates seem quite close to those implied by the restrictions, the specific model is valid, in the sense that it did not contradict the general model. The final specification is exhaustively tested to establish whether variables omitted at an earlier stage should be reintroduced. No mechanical procedure is guaranteed to uncover the true data generating process.

The specific model is reported below (see student t values in Table 6, column 4):

$$
\begin{aligned}
D\ln(C) = & -0.49 + 0.39 \cdot D\ln(Y) + 0.26 \cdot D\ln\left(\frac{PH}{P}\right) + 0.17 \cdot D\ln(EDVATX) - 0.81 \cdot \ln\left(\frac{C}{Y}\right)_{(t-1)} \\
& + 0.07 \cdot \ln\left(\frac{WF}{Y}\right)_{(t-1)} + 0.07 \cdot \ln\left(\frac{AH}{Y}\right)_{(t-1)} + 0.30 \cdot \ln\left(\frac{H}{Y}\right)_{(t-1)} - 0.19 \cdot Diff\,(DiffA\ln(P)) \\
& - 0.31 \cdot (R \cdot (1-M))_{(t-1)} + 0.47 \cdot \ln(E)_{(t-1)} + 0.04 \cdot DS - 0.02 \cdot DS \cdot D70S + \varepsilon_t \qquad (13)
\end{aligned}
$$

where the change in consumption is explained by the change in disposable income, the change in house prices, the change in the value added tax, the acceleration in the tax short term interest rate, and the levels terms are composed of the employment rate, financial wealth, house prices and housing assets plus the seasonals. The models have been estimated by OLS. This log-linear specification can be justified as we are interested in studying several price-like variables, such as interest rates, for which the logarithmic form being convenient. In addition one gets direct estimates of the elasticities.

7. Forecasting performance

Before presenting the results, we address the following questions:

(1). Is there a good consumption equation without the wealth variables?

(2). How is the consumption function affected by the inclusion of the wealth variables?

(3). Is the inclusion of wealth variables necessary to obtain a good model?

[19] See Kmenta (1990).

Table 3. The Likelihood ratio test (LR). The imposition of the unit elasticity restriction, recursive estimates. Non - linear restrictions

Sample	Computed LR. Critical values at 5% significance level
1982:S1	14.08*
1982:S2	22.21*
1983:S1	22.36*
1983:S2	10.90*
1984:S1	5.88
1984:S2	3.59
1985:S1	2.40
1985:S2	1.76
1986:S1	1.85
1986:S2	2.37
1987:S1	2.48
1987:S2	1.86
1988:S1	2.49
1988:S2	2.35
1989:S1	1.57
1989:S2	1.03
1990:S1	1.12
1990:S2	0.92
1991:S1	0.45
1991:S2	0.15
1992:S1	0.10
1992:S2	0.04
1993:S1	0.02
1993:S2	0.00

Note: For the 5% significance level the computed LR value should be greater than .216 but less than 9.348, while for the 1% significance level the corresponding values are .0717and 12.84. $LR = N \cdot (RRSS - URSS)$ where $RRSS$ denotes: Error sum of squares restrictedmodel. $URSS$ denotes: Error sum of squares of the unrestricted model. An insignificant computed. LR suggests that one might accept the hypothesis that the non - linear restrictions are valid. Only in 4 periods marked in table, the restrictions are not valid, perhaps due to a regime shift (1983) according to the Chow - test (1983).The results indicate that the homogeneity condition holds.

Table 4. The F-statistic. The imposition of the unit elasticity restriction, recursive estimates, linear restriction

Sample	Computed F	Critical values at 5% significance level	Critical values at 1% significance level
1982:S1	2.93	3.59	6.32
1982:S2	5.72*	3.49	5.95
1983:S1	5.91*	3.41	5.74
1983:S2	2.32	3.34	5.56
1984:S1	1.17	3.29	5.42
1984:S2	0.70	3.24	5.29
1985:S1	0.47	3.20	5.18
1985:S2	0.35	3.16	5.09
1986:S1	0.38	3.13	5.01
1986:S2	0.50	3.10	4.94
1987:S1	0.53	3.07	4.94
1987:S2	0.40	3.05	4.87
1988:S1	0.55	3.03	4.82
1988:S2	0.53	3.01	4.76
1989:S1	0.35	2.99	4.72
1989:S2	0.23	2.89	4.68
1990:S1	0.26	2.96	4.64
1990:S2	0.21	2.95	4.60
1991:S1	0.11	2.93	4.57
1991:S2	0.04	2.92	4.54
1992:S1	0.02	2.91	4.51
1992:S2	0.01	2.90	4.49
1993:S1	0.00	2.89	4.46
1993:S2	0.00	2.88	4.44

Note: The F is computed as = $\left(\frac{RRSS - URSS}{NPAUR - NPARR}\right) / \left(\frac{URSS}{NOBS - NPARUR}\right)$ where $RRSS$ denotes: Error sum of squares restricted model. $URSS$ denotes: Error sum of squares unrestricted model. $NPARUR$: Number of parameters in the unrestricted model. $NPARR$: Number of parameters in the restricted model. NOBS: Number of observations. The computed F value is statistically insignificant except for 3 periods marked in table, perhaps due to a regime shift according to the Chow - test in 1983. Thus one may accept the hypothesis that the restrictions are valid, except, possibly for the period 1982 - 1983.

This study is confined to three models, one without the wealth variables (no - wealth model), and one with the wealth variables disaggregated (restricted wealth model), with the imposition of unit elasticity on the long run coefficients and finally the naive model. The models are evaluated both from the theoretical and from the forecasting point of view. In order to do this in a realistic manner, we perform *ex-ante* (out of sample) forecasts for the period 1991-1993.

There are several commonly used measures of predictive accuracy: RMSE, MAE, TIC, the Mean Absolute Proportional Error (MAPE), and finally the Mean Percentage Error (MPE). Our basic econometric models, the wealth model, the no-wealth model, and a naive (or AR) model will be evaluated with respect to these forecasting statistics. MPE is included since it gives information about tendencies of the forecasts to under or over estimates the actual values. The difficulty with MAPE and RMSE measures is that there is no absolute standard against which they can be compared. The TIC is the only measure which implies a comparison of a given forecast with the naive alternative[20]. The naive model has been estimated with the following function specification:

$$\ln\Delta(c) = f\,(\,\ln\Delta c_{t-1}, \ln\Delta c_{t-2}, \ln\Delta c_{t-3}, DREG, TREND, DS, DS\cdot D70s) \qquad (14)$$

where f is linear in its arguments, C denotes consumption, *DREG* is the credit deregulation dummy, and *DS* and *D70s* are seasonal dummies and the TREND .The results in Table 5, indicate that the wealth model performs better than both the naive and the no-wealth models.

7.1 General fit and correctness of the signs of the regression estimates

The results of the three basic models are presented in Table 6. The no-wealth model has no ECM interpretation in the semi-annual version. According to DHSY, what one needs is a model generating plausible long run properties of the relationship between consumption and income, due to the fact that the earlier economic theories indicated a long run proportionality between consumption and income.

However in the semi-annual Swedish data set we cannot obtain such a plausible relationship empirically. The restricted model contains the wealth variables Table 6 is structured as in B and B (1993), facilitating comparisons with their best quarterly unrestricted and restricted models.

From the restricted wealth model with the wealth variables, the model fits the data well explaining 95% of the total variance in the change in consumption. The out of sample forecasts are accurate in the sense that both the down turn in 1990's and the upturn in 1993 are captured and are depicted in Figure 1. The out of sample forecasts are the one step ahead *ex post* forecasts[21]. The forecasts have been generated by going one step ahead in time.

The standard error is 0.01. The signs of most of the short - run dynamic variables are in agreement with prior theoretical expectations. The restricted wealth model with justifiably imposed long run elasticities of income, financial wealth, housing assets and housing stock sum to unity fulfilling the homogeneity condition that a 1% increase in income and the components of wealth would result into 1% increase in consumption. This implies that the average propensity to consume (APC) is constant in the long run.

[20] See Kottas (1990).

[21] See Pindyck and Rubinfeld (1998) on *ex-post* and *ex-ante* forecasting. In order to generate the out of sample forecast the model is estimated upto 1989. One step ahead forecasts are generated in a sequence for the period 1990 - 1993.

Table 5. Forecasting statistics

Forecasting statistics	Wealth model	Naïve model	No- Wealth model
MSPE	0.03	0.03	0.04
MAPE	0.00	0.02	0.04
MAE/MAD	0.09	0.83	1.00
TIC	0.00	1.04	0.02
R2	0.99	0.74	0.00
CV	0.00	0.02	0.03

Note: All figures except Theil in percentages. Number of periods used for forecasting is six. MSPE is mean percentage error. MAE denotes mean absolute error. CV is Standard error / mean, regression of actual on forecast. MAD mean absolute deviation of actual. R^2 is the Determinant coefficient, outcome on forecast. MAPE is mean absolute proportional error. TIC is coefficient (zero-infinity).

The long run steady state equilibrium elasticities are illustrated in Table 7. The equilibrium elasticities for financial wealth and real assets are of the same magnitude. There are merely marginal differences between the restricted and the unrestricted wealth models as the parameter values used in imposing the restrictions are from the unrestricted wealth model.The long run interest rate is significant in the restricted model. The coefficients of the unrestricted model are of the same magnitude as in the restricted case. The restricted model is superior as the standard error is smaller. All the coefficients are statistically significant and carry their expected signs under the theory outlined.

7.2 Recursive estimates of stability

Figures 2 and 3 provide some evidence on parameter stability for both the unrestricted and restricted models. They are based on recursive estimates of the equilibrium elasticities for the period 1982 - 1993. The initial instability of the parameters estimates for the interest rate and the employment rate reflects the small number of observations used to estimate them at the start of the recursion. However in the restricted wealth model, both the parameter estimates become more stable over time.

7.3 Lagrange multiplier test

In order to evaluate the possibility of misspecification the Lagrange multiplier test for serial correlations in residuals up to lags 9 for both the restricted and the unrestricted wealth models and also for the no-wealth model have been carried out. They are illustrated in Table 8.

7.4 The Akaike and the Bayesian information criteria for nested model

The Akaike (AIC) and the Bayesian information criteria (BIC) have been computed for the unrestricted wealth model. They are criteria contrasting accuracy of estimation to parsimony in parameterization. The idea behind the AIC criterion is to select the model which has the minimal loss of information, i.e. the smallest AIC. For models with the same number of parameters estimated on the same sample, this leads to selecting the model with the smallest residual sum of squares or, in other words, with the largest R^2 [22]. In this study the model selection criteria have been computed for the optimal specification and then each of the variables has been dropped one at a time. The results are presented in Table 9.

[22] See Maddala pp. 426 (1988).

Table 6. Presentation of the results. Dependent variable : Dln (C)

	Unrestricted model				Restricted model		No-wealth model	
Regressors	Coeff.	σ	HCSE	T-Stat.	Coeff.	T-Stat.	Coeff.	T- Stat.
Constant	-0.49	0.09	0.09	5.0	-0.48	8.9	0.02	2.70
D ln (Y)	0.39	0.05	0.04	7.3	0.38	8.3	0.29	2.98
D ln (PH/P)	0.26	0.05	0.04	5.6	0.26	7.5		
D ln (EDVATX)	0.17	0.08	0.07	2.14	0.17	2.3	0.37	2.48
Diff(DiffA)ln(P))	-0.19	0.07	0.06	2.4	-0.19	2.7	-0.23	1.61
ln (E) $_{(-1)}$	0.47	0.11	0.07	4.4	0.47	4.6		
(R*(1-M)) $_{(-1)}$	-0.31	0.10	0.07	3.0	-0.31	4.2	-0.34	2.59
ln (C/Y) $_{(-1)}$	-0.81	0.11	0.10	7.6	-0.81	9.1	-0.04	0.49
ln (WF/Y) $_{(-1)}$	0.07	0.01	0.02	4.6	0.08*	9.1		
ln (H/Y) $_{(-1)}$	0.30	0.05	0.04	6.3	0.37*	9.1		
ln (AH/Y) $_{(-1)}$	0.07	0.03	0.03	2.5	0.08*	9.1		
DS	0.03	0.10	0.01	3.7	0.03	3.9	0.05	2.95
DS*D70S	-0.02	0.00	0.00	6.9	-0.02	7.7	-0.04	7.08
σ	0.0083				0.0079		0.016	
R^2	0.95				0.95		0.79	
R^2 –adj	0.94				0.94		0.76	
DW	2.23				2.23			

Note: The asterisks are the long run elasticities (rounded) for the ECM terms. The test confirms that the homogeneity constraint is satisfied. The derived long-run income elasticity is 0.47. The restricted version of the model has been derived from the unrestricted version by constraining the long - run elasticities of the wealth variables to sum up to one. σ denotes the standard error for the unrestricted model. HCSE are the heteroscedastic consistent standard errors. If these values and those for the standard errors differ markedly, heteroscedastic may be inferred. The null is that the errors are homoscedastic or, if heteroscedasticity is present, it is unrelated to the explanatory variables. It must be pointed out that this is an informal approach to deciding the presence of heteroscedasticity. The computations have been carried out in PCGIVE. WHITE (1980) test statistic, for heteroscedasticity is obtained by regressing the squared residuals on the explanatory variables and alternatively on the explanatory variables squared and is distributed as $\chi 2$ (q) where q is the number of regressors and squared regressors in the test regression. The estimated value is 24.5, and the 5% critical value of $\chi 2$ (23) is 35.2. The test for heteroscedasticity was passed. There are two reasons why there is less probability of presence of heteroscedasticity: (1). The variables are in logs. (2). The variables are in ratios. The implicit assumption behind all the tests on heteroscedasticity test is that the variance (u i) = σ2 i = σ2 f(zi), where zi is an unknown variable and the different tests use different proxies or surrogates for the unknown function f(zi), see Maddala (1988). Test for Normality JB: Jarque-Bera test statistic for normality in the distribution of the residuals and distributed as χ^2. The critical 5% per cent value is 5.99 and the computed value is: Normality $\chi(2)$ = 0.33. Skewness = 0 .24. Excess Kurtosis = 0.06,. DW: is the Durbin Watson statistic. A coefficient estimate is said to be significant if its t - statistic exceeds 2 in magnitude.

Figure 1. Consumption forecast-restricted wealth model

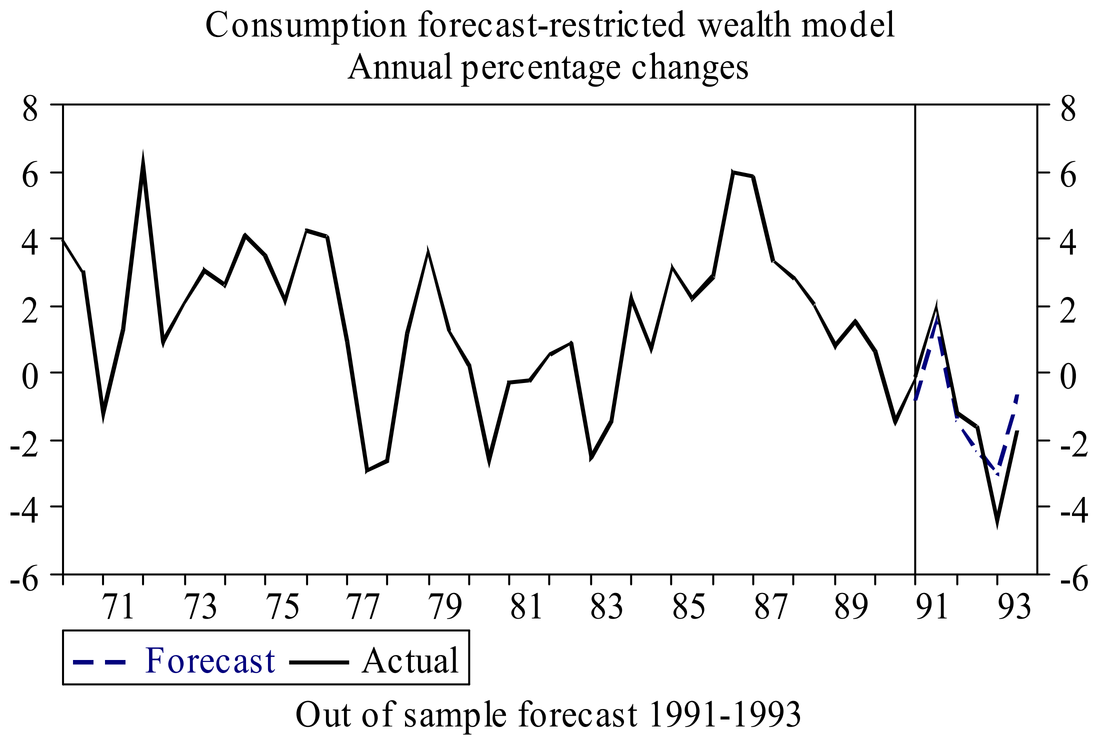

Figure 2. Unrestricted wealth model, recursive estimates

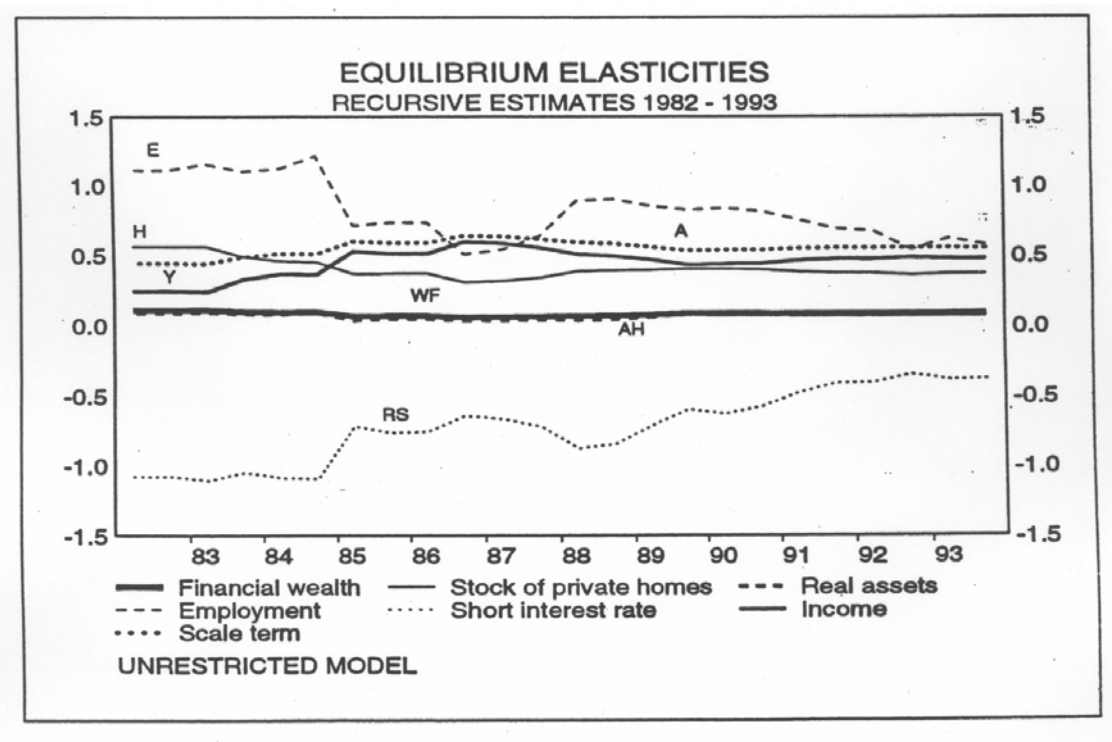

Figure 3. Restricted wealth model, recursive estimates

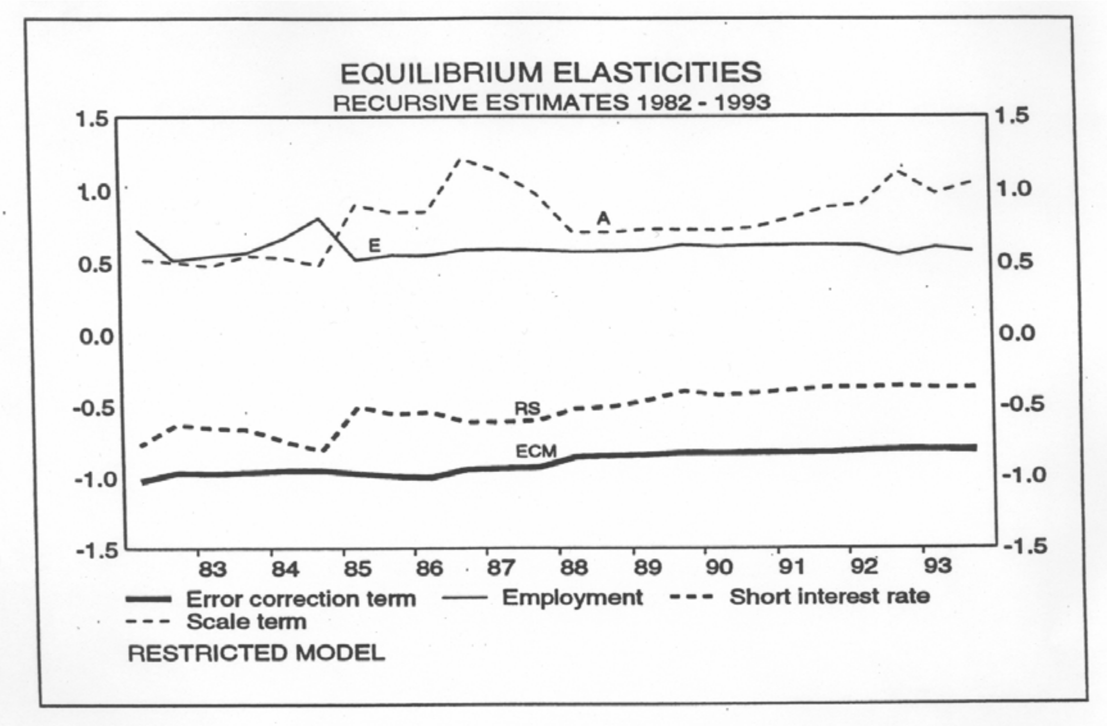

Table 7. Steady state equilibrium elasticities for the unrestricted wealth model

	ln (WF)	ln (AH)	ln (H)	ln (E)	R*(1-M)	ln (Y)
ln (C)	0.08	0.08	0.37	0.57	-0.45	0.47

Note: WF denotes net financial wealth, AH is housing wealth, H is the housing stock, R is the short term interest rate, M is the marginal tax rate and finally E is the employment rate.

7.5 Test for exogeneity

At present it seems common knowledge that the issue of exogeneity is of crucial importance to econometric modelling. Attempts to test for exogeneity have been scarce and mostly recent. Following Steel (1987), the general instrument variable approach and a variable additional test is adopted in this study. A reaction function for income, financial wealth, unemployment rate and housing wealth is searched. A first simple check is to introduce the ECM term in the so called reaction function. The Student's t-test is insignificant and we conclude that income, financial wealth, unemployment rate and housing wealth can be considered weakly exogenous for the long-run parameters. Alternatively, in the context of linear regression model, testing for exogeneity simply requires a variable additional test. Treating income, financial wealth, housing stock and

housing assets, and unemployment rate as potentially endogenous, we regress each on a set of instruments, save the residuals from the five regressions and add them to the restricted wealth model. The joint significance of the additional regressors can be tested via an F-test. Under the null of exogeneity the extra regressors should be insignificant. The results are reported in Table 10 below.

Table 8. Lagrange multiplier test

Models	Unrestricted model	Restricted model	No-wealth model
LM Test $\chi 2_{(1)}$	2.55	1.68	0.67
LM Test $\chi 2_{(2)}$	4.18	1.67	1.13
LM Test $\chi 2_{(3)}$	5.09	2.73	1.28
LM Test $\chi 2_{(4)}$	5.57	3.52	2.69
LM Test $\chi 2_{(5)}$	6.00	3.54	4.76
LM Test $\chi 2_{(6)}$	7.12	4.41	9.76
LM Test $\chi 2_{(7)}$	8.59	7.44	11.26
LM Test $\chi 2_{(8)}$	12.13	11.18	12.93
LM Test $\chi 2_{(9)}$	13.89	12.80	17.21

Note: LM (p): is the Breusch - Godfrey Lagrange Multiplier test statistic, for autocorrelation is obtained by regressing the regression residuals on the explanatory variables and the lagged residuals up to lag p and is distributed as $\chi 2$. The critical values at the 5% level of significance for LM (4) = 9.49, for LM (6) = 12.6 and LM (9) = 16.9. The results indicate no signs of autocorrelation up to lags 9, except in the last lag of the no-wealth model.

Table 9. The AIC and the BIC criteria

Models	**AIC**	BIC
The Final Model	-9.07	-8.60
Dropping D ln (Y)	-8.22	-7.70
Dropping D ln (PH/P)	-8.49	-7.98
Dropping Diff (DiffA ln(P))	-8.99	-8.48
Dropping DS	-8.82	-8.30
Dropping (R*(1-TAX)) $_{-1)}$	-8.90	-8.39
Dropping DS*D70s	-8.28	-7.76
Dropping D ln (Edvatx)	-9.02	-8.50
Dropping ln (C/Y) $_{(-1)}$	-8.15	-7.64
Dropping ln (WF/Y) $_{(-1)}$	-8.68	-8.16
Dropping ln (AH/Y) $_{(-1)}$	-8.97	-8.46
Dropping ln (H/Y) $_{(-1)}$	-8.37	-7.86
Dropping ln (E) $_{(-1)}$	-8.74	-8.22

Note: The formulas for the respective criteria's are as follows:

$$AIC = \ln(\sigma^2 + 2 \cdot (\frac{n}{N}), BIC = \ln(\sigma^2 + (\frac{n}{N}) \cdot \ln(N) ,$$

where σ the standard error n is the number of parameters. N is the number of observations.

Table 10. Exogeneity, tests on the significance of each variable

Variable Name	F(num,denom)	Critical value at 5% significance level
Y:RESIDUALS	F(1,33)	1.85
WF:RESIDUALS	F(1,33)	1.67
AH:RESIDUALS	F(1,33)	0.89
H:RESIDUALS	F(1,33)	0.05
E:RESIDUALS	F(1,33)	0.12

Note: The F-tests of each of the hypotheses: $b_0 = 0 ; b_1 = 0 ; .... b_k = 0$. These test the significance of each of the basic variable in turn. In case $H_0\ b_i\ (1) = 0$ cannot be rejected, there is no significant level effect from the variable under consideration. Under the null of exogeneity the extra regressors should be insignificant. The results suggest that the possible endogeniety of the tested variables do not result into inconsistent estimates. The 5% significance level F (1, 33) is 4.13. The F-test has been carried out in PC-GIVE.

The maintained model passes the main criteria conventionally reported i.e. goodness - of fit, absence of residual autocorrelation, accuracy of predictions and parameter constancy, absence of residual heteroscedasticity, Jarque-Bera test statistic for normality in the distribution of the residuals, test for exogeneity, and finally the AIC and BIC criteria.

7.6 Comparisons with Berg and Bergström (1993)

To facilitate comparisons of results with B and B (1993), despite data in different frequencies, both their best unrestricted and the restricted quarterly wealth models are referred to below. From their best unrestricted wealth model, the long-run elasticities on financial wealth is 0.10 (model 7) and 0.12 from (model 5), in comparison to my estimate which is 0.08. For housing assets my estimated elasticity is 0.07, whereas B and B find it insignificant. There are only marginal differences in my estimated elasticities for the respective wealth components. The wealth variable is important when it is disaggregated into its respective components. In contrast to B and B this study finds an additional effect of housing stock on consumption (model 5 and 5'). This can be interpreted as an aspect of declining housing shortage of government-subsidized houses, thus indicating that the housing stock could represent the supply constraint[23]. An alternative interpretation in the nested model (model 4 and 4'), points to the difference in the elasticities with respect to the stock and price components of housing assets as argued earlier. Finally, a third interpretation which is similar to Muellbauer and Lattimore (1994), in (model 6 and 6'), is that the proportion of nonowner-occupiers save more when real house prices rise. All these nested models are presented in section 4.

As regards the variables representing the short-term dynamics, the coefficient for the change in income is of double size. Neither B and B (1993) nor this study finds the annual inflation rate significant, while the acceleration in inflation is significant in my study. While B and B finds an additional short-run effect of financial, and housing wealth, I do not encounter any such dynamic effects. Recent empirical evidence of house prices having dual effects is supported by this study. The increase in house prices in the short run can be interpreted as a capital gain effect, while the negative relative price effect in the long-run is in agreement with Muellbauer and Lattimore (1993), Muellbauer and Murphy (1994). The Vat-rate dummies have the correct signs in both

[23] See Kanis and Barot (1993).

studies, although the magnitude of the co-efficients is different. The vital short run dynamic variables in B and B's study are the household debt variable and the tax reform dummy. There are vast differences in the functional specification of the respective studies. In contrast to B and B's study which finds the change in household debt indicating that households have been credit constrained, this study indicates no such effect. As net financial wealth has been used as a measure of household financial wealth, the use of the household debt variable may be redundant, as it results in double counting and multicollinearity.When financial wealth is netted it captures simultaneously the financial assets and liabilities of the households in the estimated coefficient, while when it is decomposed it would have two different co-efficients for the respective components (net worth and indebtedness). In order to carry out a deeper analysis of the role of the household debt variable, an analytical framework from Fisher (1932, 1933) is given in Söderström (1993)[24].

Contrary to the OECD (1994) which finds that neither unemployment nor capital gains on housing stock have any significant effect on saving behaviour, this study indicates such effects. The high unemployment prevailing in 1990 -1993 created uncertainty about the future expected income and resulted in increases in the saving rates and thus in a reciprocal fall in consumption. According to Pagano and Giavazzi (1995), the employment variable in my study, acts as a proxy for the fiscal crisis in 1990's and moreover, the unemployment rate is determined simultaneously with consumption, suggesting that it should be instrumented for in a consumption fuction. Pagano's suggestions are followed and unemployment is instrumented. The results indicate that there is no statistical significant difference between the two co-efficients (0.46 and 0.35) of the unemployment variable. In addition, the test for exogeneity in Table 11 indicates that unemployment variable is exogenous. Takala (1995) finds the unemployment variable is relevant for the Finnish consumption function. He argues as in this study that households prepare themselves for increased unemployment by saving more. Another interpretation of unemployment would be based on Keynesian theory, implying that increased saving would lower the effective demand and result into unemployment through the multiplier effect.

According to the OECD study (1994), Chow-tests indicate that a structural break occurs between 1985 and 1986, while this study indicates no structural break. The conclusion I draw is similar to Englund (1990) that the issue of financial de-regulation effects on consumption is uncertain or 'in the air for Sweden', in contrast to studies on Norway and Finland[25]. This confirms the earlier empirical findings of Lehmussaari (1989). In contrast to B and B's study both the short term interest rate and the long term interest rate (in the restricted model) are significant, whereas B and B do not encounter any such effect. Capital gains on real assets are another crucial short run variable in this study, so is the employment rate or, implicitly, the unemployment rate. A dramatic increase in precautionary savings can be interpreted as being caused by the sharp increase in the unemployment rate from 2-3% in 1990 to 14% in 1993. The recession in Swedish consumer spending for the period 1990 - 1993 can thus also be explained by the unemployment variable and not only by household debt and the tax reform, according to this study.

[24] See Söderström (1993) and Berg (1994).

[25] See Englund (1990).

8. Comparative statics and dynamic simulations with the consumption function

A simulation of a model might be performed for a variety of reasons, including model testing and evaluation, historical policy analysis and forecasting. Here we analyze comparative statics and examine dynamic properties of the unrestricted model. Such analyses can also shed light on responsiveness to policy measures.

8.1 Equilibrium (steady state)

In order to carry out the simulation experiments we must start with some initial equilibrium path values for the exogenous variables which are arbitrary but on the whole characteristic for the years 1992-1993. To establish a steady state path for the exogenous variables, disposable income is assumed to grow at 1.5%, with the consumption ratio noted as 92.9%, giving the initial savings ratio of 7.1%. Other key values and assumptions for the steady state path are as follows: the short - term interest rate (R) is 6%, the consumer deflator (P), and house prices (PH) grow at 1.6% and the relative housing deflator (PIHS/P) is 1, the unemployment rate (U) is 14%, the financial wealth/income ratio (WF/Y) is 206, the housing stock/income ratio (H) is at 400, and the marginal tax on interest income (TAX) is 30%. The consumption ratio is 92.9% of disposable income (1993 values), thus giving the initial total savings rate of 7.1%.

The endogenous variables are consumption, total savings, financial savings and financial wealth. For a steady state to be maintained financial wealth and income must grow at the same rate.

Saving (S) has been defined as income minus consumption, while financial savings has been defined residually as (S) - real savings (SR). Given the growth rate and the exogenous values of the consumption function, the real saving rate is constant and there is a one to one relation between WF/Y, S/Y and SF/Y. Assuming that the housing price deflator (PIHS/P) is unity and income and housing stock grow at the same rate, the real savings ratio is calibrated to be positive at 1.6%[26], on annual basis, which is consistent with the housing stock income ratio.

With these initial values we solve for the baseline steady state. The high financial wealth build up with high current saving rates in 1993 - 1994 cannot be maintained, as an increase in the financial saving rate leads to an increase in financial wealth and further on to higher consumption and lower savings.

The equilibrium base line solution indicates a fall of the total saving rate from 7.1% to 3.1%, where the sub components, the financial saving rate and the real saving rate are 1.5% and 1.6% respectively. The interest rate is assumed to affect neither the housing stock income ratio nor real savings, but affects financial wealth via savings.

8.2 Comparative statics

For the comparative statics a number of simulations are run. The alternative growth rates assumed for the exogenous variables are:

(1). An alternative growth rate in income of 2%.

(2). A rise in interest rate from 6% to 8%.

(3). A fall in the unemployment rate from 14% to 12%.

(4). A rise in house prices by 10%.

[26] See Appendix 1 on the real saving rate.

Assuming different growth rates for the exogenous variables, the values for the solved endogenous variables are depicted in Table 11.

Table 11. Results of comparative statics

	S/Y	SR/Y	SF/Y	WF/Y
Baseline	3.1	1.6	1.5	2.1
GY = 2%	4.0	2.1	1.9	1.9
R = 8%	3.2	1.6	1.6	2.2
U = 12%	2.7	1.6	1.1	1.6
PH / P = 10%	3.0	1.6	1.4	1.9

Note: GY denotes the growth rate in income. Y denotes disposable income. RS denotes the short term interest rate. U denotes the unemployment rate. PH denotes the house prices and P the consumption deflator. WF/Y denotes wealth income ratio. S/Y denotes total savings rate, SF/Y denotes the financial saving rate and finally SR/Y denotes the real saving rate.

A two percentage point permanent increase in disposable income results in a slight fall in the WF/Y ratios. The total saving rate increases from 3.1% to 4.0% while the financial saving rates increase from 1.5% to 1.9%. A gradual fall in unemployment from 14% to 12% decreases WF/Y and also the respective saving rates. The total saving rate falls from 3.1% to 2.7%, while the financial saving rate decreases from 1.5% to 1.1%. An increase in house prices by 10% results into a fall in the saving rate to 3.0%. Financial saving rate falls marginally to 1.4%, and WF/Y falls too. Finally, a rise in the interest rate by 2% point increases the total saving rate from 3.1% to 3.2%, while the financial saving rate rises from 1.5% to 1.6%. There is an increase in WF/Y, due to higher savings.

8.3 Dynamics

A consequence of the model is that the permanent shocks result in a move to steady state, while a temporary shock results in a temporary deviation from the baseline steady state. The temporary effects are the dynamic effects. The dynamic simulations are carried out by inducing a temporary shock during a year. The reduction in income by 5% relative to baseline results in a fall in consumption and a fall in the respective saving rates. Consumption falls but by not as much as the fall in income. It reacts as a automatic stabilizer.

A transitory rise of interest rate form 6% to 8% gives rise to merely marginal adjustments. The interest rate change does not affect disposable income in the simulations. Under the assumptions that the housing stock is constant, interest rate does not really matter much for the long run. The dynamic simulation of a 2% rise in interest rate indicates merely a half percentage point fall in consumption just a year after. King (1985), concludes in his survey of empirical studies on household savings and the rate of interest that "hence it will be difficult to conclude from aggregate data that the response of consumption to changes in interest rates is anything other than small".

A reduction in unemployment over 2 years by 2% gives an inter-temporal rise in consumption, and a fall in the saving rates as expected. A temporary rise in real house prices by 10% over a two year period results in an increase in consumption as people spend the capital gains initially, but hardly affects the saving rates compared to the baseline. There is more consumption, but the saving rates are stable at 3% and 1.5%. The results of the dynamic simulations for the above mentioned cases are depicted in Figures 4 to 11 in Appendix 3.

A temporary rise in real house prices by 10% over a two year period results in an increase in consumption, as people spend the capital gains initially, but hardly affects the saving rates compared to the baseline. There is more consumption but the saving rates are stable at 3% and 1.5%, (see Figures 10 and 11).

9 Conclusions

In this study we have formulated three empirical relationships to explain the aggregate consumption function. In addition to the common explanatory variables the study has taken into consideration the influences exerted by wealth. The model strategy applied is Hendry's general to specific modelling. A specific model has been derived applying a sequential testing procedure. The no-wealth model does not yield to ECM interpretation. The restricted model has been derived from the unrestricted wealth model by imposing the unit elasticity restriction, supported by data. The parameters of the estimated wealth models are robust. The restricted wealth model proves to be the best and the signs and the magnitudes associated with the short-run dynamics and the long-run equilibrium are plausible. From the forecasting point of view the restricted wealth model has been successful in capturing both the downturn and the upturn in private consumption and satisfies the ultimate goal of empirical testing in economics, which is to determine how well a theoretical model corresponds to the reality of an economic situation.

In the light of earlier studies, this study does indicate that the consecutive period differenced semi-annual model performs equally well as or better than a quarterly model. There is no indication of structural break. Thus wealth is an important variable from a model specification point of view, and only works when it is disaggregated. The special housing stock effect can be interpreted as housing shortage effect, even if non owner - occupiers save more when real house price rises. The aggregate wealth model expressed in this study does not fit well and thus the results from it are not presented. We have seen that incorporating wealth is necessary in order to estimate a proper consumption function for Sweden. Both the short - term treasury notes and the long term interest rate is statistically significant, but only as alternative explanations. No statistical significance could be obtained for the difference between the short and long term interest rates which was used as a proxy for credit availability in Kanis and Barot (1993). In contrast to earlier studies does not find any relevance neither of household debt nor of the tax reform. However, the interest rate, the employment rate, and house prices emerge as significant determinants. The restricted wealth model captures the development in private consumption well without any dummies for the tax reform and credit de-regulation.

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Appendix 1. The real saving rate

The real saving rate is calibrated on annual basis using the following relationship:

$$\frac{SRL}{YL} = (\frac{PIHS}{p}) \cdot (\frac{SR}{Y}) \tag{15}$$

where $Y = (1+G_y) \cdot Y_{[-1]}$, $SR = \frac{SRL}{PIHS} = \alpha \Delta H = \alpha G_h \cdot H_{[-1]}$

$= \alpha \Delta H = \alpha G_h \cdot H_{[-1]}$

$$\frac{SRL}{YL} = \alpha \cdot ((\frac{PIHS}{P}) \cdot (\frac{G_h}{1+G_y}) \cdot \quad (\frac{H}{Y})_{[-1]}) \tag{16}$$

The estimation of the above relationship gives a coefficient of $\alpha = 0.534$ from a regression on annual basis (1970 - 1993).

We assume in the steady state that $\frac{PIHS}{P} = 1$, and that $G_h = G_y = G$

$\frac{H}{Y} = (\frac{H}{Y})_{[-1]} = 4$, on annual basis, but for semi-annual data we use $(\frac{H}{2})$,

thus $\frac{SRL}{Y} = 0.534 \cdot \{1 \cdot \frac{0.015}{1.015} \cdot \frac{4}{2}\} = 0.016$

See List of variables for the definition of the data set.

Appendix 2: Dynamic simulations

Figure 4. Response of consumption to a 5% fall in income

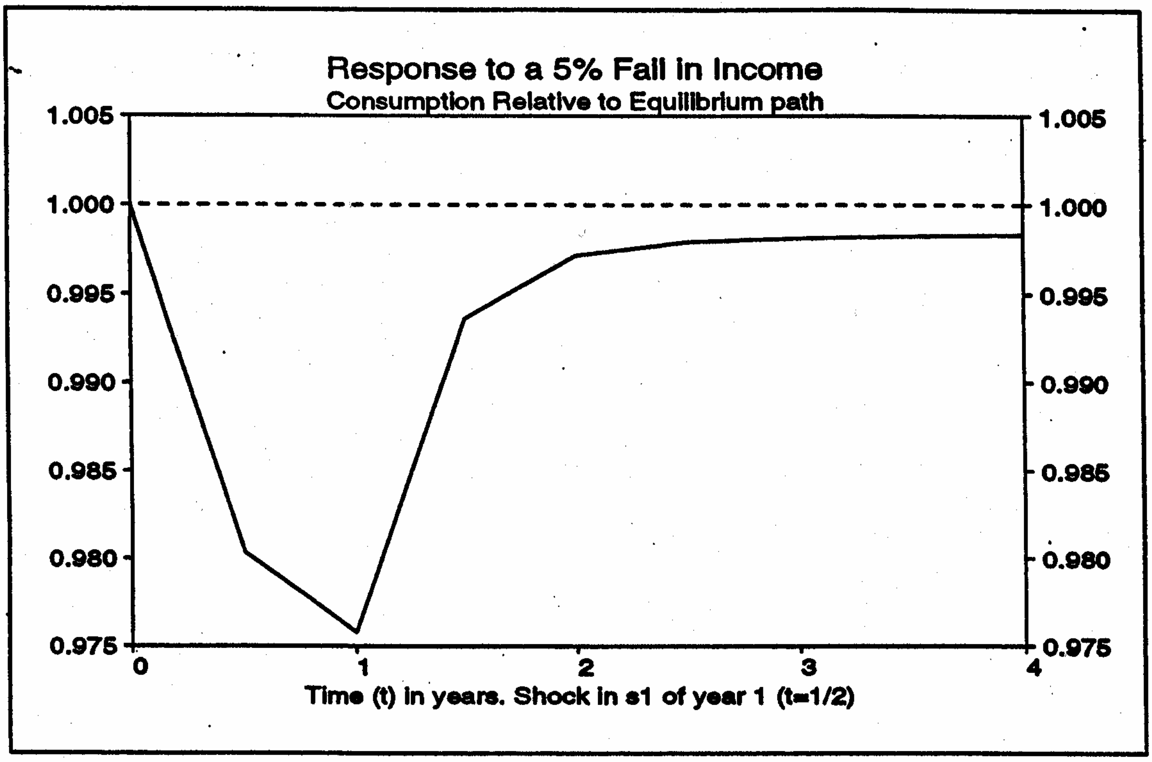


Figure 5. Response of saving rates to a 5% fall in income

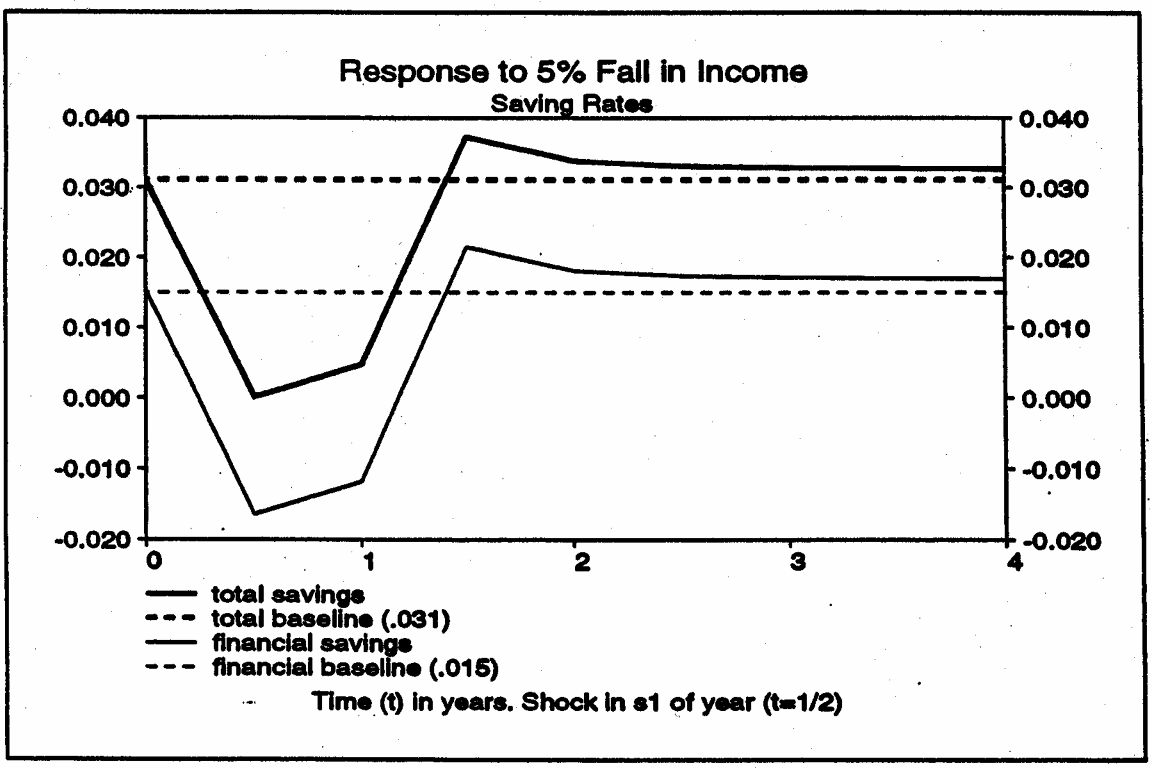


Figure 6. Response of consumption to a 2% increase in interest rate

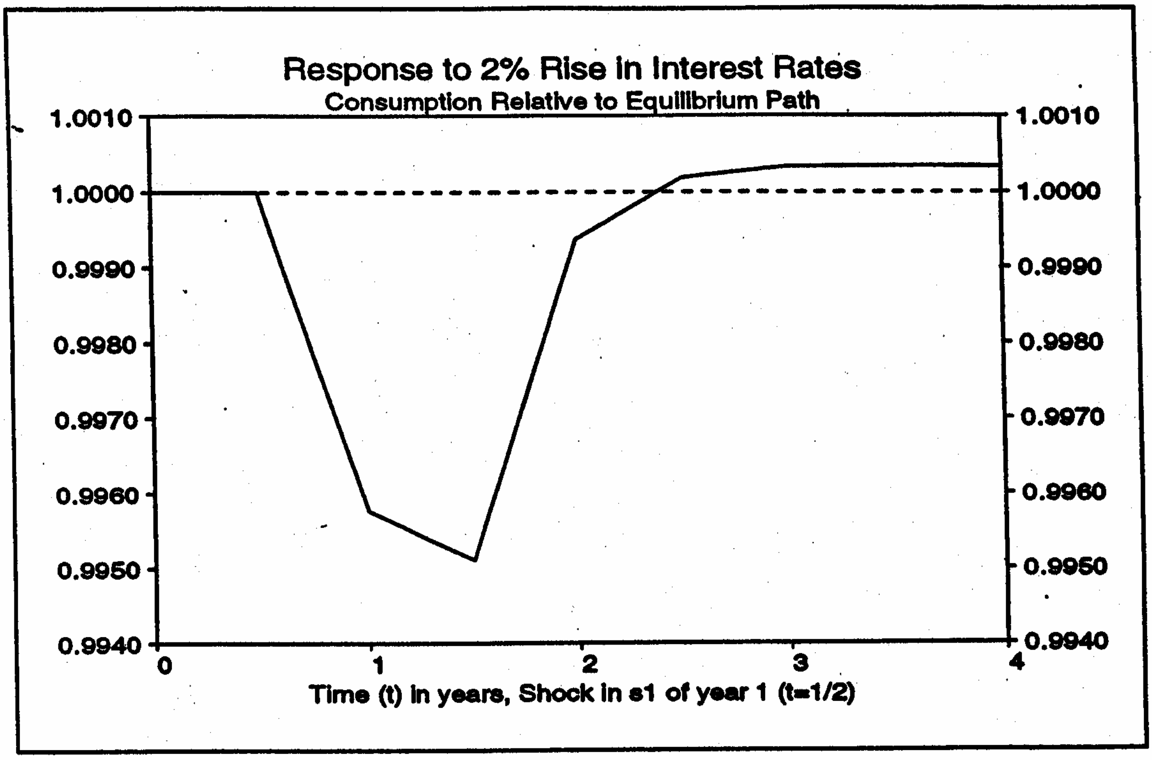


Figure 7. Response of saving rates to a 2% increase in interest rates

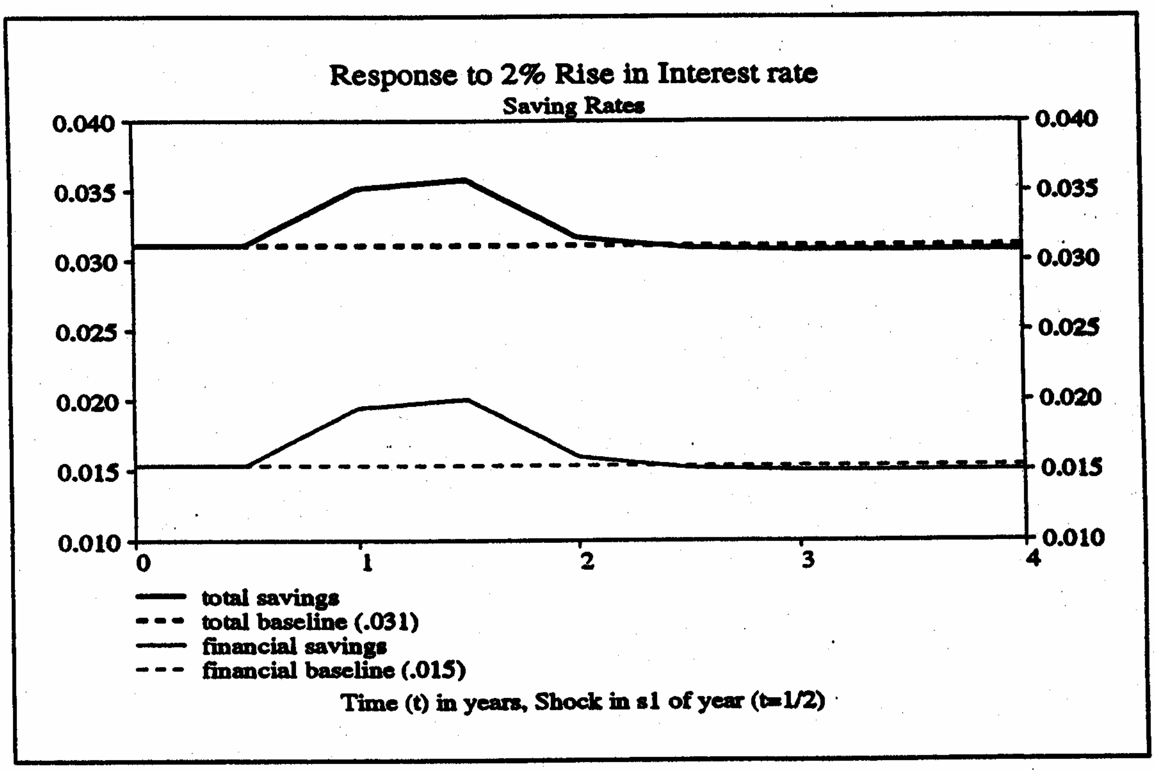


Figure 8. Response of consumption to a 2% fall in unemployment

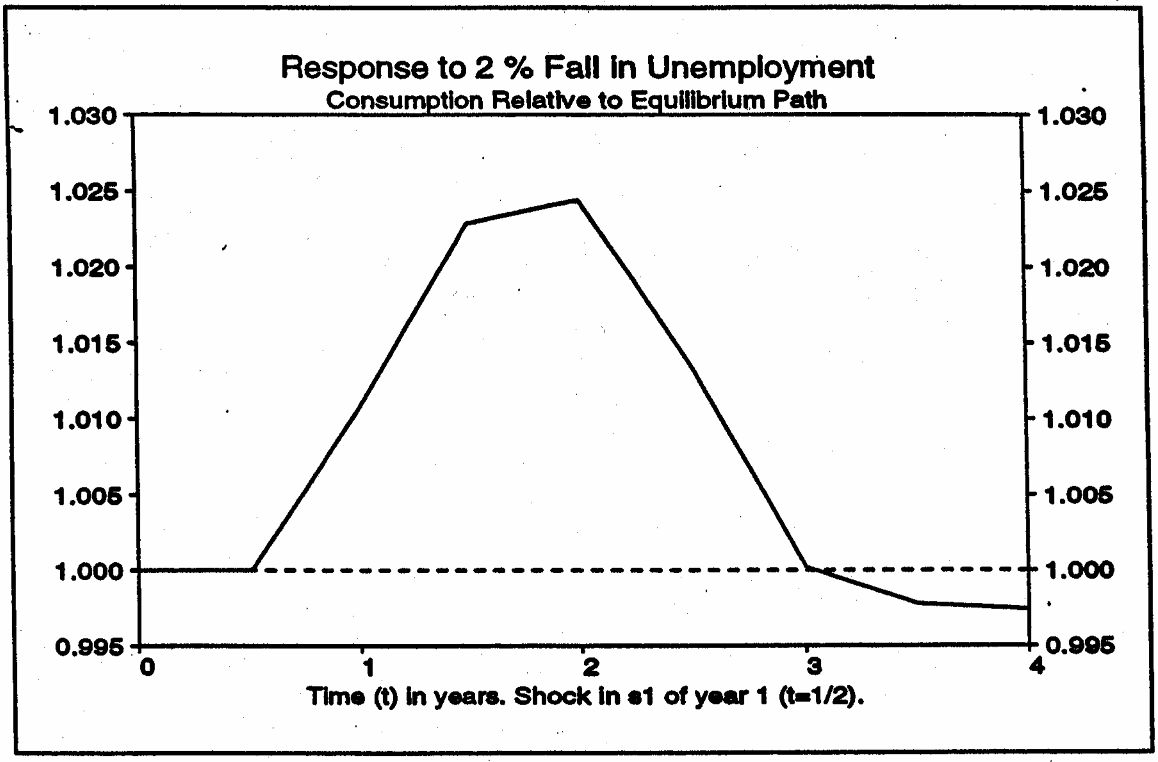


Figure 9. Response of saving rates to a 2% fall in unemployment

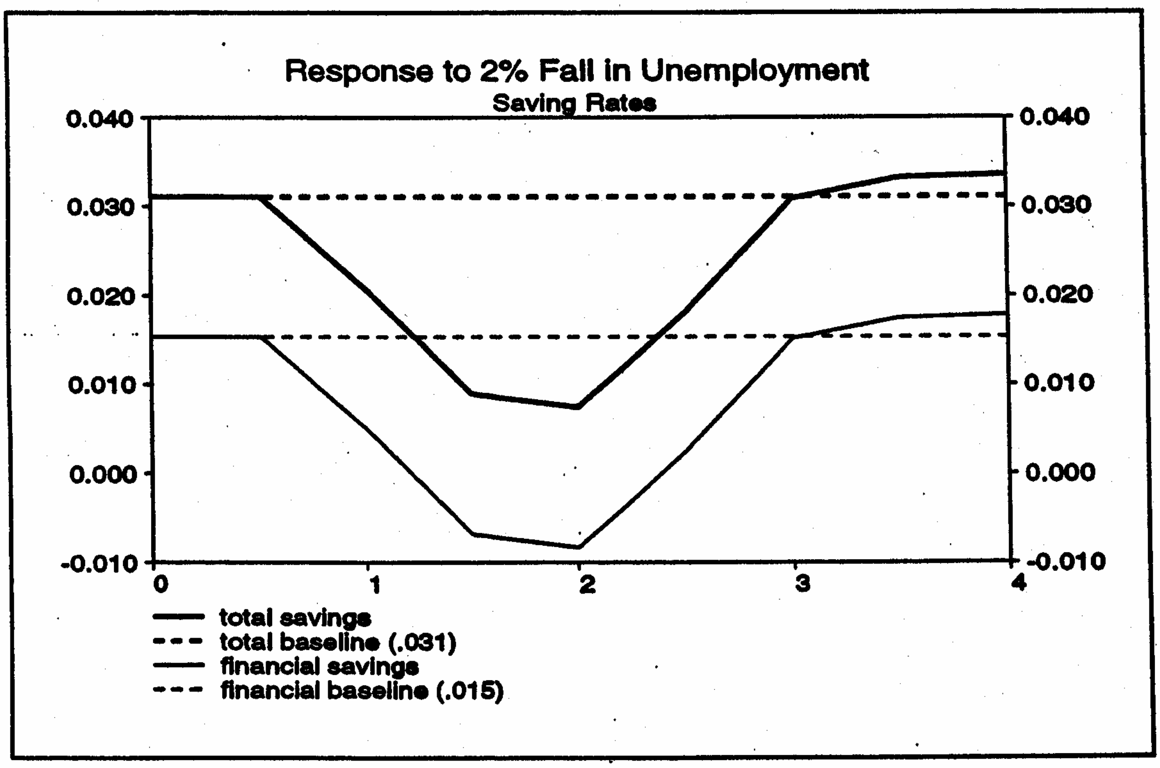


Figure10. Response of consumption to a 10% rise in house prices

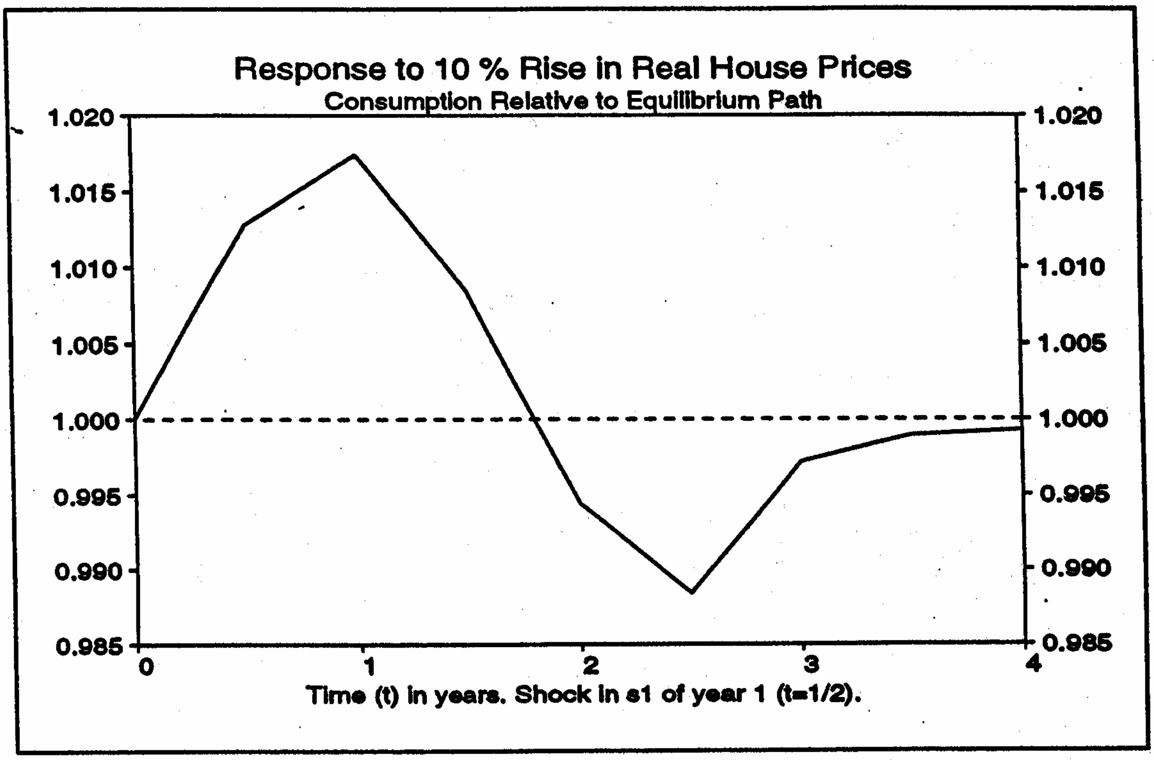
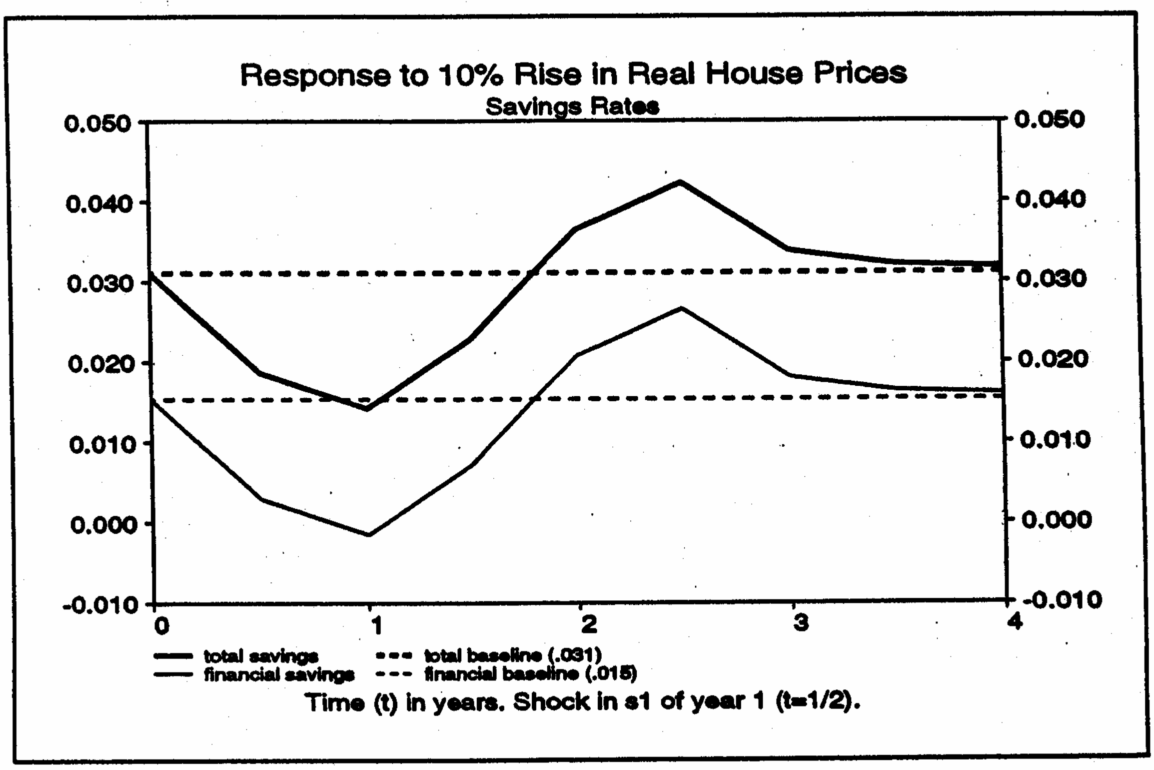


Figure11. Response of saving rates to a 10% rise in house prices



Appendix 3. Plots of the data set

Figure 12. Consumption and income

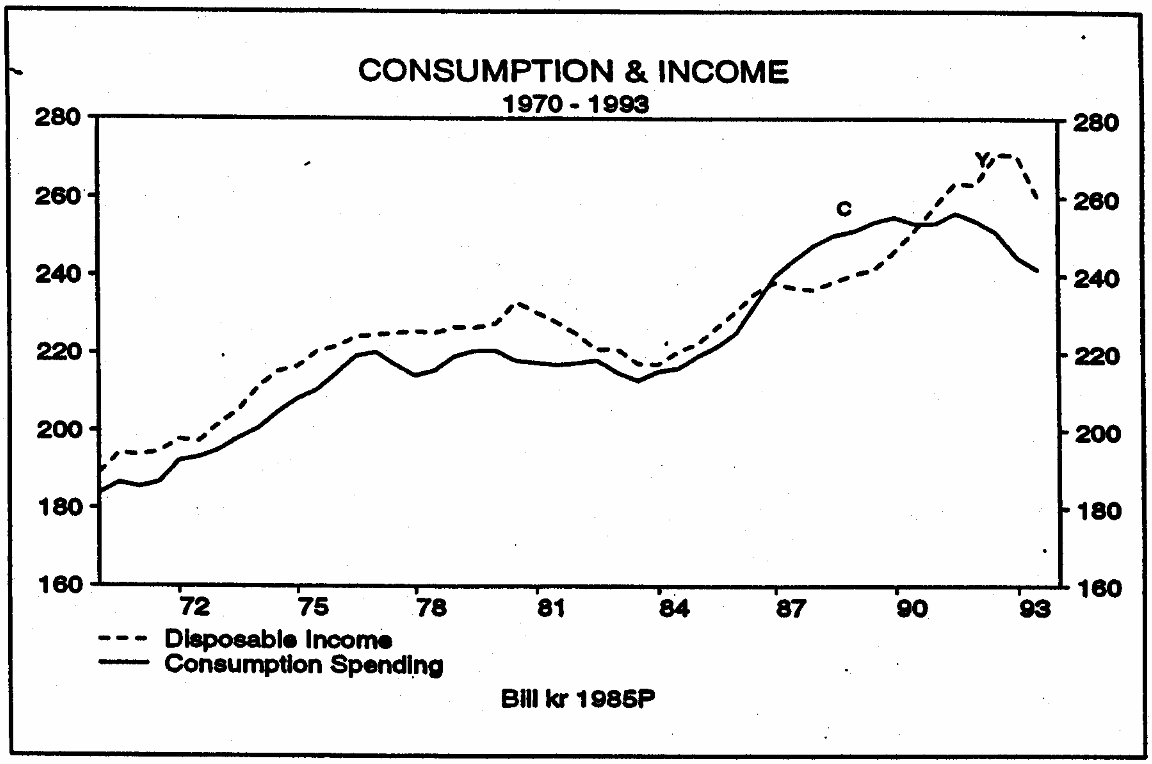


Figure 13. Consumption income and total wealth income ratios

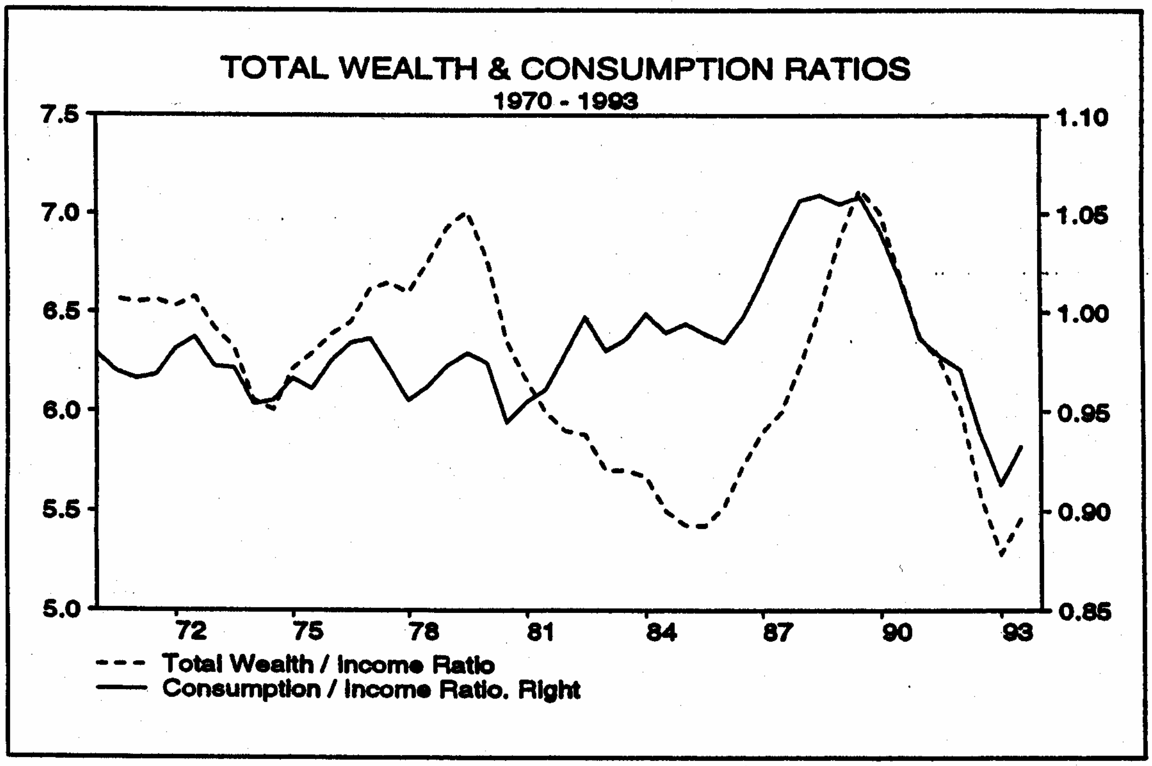


Figure 14. Financial wealth, housing wealth and housing stock income ratios

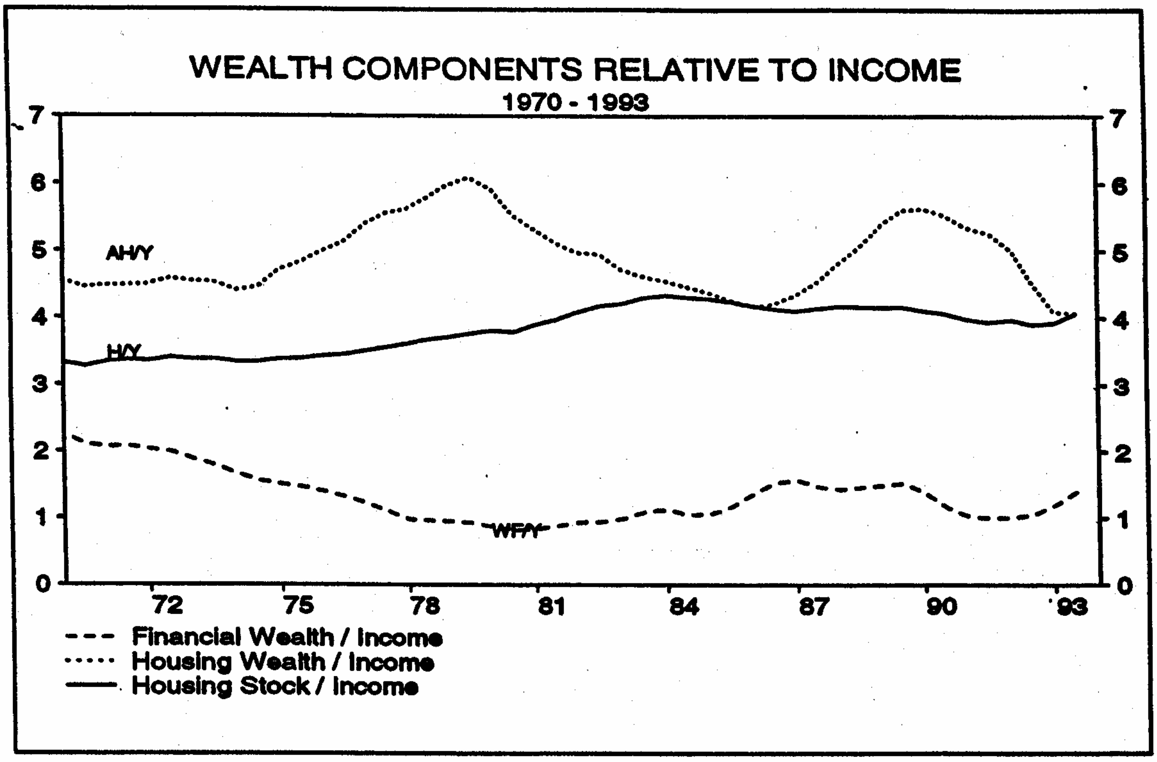


Figure 15. House prices and consumption deflator

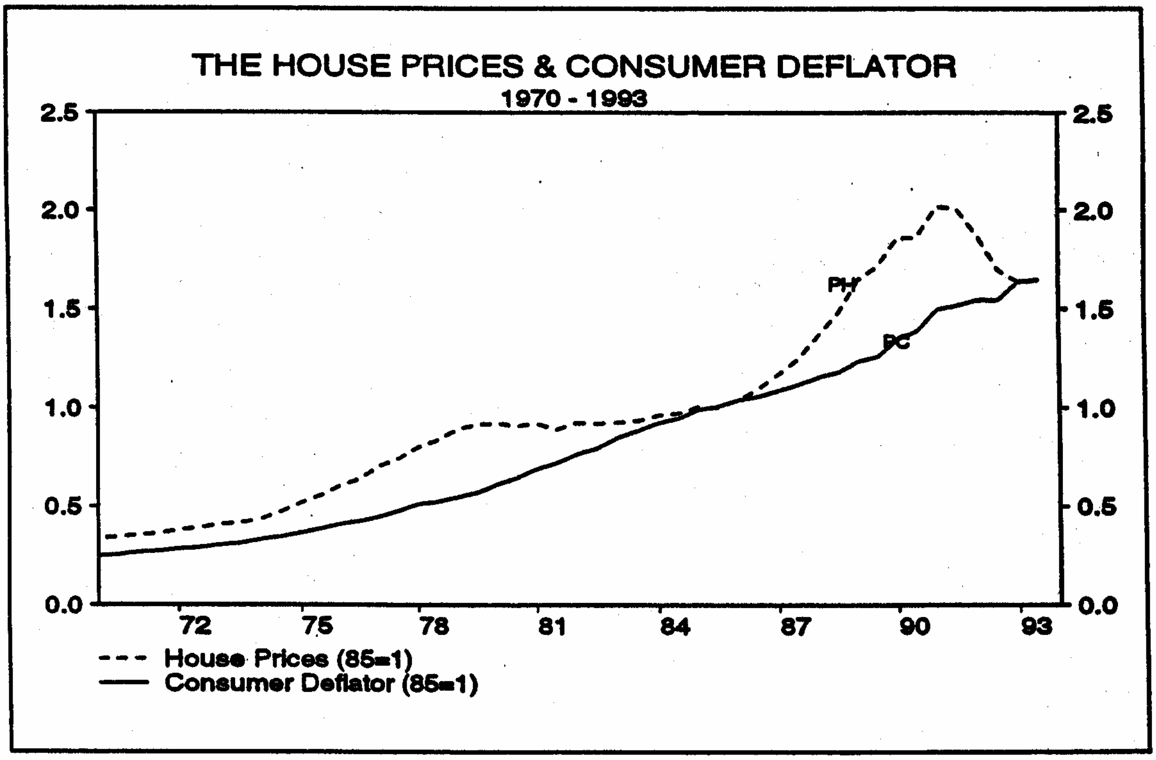


Figure 16. Short term interest rates

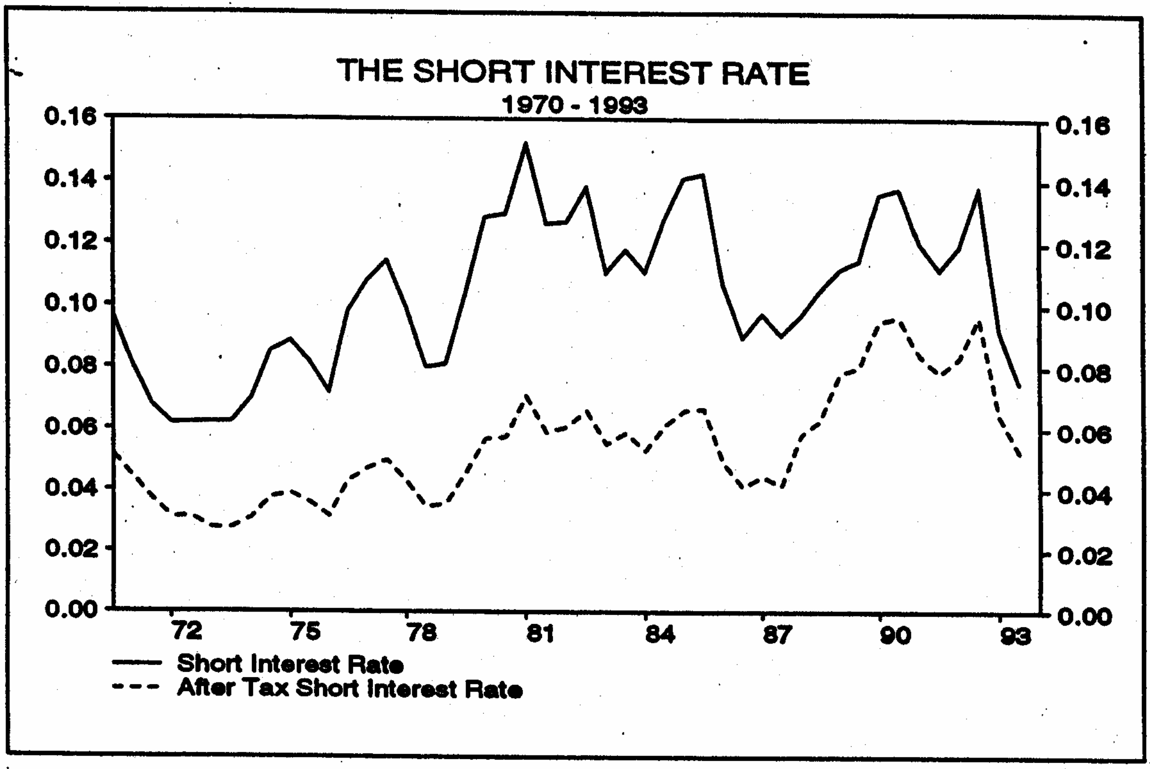


Figure 17. Long term interest rates

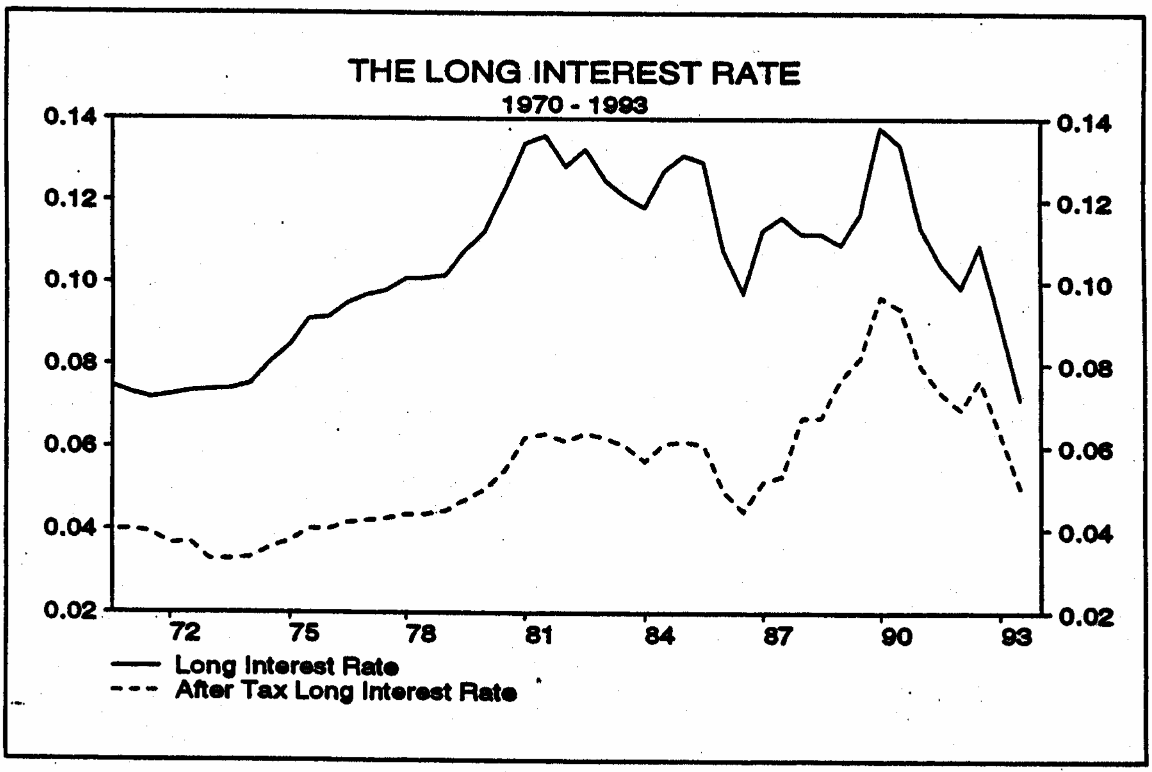
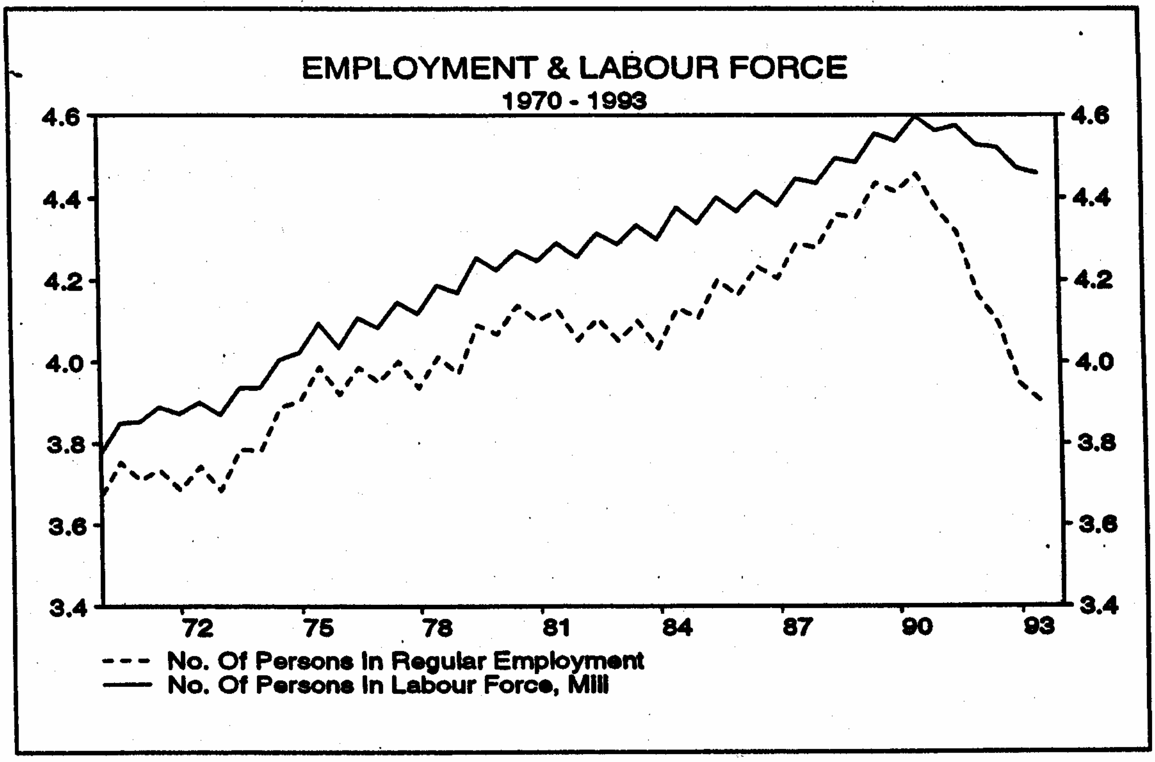


Figure 18. The employment rate and number of persons in the labour force



List of variables

C: Total private consumption, mill 1985 prices.

Y: Disposable income, mill 1985 prices. Disposable income million SEK 1985 prices. Disposable income consists of the compensation of employed, less employer contribution for private group and social insurance, other earned income, net interest and dividens and transfer less taxes, From the National Accounts, Statistics Sweden.

P: Consumption deflator (85=1).

PH: Market price index for private homes (85=1), weighted mean of fastighetsprisindex egnahem, fritidshus.

PIHS: Deflator for housing investment in small home. Investment deflator (1985=1), is for investment in small homes.

AH: Household real assets (mill 1985 prices).

H: Stock of private home (mill 1985 prices), sum of stock of primary and second homes. The stock of private homes (H) i.e. the sum of the stocks of primary and second homes computed according to the perpetual inventory stock method (approximately equal to Statistics Sweden's gross stock), the value of house assets (AH) is the stock of primary and secondary homes at constant 1985 prices, multiplied by the property price index and linked backwards using 1970 purchase price co-efficients. Berg (1990) used the real estate taxation data and see Markowski (1994) for the computation of the net stock. Our stocks differ from the above mentioned authors in the sense that the computations are based on the total relevant building category.

WF: Household net financial wealth 1985 prices. Total household net wealth (W) has been defined as the sum of net financial wealth and real assets (housing assets). The statistics for financial wealth and liabilities have been collected from SCB's financial accounts. The stocks have been computed at NIER Household net financial wealth (WF) is defined as the sum of notes coins, bank deposits and the National Saving Scheme (Allemansspa-rande), bonds and treasury discount notes (statsskuldväxlar), private insurance savings, listed and non - listed equity shares and other assets, minus total direct lending. The annual stock figures for household financial assets and liabilities were taken from the Financial Accounts (Finansräkenskaper) 1970 - 1993.

M: Marginal tax rate on interest deductions leading 1 year. M for earlier years, the marginal tax rate for interest (TAX), is computed from tax returns (Statistics Sweden Income and Wealth distribution figures 1975 - 1980), and is the interpolative guess linked to estimates in Forslund (1991), for industry worker pre 1975). Later the statutory maximum applicable to interest deductions on tax returns have been reduced from 50% in the 1980's to 30% in the present period.

R: Treasury bill rate 3 - months or Short interest rate. The short interest rate (RS) is from Markowski's Minimac model extended forward using treasury bills (statskuldsväxlar) and backward 1969q1 - 1970q3 as the three month treasury bill rate (Central bank) + 1.5% point (mean absolute difference 70q4 - 71q4).

RL: Long gov't interest rate (10 years, recently 5 years). The long government interest rate (RL: ten years, recently five years), is the mean of months from SCB's Monthly Digest of Swedish Statistics.

EDVATX: The value added tax change variable (EDVATX) has been defined as: $EDVATX_t = (1 – m_{t-1} / 100) / (1 – m_t / 100)$ i.e. the ratio between the current price of goods including the Vat rate (m_t) and the previous price with the Vat rate (m_{t-1}). The expected $EDVATX_t = EDVATX_{(t+1)}$.

DVAT: is the value added tax change, price expost/exante. The data has been collected from the Business and Industry Information Group (Näringslivets Ekonomifakta).

D70S: Dummy for the 70's, is 1 for the 70's and 0 for the 80's. Dummy equal to unity before 1980s.

DS: Dummy and is 1 in the first half and 0 for the second half for the whole sample period.

DREG: Credit de-regulation dummy = 1 from 1986, otherwise 0.

TSY: The time trend.

NREMP: Number of persons in regular employment in millions.

NLFIADJ: Number persons in labour force.= nremp+nlmp+nunp, in millions.

NUNP: Number of persons in open unemployment, in millions.

NLMP: Number of persons in labour market programs.

E: Employment rate (regular / labour force inclusive programs), in millions.

The employment rate (E) is the ratio of persons in regular employment to all in the labour force (the sum of number of persons in regular employment, the number of persons in labour market programs and the number of persons in open unemployment). The data has been collected from Labour force Survey, Statistics Sweden.

S/Y: Saving rate.

SF/Y: Financial saving rate.

SR/Y: Real saving rate.

WF/Y: Financial wealth income ratio.

H/Y: Housing stock income ratio.

AIC: Akaike information criteria.

BIC: Bayesian information criteria.

H.C.S.E: Heteroscedastic consistent standard errors.

σ: Standard errors.

G : Growth rate

ln(X): Natural log(X).

Dln(X): The logarithmic difference, ln(Xt / Xt-1).

DiffAln(X): The annual logarithmic difference for series X i.e. the logarithmic difference between a period and the same period a year ago. ln(X / X.n) where n is the number of periods in each year.

Diff(X): The simple difference between successive values in series X.

The semi-annual seasonal effects sum to zero over the year, implying that the intercept is an average over the year i.e. dummy (DS) = (1, -1), in the first and second half years respectively. In order to account for differences in seasonal patterns between the 1970S and 1980S the seasonal dummy is multiplied by a period dummy (DS*D70s), which equals zero from the 1980S on.

Chapter III

A Full Fledged Demand-Supply Econometric Model for Swedish Private Housing for the period (1970 - 2000)

1. Introduction

Housing markets are highly volatile, and modelling both prices and investment simultaneously has been a challenge for economists and econometricians. A stock-flow model of the real sector serves as the theoretical basis for the fundamental determinants of real estate construction and prices. The reduced form approach is adapted in this study. The reduced form approach specifies separate housing demand and supply equations and then equates the two to derive a price equation. The model developed in the paper is also used as a tool with which to analyse the controversy over the causes of the 1990s recession, in the context of the 1991 tax reform (91TR). We also conduct dynamic policy simulations to assess the responsiveness of house prices to shocks from income, the long interest rate, housing stock and household debt. In addition house prices are *ex-ante* forecasted for the period 1999 – 2000.

The major econometric models both in the UK and in Sweden now incorporate both housing wealth along with financial wealth in their consumption function (see Davidson et al. (1978) and Hendry (1981) for the UK; Berg et al. (1995), Kanis and Barot (1993), Barot (1995), and finally Johnsson and Kaplan (1999) for Sweden). This makes it important to have an econometric model that increases our understanding of the determinants of house prices and of the effects on house prices of both fiscal and monetary policies.

The objective of the paper is to develop a dynamic and long run model for the Swedish housing market. Demand and supply sides are modeled for the purpose of both the short term forecasting and medium to long term assessments. While investigating these issues, the study also contributes to the development of the stock - flow model for private homes in the econometric model KOSMOS, a semi-annual Keynesian model, developed at NIER and still in use at the Ministry of Finance Sweden.

The paper is structured as follows: Section 2 presents a review of earlier studies. In section 3 the theoretical considerations for modelling real house prices and housing investment in Sweden is outlined. Section 4 discusses and describes the data used in this study. Section 5 explains the econometric methodology used in this study. Sections 6 and 7 present the empirical results on house prices and housing investment models and the reduced form. Section 8 discusses the controversy over the causes of crisis in the Swedish housing market. In section 9 some policy simulations are carried out and their usefulness to the Swedish policy maker discussed. Section 10 highlights the simultaneous model and explains the mechanism underlying the simultaneous model solution. Section 11 outlines the house price ex- ante forecast for the years 1999-2000. Finally section 12 concludes. Appendix 1 presents results from the unit root test for integration and cointegration. Appendix 2 defines the data set for the sample period 1970-2000.

2. Earlier studies

Since the seminal work by Hendry (1984) there has emerged a plethora of empirical macro estimates of house price functions. Fluctuations in house prices have been analysed in terms of an inverted demand function for houses, conditional on last period's housing stock. In the short term, the housing stock is taken as fixed and only house prices react to disturbances, but house price changes induce changes in construction activity in accordance with Tobins (1969) q. In the long term construction achieves adjustment of the stock supplied to its long term demanded level. Tobin's (1969) q theory is adopted in order to model housing investment and using a perpetual inventory relation, the long-term changes in the housing stock. House prices are commonly derived as a reduced form from separate housing demand and supply equations. Studies in this category are those by Mayes (1979), Nellis and Longbottom (1981), Bradley (1981), Hendry (1984), Meen (1990), Tse (1999) and Meese and Wallace (1997).

Swedish house prices are studied by Heiborn (1994), in which she analyses how the quantity of housing demand can be explained by the size of different age cohorts. Her study indicates that there is a positive effect of demographic demand on house prices. Hort (1997) uses a dynamic capital asset market model in which an error correction model estimates real house prices as a function of total income, user and construction costs. The results from her study indicate that the volatility in house prices can be traced back to fundamental demand and supply conditions.

3. A framework for analysis

3.1 The long run demand side of the equation

A stock-flow model of the real sector serves as the theoretical basis for the fundamental determinants of real estate construction and prices. The term stock refers to the outstanding stock of structures, for which demand and supply interact to determine asset prices. The term flow refers to the rate of new construction, which is determined by profit potential as measured by the rate of asset prices to construction costs called Tobin's q. This type of stock-flow modelling in macroeconomic studies of the housing market is motivated by a concern for business cycles and forecasting. The long-run demand for the stock of housing services can be written as:

$$\frac{H^D}{Y} = f\left(\underset{(-)}{\frac{PH}{P}}, \underset{(-)}{(R\cdot(1-M)-(\frac{\Delta P}{P}))}, \underset{(+)}{\frac{DE}{Y}}, \underset{(-)}{\frac{DE}{WF}}, \underset{(-)}{\frac{HF}{H}}\right) \tag{1}$$

where, H^D denotes the demand for housing services (stock), Y is disposable income, M is the marginal tax rate on interest deductions, $\frac{PH}{P}$ is real house price, PH is the nominal house price index and P is the consumption deflator, HF is the stock of rental housing (flats), DE is the household debt, WF is the household net financial wealth, R is the nominal long interest rate on government bonds, and inflation ($\frac{\Delta P}{P}$) is defined as the annual change in P. Solving (1) for house prices, we get the inverted demand function:

$$\frac{PH}{P} = g\left(\underset{(-)}{\frac{H^D}{Y}}, \underset{(-)}{\frac{HF}{H}}, \underset{(-)}{(R\cdot(1-M)-\frac{\Delta P}{P})}, \underset{(+)}{\frac{DE}{Y}}, \underset{(-)}{\frac{DE}{WF}}\right) \tag{2}$$

The anticipated signs of the partial derivatives are indicated in the equations.

3.2 The long run supply side of the equation

Applying Tobin's- q theory to the housing market, construction activity is determined by the profit incentive represented by the ratio of the asset prices of existing structures, to the cost of new construction. Average Tobin's q is defined here as an index (1991 = 1)

$$q = \frac{PH}{PB}$$

of market price PH to PB, the construction price index. In long- run equilibrium, the value of Tobin's q converges to 1, implying that asset prices converge towards construction costs, but in the short run q may deviate from 1. Our q-index would however converge to some other constant where Tobin's q = 1, since our q = 1 merely signifies the base year (and also happens to be the sample mean value of our q index) approximately. In equilibrium, investment equals depreciation of the capital stock (if net investment is zero), see Jaffee (1994), or adjusted for a constant growth rate. The augmented Tobin's model of housing investment can be written as:

$$\frac{IH}{GDP} = f\left(\frac{PH}{PB}, RS\right) \tag{3}$$

where IH is housing investment, GDP is the gross domestic product (the correct specification of the supply side would be to have the ratio of housing investment to the housing stock), and RS is the short-term interest rate, reflecting the cost of financing investment in the construction industry.

In the long run $H^D = H = H^S$. (4)

Equations (2) and (3) are the basic demand and supply equations respectively. Finally, the housing stock evolves over time with investment through the perpetual inventory relation:

$$H^S = IH + (1-\delta)\cdot H_{(-1)} \tag{5}$$

where H is the housing stock in hand and δ is the rate of depreciation of the stock (H). Equations (2) and (3) are estimated separately and a reduced form is derived by equating the identity, $H^D = H = H^S$. The full model is finally simulated using equations (2), (3), (4) and (5), where we want to determine the price and the quantity (see Section 10 on responses of the simultaneous model solution, and Figures (10 - 14).

The house price function is expressed in ratio form to highlight the long term features of steady state, that is, all ratios are constant if numerator and denominator expand at the same constant rate (of growth inflation) and the income elasticity of demand for stock is unity. The long-run relationship to be tested is in log linear form. In the error correction equation real house prices depends negatively on real interest rates, household debt / financial wealth ratio[27], and the stocks of both owned homes and rented flats (rental stock)[28], and positively on the debt / income

[1]An increase in indebtedness or a decrease in holdings of financial assets would raise the risk of financial distress, thus prompting the consumer to shift his demand away from durables and housing. With this shift in demand there would be a reduction in house prices. The financial wealth income ratio could have been used alternatively. This would merely change the sign of the coefficient in a log model and hence provide us with a different interpretation i.e. we would expect different responses from liquid and non-liquid assets (see Miskin (1977)).

[2] Given the private housing stock, an increase of price in the rental market induces substitution, affecting the kind of

ratio[29].

In the long run on the demand side, real housing prices begin to diverge from their long run relationship, the four ratios along with the level of the real long interest rate act in the error correcting mechanisms driving house prices towards equilibrium. There is similar error correcting mechanism on the supply side, i.e. when investment begins to diverge from its long run relationship (e.g. in response to the price deviation), Tobins q ($\frac{PH}{PB}$) and RS act as error correcting mechanism driving housing investment towards equilibrium. The two mechanisms thus interact.

4. Data and the explanatory variables

The data are semi-annual in frequency and cover the sample period 1970-2000. In international studies the standard variables used in order to model the demand side are as follows: (1) the average price of dwelling (2) the cost of housing services given by the mortgage or other interest rates (3) disposable income, permanent income, or real wages. (4) population and a demographic cohort (5) some credit variable i.e. extent of mortgage rationing (6) expected capital gains on dwellings (7) interest rates on short-run treasury bills or long-term government bonds (8) a proxy measure of the stock of outstanding mortgage (9) the wealth stocks usually disaggregated initially between liquid and fixed assets since one can expect different types of responses (see Meen (1990)) (10) the user costs (11) the marginal tax rate on interest. This study employs approximately the same type of variables in order to model the demand side in the UK.

The short term dynamics are represented by the following variables: the yearly change in long term interest rate, the acceleration in financial wealth and the employment rate, the yearly change in total population and lastly the change in rents. The long-term level terms are represented by the four ratios as explained earlier along with the level of the interest rate. The income variable used in this study is disposable income. Permanent income defined as a moving average of disposable income could have been used instead. Other methods of specifying permanent income involve hypothesis concerning the formation of expectations which are not used in this study.

The supply side variables used to model Tobin's q are as follows: (12) housing investment alternatively housing starts are usually the dependent variables (13) construction costs which include the building cost index, or the factor price index. It should be noted that the building cost index is based on the units actually constructed and incorporates builder profits and quality change that are not included in factor price index (14) interest rates can be used reflecting the cost of capital in order to finance housing investment which might be the interest on long-term government bonds or short- term treasury bills (15) housing prices for Tobin's q is defined as a ratio of house prices to construction costs (16) the housing stock is also used as a scalar on the supply side and finally (17) gross domestic product (GDP) has recently been used as strong separate influences are expected from output. For a detailed description and sources of the data set, see data Appendix 2.

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housing desired (e.g. single ownership dwellings may get replaced by rental apartments). This adjustment continues until both markets (stocks and flows) are again in joint equilibrium, with new construction yielding normal profits.

[3] Usually increases in debt are deemed to be an indicator of consumer optimism and strong demand. People buy houses with debt financing to large extent, which suggests that real house prices and debt could be positively correlated.

5. Econometric methodology

The econometric methodology adapted in this study is based on the Error Correction Method (ECM). This approach implies linking equations formulated in levels presenting the long-run component of the model and with those formulated in differences, representing the short run component. The notion of the long-run is inextricably linked with the concept of equilibrium in economics. The long-run steady state relationship is usually based on the solution of an inter-temporal optimisation problem. The statistical part of the analysis is based on a test for unit root often called the integration test. The test for relationship between the variables included in the long-run part of the model is called the test for co-integration. There is a family of tests for integration and co-integration but in this study we focus our attention on the well known Augmented Dickey-Fuller test usually called the test for unit roots and the Johansen and Juselius (1990) test for co-integration.

As a preliminary step to co-integration analysis, the unit root test for the order of integration of the housing model data set is carried out. Several procedures are available (see Dolado et al. (1990), for a survey); in the present analysis, the Augmented Dickey-Fuller (ADF) unit root test is employed. The results of the ADF test are presented in Table 1, Appendix 1.

If the variables are found to be balanced (integrated and co-integrated), an ECM can be formulated. An unrestricted autoregressive distributed lag model (ADL) is finally estimated in this study. We do not estimate Vector Error Correction Model (VECM) because co-integrating vectors are generally obtained from the reduced form of a VAR system where all the variables are assumed to be jointly endogenous. Consequently, they cannot be interpreted as representing structural equations because, there is generally no way to go from reduced form back to the structure[30]. However in a multivariate VAR, it could be possible to give the so called structural interpretations by imposing identifying restrictions on the reduced form parameters. In our single equation framework we do impose the unitary income restriction from the theory. We identify two co-integrating relationships, representing the demand and supply sides respectively. If there is only one co-integration relationship, it may be easier to interpret it as a long-run relationship. It should be noted that the Johansen method, estimates a VAR model and first determines the number of co-integrating vectors. This approach is in particular a-theoretical. Co-integration is a purely statistical concept and the co-integrating vectors need not have any economic meaning. That is why Johansen (see Johansen (1994)) distinguishes between three concepts of identification: (I) generic identification related to a linear statistical model; (II) empirical identification related to the estimated parameter values; and (III) economic identification related to the economic interpretability of the estimated coefficients of an empirically identified structure. We follow the third concept in this study. The long run on the demand and supply sides are based on equations (2) and (3). The critical values for these tests are found in Johansen and Juselius (1990). The appropriate table depends on the role of the intercept and trend in the model. The results from the co-integration tests are presented in Table 2A and Table 2B in Appendix 1.

6. The demand side results – real house prices

The estimated specific model, using the general to specific approach, is reported in Table 6. The standard error of the regression is less than 2% and 95% of the total variation in the annual log change in real house prices is accounted for. Equation (2) has a clear economic interpretation. The adjustment coefficient for the level of real house prices ($\frac{PH}{PB}$) indicates that in cases of

[30] See Rao pp.17 (1994).

departure from equilibrium, 32%[31] of the shock is corrected within one year. The signs of all of the long and the short-run dynamic variables are in agreement with prior theoretical expectations and significant. The change in the long term interest rate has a semi-elasticity of 3.3, i.e. an increase in the long term interest rate after tax would decrease the real house prices by 3.3% in the short term and 1.4% in the long run. The direct real interest rate effects depend on the income and substitution effects. Although the empirical evidence indicates that this effect is often small, we find significant effects both in the short and long run of the real bond rates on Swedish house prices. The rise in interest rates should cause a portfolio switch by consumers into less liquid and so less spendable assets. For details (see Maclennan et al. (2000)). In addition, increases in interest rates directly affect the user costs. The elasticities for change in the population are quite high. Demographics incorporated in the change in population definitively have a strong effect on house prices. There is a fair amount of substitution between the choice of private housing and flats as defined here. The increase in rental stock decreases house prices and induces substitution i.e. people move from first homes to flats. The debt income ratio has a strong effect on house prices as indicated by the estimated coefficient. The upsurge in the debt-income ratio is correlated with increase in real house prices and increased by 23 percentage points between 1986-1989 Berg et al. (1994).

The specific model is an annual change model, as it may be of interest to forecast house prices on a yearly basis at NIER. In Figures 1 and 2 the preferred equations are presented for the period 1970 - 1997 both in levels and in annual percentage changes. Figure 3 illustrates an out of sample forecast for the period 1991 - 1997. It is a one step ahead ex-post forecast. The procedure is that one estimates the model up to 1990 and one makes a projection one step ahead at a time. Figure 4 plots some evidence on parameter stability for the long-run parameters. All the parameters are shown to become stable over time. The diagnostic tests indicate that the demand side is well specified

7. The supply side results - housing investment

The housing investment function with diagnostics is reported in Table 4. Eighty-eight percent of the total variation in the annual log change in housing investment is accounted for, while the standard error of the regression is 6%. These results indicate a poorer fit than for the price equation though this may be characteristic of investment functions. The signs of most of the short-run dynamic variables and the long run variables are in agreement with prior theoretical expectations. The adjustment coefficient for Tobin's q model indicates that in case of departure from equilibrium, 23% of the shock is corrected within one year. Both the change and the levelof Tobin’s q $\frac{PH}{PB}$ are significant playing an important role in the investment function. Diagnostics indicate that the applied Tobin’s q model is well specified.The 91TR tax reform dummy plays a significant role in the specification of the investment equation. The supply-side of the housing market responded sharply to the scale of the demand downturn. According to Englund et al. (1995), new construction fell dramatically from a peak of 70,000 dwellings in 1991 to 12,000 in 1995. The share of single family houses out of all new construction fell from 50 per cent in the 1980s to 25 per cent in 1993 and 30 percent in the first quarter of 1995. Fluctuations of this magnitude have important consequences for the Swedish national economy in terms of the direct impact on the house construction industry and the knock-on-effects for investment and and aggregate demand in general. Thus on theoretical grounds one would expect to find that low

[31] The speed of adjustment varies between quarterly and semi-annual data. It is partly conditional on the specification adapted despite been models in yearly changes.

levels of real house prices, relative to construction costs, would discourage investment because of the unfavourable effect on builders expected profits and aggregate demand in general.

According to the OECD Economic Survey (1998), the recent recovery in house prices has not been sufficient to make up for the faster developments in construction cost since 1990. The recent upswing in housing investment, according to the survey report can be linked to a temporary subsidy for the construction of new houses and housing investment. These schemes of subsidies were terminated in December 1996, which consequently lead to a fall in housing investment in 1997. The current recovery in housing investment has occurred in concert with continued persistent rise in real house prices. Figure 5 depicts plots for housing investment based on the estimated investment function. of crisis (1990-1994) in the real estate market, this is what our estimates imply, although the other variables in the investment function round out the picture (see further below).

7.1 The long run housing demand and supply

Table 3 and Table 4 contain the empirical counterparts to the dynamic forms of equations (2), (3), (4) and (5), and the long run or steady state forms follow for assumed constant growth, inflation, interest, employment and tax rates, and seasonal DS = 0 over the calendar year. Setting the annual log changes in IH, H, HF, DE, WF and Y equal to the constant growth rate G in GDP, the ratios $\frac{H}{Y}, \frac{HF}{H}, \frac{IH}{GDP}, \frac{DE}{Y}, \frac{DE}{WF}$ take steady state values. Assuming economic growth exceeds population growth (D_2 ln (POP) renamed $(GPOP)$), per capita GDP rises by $G - GPOP \succ 0$. Similarly for prices, annual log changes in PH and PB both equal the rate of inflation $\frac{\Delta P}{P}$ in the consumption deflator P make $q = \frac{PH}{PB}$ constant and there are no long run capital gains on homes. In the other hand, a faster rise in nominal share prices than in consumer prices implies a positive long run real return on stocks, $(D\ln(\frac{PAKT}{P})) = RAKT - \ln(\frac{\Delta P}{P})$. To facilitate interpreting the growth and rate of return variables are expressed in percent below ("% "added to the name).

From Table 3, we replace $\ln(\frac{HF}{H}) = \ln(\frac{HF}{Y}) - \ln(\frac{H}{Y})$ with $\ln(\frac{HF}{Y})$ and collect terms, yielding the long-run demand function:

$$\ln(\frac{H^D}{Y}) = 1.81 - 0.13 \cdot G\% + 0.17 \cdot GPOP\% - 0.76 \cdot \ln(\frac{PH}{P}) + 1.81 \cdot \ln(\frac{DE}{Y}) - 0.48 \cdot \ln(\frac{DE}{WF})$$
$$-1.55 \cdot \ln(\frac{HF}{Y}) - 0.01 \cdot (R \cdot (1-M) - \ln(\frac{\Delta P}{P}))\% . \quad (6)$$

Table 3. The demand side results (1970 - 1997). Dependent variable: D_2 ln (PH/P)

Regressors	Coefficient	Student t – values
Constant	0.76	3.74
Short-run		
D2 ln (PH/P) $_{(-1)}$	0.35	3.79
D2 {avg(2,R*(1 – M))}	-3.33	3.72
D2 (D2 ln (WF)) $_{(-1)}$	0.12	3.73
D2 (D2 ln (E))	2.78	5.65
D2 ln (H) $_{(-1)}$	-3.19	2.50
D2 ln (HF) $_{(-1)}$	-2.74	6.90
D2 ln (POP) $_{(-1)}$	7.07	2.90
D2 ln (RENTS/P) $_{(-1)}$	0.51	3.22
Long-run		
ln (PH/P) $_{(-2)}$	-0.32	6.73
ln (DE/Y) $_{(-2)}$	0.76	8.03
ln (DE/WF) $_{(-2)}$	-0.20	5.79
ln (H/Y) $_{(-2)}$	-1.07	5.95
ln (HF/H) $_{(-2)}$	-0.65	7.03
DS (Seasonal)	-0.07	2.80
{R*(1 – M)- ln (ΔP/P)} $_{(2)}$	-0.44	1.99
R2	0.95	
R2 (adj)	0.93	
Standard error	1.93	
Durbin Watson, Durbin H	(1.90), (0.96)	
Model Diagnostics		Critical Values at 5%
LM test $\chi 2_{(-1)}$	0.03	3.84
LM test $\chi 2_{(-2)}$	5.54	5.99
LM test $\chi 2_{(-3)}$	6.85	7.81
LM test $\chi 2_{(-4)}$	8.88	9.49
RESET	0.01	3.18
J-BERA NORMALITY	0.24	5.99
ARCH	0.96	9.49

Note: In the table above special notation is used for natural logs and changes. The operator Dj stands for a j - period difference, with D 1 = D for simplicity, and ln(x) = log(x) for short. Thus D j ln(x) =log (x / x j) is a j - period difference in the logs. For semi-annual data j = 2 in the dependent variable: and D2 ln(x) is annual rates of change. Items indicated avg = are n period averages in the particular variable. LM is the Breusch (1978) and Godfrey (1978) Lagrange multiplier test. The F -Values for the Chow structural break test are as follows 1985: = 2.5 and 1986 = 3.1. The test for weak exogeneity is reported in Appendix 2.

Figure1 . House price model, within sample forecast, levels

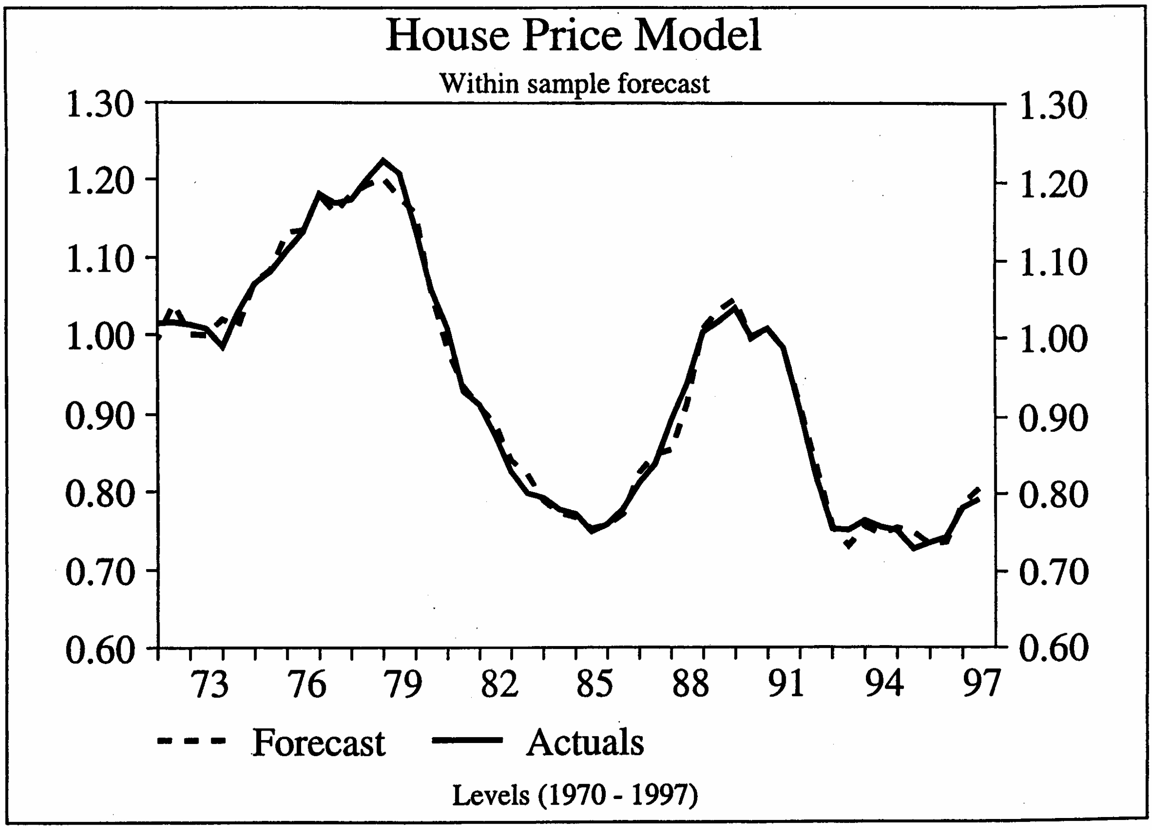

Figure 2. House price model, within sample forecast, annual percentage

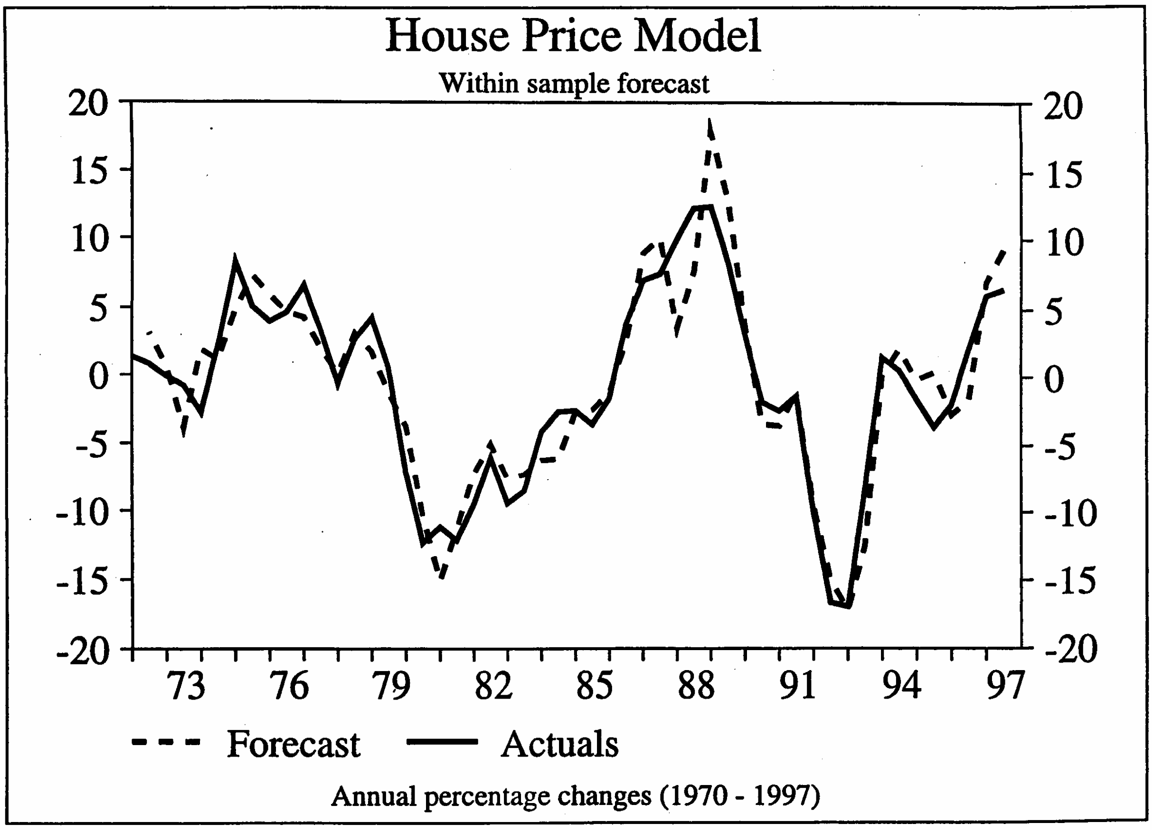

Figure 3. House price forecast, annual percentage changes (1991-1997)

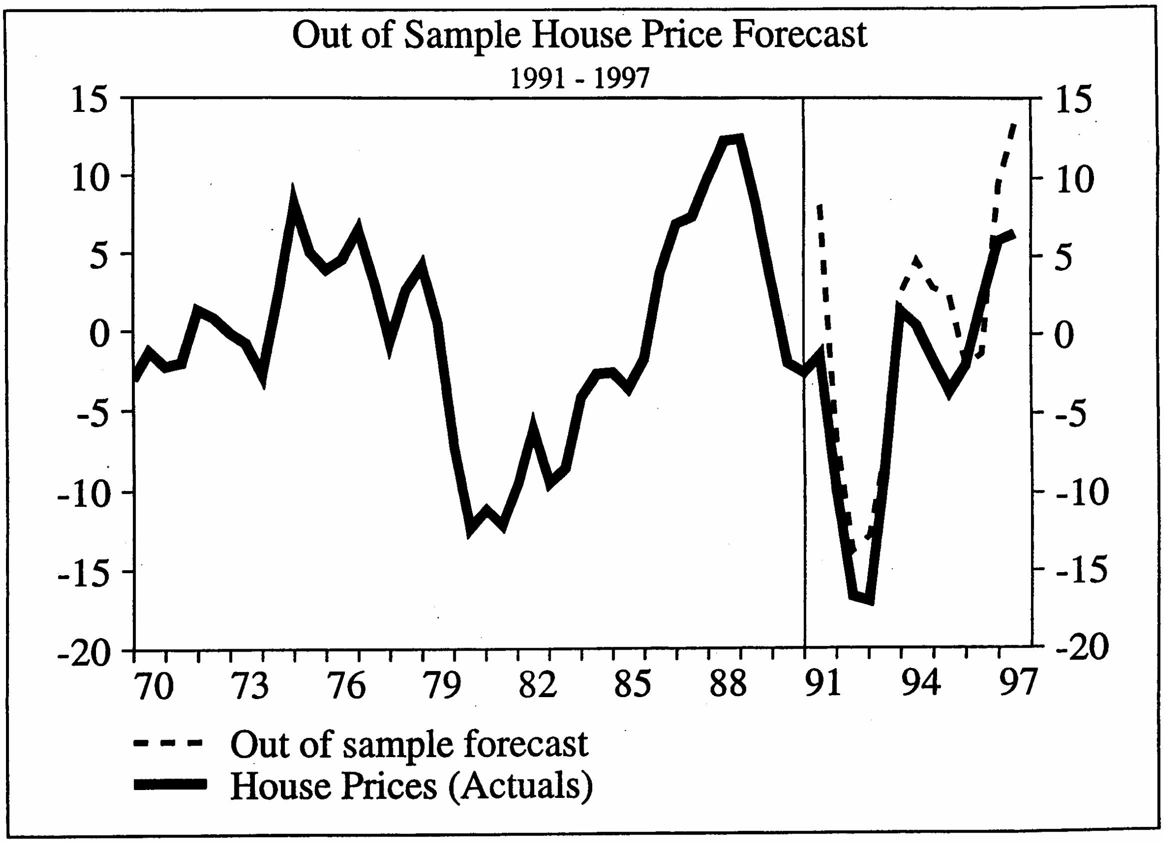

Figure 4. Equilibrium elasticities, recursive estimates

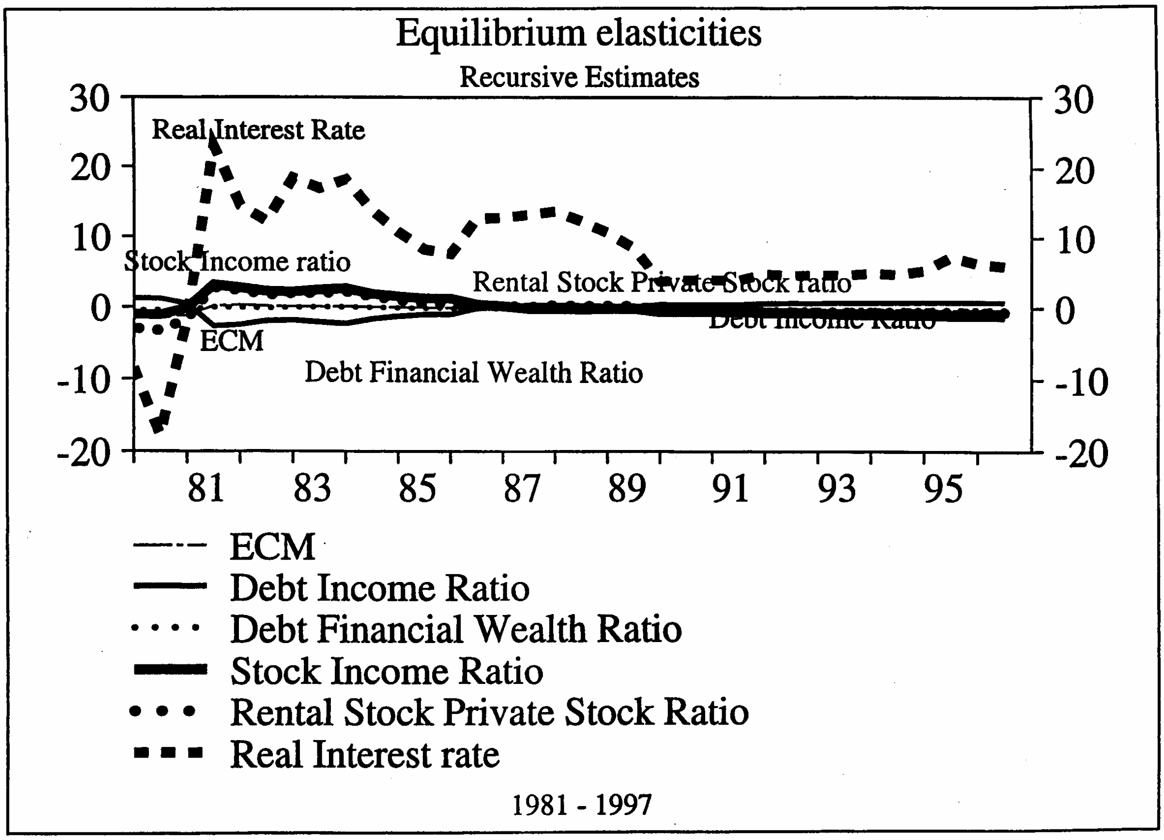

Table 4 quantifies the long term q – function for flow-supply:

$$\ln(\frac{IH^S}{GDP}) = -2.78 + 1.04 \cdot \ln(\frac{PH}{PB}) - 0.01 \cdot (RAKT - \ln(\frac{\Delta P}{P}))\% - 0.05 \cdot RS\% + 0.02 \cdot G\%$$
$$-1.22 \cdot 91TR \quad . \qquad (7)$$

Expanding in $\ln(\frac{IH}{GDP}) = \ln(\frac{H}{Y}) + \ln(\frac{IH}{H}) - \ln(\frac{GDP}{Y})$, and substituting the steady state perpetual inventory condition (5), $\ln(\theta) = \ln(\frac{IH}{H})$, and separating q into real house and building prices, $\ln(q) = \ln(\frac{PH}{P}) - \ln(\frac{PB}{P})$, converts flow-supply into stock supply in (8).

$$\ln(\frac{H^S}{Y}) = -2.38 + 1.04 \cdot \ln(\frac{PH}{P}) - 1.04 \cdot \ln(\frac{PB}{P}) - 0.01 \cdot (RAKT - \ln(\frac{\Delta P}{P}))\% - 0.05 \cdot RS\%$$
$$+ 0.02 \cdot G\% - 1.22 \cdot 91TR + \ln(\frac{GDP}{Y}) - \ln(\theta). \qquad (8)$$

These stock / income function become a stock functions with unitary income elasticities if log income is added to both sides. The unitary elasticity was tested by adding log income (lagged one year) in estimation, where its coefficient, representing deviation from unity, is insignificant. We find no compelling reason either in the Swedish literature to reject the unitary income elasticity.

The house price elasticity for housing demanded, -0.76, indicates inelastic demand. The absolute elasticity is smaller (-0.30) if (cf. (1) housing demanded is related to the relative stock ratio $\frac{HF}{H}$ instead of to $\frac{H}{Y}$, because a price-induced change in H is then matched by proportional change in HF, for $\frac{HF}{H}$ to remain constant, and the HF change reduces the H response to price. Inversely (cf. (2), price-inelastic demand means that housing prices are elastically responsive to stock, i.e., excess demand results in appreciable price rise, and stock increase depresses price appreciably.

The supply curve, in contrast slopes upward with approximately unitary price elasticity. Upward sloping supply curves are typical for almost all markets. One possible explanation for the upward sloping supply curve is that as the construction industry expands, the price of land rises, and the price of non-land also increases, but relatively less than the price of land. The housing market is a typical market in which the stock of housing is fixed in the short run and additions to the stock take time to build. The main argument for the upward sloping supply curve is framed in terms of time to build. The short-run price elasticity of supply will, therefore, be less than the long-run elasticity[32].

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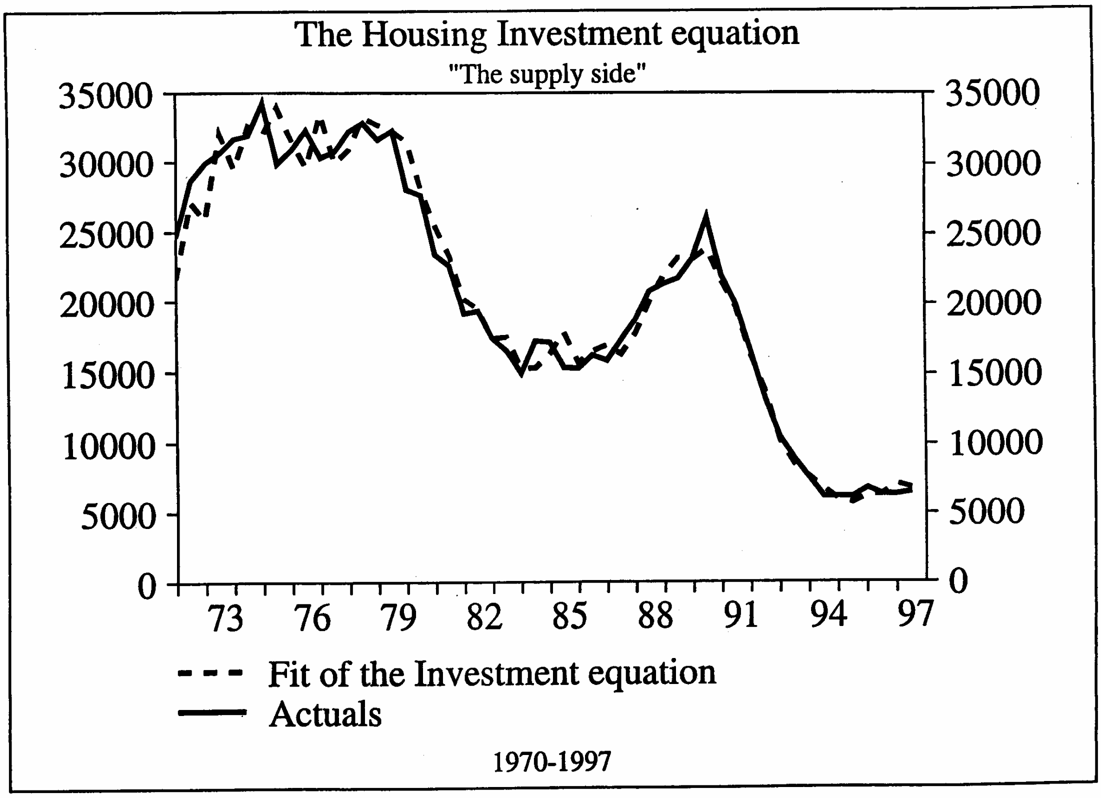
[32] For a perfectly competitive industry the supply curve is simply the aggregate marginal cost (MC) curve above the marginal revenue curve (and the average revenue curve).

Table 4. The supply side results (1970 - 1997). Dependent variable: D_2 ln (IH)

Regressors	Coefficient	Student t – values
Constant	-0.64	3.65
Short-run		
D2 ln (IH) $_{(-1)}$	0.62	5.64
D2 ln (IH) $_{(-2)}$	-0.41	3.03
D2 ln (IH) $_{(-3)}$	0.42	4.03
D2 ln (AKT / P)	-0.20	3.24
D2 ln (PH /PB)	0.38	2.32
D2 (avg, 2 (RS – ln (ΔP/P))	-3.52	3.05
Long-run		
ln (IH / GDP) $_{(-2)}$	-0.23	5.65
ln (PH / PB) $_{(-2)}$	0.24	2.00
91TR	-0.28	7.18
RS $_{(-2)}$	-1.14	2.09
R^2	0.88	
R^2 –adj	0.85	
Standard error	0.06	
Durbin Watson	2.07	
Model Diagnostics		Critical Values at 5%
LM test$\chi 2_{(1)}$	0.18	3.84
LM test$\chi 2_{(2)}$	2.53	5.99
LM test$\chi 2_{(3)}$	3.42	7.81
LM testχ 2 $_{(4)}$	8.62	9.49
LM test$\chi 2_{(5)}$	7.46	11.07
LM test $\chi 2_{(6)}$	12.17	12.59
NORMALITY $\chi 2_{(2)}$	1.17	5.99
ARCH $\chi 2_{(4)}$	3.58	9.49
RESET F (2,50)	0.06	3.18

Note: From the diagnostic statistics, the residual of the estimated equation appears to be white noise. The Breush-Godfrey (1978, 1978) Lagrange Multiplier test statistic for autocorrelation is obtained by regressing the residuals on the explanatory variables and the lagged residuals up to lag (p) and is distributed $\chi 2$ (p). ARCH, Engle (1982) is the Lagrange multiplier test for heteroscedasticity, obtained by regressing the squared residuals on the explanatory variables and the explanatory variables squared and is distributed as $\chi 2$ (q), where q is the number of regressors and the squared regressors in the test regression. Normality $\chi 2$ (2) refers to the Jarque - Bera (1980), test for normality of the residuals, with a correction for degrees of freedom. Reset is Ramsey's test (1969) for correct specification performed by testing the relevance of adding the squared predicted values in the original model. The long-run equilibrium elasticities for q = 1.04 and the semi-elasticity for interest rate is 4.9. The test for weak exogeneity is presented in Appendix 2.

Figure 5. Tobins.s q model



The impressive large negative elasticity of rental housing supplied on housing demanded (-1.55) suggests that the provisions of (public) rental housing demand in Sweden induces households to substitute rentals for owner occupancy. We encounter no similar substitution effect of rents, as the positive effect of rent increases on housing demand in Table 3, is only transitory. The quantity effect works two ways, as the failure of public sector to provide rental housing (currently alleged in the urban areas) evidently boosts demand for private homes, which (especially with substantial price sensitivity) provides existing owners with higher real estate values and prospective owners with an affordability problem-as well as problem of finding rental housing.

As for the financial effects, permanent rises in "interest rates", broadly defined to include stock market returns (R , RS , $RAKT$), imply decreases in both housing demanded and supplied. The large elasticity (1.81) of the debt/income ratio indicates that indebtedness is important for private housing demand, where as the negative "risk aspect", represented by the debt/financial wealth term, and is more modest. This impression is not altered substantially if the latter is replaced by the net financial wealth/income ratio[33], in which case the debt/income and net financial wealth/income ratios have elasticities of 1.33 (1.81 - 0.48) and 0.48, respectively. A further evaluation calls for endogenization of financial stocks in the model.

Growth ($G\%$) appears to boost supply and reduce demand, by 2% and -13%, respectively, per percentage points of growth. The negative growth effect on demand should be gauged against the larger positive population growth effect (17%). Together they imply a -4% reduction in demand per percentage point of per capital growth ($G\% - GPOP$). Thus, faster population growth relative

[33] a * (ln WF - ln Y) – a* (ln DE – ln WF) = -a* (ln DE - ln WF) + a* (ln WF- ln Y) = a*ln (WF/Y) – a * ln (DE/WF).

to income growth raises the housing/income ratio demanded, but with economic growth typically exceeding population growth, this ratio is typically lower.

Illuminating as structural insights into the demand and supply sides are, they do not clearly reveal how housing its prices are determined or develop over time. Housing price developments depends on the joint forces behind demand and supply.

7.2 The long run price and quantity of housing

Invoking market clearing (5), $H^D = H = H^S$, $PH^D = PH = PH^S$, yield the reduced form values of the long run:

$$\ln\left(\frac{PH}{P}\right) = 2.54 + 0.58 \cdot \ln\left(\frac{PB}{P}\right) - 0.86 \cdot \ln\left(\frac{HF}{Y}\right) + 1.00 \cdot \ln\left(\frac{DE}{Y}\right) - 0.26 \cdot \ln\left(\frac{DE}{WF}\right)$$
$$- 0.06G\% + 0.09 \cdot GPOP\% + 0.005 \cdot \left(RAKT - \ln\left(\frac{\Delta P}{P}\right)\right)\% - \cdot 0.02RS\% - 0.006 \cdot (R \cdot (1 - M) \quad (9)$$
$$- \ln\left(\frac{\Delta P}{P}\right))\% + 0.021 \cdot RS + 0.16 \cdot TR91 + 0.55 \cdot \ln(\theta) - 0.55 \cdot \ln\left(\frac{GDP}{Y}\right)$$

$$\ln\left(\frac{H}{Y}\right) = -0.13 - 0.44 \cdot \ln\left(\frac{PB}{P}\right) - 0.89 \cdot \ln\left(\frac{HF}{Y}\right) + 1.05 \cdot \ln\left(\frac{DE}{Y}\right) - 0.28 \cdot \ln\left(\frac{DE}{WF}\right)$$
$$- 0.006 \cdot \left(R \cdot (1 - M) - \ln\left(\frac{\Delta P}{P}\right)\right)\% - 0.021RS\% - 0.004 \cdot \left(RAKT - \ln\left(\frac{\Delta P}{P}\right)\right)\% - 0.08G\% \quad (10)$$
$$+ 0.10 \cdot GPOP\% - 0.51 \cdot TR91 - 0.42 \cdot \ln(\theta) + 0.42 \cdot \ln\left(\frac{GDP}{Y}\right)$$

reduced form coefficients are generally of the same sign but smaller than in the originating demand or supply equation because of supply- demand interaction. Factors which depress demand, but not supply, such as lower financial stock/income ratios or population growth, or rise in rental stock supplied, shift the demand curve down against an upward sloping supply curve, thus reducing price. The effect cushions the fall in amount of housing demanded.

The long term parameters indicate that higher prices in the construction industry cost-push up the price of homes by about half the percentage building price increase and thereby reduce private housing by about as much. Expansion of rental housing on the other hand has a depressing effect on both the quantity and price of private housing, it is depressing effect on housing demand results in a price fall which in turn contracts the quantity supplied. Expansion of financial stocks and population growth, have the opposite effect of raising both price and stock, by shifting demand up along an upward sloping supply curve. As described in the previous section, per capita growth reduces housing price and stock relative to income, because faster income increase is more sufficient to meet increased housing needs from increased population growth. Nevertheless, although higher growth reduces housing per unit of income, income and stock are ultimately are higher on a higher growth path relative to that of the population.

The financial returns have a negative impact on stock. That is, interest rate and stock market returns reduce private housing, but the effect on house prices is mixed. To gauge a rough net effect, suppose that the nominal short interest rate and stock return differ from the nominal long interest rate by a constant term component and risk premium, respectively: $RS = R + (RS - R)$

and $RAKT = R + (RAKT - R)$, where $(RS - R)$ and $(RAKT - R)$ remain constant when R changes. Where a, b, c are the respective coefficients for R, RS, and $RAKT$, the combined semi-elasticity for a change in "interest rate" is $a \cdot (1 - M) + b + c = d$, where M is marginal interest tax rate. Evaluating d for the post tax reform value $M =$ 0.3, the semi-elasticities for house prices and stock, respectively are 0.022 and -0.029; that is a permanent rise in interest rates raises house prices in the long run by more than 2 percent and reduces private housing by less than 3 percent. These figures are not appreciably changed for a pre-tax-reform value of $M = 0.5$ or higher. This does not signify, however that the tax reform was ineffectual in raising the importance and effect of interest rates because M appears only in the long interest rate term.

The correlation between the residuals of the supply and the demand side equation are insignificant. The contemporaneous correlation coefficient is 0.02. The correlations with leads 1-5 are 0.04, 0.05, 0.06, 0.04 and 0.08. The 5% significance level is at 0.34. In addition the results of a regression between the residuals of the demand and supply side indicates a $R^2 = 0$, and the student t-value of 0.14. Hence our single equation approach is reasonable after all.

8. Controversy of the causes of the crisis in the Swedish housing market

Prior to the 91TR tax reform Swedish housing had been among the most subsidized in the world. Rent allowances were paid directly to low income households to lower their housing costs. These allowances increase the demand for housing space, which creates pressure for higher rents and asset prices and thereby greater production. Mortgage interest subsidies had (not among our model variables) been provided to purchasers of newly produced homes in the form of mortgage interest rates that are below market levels. Finally tax benefits were provided by allowing mortgage interest payments to be tax deductible against labour income. These tax benefits induce a larger stock, lower rents and lower asset prices, as with mortgage interest subsidies (see Jaffe (1994)).

In 1991 "The Tax Reform of the Century" was implemented. One of the main goals of the 91TR was to reduce the distortions in housing. Net capital income was taxed separately from earnings at a flat 30 per cent rate. In addition the property tax rate of 1.2 per cent was gradually increased to 1.5 per cent in 1993, which replaced the tax on imputed rental income of owner-occupiers. Both for owners and renters interest subsidies were reduced. The value added tax (VAT) on building material, along with other goods and services was increased by 12 per cent. In order to offset the increase in VAT a 10 per cent investment subsidy was implemented, which was gradually reduced and eliminated in 1993. For details on the 91TR reform (see cf. Englund (1995)). Our tax reform dummy represents all of these aspects crudely.

The volatility in the Swedish housing market and the controversy over the causes of the recession in Sweden during the years 1991 - 1993 are diverse. According to Giavazzi et al. (1996), asset prices tended to correlate inversely with the government debt-GDP ratio, while the real interest rate featured a strong positive correlation with the government debt-GDP ratio. These relationship induced gyrations in asset prices. The asset price fluctuations are associated with dramatic developments in monetary and exchange rate policy. The peak in real interest rate coincided with the currency crisis, and so did the trough in real stock prices. To a certain extent, however, they may have been also determined by fiscal policy. They argue that asset prices may be one of the channels through which fiscal impulses have affected private demand.

Agell et al. (1996) estimate that 12-15 percentage points of the 30% fall in house prices were due to the effect of 91TR, and 8% was caused by the fall in real GDP. The implementation of the 91TR was accompanied by a severe economic downturn. Between 1991-1993, GDP fell by more than 5%, unemployment (including those enrolled in various market programs) rose by 12%, asset prices fell dramatically and residential construction activity came to a virtual standstill (see

Agell et al. (1996) for details). Their simulations using Poterba's (1984) perfect foresight model suggests a drop in prices around 10% - 15% with the announcement and implementation of 91TR.They argue that the severity of the recession is probably due to the fact that macroeconomic policy was firmly devoted to non-accommodation. In addition they conclude that the timing of 91TR was unfortunate. However, it is difficult to disentangle the effects of 91TR from those of the severe economic recession.

Berg et al. (1995), point out a positive relation between capital gains on houses and consumption, and this is the basis for their argument that a capitalization effect in the housing market through which 91TR affected consumption. In contrast, Agell et al. (1995a), propound another view that the after-tax real interest rate cannot have had a large impact on consumption owing to its small interest rate sensitivity. According to them, the 91TR affected consumption via its impact on the price of assets.

According to the analysis of Söderström (1993), the debt deflation process seems to have prevailed in the Swedish economy at least through 1993. The idea that asset market behaviour could have substantial effects on real economic activity is not new: as early as 1933, Irving Fisher claimed that debt deflation made an important contribution to the great depression due to real-financial linkages in the economy.

Our view is that the deregulation of the credit market in 1985 was simultaneously followed by both a stock market and housing price boom. During this period the construction industry undertook a fair amount of investment. There were two peaks in real house prices in Sweden, one in 1979 and the other one 1990. There was a 38% increase in asset prices between the years 1986 -1989, partly driven by the financial deregulation of the credit market, beginning in 1985. As a result, household demand for credit increased as former liquidity constraints were relaxed. Borrowing against property for consumption purposes became easier and homes could be bought with a smaller down payment (this aspect is captured by the debt to income ratio, a major driver in the model). This borrowing eventually resulted in financial distress when the Swedish consumer could not readily pay his bills in the economic downturn. When indebtedness was high, the consumer had large contractual payments for the debt service, and other financial obligations, that increased the likelihood of financial distress, thus decreasing the demand for tangible assets, (see Mishkin (1977)). This aspect is captured by the debt to financial wealth ratio (the solvency aspect).

According to Barot and Takala (1998), the Swedish economy began to slide into recession in the 1990s. First, escalating interest rates due to a rising budget deficit, then rising unemployment signalling greater uncertainty about the future brought a radical decline in housing demand. Since the 1990's real house prices have dropped by an average of 15 per cent across the country. From our estimates (Table 3), we observe the following effects. The short-term effects derived from the nominal long term interest rate which accounts for 3.3 per cent fall in real house prices, 2.8 per cent of fall in real housing prices is due to the increase in unemployment. The long run effects are derived by dividing the estimated coefficients for the variables in the long term part of the model by the speed of adjustment coefficient. The long-term effect for the after tax real interest rate is approximately 1.4%, the financial distress captured by the debt to financial wealth ratio explains 0.1% of the fall in real house prices. Real rents for rental apartments increased by 20 per cent between the years 1990 – 1992 (see Englund et al. (1995)). This soaring of rents is partly due to the reduction in interest subsidies that was embedded in 91TR, which induced substitution from rental markets (flats) to purchasing small homes. This process accounts for a 2 percent fall in real house prices according to our model. The final 3.3 per cent fall in house prices are explained by decreased income which raised the housing stock to income ratio. The sum of the short and long-terms effects result in approximately a 13 per cent fall in real house prices. The results are consistent with findings of Englund et al (1995). In Sweden, financial liberalization and the surge in borrowing came later than in the UK; but the sharpness of the boom in house prices-and the severity of the subsequent fall - was even greater than in the UK.

9. Simulations and housing policy issues

To address the sensitivity of housing prices we run four scenarios for 1970 -1997 based on a:

(1). Permanent increase in disposable income by 5 percentage points, with stock unchanged

(2). Permanent increase in long nominal interest rate by 5 percentage points

(3). Permanent increase in housing stock by 5 percentage points and a

(4). Permanent increase in household debt by 5 percentage points.

The simulations are carried out to point out the models policy implications. Each simulation consisted of re-running the baseline run with one exogenous variable changed. Once changed, the variable was kept at its new value throughout the simulation period.

(1). A permanent increase in disposable income by 5 percentage points e.g. as a result of decreases in taxes or increases in transfers gives an increase in house prices by 5 percentage points. The results of this dynamic simulation are depicted in Figure 6. The interpretation is that high disposable income acts as a signal about the future higher income and hence about creditworthiness, thus stimulating demand for houses and hence increasing house prices. From the policy point of view the policy maker can stimulate the demand for owner occupied homes by both decreasing tax on income or increasing transfers.

(2). The effects of monetary policy on housing prices arise through Central Bank influence on the nominal interest rate. The results of the simulation are depicted in Figure 7. An increase in the long term government nominal interest rate by 5 percentage points, a hypothetical policy measure of the Central bank decreases house prices by 5 percentage points as it increases the borrowing costs and reduces the demand for housing on this account. The after tax interest rate incorporates the effects of 91TR via the marginal tax rate. In the long term, the prospects for the housing market in terms of the volume of sales, the rate of new building and house prices are fundamentally dependent on what happens to interest rates, given the high sensitivity of the market to interest rate changes. These changes impact upon both the demand and supply sides of the market. The conclusion of this simulation is that an easy monetary policy can be an important force behind excessive asset price inflation and vice versa.

(3). An increase in the housing stock by 5 percentage points as a result of government investment subsidies or (new housing construction responding to high Tobins q) decreases house prices by 7 percentage points as expected (see Figure 8). For future stimulus to the construction sector investment subsidies can increase the housing stock, whereas reduction in excessive subsidization reduces it.

(4). A permanent increase in household debt by 5 percentage points would increase house prices by 10 percentage points (see Figure 9). Wealth effects are triggered by changes in interet rates. Lower interest rates facilitate borrowing in order to finance the booming purchases of houses.

Before 1985 mortages were generally rationed, at least in principle. A surge in new credit availability (reflected by the debt to income ratio in the model) generated an increase in the demand for housing. Since the supply of housing is inelastic in the short-run, the increase in effective demand would lead to increase in house prices. The impact of liberalization in the housing finance market strongly suggests that in the adjustment period following an easing of

Figure 6. Permanent increase in disposable income by 5 percentage points

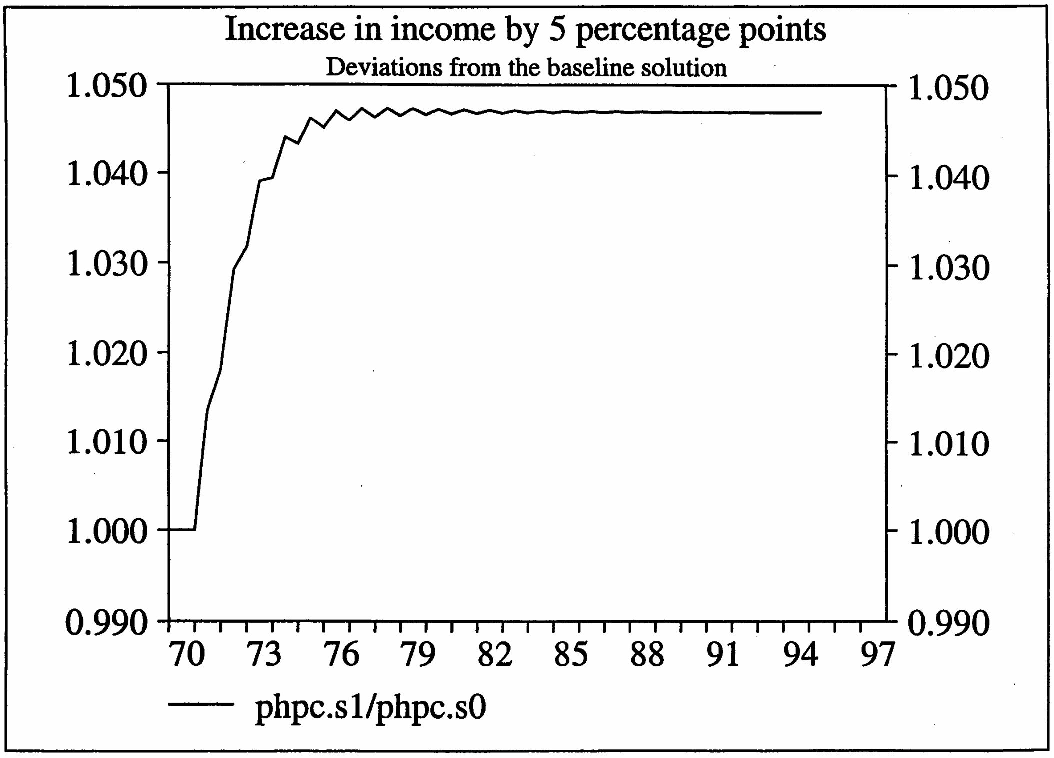


Figure 7. Permanent increase in long nominal interest rate by 5 percentage points

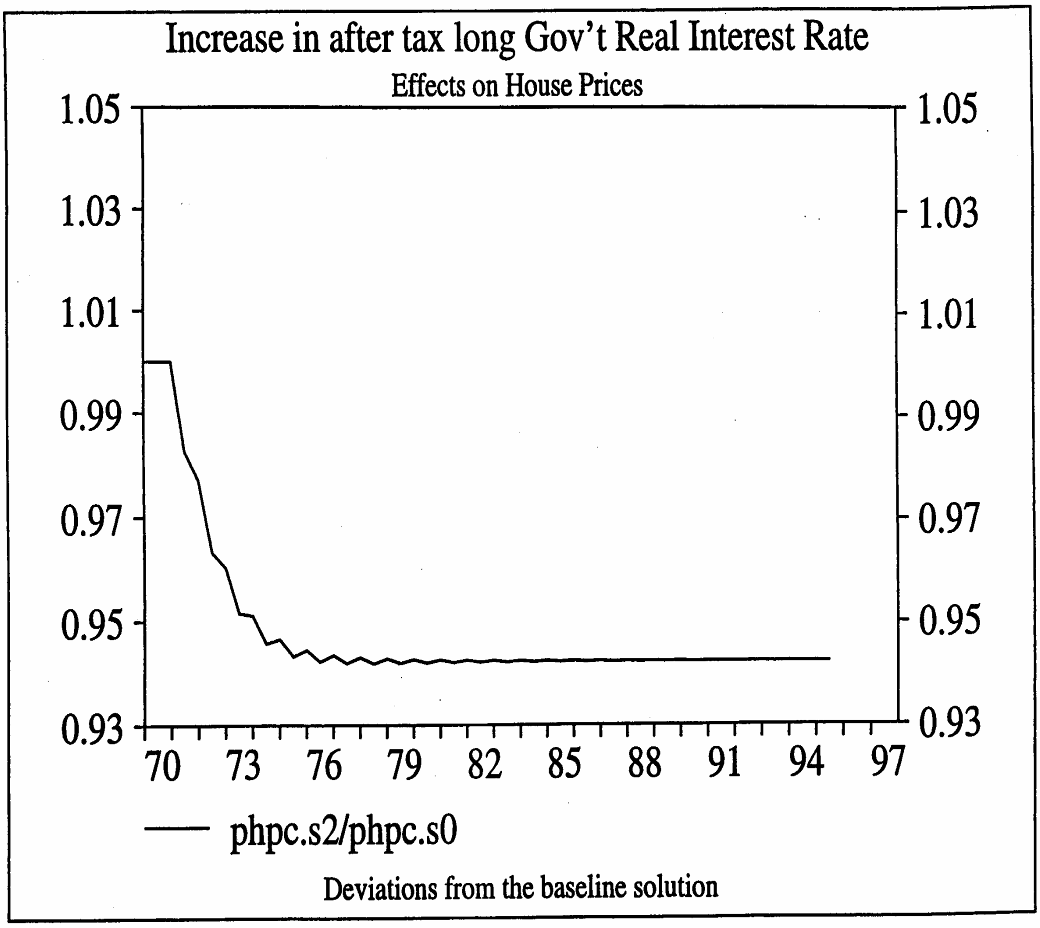
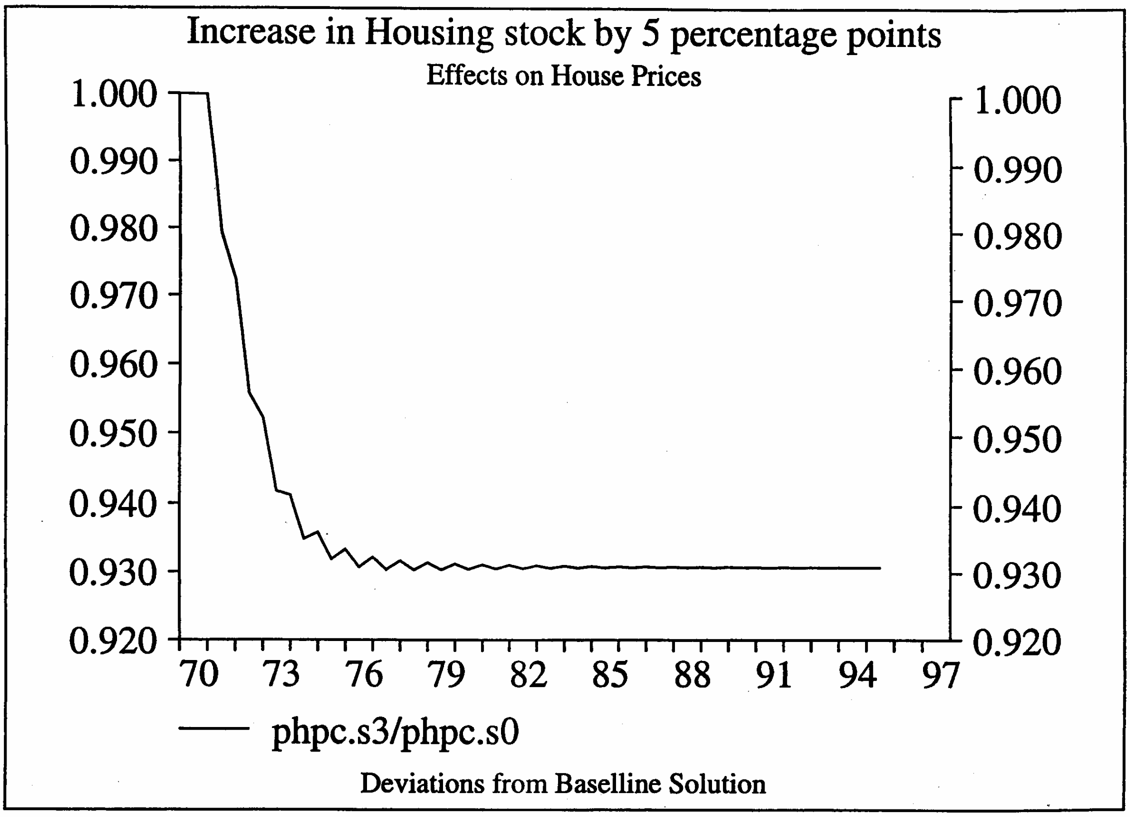


Figure 8. Permanent increase in housing stock by 5 percentage points



credit restrictions we would expect to see substantially reduced saving, higher house prices,deterioration in the current account and significant equity withdrawal.

Policy makers in Sweden should be aware of the kinf of adjustment instabilities which can resemble those during post-financial liberlisation and transition to new steady states. Monetary policy affects the valuation of the financial assets in the economy. Looser monetary policy leads to increase in the stock of housing debt and vice versa. This is illustrated by the policy experiment depicted in Figure 9, of increasing household debt by 5 percentage points which would increase house prices by 10 percentage points.

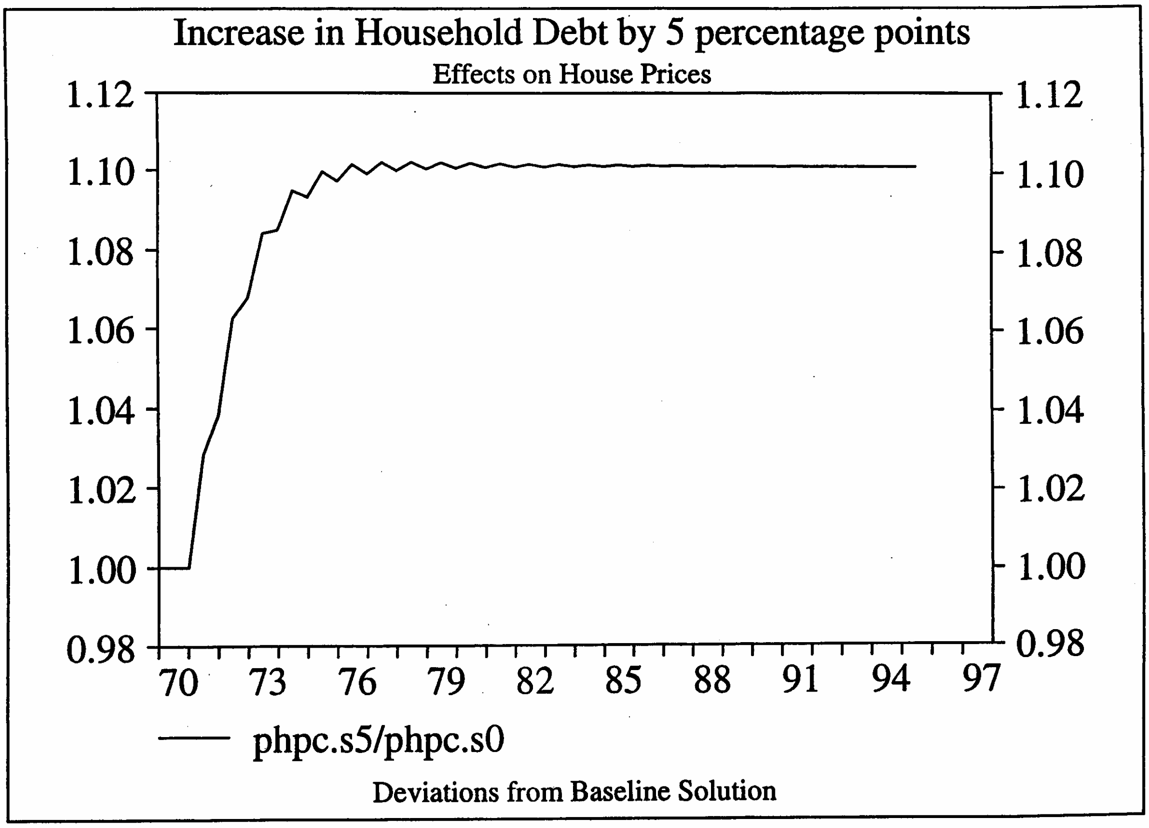
The natural policy conclusion is that without financial mortgage controls the interest rate instrument may be necessary to prevent any recurrence of a housing boom. However it is difficult to speculate on the ways in which housing finance may change within the European market.

The most important lessons for policy makers from our analysis are:

(1). The sharp rise in house prices after 1985, tended to be followed by gradual declines over a prolonged period. This stems from the fact that supply responses to changes in the relative prices of houses are likely to be very small in the very short run. They will build up over time which ultimately dampens the kind of overshooting in prices which results from short-run stickiness in the stock of housing. The demand for housing is sensitive to a large range of macro variables for many periods ahead, and hence house prices are susceptible to large and sudden jumps.

(2). For the Swedish policy makers the simulations shed light on responsiveness to both fiscal and monetary measures. From the accuracy of the model as indicated by (Figures 6 through Figure 9) and from the magnitude of the policy responses illustrated, it would be roughly possible to draw qualitatively correct conclusions for the Swedish housing market about the set of measures necessary to aim at a set of policy targets in the future from the magnitude of

Figure 9. Increase in household debt by 5 percentage points



the policy responses illustrated.

10. Simultaneous model solution

The main purpose of this section is to analyse the properties of the real estate model for the household sector as revealed by the full dynamic responses including investment. The closed model has a demand function, supply function and an identity as discussed earlier. The equilibrium long-run impact of the broader Swedish economy on the real estate market for the household sector can be analysed within the simple framework adopted, which is similar to that of DiPasquale and Wheaton (1992).

In the short run it is often assumed that the supply of stock is fixed and asset prices are determined merely by demand factors. Let us assume that in the Swedish economy there is a growth in income, signalling increases in future income. This would lead to an increase in employment and production. Households would be willing to buy small homes and seek more rental housing flats and this would mean that the household debt (effective demand) would increase. With the fixed supply this would result in an increase in rents, boost demand for owner-occupied homes further which would in turn lead to higher asset prices, which would generate a higher level of Tobin's q. This would give incentives for the construction sector to expand, increasing investment. A higher level of investment would augment the stock and would eventually lead to a fall in prices.

The estimated error correction adjustment coefficient (indicating the speed of adjustment) on the demand side is -0.32 which is in line with other international studies. The speed of adjustment on the supply side -0.23 is slower due to lags and inertia in the construction sector. It is apparent that it takes time for the quantity to adjust to equilibrium.

Figure 10. Simultaneous- model solution, house prices, levels

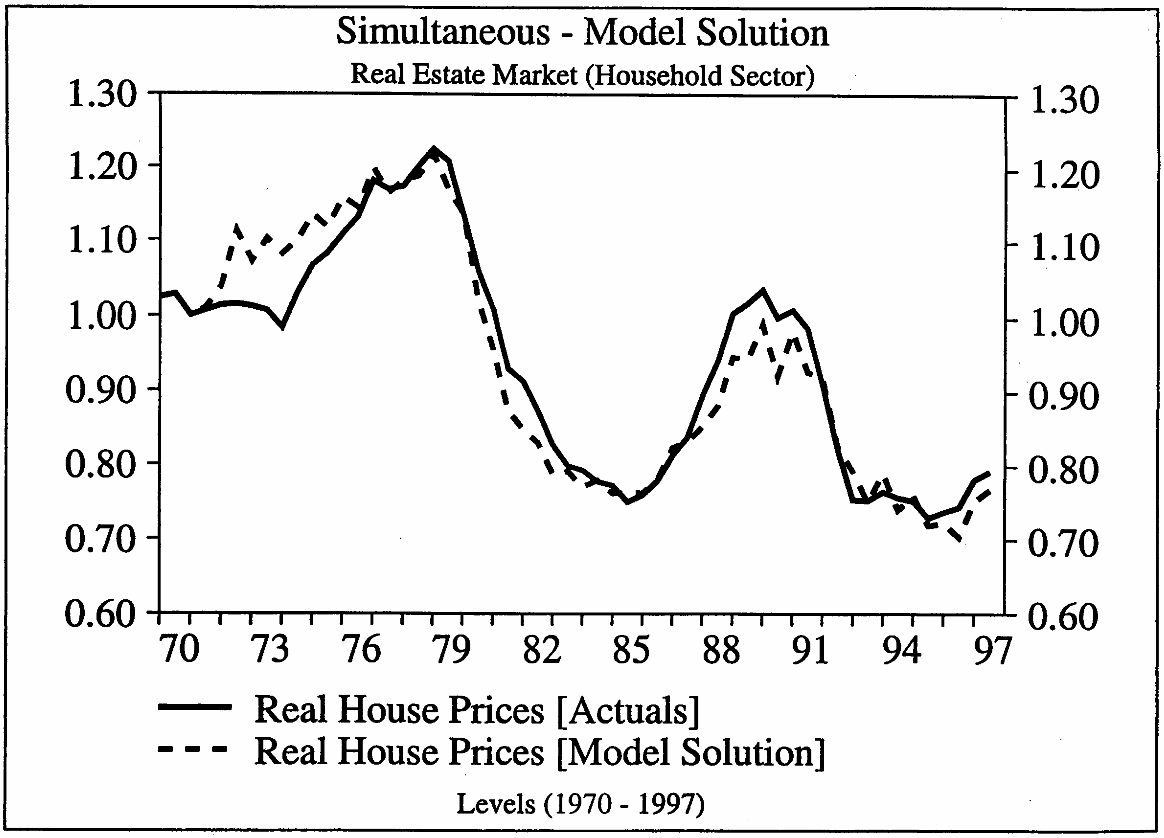


Figure 11. Simultaneous- model solution, house prices, annual percentage

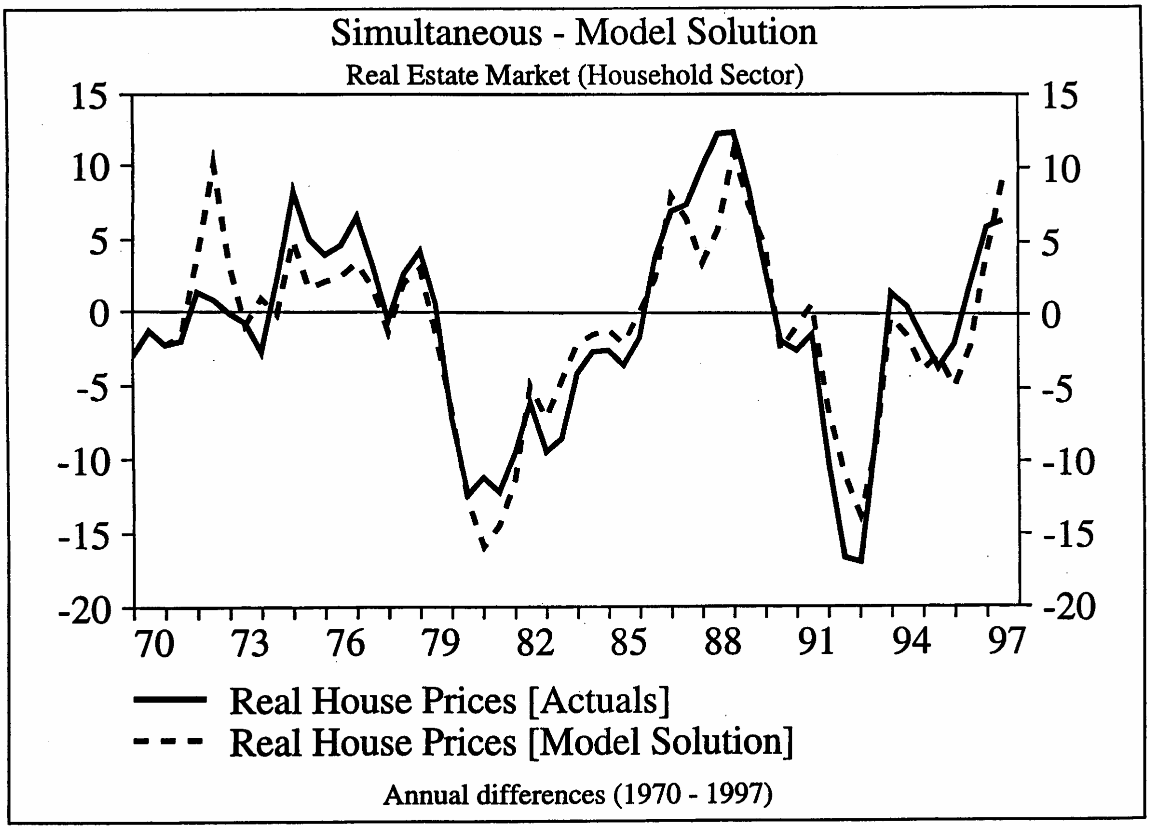


Figure 12. Simultaneous-model solution, housing investment, levels

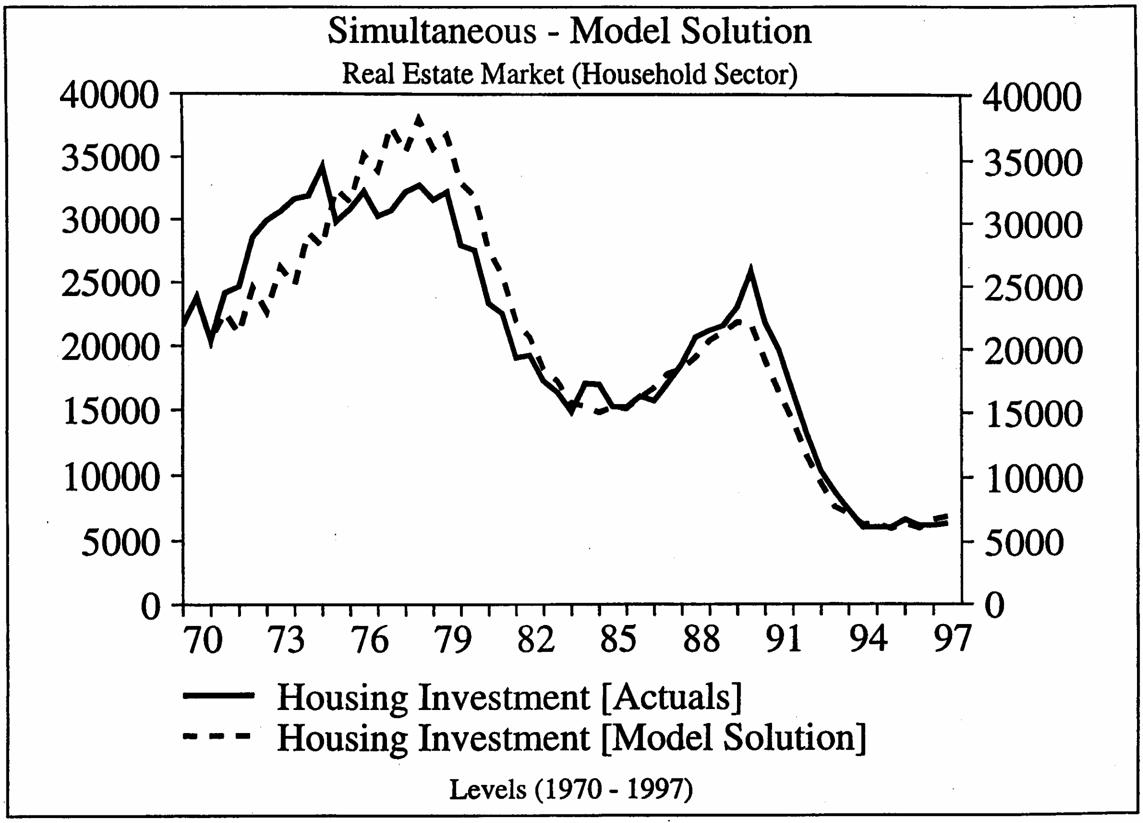


Figure 13. Simultaneous-model solution, annual percentage changes, investment

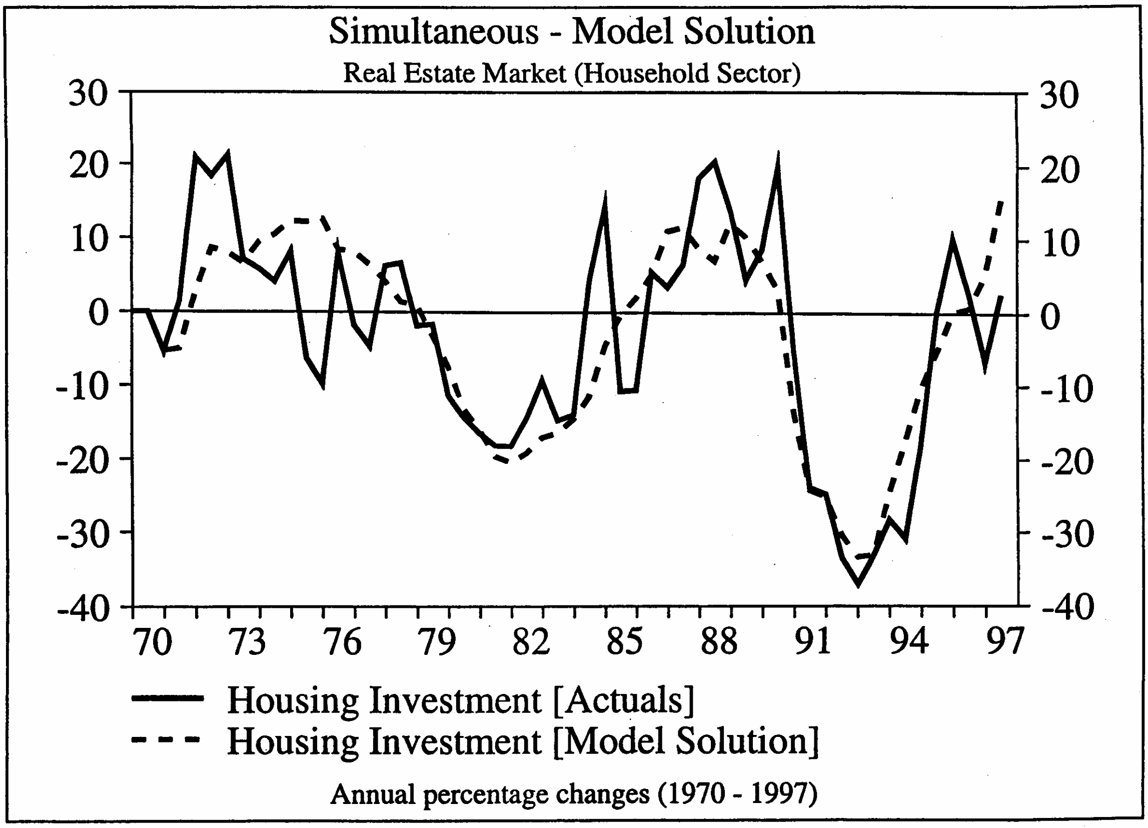
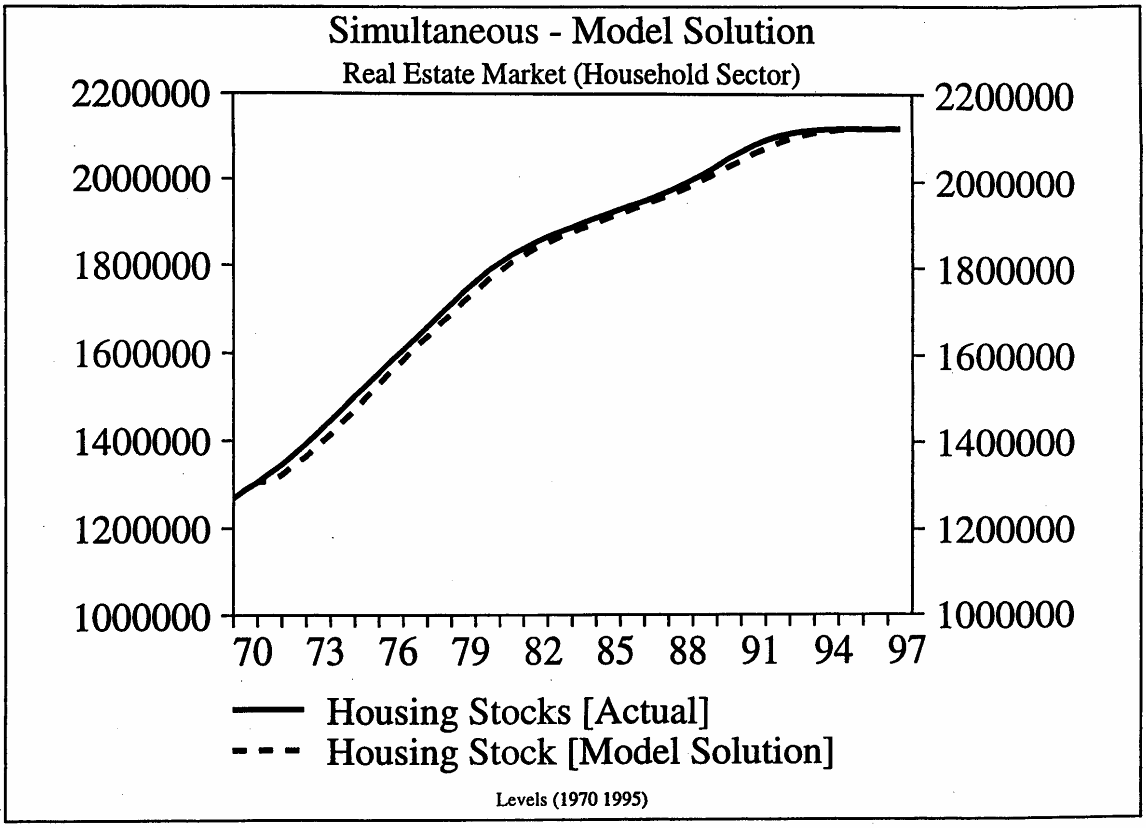


Figure 14. Simultaneous- model solution, housing stock, levels



There are, however several reasons to expect that the housing market will often be characterised by significant lingering deviations from long-run market-clearing price. The large transactions costs which are typically involved in buying a private home will cause significant adjustment lags on the demand side of the market. As a result, economic agents will only adjust slowly toward their desired stock of housing following a change in exogenous demand-side variables.

On the supply side of the market, adjustment of the stock of dwellings is also generally held to be quite slow. Over the very short term, since the level of housing completion is small relative to the total stock of housing, it is often argued that the supply of housing is almost completely fixed. Against this, over the medium to long-run, firms in the construction sector will make their production decision based on the expected profitability of house building activity. Over the medium to long-run, therefore, the supply of dwellings is thought to be quite, although not perfectly, elastic. The results of the simultaneous model solution when the demand and the supply side are allowed to interact are presented in Figures 10 through 14. The overshooting in the early 1970s on the demand side might have to do with our omissions in treatment of price controls and the regulated market. During the post deregulation period, with the exception of the slight deviation of the model solution for the historical period, the simultaneous model looks promising as it captures both the boom and the bust. The simulated stock derived from (5) follows the actual stock promisingly well (see Figure 14), indicating the accuracy of the model.

11. The house price forecast and projections 1999-2000

In this section house prices are *ex ante* forecasted for the period 1999-2000, are illustrated in Figure 15 and in Figure 16. The projection on house prices is conditional on the future course of explanatory variables the development of which is not explained within the model.

Figure 15. House price forecast, levels (1999-2000)

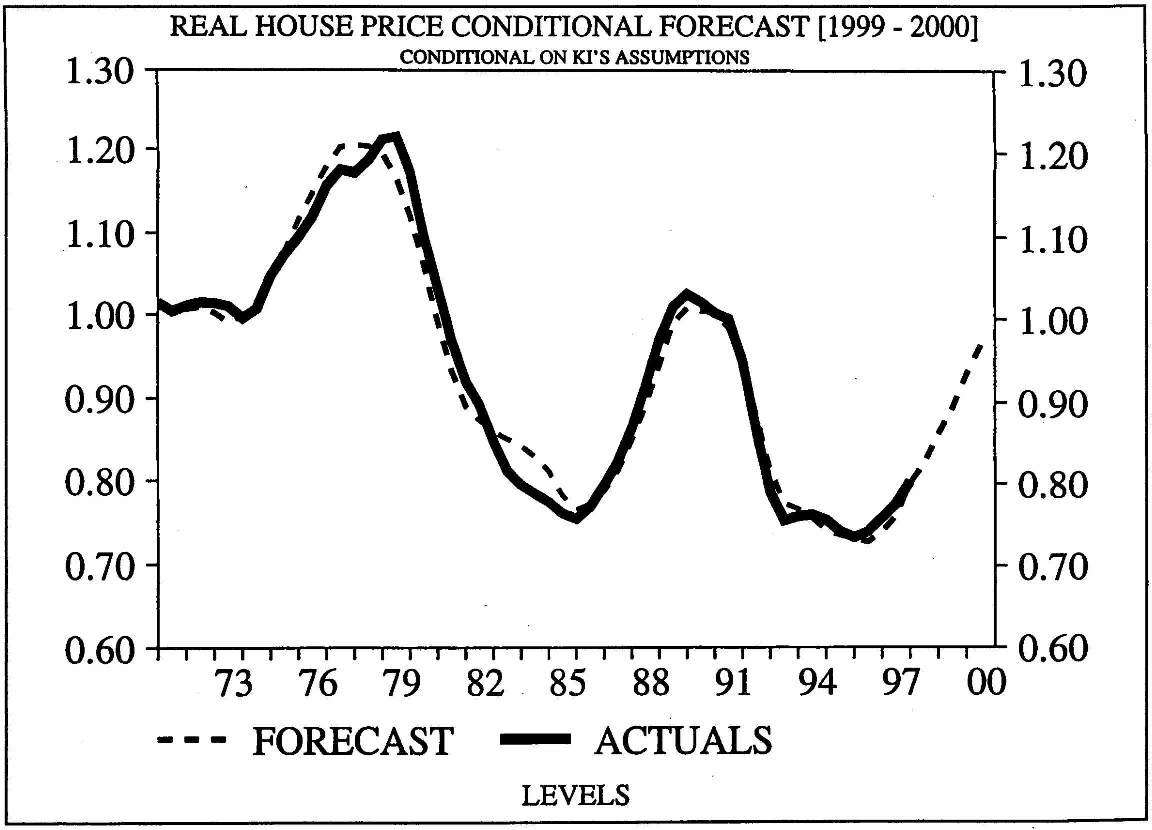
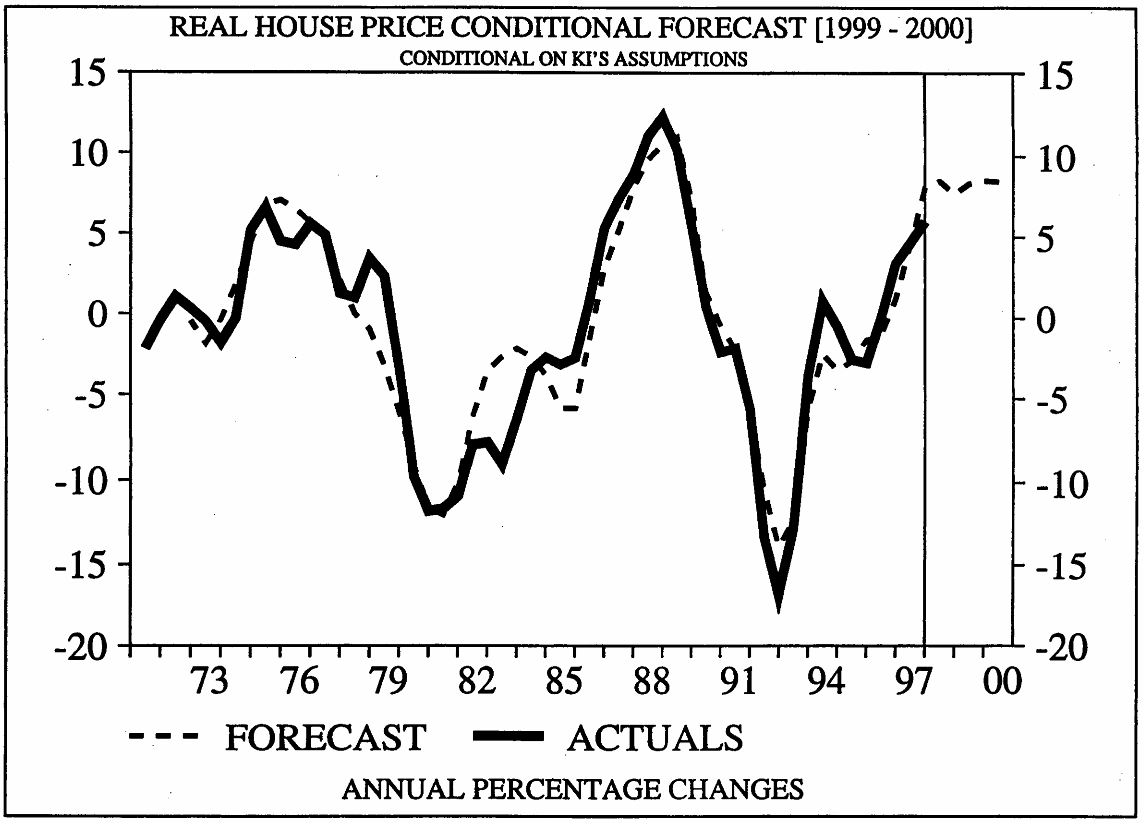


Figure 16. House price forecast, annual percentage changes (1999-2000)



It is assumed that disposable income grows at 2.5% for 1999 and 2.2% for the year 2000. The consumption deflator grows at 1.2% for the projection years. The long government bond interest rates are assumed to be at 4% level. Given forecasts on consumption (*C*) and income (*Y*) for the period 1999 - 2000 we define total savings $S = Y - C$. Having defined total savings *S* we define financial savings for the period 1998 - 2000, using the identity $WF = W_{(-1)} + Y - C - SRL$ (real savings). Household debt and financial wealth variable for the period are projected by the financial model (FIMO) at NIER. As debt is the end year stock the yearly figures can be interpolated into half years. The assumptions of a steady increase in demand factors for the period 1999 - 2000, indicate annual percentage growth rates in real house prices of the magnitude 8.3% and 8.4% for the years 1999 and 2000. The outcomes for 1999 and 2000 are 8.2% respective 10.2%. The results indicate that the model is not inconsistent with the aggregate data.

12. Conclusions

House prices are commonly derived as a reduced form from separate housing demand and supply equations. This study specifies a full macro theoretical model within a stock - flow context, i.e. the system of equations describing the demand for stock, and supply of investment. The model has deliberately been kept as simple as possible in order to highlight its salient features. The strategy applied is Hendry's general to specific modelling, applying a sequential testing procedure. The fit of the separate demand and supply sides tracks well the actual developments in the respective variables and illustrates how accurate a theoretical model corresponds to statistical data. According to Hendry and Richard (1983), a model should be data-coherent i.e. the model should be able to explain adequately existing data.

There are several lessons for the conduct of macroeconomic policy from our analysis of the effects in the housing markets. The reduction in the volatility of new housing markets could be attempted either directly through targeted monetary and fiscal policies towards homeownership, or, indirectly, through public subsided new building, including the socially rented sector, being phased to operate with a counter-cyclical bias. This study has also sought to explain both the depth and the longevity of the recent downturn in the Swedish housing market for the household sector, and discusses the controversy over the causes of the crisis, in context of the 1990-1991 tax reform. The dynamic simulations illustrate the importance of both fiscal and monetary policies for house prices, and can be useful to the Swedish policy maker in the future. Given an expected low supply of rented property (and cooperatives) and a steady increase in demand factors (and a reluctance to produce more single family houses) the model forecasts 8.3% and 8.4% price increases for the years 1999 and 2000, while the actual price increases were 8.2% and 10.2% respectively. Subsequently, the prices level out. Both the *ex post* and *ex ante* forecasts gives relatively good results. This study indicates that the volatility in both house prices and housing investment can be sought in the fundamentals representing the demand and the supply sides in accordance with common theoretical conceptions of how the housing market works.

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Appendix 1. Integration, and cointegration

Table 1. The Augmented Dickey-Fuller tests for integration

Variable	With Constant	With Constant & Trend	Conclusion
ln (AKT/P)	-2.75	-3.01	I(1)
ln (HF)	-0.37	-3.28	I(1)
ln (H)	-2.67	-2.53	I(1)
ln (WF)	-0.28	-1.90	I(1)
ln (E)	-2.61	-1.27	I(1)
ln (POP)	-0.30	-2.27	I(1)
ln (PH /P)	-2.25	-3.20	I(1)
ln (DE / Y)	-2.19	-3.18	I(1)
ln (DE / WF)	-1.88	-1.38	I(1)
ln (H / Y)	-1.75	-0.87	I(1)
ln (HF / H)	-0.31	-2.86	I(1)
R	-2.16	-3.04	I(1)
RS	-2.00	-3.25	I(1)
ln (RENTS / P)	0.96	-1.20	I(1)
ln (IH)	-1.24	-2.91	I(1)
ln (IH / GDP)	-0.95	-2.89	I(1)
ln (PH / PB)	-0.89	-2.19	I(1)
ln (PH)	-1.61	-3.08	I(1)
ln (P)	-2.69	-0.02	I(1)
ln (DE)	-2.05	-2.07	I(1)
ln (RENTS)	-1.74	-1.50	I(1)
ln (RENTS/P)	0.33	-1.65	I(1)
ln (PB)	-1.69	-0.80	I(1)
Critical value 5%	-2.92	-3.50	

Note: The ADF test has been carried out with maximum 2 lags. The stock of dwellings (H) and the employment rate (E) have 4 - 7 lags in the dependent variable to pre-whiten the residuals, whereas the other variables have maximum 2 lags. The results indicate that all the variables are I (1). See variable list on the definitions of variables. The ADF test is based on equation:

$$\Delta y_t = \alpha + \delta t + \gamma y_{t-1} + \beta \Delta y_{t-1} + \cdots + \beta_s \Delta y_{t-s} + \varepsilon_t \qquad (11)$$

where yt is the relevant time series and ε t is the residual, t is a linear deterministic time trend and s is the lag length. One can choose whether to include a constant or constant and trend, and the lag length. The null and the alternative hypothesis are $H_0 : \gamma = 0$, $H_1 : \gamma < 0$ in (11). The results of the ADF test indicate that we are unable to reject the null γ = 0 that implies that the data generating process (DGP) has a unit root.

Table 2A. Johansen's Co-integration test demand side

Null hypothesis	Maximal Eigenvalue test	95% Critical Values	Trace test	95% CriticalValues
$R = 0 \mid p = 1$	82.15**	39.4	131.4**	94.2
$R = 1 \mid p = 2$	26.04	33.5	58.59	68.5
$R = 2 \mid p = 3$	19.84	27.1	35.5	47.2
$R = 3 \mid p = 4$	10.76	21.0	17.9	29.7
$R = 4 \mid p = 5$	5.98	14.1	8.36	15.4

Note: The critical values are at 5% and 1% significance level. The asterisks * and ** denote significance at 95% and 99% significance level. However on the grounds of the low power of these tests VECM (Vector error correction model) is not estimated. The Johansen method proceeds by first testing for no co-integration. If this hypothesis cannot be rejected, the procedure stops because the variables are not co-integrated. If however, this hypothesis is rejected, it is then possible to test the hypothesis that there is at most 1 co-integrating vectors. If this hypothesis is also rejected then the hypothesis for two or more co-integrating vectors until a hypothesis cannot be rejected. It is expected that there is a co-integrating vector, including all six variables, as mentioned earlier. According to the trace and the maximum eigenvalue statistics, definitely one co-integration vector is significant at 1% level. The number of lags used in the analysis is 1. The variables entered unrestricted are constant and the seasonal. Inclusion of a trend gave us similar type of results. If there is only one co-integrating relationship, it may be easier to interpret it as a long-run relationship. For the Johansen method, there are two test statistics for the number of co-integrating vectors: the trace and maximum eigenvalue statistics. In the trace test, the null hypothesis is that the number of co-integrating vectors is less than or equal to r, where r is 0, 1 or 2. In each case the null hypothesis is tested against the general alternative. The maximum eigenvalue test is similar, except that the alternative hypothesis is explicit. The null hypothesis r = 0 is tested against the alternative that r = 1, r =1 against the alternative r = 2.The long-run restriction imposing the unit elasticity restriction on the demand side in the VAR framework takes the following form:

$$\ln\left(\frac{PH}{P}\right) = -1.00\cdot\ln\left(\frac{H}{Y}\right) + 0.56\cdot\ln\left(\frac{DE}{Y}\right) - 0.08\cdot\ln\left(\frac{DE}{WF}\right) - 0.30\cdot R\cdot(1-M) - \ln\left(\frac{\Delta P}{P}\right) \tag{12}$$

The ratio of rental stock to stock of small homes enters the long-run relationship unrestricted. LR (Likelihood ratio) test, rank = 1: Chi (2) = 188.79** which rejects the restriction.

Table 2B. Johansen's Cointegration test supply side

Null hypothesis	Maximal Eigenvalue. Test	95% Critical Values	Trace test	95% CriticalValues
$R = 0 \mid p = 1$	22.34**	21.0	36.64**	29.70
$R = 1 \mid p = 2$	13.53	14.1	14.30	15.40
$R = 2 \mid p = 3$	0.59	3.80	0.77	3.80

Note: The supply side long run co integrating vector can possibly represent Tobin's q. The standardised β eigenvectors ln(IH/GDP) = 3 49*ln (PH/PB) . Number of lags in the analysis is 4 based on the Akaike Information Criterion), and the variables entered unrestricted is constant and seasonal. Inclusion of a trend gave us similar type of results. General co-integration restrictions are that alpha and beta restrictions are variation free. Beta restrictions are homogenous when scaling down. However the restriction imposed that the interest rate have no long-term effect are rejected according to the LR test rank = 1: $\chi 2$ (1) = 7.25 (0.007)**. The model is exactly identified when we live out the interest rate. This is theoretically plausible.

Appendix 2.Weak exogeneity

A simple and direct way to check the weak exogeneity (see Urbain (1992)) of the housing and rental stock, debt, financial wealth, the long term interest rate, and the building cost index is to test the significance of the error-correction term ln (PH/P) in the six marginal models using the traditional *t* test. The results are presented in Tables 3A to 3G. The Student's t-test is insignificant in the marginal models and we conclude that housing stock, rental stock, income, debt, financial wealth long term interest rate, and finally the building cost index can be considered weakly exogenous for the long-run parameters.

Table 3A. Marginal model for housing stock.
Dependent variable D_2 ln(H)

Variables	Coefficient	t statistic
D_2 ln(H)$_{(-1)}$	1.69	15.98
D_2 ln(H)$_{(-2)}$	-0.69	6.55
ln (PH/P) $_{(-2)}$	-0.00	0.55
Constant	-0.00	0.63
R^2	0.99	
R Bar sq.	0.99	
Std.	0.00	
D.W.	2.13	

Table 3B. Marginal model for rental stock.
Dependent variable D_2 ln(HF)

Variables	Coefficient	t statistic
D_2 ln(HF)$_{(-1)}$	0.94	33.4
ln (HF)$_{(-2)}$	-0.11	4.65
D_2 ln(H)$_{(-1)}$	0.15	0.43
Trend	0.00	3.76
ln (PH/P) $_{(-2)}$	0.00	0.97
Constant	-6.52	3.58
Seasonal	0.00	0.22
R^2	0.98	
R Bar sq.	0.97	
Std.	0.00	
D.W.	1.64	

Table 3C. Marginal model for income.
Dependent variable D_2 ln(Y)

Variables	Coefficient	t statistic
$D_2 \ln(Y)_{(-1)}$	0.20	1.68
$\ln(Y)_{(-2)}$	-0.32	4.02
$D_2 \ln(E)$	-0.36	0.43
$RS_{(-2)}$	-0.27	2.16
$\ln(GDP)_{(-2)}$	0.21	0.95
$D_2 \ln(AKT)_{(-1)}$	-0.03	2.21
$D_2 \ln(GDP)_{(-1)}$	0.21	0.95
$\ln(PH/P)_{(-2)}$	0.03	0.97
Constant	1.06	2.21
Seasonal	0.05	3.31
R^2	0.48	
R Bar sq.	0.38	
Std.	0.02	
D.W.	2.02	

Table 3D. Marginal model for debt.
Dependent variable D_2 ln (DE)

Variables	Coefficient	t statistic
$D_2 \ln(DE)_{(-1)}$	0.54	5.42
$\ln(DE)_{(-2)}$	-0.24	4.43
$\ln(H)_{(-2)}$	-0.14	0.49
$RG_{(-2)}*(1-M)-\Delta P/P$	-0.33	1.97
$\ln(HF/H)_{(-2)}$	-0.34	2.78
$D_2 \ln(AKT)_{(-1)}$	-0.01	1.05
Trend	0.00	1.46
$\ln(PH/P)_{(-2)}$	0.00	0.00
Constant	-13.84	1.47
Seasonal	0.01	1.11
R^2	0.90	
R Bar sq.	0.87	
Std.	0.01	
D.W.	2.14	

Table 3E. Marginal model for financial wealth. Dependent variable D_2 ln (WF)

Variables	Coefficient	t statistic
D_2 ln(WF)$_{(-1)}$	0.55	4.01
D_2 ln (WF)$_{(-2)}$	-0.48	4.09
ln (WF)$_{(-2)}$	-0.16	2.61
ln (DE)$_{(-2)}$	-0.34	2.28
D_2 (E)$_{(-2)}$	-1.04	1.15
DREG	0.09	1.61
ln (HF/H)$_{(-2)}$	-0.34	2.78
D_2 ln (AKT)	0.19	2.71
Trend	0.00	1.46
ln (PH/P)$_{(-2)}$	-0.23	1.40
Constant	6.75	2.55
Seasonal	0.00	0.13
R^2	0.84	
R Bar sq.	0.80	
Std.	0.07	
D.W.	1.86	

Table 3F. Marginal model for long-term interest rate. Dependent variable D_2 ln(R)

Variables	Coefficient	t statistic
D_2 ln(R)$_{(-1)}$	1.11	8.28
D_2 ln (R)$_{(-2)}$	-0.75	5.14
D_2 ln (R)$_{(-3)}$	0.43	4.09
D_2 ln (P)$_{(-3)}$	0.07	1.36
RS	-0.26	3.37
RS$_{(-1)}$	0.09	1.61
TREND	-0.00	0.63
D_2 ln (AKT)	0.01	0.99
ln (PH/P)$_{(-2)}$	-0.01	0.63
Constant	0.22	0.63
Seasonal	0.00	2.11
R^2	0.954	
R Bar sq.	0.94	
Std.	0.01	
D.W.	2.08	

Table 3G. Marginal model for building cost index. Dependent variable D_2 ln(PB/P)

Variables	Coefficient	t statistic
D_2 ln(PB/P)$_{(-1)}$	0.55	4.01
D_2 ln (PB/P)$_{(-2)}$	-0.48	4.09
Trend	-0.00	0.96
ln (IH/GDP)	-0.02	0.84
Constant	2.65	0.97
R^2	0.71	
R Bar sq.	0.69	
Std.	0.04	
D.W.	1.90	

Appendix 3. Swedish data

PH: Nominal house prices. PH (1991 = 1) is the weigted mean of (fastighetsprisindex) of primary and leisure homes (fritidshus). The market price index covers only direct ownership including second homes, not indirect ownership.

P: denotes the consumption deflator (1991 = 1).

PHPC: Real house prices (PH/P)

Y: is real disposable income.

WF:: is households net financial wealth defined as the sum of notes, coins, bank deposits and the National Saving Scheme (Allemanssparande), bonds and treasury discount notes, private insurance savings, listed and non-listed shares and other assets, minus total direct debt.

DE: is household debt. The annual stock figures for household financial assets and liabilities were from Financial Accounts Sweden, (Financial Accounts 1970 - 1997).

H: is the stock of private homes i.e. the sum of stocks of primary and secondary homes computed according to the perpetual inventory stock method approximately equal to Statistics Sweden's gross stock. In the perpetual inventory stock, all construction of small homes including secondary homes are treated as owned by householders. Apartments (or flats) are regarded as rental housing.

HF: is the stock of rental housing. This perpetual stock is our measure interpolated from the bench marks based on Statistics Sweden=s previous stocks, which have since been revised. For details of computations of the stocks, see Kanis and Barot (1993).

M: The marginal tax rate on interest, is computed from tax returns (Statistics Sweden Income and Wealth Distribution figures 1975-1980), and is the interpolative guess linked to estimates in Forslund (1991), for industry worker pre-1975. Later the statutory maximum applicable to interest deductions on tax returns has been reduced from 50% to 30% in the present period.

R: Long term government interest rate (at least 5 years time span).

RS: Short term interest rate (less than 5 years).

AKT: is the general price index for shares of stocks as reported by Statistics Sweden.

RENTS: Rents on housing (deflator for housing consumption).

E: Employment rate (regular / labour force inclusive programs), in thousands.

IH: gross investment in private (small) homes in 1991 prices.

PB: is the building cost index in 1991 prices.

GDP: gross domestic product in 1991 prices.

91 TR: is the 91 Tax Reform Dummy.

DS: Dummy, 1 in the first half year and 0 for the second half year.

q: is Tobin's q defined as Tobin's q is defined here as an index (1991 = 1).

of market price *PH to PB,* the construction price index.

Chapter IV

The Stock- Flow Model for Sweden and the United Kingdom. Econometric Analysis for the period 1970 – 1998

1. Introduction

The importance of housing for the wider economy, the financial system, the labour market, and the construction industry justifies this study. House prices have important direct economic implications for homeowners and renters. Moreover, house price changes have been scrutinised in the United Kingdom and Europe as advanced indicators of demand pressure. The growth of real house prices and output gap is closely related to the strength of economic expansion. In addition, central banks take housing demand pressures into account when determining monetary policy.

The major econometric models both in the UK and in Sweden now incorporate housing wealth along with financial wealth in their consumption function. (See Davidson, Hendry, Srba and Yeo (1978) and Hendry (1981) for the UK; Berg et al. (1995), Kanis et al. (1993) and Barot (1995) for Sweden). This makes it all the more important to have an econometric model that increases our understanding of the determinants of house prices the effects on house prices of both fiscal and monetary policies. We refrain making specific the policy recommendations, (see Barot 2001), and instead the main focus of the paper is on econometric modelling of house prices and investment for owner-occupied homes both in the UK and Sweden.

Case et al. (2001) examine consumer behaviour at the USA State level from 1982 to 1999. They find that the wealth effect from housing value is statistically significant and twice as large as the stock market effect. On average a 10% increase in house prices results in an increase in consumption of roughly 0.6% whereas a 10% increase in stock market wealth increases consumption up only 0.3%. For the USA the marginal propensity to consume is about 0.04 out of stock wealth and somewhat higher out of housing wealth (see Boone et al. (1998)). This study examines data for 14 countries, including the USA, and finds an even larger wealth effect from housing values. The study concludes that aggregate consumption increases roughly 1.3% from a 10% rise in housing wealth. The authors find no discernible equity wealth effect at all. Greenspan (1999, 2001) investigates the relationship between consumption and wealth for 16 OECD countries using panel data techniques. The results indicate that both types of wealth are statistically significant in the long as well as the short run. Similar results are found for Sweden (see Kanis et al. (1993) and Barot (1995)). These empirical results indicate that asset prices have become increasingly important in the transmission of domestic and global business cycles (see I.M.F. study April 2002).

According to Meen (2001), the UK national housing models for owner occupied homes have experienced important structural changes after 1990, making the parameters for house price equations particularly volatile compared to other aggregate time series relationships.

There are two main objectives for this paper. The primary objective is to investigate the similarities and differences in private owner-occupied housing markets for Sweden and the UK. The owner-occupier rate in Britain is *68%* but is only *40%* in Sweden. In order to facilitate comparisons between the countries we use approximately the same types of exogenous variables to model house prices and housing investment. We compare the short and the long-term point estimates, the elasticities and the error correction speed of adjustment coefficients. Both of the countries under examination are modelled using a stock-flow model to facilitate comparisons between Sweden and the UK. This in turn would imply that a single theory of housing prices would not apply internationally to all cases. Long-run trends in real house prices differ across countries and therefore it is important to investigate why these differences occur.

The secondary objective is to investigate whether or not changes in house prices can be predicted. There is a common belief that share and house prices follow random walks. The questions to be explored are as follows: (1). Can the private owner-occupied markets in Sweden and the UK be explained within the theoretical framework of stock-flow model? (2). Is there a good house price and investment model in the sense that these structural models out perform their auto-regressive counterparts? (3). Can these models be used for forecasting?

This study is structured in the following sections: Section 2 presents a review of earlier studies. In section 3 the theoretical considerations for modelling real house prices and housing investment in Sweden and the UK are outlined. Section 4 describes the data used in this study. Section 5 explains the ECM methodology applied in this study. Section 6 presents the empirical results on house prices and investment functions for Sweden and the UK. Section 7 presents the forecasting evaluations of the Sweden and UK models. A comparison with naive auto-regressive alternatives is carried out. Section 8 presents results of the Granger causality test for the determinants of house prices. Section 9 concludes. Appendix 1 presents the results from unit root tests of integration and cointegration. In Appendix 2, we present data and data sources for Sweden and the UK.

2. Review of earlier studies

Since the seminal work by Hendry (1984) there has emerged a flora of empirical macro estimates house price functions. Fluctuations in house prices have been analysed in terms of an inverted demand function for houses, conditional on the last period's housing stock. In the short term, the housing stock is taken as fixed. In the long term it evolves as new construction, conversion and rehabilitation of the older stock takes place. Tobin's (1969) q investment theory is often adopted in order to model long-term changes in the housing stock.

House prices are commonly derived as a reduced form from separate housing demand and supply equations. The UK studies in this category are those by Mayes (1979), Nellis and Longbottom (1981), Bradley (1981), Hendry (1984), Meen (1990), Westway and Pain (1996), Chen and Patel (1996), Muellbauer et al. (1997), and Kapparova and White (2001). The US studies in this tradition are the studies of Malpezzi (1999), and Meese and Wallace (1997). For Asian studies see Tse (1999), and Chen and Patel (1998). Similar ECM models of house prices in other countries include Barot and Takala for Sweden and Finland (1998) and Ahlgren (1999) for Finland.

For details of specifications and estimates from different studies see Meen (1990)[34]. Pain and Westway derive their house price equation from the marginal rate of substitution between consumption goods and housing services in an intertemporal optimising model. It should be pointed out that their model differs from previous work since they condition the demand side equation on consumption rather than income (i.e. consumption is used as a proxy for income). Jaffee (1994) studies the determinants of Swedish house prices using the stock-flow model. Heiborn (1994) analyses how the quantity of housing demand can be explained by the size of different age cohorts. Her study indicates that there is a positive effect of demographic demand on house prices. Another study on Sweden is by Hort (1997), who uses a dynamic capital asset market model in which an ECM estimates real house prices as a function of total income, user costs and construction costs. Barot (2001) models Swedish house prices using a simple demand

[34] Meen (1990) on pp. 11 presents results and estimates of Nellis and Longbottom, Bradley, Hendry and finally an autoregresive model.

and supply econometric model and finds, similar to Hort, that Swedish house prices can be explained by demand and supply conditions. Barot shows that the Swedish model can be used for both short and medium - term forecasting.

More recently, the investment debate has focused on the issue of whether Tobin's q is sufficient to explain housing investment. Tax policies and interest rates have been used as additional variables in models based upon Tobin q. According to Feldsten (1982), the general failure of "Tobin's q" models has led to the development of new challenging approaches. Feldsten uses of reduced form equations and obtains separate strong influences for both output (GDP) and capital cost measures (including tax policies).

3. Theoretical considerations

3.1 The long run demand side of the equation

A stock-flow model of the real estate sector serves as the theoretical basis[35] for the fundamental determinants of real estate construction and prices. The term stock refers to the outstanding stock of structures, upon which demand and supply interact to determine asset prices. The term flow refers to the rate of new construction, which is determined by profit potential as measured by the ratio of asset prices to construction costs (Tobin's q). These types of stock-flow models in macroeconomic studies of the housing market are motivated by a concern with business cycles and forecasting, more specifically a concern with new residential construction, a volatile component of gross investment. The long-run demand for the stock of housing services can be written as:

$$\underset{}{\frac{H^D}{Y}} = f\Big(\underset{(-)}{\frac{PH}{P}},\ \underset{(-)}{\big(R\cdot(1-M)-(\tfrac{\Delta P}{P})\big)},\ \underset{(+)}{\frac{WF}{Y}},\ \underset{(+)}{\frac{DE}{Y}}\Big) \qquad (1)$$

where H^D denotes the demand for housing services (stock), Y is disposable income, M is the marginal tax rate on interest deductions, $\frac{PH}{P}$ is the real house price, PH is the nominal house price index, P is the consumption deflator, DE is the household debt, WF is the household financial wealth, $R\cdot(1-M)-(\frac{\Delta P}{P})$ is the after tax, after inflation, long-run government bond rate and inflation $(\frac{\Delta P}{P})$ is defined as the annual change in P. Solving (1) for house prices, we derive the inverted demand function:

$$\frac{PH}{P} = g\Big(\underset{(-)}{\frac{H^D}{Y}},\ \underset{(-)}{\big(R\cdot(1-M)-\tfrac{\Delta P}{P}\big)},\ \underset{(+)}{\frac{WF}{Y}},\ \underset{(+)}{\frac{DE}{Y}}\Big) \qquad (2)$$

The anticipated signs of the partial derivatives are indicated below the equations. The house price function is expressed in ratio form to highlight the long-term features of a steady state. This

[35] For theoretical derivations see Meen (2001).

means that all ratios are constant if numerator and denominator expand at the same constant rate [36]. The long-run relationship to be tested is log linear. In the error correction equation real house prices depend negatively on real interest rates and the housing stock/income ratio, and positively on the financial wealth / income ratio and the debt/income ratio. Higher income raises prices by reducing the stock. For example, a rise in income first boosts demand and thereby raises prices where stock is initially given. The debt and wealth ratios have a net positive effect. In the long run, when real housing prices begin to diverge from their equilibrium relationship, the three ratios with the level of interest rate act in the error correcting mechanisms driving house prices and stock toward equilibrium.

The short-term dynamics on the demand side for Sweden are represented by the following variables: the yearly change in the long term interest rate, the unemployment rate, household debt, rental stock, and the yearly changes in total population. The short-run dynamics on the demand side for the UK are similar with the addition of the yearly changes in disposable income and the inflation rate. The interest rates for the UK are not after tax interest rates.

3.2 The long run supply side of the equation

Much of the work on the supply side of housing has not paid particular attention to the stock in existing private owner-occupied homes. The macroeconomic literature has usually assumed that the supply in the short-run is perfectly inelastic and all increases in supply come from new construction. The full analysis requires not only the supply side decision, but also the demand side with household preferences. The UK tradition in modelling the supply side is to model new construction (i.e. housing starts). We use a slightly different approach, modelling UK housing investment using the same Tobin's q model as is used in Sweden.

Applying Tobin's q theory to the housing market, construction activity is determined by the profit incentive represented by the ratio of the asset prices of existing structures, to the cost of new construction. Average q is defined here as the market price index (PH) divided by construction price index (PB):

$$q = \frac{PH}{PB}$$

In long-run equilibrium, the value of Tobin's q converges to 1, implying that asset prices converge towards construction costs, but in the short run q may deviate from 1. In equilibrium, investment equals depreciation of the capital stock if net investment is zero (see Jaffee (1994)), or equals depreciation adjusted for a constant growth rate. The augmented Tobin's model of housing investment incorporating the interest rate can be written as:

$$\frac{IH}{H} = h\,(q, RS) \qquad (3)$$

where IH is housing investment and RS is the short term interest rate reflecting the cost of financing housing investment. H is the capital stock of housing and it acts as a scalar in (3).

In the long-run $H^D = H = H^S$ (4)

[36] In the steady state equation (2) all the ratios are constant provided the numerator and denominator for each ratio grows at constant rate. If housing stock, financial wealth, and debt and income all grow at the same rate (g), all ratios including real house price are steady state stable (all relevant variables all grow at an identical rate). The economic justification of a model like (2) is because many economic theories suggest long-run proportionality for example the quantity theory of money and life cycle hypothesis. ECM is consistent with static equilibrium. By equilibrium here, we mean no inherent tendency to change.

On the supply side, when investment rises above its long run equilibrium (in response to the price deviation), Tobin's q $\frac{PH}{PB}$ acts as an error correcting mechanism driving housing investment toward equilibrium. The two mechanisms thus interact. A higher interest rate depresses both supply and demand. The Tobin's q model treats old and new housing as perfect substitutes[4]. However in applied work, particularly when using micro data one should correct for the different characteristics of these groups. Equations (2) and (3) are the basic demand and supply equations respectively. Finally, the housing stock evolves over time with investment through the perpetual inventory relation as specified in (5).

$$H^S = IH + (1 - \delta) * H_{(-1)} \tag{5}$$

where H is the housing stock in hand and δ is the rate of depreciation of the stock (H). Equation (2) and (3) are estimated separately and a reduced form can be derived by the identity (4).

We refrain from assessing the identifiability of the structural equations, by applying the technique of reduced – form equations, which expresses an endogenous variable as a function of predetermined variables as presented in Chapter 2. The reduced form coefficients would generally be of the same sign.

4. Data

According to Hendry (1993) there exists a data generating process (DGP), which produces and measures economic data. This data are assumed to be generated by a process of immense generality and complexity. Economists and the econometricians seek to model the main features of the data-generating process using a simplified representation based on the observable data as related to economic theory. We for simplification purposes assume that the underlying unknown DGP for the housing market is correctly measured.

The data for both Sweden and the UK are quarterly and cover the sample period 1970q1–1998q4. The advantages of using quarterly data in contrast to semi-annual or annual data is the larger number of observations which provide us with more degrees of freedom to conduct testing and draw inferences. Housing demand in international studies is related to a range of variables and they are as follows for Sweden: real house prices, real personal disposable income, personal sector financial wealth, household total debt, the consumer expenditure deflator, interest rates, the unemployment rate, total population, user cost, and the 1991 year tax reform dummy. For the UK we use the same types of variables with the exception that the number of owner-occupied dwellings is used instead of the housing stock, and mortgages outstanding is used instead of total household debt. The UK does not calculate housing stock using the perpetual inventory relation, as is the case for Sweden. It would have been preferable to use the housing stock for the UK in pounds had this statistic been available, since it is more compatible with economic theory underlying Tobin's q. For Sweden a time series for outstanding mortgage debt does not exist for the earlier period of the study. It's only recently that Statistics Sweden, in the Financial Accounts 1995-1999 (FM 11 SM 0001) has started publishing this series. The consequence of these weaknesses is that the earlier studies for the UK report income elasticities above unity. To avoid this problem we impose unitary income elasticity for both the countries by estimating the long run part of the demand side in ratio form. The unitary elasticitties are tested by adding log income (lagged one year) in the dynamic counterpart to (2). A detailed description of the sources of data is given in Appendix 2.

5. Econometric methodology

Error correction models link equations formulated in levels and with those formulated in differences of the original variables. The levels represent the long run while the differences represent the short-term dynamics. ECM implies testing for integration and cointegration. An important issue in econometrics is the need to integrate short-run dynamics with long-run equilibrium. The analysis of short-run dynamics is often done by first eliminating trends in the variables, usually by differencing. Explicit attention is paid in this study to using the time series properties of the housing data set to form a meaningful model. Thus unit root and cointegration tests are performed.

5.1 Integration

A series that is itself non-stationary, but which is stationary after first differencing is defined as being integrated of order one I (1). Therefore as a preliminary step to cointegration analysis, the order of integration of the housing model data set is tested. Several procedures are available (see Dolado et al. (1990), for a survey)).The Augmented Dickey-Fuller (ADF) integration test is employed using the log level of the respective variables. Tests for unit roots are performed on the Swedish and the UK housing data set employing equation (6) using 1 up to 9 lags.

$$\Delta y_t = \alpha + \delta t + \gamma y_{t-1} + \beta \Delta y_{t-1} + \cdots + \beta_s \Delta y_{t-s} + \varepsilon_t \qquad (6)$$

where y_t is the relevant time series, ε_t is the residual, t is a linear deterministic time trend and s is the lag length. One can choose whether to include a constant or constant and trend, and the lag length. The null and the alternative hypothesis are $H_0 : \gamma = 0$, $H_1 : \gamma < 0$ in (6). The results of the ADF test indicate that the variables are stationary after first-differencing. We conclude that all the variables are integrated of order one. The results are presented in Table A1, in Appendix 1.

5.2 Cointegration

The primary objective of cointegration analysis is to uncover the long-run relationships between non-stationary variables under consideration. The basic idea of cointegration is that individual economic time series wander considerably, but certain linear combinations of the series do not move too far apart from each other. Economic forces tend to bring them into line. Engle and Granger (EG) (1997) developed the theory of cointegration. Economic theory tells us that two variables should be cointegrated, and a statistical test for cointegration is a test of the theory. There is a flora of tests for cointegration. Cointegration results, using the well-known Johansen and Juselius (1990) procedure, are presented in Table A2 and Table A3 for Sweden and Table A4 and Table A5 for the UK in Appendix 1. A deterministic trend, a constant and four to eight lags are included when carrying out the test. We identify four cointegrating relationships, two for each country representing the demand and supply sides respectively. If there is only one cointegration relationship, it may be easier to interpret it as a long-run relationship. It should be noted that the Johansen method estimates a VAR model and first determines the number of co-integrating vectors. This approach is in particular a-theoretical. Cointegration is a purely statistical concept and the co-integrating vectors need not have any economic meaning. That is why Johansen (see Johansen (1994)) distinguishes between three concepts of identification: (I) generic identification which is related to a linear statistical model; (II) empirical identification which is related to the estimated parameter values; and (III) economic identification which relates to the economic interpretability of the estimated coefficients of an empirically identified structure. We follow the third concept in this study. The long run on the demand and supply sides are based on equations (2) and (3). The critical values for these tests are found in Johansen and Juselius (1990). The appropriate table depends on the role of the intercept and trend in the model. The VAR test has been carried out in PCFIML[37]. The existence of cointegrating vectors implies Granger-causality. The causality analysis in Section 8 is an added feature to reconfirm that our stock-flow model is correct. We refrain from testing for seasonal cointegration (see Löf (2001)).

5.3 Estimation

Because the variables are found to be integrated and cointegrated an error correction model can be formulated. An unrestricted autoregressive distributed lag model (ADL) is finally estimated for the respective countries. This model is then solved numerically for the static long run and reparametrized into ECM form. The ECM here estimates the long-run parameters and the short-run dynamics jointly. The general model on the demand side for both the countries is over-parameterised with lags for both house prices, income, wealth and a broad set explanatory variables (both nominal and real interest rates, household debt, population, unemployment, the inflation rate, financial net wealth, household debt, the housing stock, the rental stock, seasonal dummies and finally the ECM term). Similarly the general model on the supply side is over-parameterised with lags for investment[38], Tobin's q, GDP, and interest rates.

We do not estimate a Vector Error Correction Model (VECM) because in general, co-integrating vectors are obtained from the reduced form of a VAR system where all the variables are assumed to be jointly endogenous. Consequently, they cannot be interpreted as representing structural equations because, in general, there is no way to go from reduced form back to the structure[39]. However in a multivariate VAR, it could be possible to give the so-called structural interpretation by imposing identifying restrictions on the reduced-form parameters. Nevertheless we do not estimate a VAR. In our single equation framework we do impose the unitary income elasticity restriction.

The quarterly models are estimated using the fourth difference, as it removes much of the seasonality in the time series and also is helpful for interpreting and forecasting short term developments in annual terms. In addition, fourth differencing reduces the impact of any level shifts in seasonality (or intercepts) to transient four-quarter blips, and reduces trend shifts to level shifts[40]. The models can be interpreted in the dependent variable as the yearly change in house prices is explained by the yearly changes in a broad set of variables representing the short term dynamics as well as variables in log levels representing the long-run adjustments. We refrain from testing for seasonal cointegration.

[6] See Doornik and Hendry (1997).

[38] One begins in the general to specific methodology with an over parameterised model. An overparametized model is defined as a model, which contains more lags than are expected to be necessary. The model is then reduced in scale by a sequence of statistical tests. The final derived model is the specific model.

[39] See Rao, pp.17 (1994).

[40] See Clements and Hendry (1997).

6. Presentation of results

6.1 The demand side Sweden and the UK

To facilitate comparisons of results between the Swedish and the UK dwelling markets, the estimated specific model, equation (2), including the short-run dynamics using the general to specific approach, is reported in Table 1. For both countries the standard error of the regression is approximately 2% and 95% of the total variance in the annual log change in real house prices is accounted for. Equation (2) has a clear economic interpretation. The signs of all of the long and short-run dynamic variables are in agreement with prior theoretical expectations and significant. The empirical significance of lagged behaviour is a feature of estimated house price equations. The inclusion of lags in the house price equation is motivated on the basis of down payment constraints, housing market search time, expectation formations and construction delays. Interesting to note is that in both Sweden and the UK has the same lag structures and they are significant. However, there are some marginal differences in the magnitude of the coefficients.

The elasticity for change in the population, an important demographic variable, is quite high for both Sweden and the UK. Changes in population definitely have a strong effect on house prices both for Sweden and the UK. The short- run elasticity for debt for the UK and Sweden is 0.4 and 0.8. The annual change in mortgage debt has a larger elasticity for the UK than for Sweden. This finding may result from the use of outstanding mortgage debt as the matric for the UK. In the UK both the level and the change in unemployment are significant, while for Sweden the employment rate is significant only in the short-run dynamics. The unemployment variable reflects uncertainty[41]. Unemployment is the macroeconomic problem that affects individuals most directly and severely. The unemployment variable is important as it reflects the earning of both the owners and potential buyers of homes.

The speed of adjustment is approximately two times faster in the UK than in Sweden. The signs of all long and the short-run dynamics are in agreement with prior theoretical expectations and significant. As expected the error correction term is negative and significant. The adjustment coefficient for the level of real house prices $\frac{PH}{P}$ indicates that in case of departure from equilibrium, 12% of the shock is corrected within one year for Sweden and 23% for the UK. The speed of adjustment is approximately two times faster in the UK than Sweden. The speed of adjustment is faster in the UK may be due to the owner occupied rates are different for the respective countries. The owner occupied rates are 67% and 49% for the UK and for Sweden respectively. In addition the deregulation of the financial markets started earlier in the UK than Sweden. In the UK there is less space compared to Sweden. The institutional set up in the respective countries is different. We refrain from analysing these aspects in this study. Earlier UK studies had the adjustment coefficient between 12% - 17%, (see Meen, (1990)), for the sample period 1964-1987. Both the changes in the nominal interest rates in the short term and the real interest rate in the long term affect house prices in both the countries. The change in the long interest rate has a semi-elasticity of –0.5 for Sweden and –0.3 for the UK in the short term. The long real interest rate has a semi-elasticity of 2.1%, i.e. a one percentage point increase in the long after tax rate would decrease the real house prices by 2.1% for Sweden. In the UK the long run semi- elasticity for the real building interest is 0.9%. The point estimates are not much different. The differences for the long-run real interest rates are conditional on the speed of adjustment coefficients for the respective countries.

[41] See Barot (1995).

Table 1. The demand side results (1970 – 1998). Dependent variable : D4 ln (PH/P)

Regressors: Sweden	Coeff.	T-Stat.	Regressors: UK	Coeff.	T-Stat.
Constant	0.25	3.17	Constant	0.57	1.71
D4 ln (PH/P) $_{(-1)}$	0.80	10.94	D4 ln (PH/P) $_{(-1)}$	0.78	13.76
D4 ln (PH/P) $_{(-4)}$	-0.45	4.73	D4 ln (PH/P) $_{(-4)}$	-0.30	3.22
D4 ln (PH/P) $_{(-5)}$	0.23	2.53	D4 ln (PH/P) $_{(-5)}$	0.19	2.41
D4ln (POP) $_{(-5)}$	3.63	2.78	D4ln (POP) $_{(-1)}$	6.92	1.82
D4 (R)	-0.47	3.17	D4(RB)	-0.27	1.79
91TR	-0.02	2.47	D4ln (RY) $_{(-1)}$	0.41	3.99
D4 ln (E)	0.47	1.90	D4 ln (UNP)	-0.06	2.86
D4 ln (HF) $_{(-1)}$	-0.67	3.70	D4 ln (HS) $_{(-1)}$	-	-
D4 ln (DE)	0.20	2.39	D4 ln (RL)	0.75	6.90
D4 ln (P)	-	-	D4ln (P)	0.87	4.91
Long-run			Long-run		
ln (PH/P) $_{(-4)}$	-0.12	4.18	ln (PH/P) $_{(-4)}$	-0.23	6.16
ln (H/Y) $_{(-4)}$	-0.30	4.56	ln (HS/RY) $_{(-4)}$	-0.30	2.18
ln (WF/Y) $_{(-4)}$	0.05	3.14	ln (RW/RY) $_{(-4)}$	0.04	2.32
ln (DE/Y) $_{(-4)}$	0.19	4.13	ln (RL/RY) $_{(-4)}$	0.07	1.82
{R*(1-M)-ln (ΔP/P)} $_{(-4)}$	-0.26	2.13	{RB – ln(ΔP/P)} $_{(-4)}$	-0.20	1.95
ln (E) $_{(-4)}$	-	-	ln (UNP) $_{(-4)}$	-0.03	1.96
Q2	0.00	0.11	Q2	-0.00	0.49
Q3	0.00	0.39	Q3	0.00	0.45
Q4	-0.02	1.74	Q4	0.00	0.08
R^2	0.95		R^2	0.97	
R- Bar	0.94		R- Bar	0.97	
Std Err	0.02		Std Err	0.02	
D.W.	2.05		D.W.	2.08	
Diagnostics		Critical Values	Diagnostics		Critical Values
Normality	4.95	5.99	Normality	29.1	5.99
ARCH	2.97	9.49	ARCH	0.56	9.49
RESET	0.81	3.18	RESET	1.27	3.18
LM (1)	0.31	3.84	LM (1)	0.32	0.69
LM (2)	0.28	5.99	LM (2)	2.62	0.93

Note: The operator Dj stands for a j-period difference, with D = D1 for simplicity, and L(x) = log(x) for short. Thus Dj L(x) = log (x/x-j) is a j-period difference in logs. For quarterly data j = 4 in the dependent variable. D4 L(x) is the annual rates of change. D (D4 L(X)) is the change in an annual rate of change. Normality test is violated for the UK. The test for weak exogeneity requires a variable additional test. Reaction functions for income, debt, housing and rental stock and interest rates are searched. Treating these variables as potentially endogenous we regress each on a set of instruments, save the residuals from the regressions and add them to the demand side model.

Wealth effects are triggered by changes in interest rates. The interest rate channel works in the following way. Given some degree of price persistence, an increase in nominal interest rates, translates into increases in the real interest rate and the user cost of capital (see Federal Reserve Bank of New York (2002)). Indeed most of the UK studies of house price determinants use nominal and not real interest rates. However we find that both the nominal (in the dynamics) and the real interest rate (in the long-term) works as well for both Sweden and the UK.

Inflation causes owner-occupied housing to be less affordable i.e. the price of housing rises relatively quickly. We find this effect for the short run in the UK. Assuming that the housing stock is fixed in the short run, an increase in the rate of inflation will increase the real price of houses as long as the nominal interest rate rises proportionally and keeps the real interest rate constant.

Since the nominal interest rate enters the house price equation for both the countries, this is also the term for the inflation level. Increased inflation changes the time profile of real mortgage payments. Because expectations of rising inflation increase the nominal rate of interest, higher anticipated inflation not only increases mortgage but also increases the opportunity cost of homeowner equity.Since the stock is fixed in the short run, an increase in the rate of inflation will increase the real price of houses as long as the nominal interest rate rises proportionally and keeps the real interest rate constant. Thus, an important implication concerning the regime of permanently low inflation is that it will lead to lower relative house prices (see Holly and Jones, 1997 pp.554). Since the nominal interest rate enters the house price equation for both the countries, this is also the term for the inflation level. Increased inflation changes the time profile of real mortgage payments. Because expectations of rising inflation increase the nominal rate of interest, higher anticipated inflation not only increases mortgage but also increases the opportunity cost of homeowner equity.In this study, however, interest rates are used as a proxy for debt amortisation. Households paying back mortgage debt are directly influenced by changes in nominal interest rates. Sweden has stronger effects from interest rates, financial wealth and debt than does the UK.

The solved long-run estimated equations (2) on the demand side excluding short run dynamics for Sweden and the UK can be written as:

$$\ln\frac{PH}{P} = 2.1 - 2.4\cdot\ln\frac{H}{Y} + 1.5\cdot\ln\frac{DE}{Y} - 2.1\cdot(R*(1-M) - \ln\frac{\Delta P}{P}) + 0.4\cdot\ln\frac{WF}{Y} \tag{7}$$

$$\ln\frac{PH}{P} = 2.5 - 1.3\cdot\ln\frac{HS}{RY} + 0.3\cdot\ln\frac{RL}{RY} - 0.9\cdot(RB - \ln\frac{\Delta P}{P}) + 0.2\cdot\ln\frac{RW}{RY} - 0.13\cdot\ln UNP \tag{8}$$

The long run elasticity for financial net wealth is 0.4 for Sweden and 0.2 for the UK. The long run elasticity for household debt is 1.5 for Sweden and 0.3 for the UK. The differences in the debt elasticities may result from differences in the household debt series for Sweden and the UK.

Using gross financial wealth instead of net implies that we would capture simultaneously the financial assets and liabilities of the households in the estimated coefficients. In this study we measure net worth and indebtedness separating each component. In the household balance sheet, net financial wealth plays an important role in the purchase of new homes, since buyers must make down payments of about 25% percent of the purchase price of owner-occupied homes in Sweden. Usually increases in debt are considered to be an indicator of consumer optimism and strong demand. People buy houses with debt financing to a large extent, which tells us that real house prices and debt could be positively correlated.

On the other hand an increase in indebtedness or a decline in holdings of financial assets would raise the risk of financial distress, thus prompting the consumer to shift his demand away from durables and housing thus reducing house prices. In 1991 (91TR), "The Tax reform of the Century" was implemented in Sweden. One of the main goals was to reduce distortions in housing prices. The 91TR affected the user costs for owner occupied homes and hence made it more expensive for private homeowners.

The income elasticity of housing demand is one of the most important parameters in housing economics. Table 2 presents estimates of both income and price elasticity from previous UK and Swedish studies. The long-run demand side is estimated using ratios which imply unitary income elasticity for both countries. The unitary elasticities are tested by adding log income (lagged one year) in the dynamic part of (2) and testing whether or not its elasticity is zero. We find no compelling reason either in the Swedish or the UK literature to reject unitary income elasticity. For the sake of comparison we present earlier UK and Swedish studies and their estimates of income and price elasticities where no restrictions have been imposed. In the UK literature estimates are in the range of 1.0 to 1.4. Elasticity in excess of unity is bound to lead to problems in macro models when the consumption function is related to housing wealth and house prices, implying that any shock to house prices will generate large explosive multiplier effects to aggregate consumption. Hence we find justification for imposing unitary income elasticity as implied by economic theory. Given that the ratios of the long-term part of the model are constant, the housing stock is proportional to income. The long-run steady state equations (7) and (8) can be solved for the stock income ratios in anti-logs. This gives us a value of 0.05 for Sweden and 0.19 for the UK. In logs it comes down to approximately 1.0 and 1.2 for Sweden and the UK.

Table 2. Income and Price elasticity of housing demand

UK	Income	Price	Sweden	Income	Price
Meen (1996)	1.4	-0.4	Englund	0.4	-0.3, -0.4
Muellbauer&Murphy	1.3	-0.5	Hort	1.0	
Westway & Pain	2.0	-0.5	Barot &Yang	1.0	-0.50
Barot & Yang	1.0	-0.8			

Note: See Meen (1998). Solving the long-run steady state equations for the respective countries in anti-logs one gets for both Sweden and the UK unitary income elasticity.

The model tracks the size and the direction of changes in house prices for owner-occupied homes for both Sweden and the UK fairly well (see Figure 1 and Figure 3). The out of sample forecasts for the period 1991-1998 are impressive indicating that house prices are predictable (see Figure 2 and Figure 4). The out of sample forecasts have been constructed by estimating the respective models to 1990. The forecasts are the one step ahead *ex post* forecasts in a sequence up to 1998. The model captures quite well the turning points for recessions and recoveries in Sweden and the UK for the sample period.

Figure 1. Demand side: Sweden

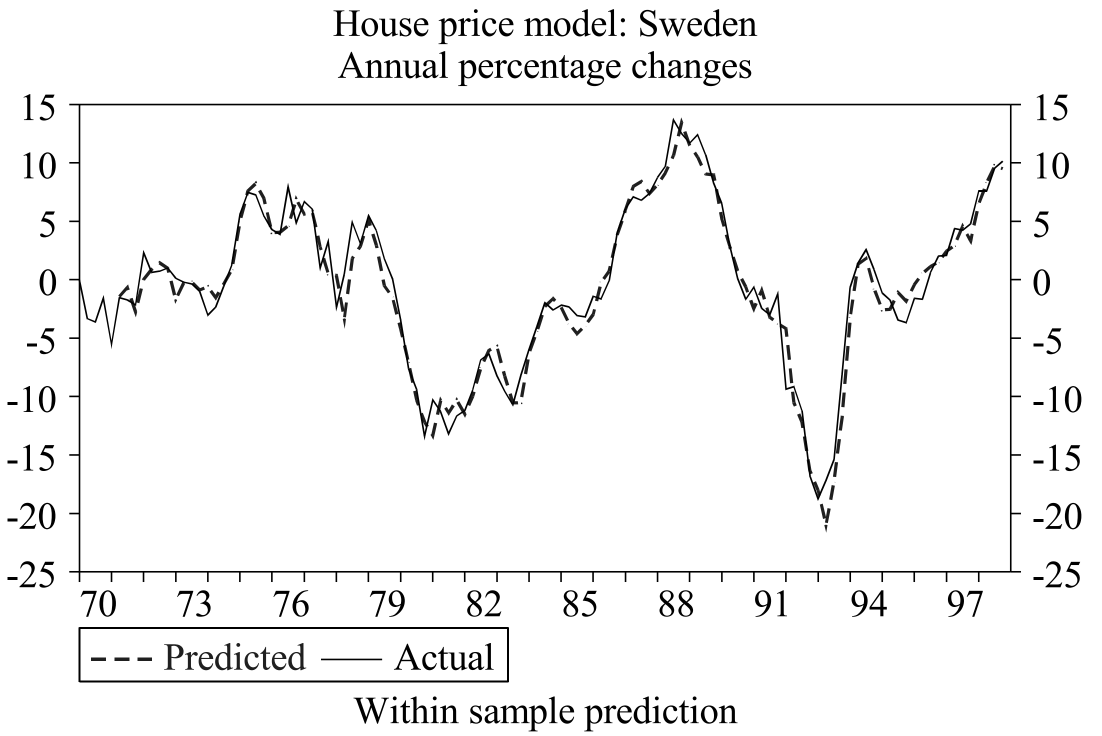


Figure 2. Demand side: Sweden

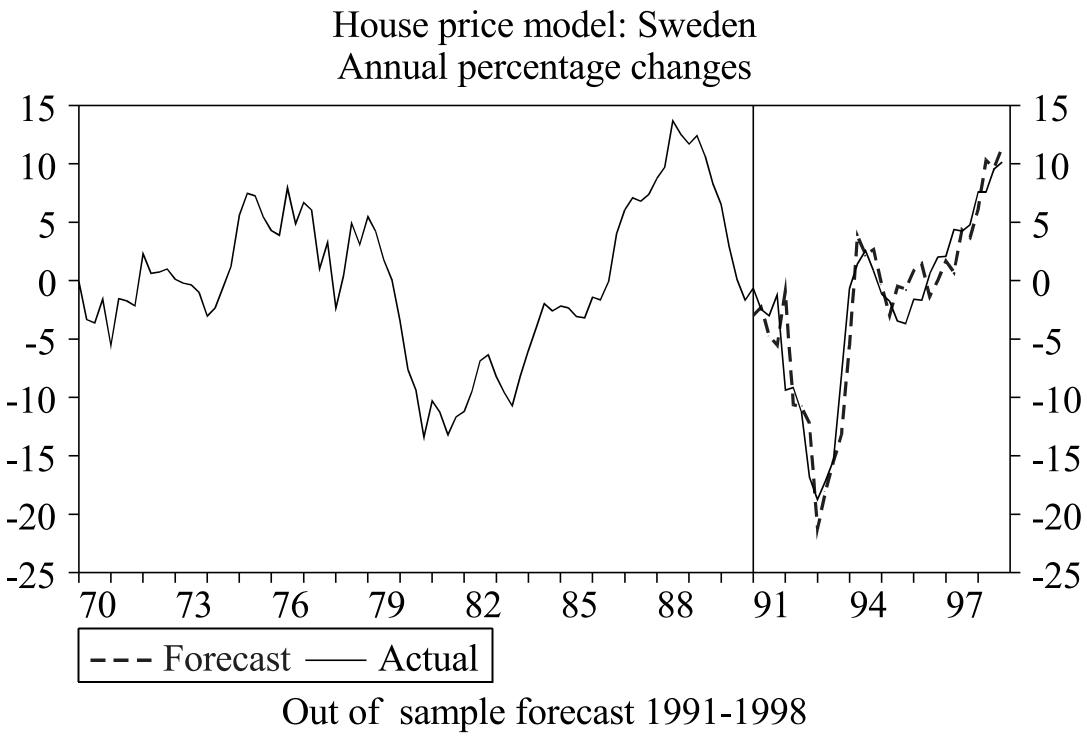


Figure 3. Demand side: UK

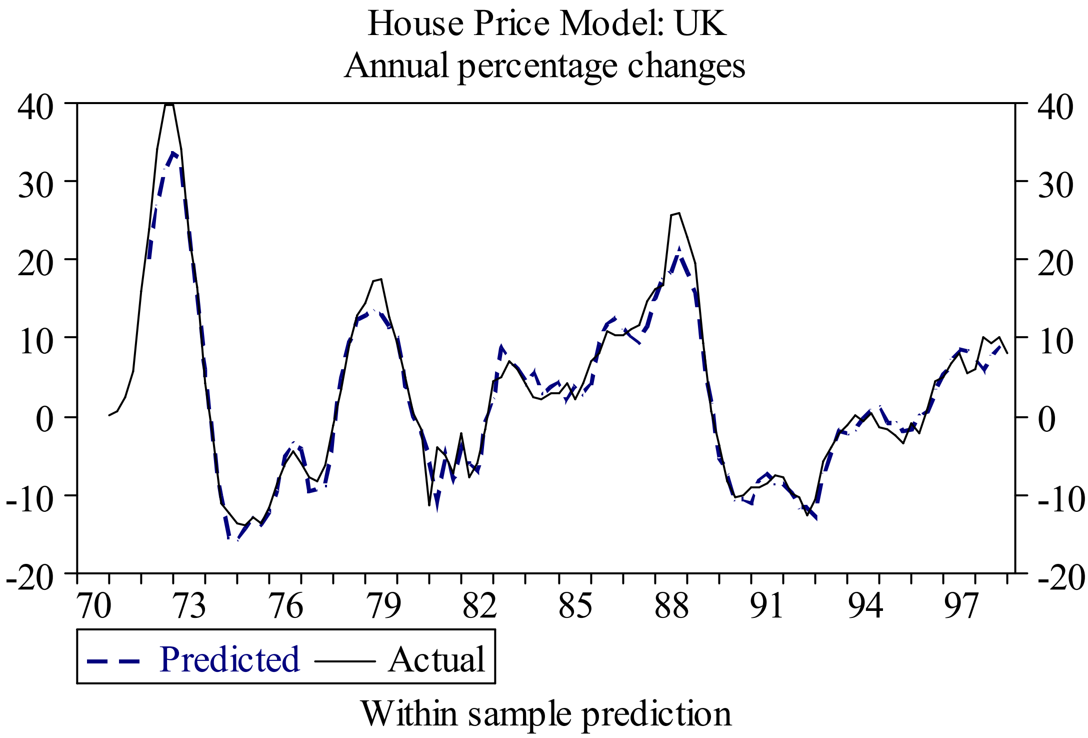
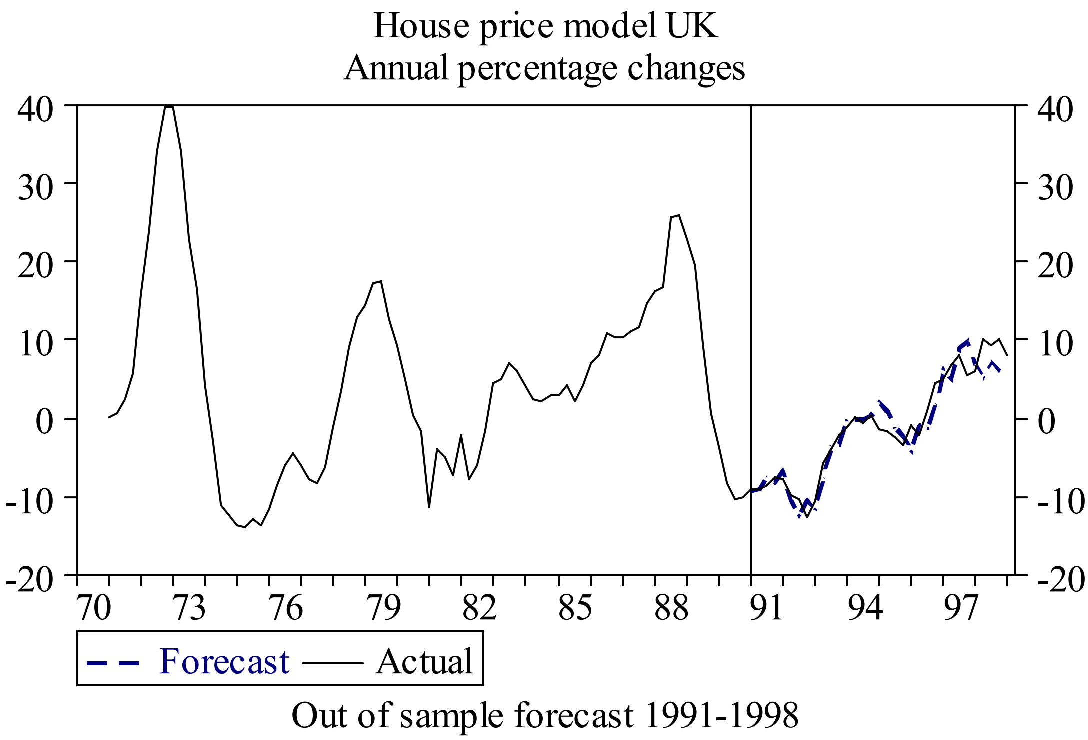


Figure 4. Demand side: UK



6.2 The supply side Sweden and the UK

The estimated dynamic housing investment function for Sweden and the corresponding one for the UK, where we model housing investment as a function of Tobin's q using a dynamic version of equation (3), are reported in Table 3. The standard errors of the regression are 8% for Sweden and 9% for the UK, and 82% of the total variance in the annual change in housing investment for Sweden and 54% for the UK is accounted for, thus indicating poorer fit than for the house price equations, though this may be characteristic for supply sides models. The signs of most of the short run and long run coefficients are in agreement with prior theoretical expectations. The lags in the investment functions are distributed lags which reflect cyclical fluctuations and implementation of earlier projects. The short run q for the UK has an elasticity of 0.4 which is stronger than that for Sweden. The nominal interest rate matters for the supply side in the UK but not in Sweden. The interest rate reflects the cost of borrowing in order to finance housing investment. A one percentage point increase in the London clearing bank's base rate would decrease housing investment by 2.7 percent.

The solved long-run equation on the supply side excluding the short run dynamics for Sweden and the UK can be written as:

$$\ln \frac{IH}{H} = 3.7 + 2.8 \cdot \ln \frac{PH}{PB} \tag{9}$$

$$\ln IH = 8.8 + 0.5 \cdot \ln \frac{PH}{PB} - 2.7 \cdot AMIH \tag{10}$$

Tobin's q is significant in the UK for the short run but not for Sweden, while for the long run it is significant in both countries. The solved long run Tobin's q model for Sweden is more plausible with respect to its steady state properties. The error correction coefficient and the speed of adjustment for Sweden is 6% while for the UK it is *48%*, which is eight times faster. The interpretation is that when housing investment begins to diverge from its long-run equilibrium value Tobin's q will error correct it, i.e. 6% - 48% of the error is corrected within a year for Sweden respectively the UK. The fasts speed of adjustment for the UK may be at least explained by the slightly different specification for the long-run part of the model. A preferable specification would be the same as that used for Sweden (investment divided by the stock). The speed of adjustment is affected by the functional form. The UK model however is richer since it measures significant effects from the interest rate, which is the cost of financing the investment.

With respect to residual diagnostics both the Swedish and the UK models clear all the residual based tests (with the exception of the UK demand side not passing the Jarque and Bera's normality test). However the steady state properties of supply side for the UK are not plausible since investment in the long run should grow proportionally to the housing stock. The evolution of the Tobin's q indicator for the majority of the OECD countries indicates that there is a fairly close contemporaneous association between movements in the price / cost ratio and private residential investment. The results from an OECD study by Girouard and Blöndal (2001) indicate that over the period 1980 – 1999 the correlation coefficient is above 0.5.

Table 3. The supply side results (1970 – 1998). Dependent variable: D^4 ln(IH)

Regressors Sweden	Coeff.	T-Stat.	Regressors UK	Coeff.	T-Stat.
Constant	0.21	0.40	Constant	4.11	5.98
Short-run			Short-run		
D4 ln (IH) $_{(-1)}$	0.86	14.59	D4 ln (IH) $_{(-1)}$	0.32	3.97
D4 ln (IH) $_{(-4)}$	-0.36	3.53	D4 ln (IH) $_{(-2)}$		
D4 ln (IH) $_{(-5)}$	0.39	4.09	D4 ln (IH) $_{(-3)}$	0.13	1.63
D4 (ln (PH/PB))	0.16	1.21	D4 ln (PH/BH)	0.35	3.14
D4 ln (GDP)	0.73	1.73	D4 ln (GDP)	0.04	1.66
Long-run			Long-run		
ln (IH/H) $_{(-4)}$	-0.06	2.43	ln (IH) $_{(-4)}$	-0.48	5.83
Ln (PH/PB) $_{(-4)}$	0.16	1.91	ln (PH/BH) $_{(-4)}$	0.22	3.61
			AMIH $_{(-4)}$	-1.28	4.33
Q2	-0.01	0.64	q2	0.04	1.55
Q3	-0.02	0.82	q3	0.04	1.71
Q4	-0.00	0.41	q4	0.05	2.09
R2	0.82		R2	0.54	
R- Bar	0.80		R- Bar	0.50	
Std Err	0.08		Std Err	0.09	
D.W.	2.03		D.W.	1.97	
Diagnostics		Critical values	Diagnostics		Critical values
Normality	3.68	5.99	Normality	0.43	5.99
ARCH	1.06	9.49	ARCH	0.94	9.49
RESET	1.98	3.18	RESET	0.90	3.18
LM (1)	0.47	3.84	LM (1)	2.20	3.84
LM (2)	0.53	5.99	LM (2)	4.88	5.99
LM (3)	3.02	9.49	LM (4)	5.86	9.49

Note: From the diagnostic statistics, the residual of the estimated equation appears to be white noise. The Breaush (1978) and Godfrey (1978) Lagrange multiplier test (LM) statistic for autocorrelation has been applied. ARCH is Engle (1982) test for heteroscedasticity. Normality refers to the Jarque and Bera (1980) test for normality of residuals, with a correction of degrees of freedom. RESET is Ramsey's (1969) test for correct specification. Standard deviations for the change in investment are 17% for Sweden and 12% for the UK. The test for weak exogeneity requires a variable additional test. Reaction functions (marginal processes) for house prices, construction costs for Sweden, and interest rates for the UK are searched. Treating these variables as potentially endogenous we regress each on a set of instruments, save the residuals from the regressions and add them to the supply side model. The joint significance of the additional regressors can be tested by using an F-test. The results are available on request.

Figure 5. Supply side: Sweden

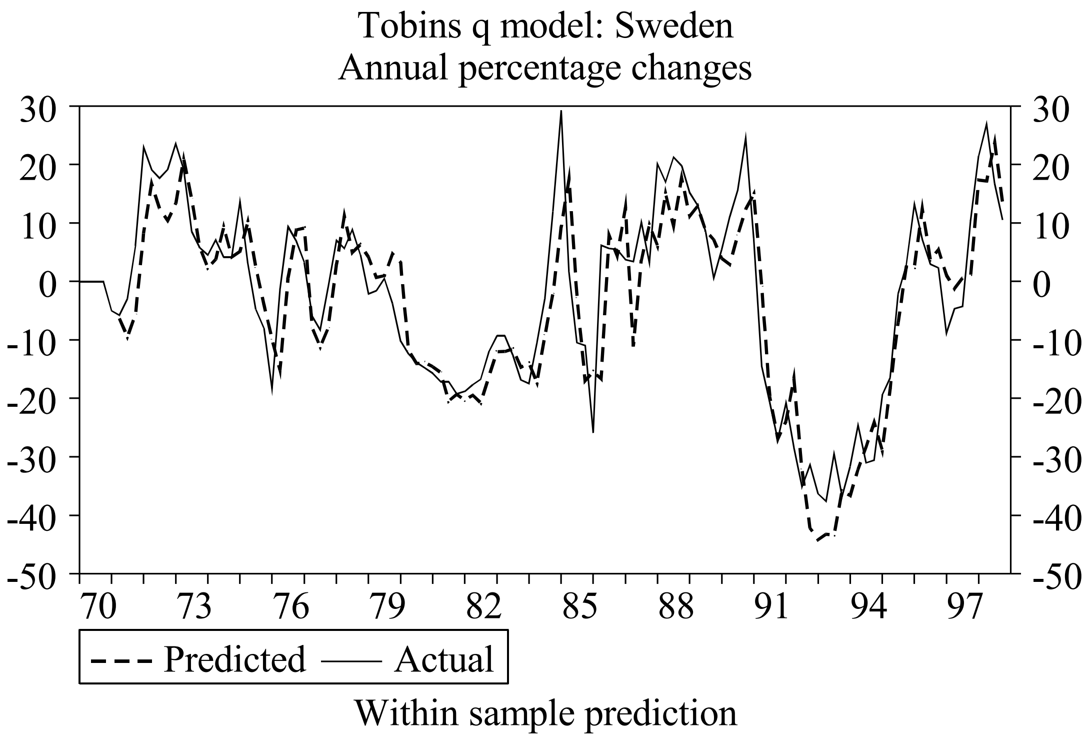


Figure 6. Supply side: Sweden

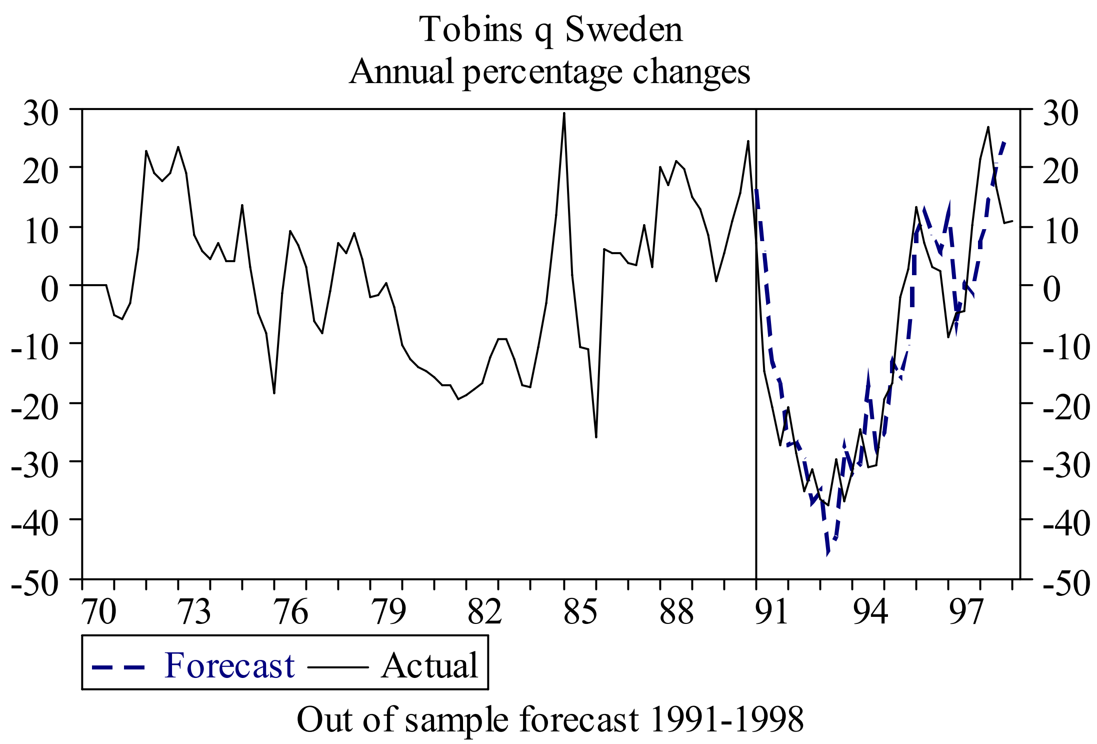
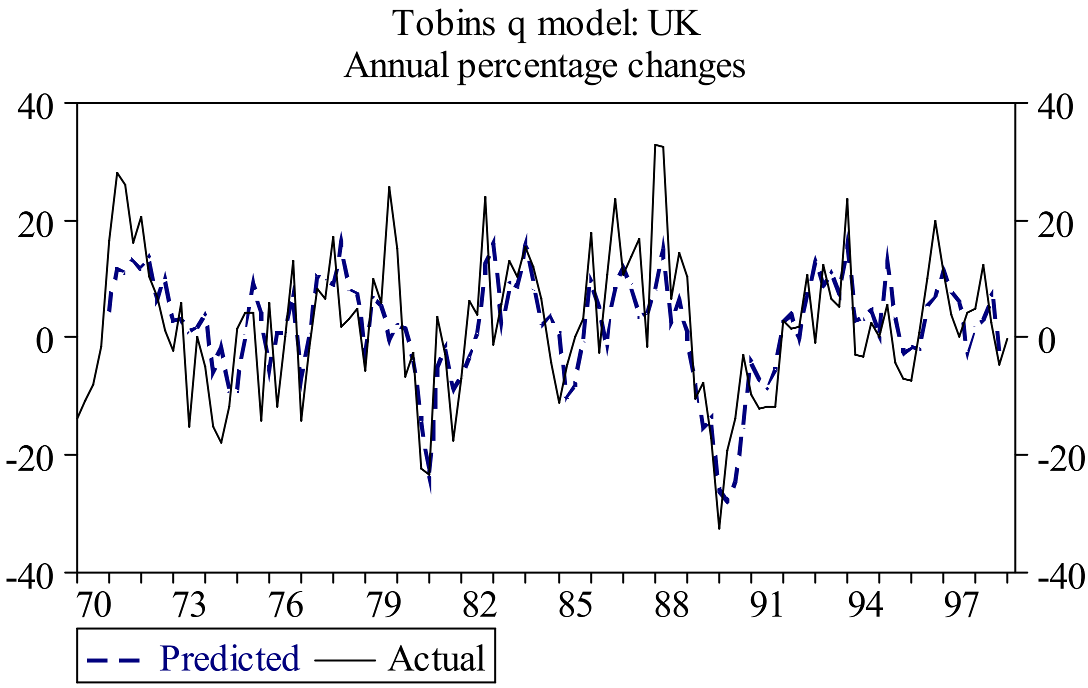
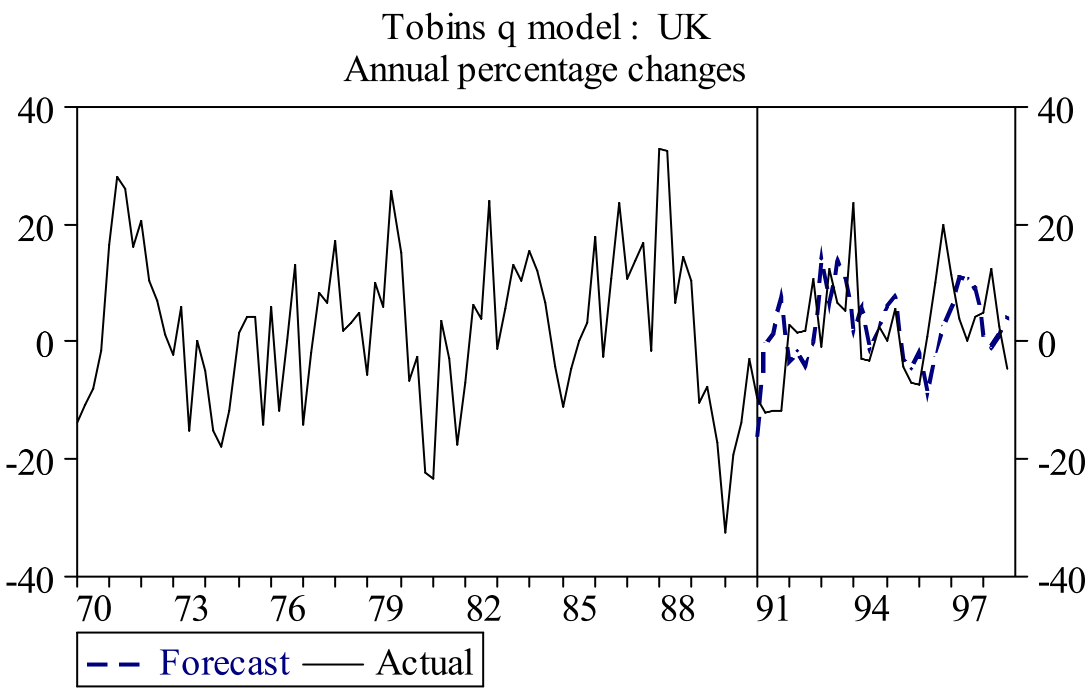


Figure 7. Supply side: UK



Within sample prediction

Figure 8. Supply side: UK



Out of sample forecast 1991-1998

On the supply side of the market, adjustment of the stock of dwellings is also generally held to be quite slow. Over the very short run, since the level of housing completion is small relative to the total stock of housing, it is argued that the supply of housing is completely fixed. Against this, over the medium to long run, building firms in the construction industry will make their production decision based on the expected profitability of house building activity. Over the medium to long run, therefore, the supply of dwellings is thought to be elastic.

Compared to the housing investment functions, which are difficult to model, the Swedish model tracks the size and the direction of changes in housing investment exceptionally well (see Figure 5 and Figure 6 for Sweden). However both the within sample prediction and out of sample forecast are poorer for the UK (see Figure 7 and Figure 8).

7. Forecasting ability

The Swedish and the UK models will be evaluated from a forecasting point of view. In order to do this in a realistic manner, we perform ex-ante (out of sample) forecasts for the period 1991-1998 using data for 1970-1990. There are several commonly used measures of forecasting accuracy: the Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Theil's Inequality Coefficient (Theil-U index), the Mean Absolute Proportional Error (MAPE), and the Mean Percentage Error (MPE). Our basic econometric models for the demand and supply sides for the two countries, and a naive autoregressive (AR) model are evaluated using some of these tests. The *naive autoregressive* models have been estimated with the following specifications for the demand and the supply sides:

$$D^4 \ln(\frac{PH}{P}) = g(D^4 \ln(\frac{PH}{P})_{(-1)}, D^4 \ln(\frac{PH}{P})_{(-2)}, DREG, TREND, 91TR) \quad (11)$$

$$D^4 \ln(IH) = g(D^4 \ln(IH)_{(-1)}, D^4 \ln(IH)_{(-2)}, DREG, TREND, 91TR) \quad (12)$$

where f and g are linear arguments. $D^4 \ln(\frac{PH}{P})$ is the annual change in real house prices. Results for the out of sample forecasting accuracy are presented in Table 4 and Table 5.

Table 5. Forecasting accuracy house prices (1991 - 1998)

Measures	SW	SWN	UK	UKN
MAE %	1.41	1.62	0.46	2.20
RMSE %	1.63	1.80	0.66	2.50
R^2	0.95	0.94	0.94	0.85

Note: SWN and UKN denote the naive models for Sweden and the UK.
R^2 is forming the realisation regression of the actual on the forecast.

The out of sample estimates are *ex- post* forecasts. We conclude that for both Sweden and the UK forecasting accuracy of the structural models is better than those of their the naive auto-regressive counterparts.

Table 5. Forecasting accuracy housing investment (1991 - 1998)

Measures	SW	SWN	UK	UKN
MAE %	4.60	6.30	3.02	3.95
RMSE %	6.40	7.90	4.00	5.70
R^2	0.91	0.88	0.47	0.33

Note: SWN and UKN denote the naive models for Sweden and the UK. R^2 is forming the realisation regression of the actual on the forecast.

8. Granger causality

Economic causality must be based on a theory. One reason why economists and econometricians are forced to tie their concept of causality to time is that there are so many two-way causal relationships in economics. For example price "causes" the quantity demanded but the quantity demanded also causes prices. Because the stock-flow model has a supply and demand side it is interesting to test for causality using the concept of Granger causality. Granger causality tests are applied to find out in which direction the predictive causation runs.

The relationships between house prices and determinants can be ambiguous at times. There is an on going debate in the housing literature. Theoretically one would expect that the house price determinants are exogenous (independent variables) and therefore are expected to Granger cause house prices. However a possibility exists that there might be a feedback.

A time series Y_t Granger causes another time series X_t if the present value of X can be better predicted by using past values of Y than by not doing so, in the presence of other relevant variables including the past values of X. The standard Granger-causality test can be expressed as in equations (13) and (14) below without μ_{t-1}. But if the variables are cointegrated, μ_{t-1} is necessary. Therefore, more specifically, X_t is said to cause Y_t provided some β_i in equation (13) is non-zero. Similarly, Y_t is causing X_t if some δ_i is not zero in equation (14). Causality occurs in both directions there is a feedback effect present.

$$\Delta Y_t = \theta_y \mu_{t-1} + \sum_{i=1}^{n} \alpha_i \Delta Y_{t-i} + \sum_{j=1}^{n} \beta_i \Delta X_{t-j} + \varepsilon_{1t} \tag{13}$$

$$\Delta X_t = \theta_x \mu_{t-1} + \sum_{i=1}^{n} \delta_i \Delta Y_{t-i} + \sum_{i=1}^{n} \Phi_i \Delta X_{t-j} + \varepsilon_{2t} \tag{14}$$

The null hypothesis is that $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$, in (13). Our alternative hypothesis is that

$H_0 : \beta_1 = \beta_2 = \beta_3 \neq 0$ the policy responses illustrated.

In the initial stage we test for cointegration between the bi-variate variables. Having found cointegration, we proceed to test for the direction of Granger causality. The hypothesis is tested using a Wald test for linear restrictions. The number of lags used while conducting the test is between 4 up to 7. Looking at Table 6 and Table 7, we see that for Sweden income Granger causes house prices, while for the UK we have feedback from house prices to income.

The economic intuition is that increases in disposable income imply that the households feel wealthier. This leads to increases both in demand for housing and house prices. Homes represent an accumulation of wealth to households that increases with the appreciation of house prices. House prices Granger cause income for the UK as persistent increases in house prices result into capital gains (when realised). For Sweden house prices cause financial wealth. The intuition behind this observation is that increases in house prices increase financial wealth because homeowners feel richer and expand their financial portfolios. For Sweden and the UK financial wealth Granger causes house prices. This finding makes economic sense in that one needs an initial down payment in order to buy a house and hence greater financial wealth increases demand and prices.

Table 6. Granger-Causality tests: Sweden

Dependent Variable			F-test values
ΔPH/P	←	ΔINCOME	F(5,102) = 5.18 P(0.00)**
ΔPH/P	→	ΔFINANCIAL WEALTH	F(5,100) = 2.89 P(0.02)*
	←		F(5,100) = 3.03 (0.01)*
ΔPH/P	→	ΔDEBT	F(5,100) = 4.37 P(0.00)**
	←		F(5,100) = 2.77 P(0.02)*
ΔPH/P	←	ΔREAL INTEREST RATE	F(4,100) = 5.91 P(0.00)**
	→		F(5,100) = 4.62 P(0.00)*
ΔPH/P	→	HOUSING STOCK	F(5,100) =6.43(0.00)**
ΔIH	←	TOBINS Q	F(5,100) = 2.77 P(0.02)*

Note: ← denotes causes in the Granger sense. Arrows in both the directions implies feedback.

Both for Sweden and for the UK house prices Granger cause debt and there is a feedback from debt (simultaneous). Debt is incurred in order to purchase a house. Hence greater debt is associated with increases in both effective demand for housing and housing prices. Appreciation in prices can encourage more borrowing the value of the homec as collateral. In the UK an overwhelming proportion of the debt in the personal sector is in the form of mortgages (over *80%* at the end of 1992). In both countries real interest rates Granger cause house prices.

The economic intuition is that the real interest rate acts the consumer durable component of consumer expenditure, via the user cost. According to the stock flow model it is assumed that in the long run demand equals supply. In the short run an unbalance may exist. A shortage of housing would cause house prices to increase. Excess supply would reduce prices. One would expect that Tobin's q would Granger cause housing investment. Our test results indicate that both for Sweden and the UK Tobin's' q Granger causes housing investment a result that is intuitive because decisions on profitability which is reflected by the q index. The out of sample estimates are *ex post* forecasts. We conclude that for both Sweden and the UK forecasting accuracy of the structural models is better than those of their the naive auto-regressive counterparts.

Table 7. Granger-Causality tests: UK

Dependent Variable			F-test value
ΔPH/P	←	ΔINCOME	F(5,99) = 3.47 P(0.00)**
	→		F(5,99) = 6.31 P(0.00)**
ΔPH/P	←	ΔFINANCIAL WEALTH	F(5,99) = 5.29 P(0.00)**
ΔPH/P	←	ΔDEBT	F(5,99) = 2.47 P(0.04)*
	→		F(5,99) = 2.37 P(0.04)*
ΔPH/P	←	ΔREAL INTEREST RATE	F(7,93) = 2.37 P(0.03)*
	→		F(5,97)=2.34 (0.04) *
ΔPH/P		HOUSING STOCK	
ΔIH	←	TOBINS Q	F(5,97) = 2.55 P(0.03)*

9. Conclusions

The main objective of this study is to econometrically model house prices and housing investment in Sweden and the UK using the stock-flow model. We also compare the models for the two countries with respect to elasticities, parameter estimates and speed of adjustment coefficients. The result from the ADF tests indicate that all the variables have unit roots i.e. they are integrated of order I (1). Our cointegration results indicate that there are four cointegrating vectors, two for each country, representing the demand and supply sides respectively.

The results on the demand side indicate that the dynamics of lagged house prices are very similar for both countries with marginal differences in the magnitude of the estimated coefficients. Changes in debt levels have stronger effects for the UK than for Sweden. These differences may be related to the use of slightly different metrics for the two countries. Mortgage debt is used in the UK, while total household debt which includes debt incurred to buy other durable goods is used in Sweden. Both nominal and real interest rates matter for house prices in Sweden and the UK. However, the results indicate that Sweden has stronger interest rate effects both in the short and the long run. In the long-run part of the model the wealth, debt and interest rate effects are stronger for Sweden than for the UK. The ECM adjustment coefficient for the level of real house prices indicates that in case of departure from equilibrium, 12% of the shock is corrected within one year for Sweden and 23% for the UK.

Using gross financial wealth (financial wealth plus debt) instead of net implies that that we capture simultaneously the financial assets and liabilities of households in the estimated coefficients. When gross financial wealth is decomposed as done in this study, different coefficients for the two components (net worth and indebtedness) are estimated. In the household balance sheet, net financial wealth plays an important role in the purchase of new homes since buyers make a down payment of about 25% percent of the purchase price in Sweden. Usually, increases in debt are considered to be an indicator of consumer optimism and strong demand. People buy houses with debt financing to a large extent, which tells us that real house prices and debt should be positively correlated.

On the other hand, an increase in indebtedness or a drop in holdings of financial assets would raise the risk of financial distress, thus prompting consumers to shift their demand away from durables and housing thus reducing house prices. Increased inflation changes the time profile of real mortgage payments. Because expectations of rising inflation increase the nominal rate of interest, higher anticipated inflation raises both the cost of the mortgage, and the opportunity cost of homeowner equity. In this study, interest rates are used as a proxy for debt amortisation.

Scrutinising the supply side with almost identical specifications for both the countries we find that the Tobin's q variable is significant for both the countries. The Swedish data fits the Tobin's q model better than the UK data does. In addition the Swedish supply side has a much more plausible steady state specification and interpretation than does that of the UK. Usually the steady state is defined in ratios that grow at constant rates. We encounter difficulties estimating the steady state in ratio form for the UK. This problem might be related to the measurement of the housing stock, which is in numbers rather than in pounds. For the UK supply side q is significant both in the short and long run, while for Sweden q is only significant in the long run. The out of sample forecast is less accurate for the UK supply side, which may result from the less precise specification of the model. The best specification would be housing investment divided by the stock. However the model for the UK is richer since it includes the interest rate and therefore reflects the cost of financing housing investment. The speed of adjustment on the supply side for Sweden is 6% while it is 48% for the UK. This vast difference may be related to a different specification of the supply side for the UK. The forecasting evaluation indicates that both the Swedish and the UK models are more accurate than their naive auto-regressive counterparts with respect to MAE and RMSE.

House prices are commonly derived from an estimated reduced form function derived by integrating separate housing demand and supply equations. We refrain from assessing the identifiability of the structural equations by applying the technique of reduced –form equations, which expresses an endogenous variable as a function of predetermined variables. Nevertheless the reduced form coefficients are generally of the same sign.

The model has deliberately been kept as simple as possible in order to highlight its salient features of demand and supply. The strategy applied is Hendry's general to specific modelling, applying a sequential testing procedure to error correction dynamics. The fit of the separate demand and supply sides for both Sweden and the UK tracks actual changes in the respective variables well except for the supply side in the UK. In general, this expresses the usefulness of fundamental economic theory in the development of explanatory models. It should be noted that no matter what methods are used to develop economic models, they are unlikely to be taken seriously until they can be shown to be congruent with the empirical observations (see Mizon (1989)). Results with respect to Granger causality tests indicate reasonable results that correspond to the economic intuition underlying housing theory.

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Appendix 1. Integration and cointegration

The test for integration has been conducted using equation (6) .The results are presented in Table A1. A constant, a linear and a quadratic trend can be included while conducting the integration test. The constant (intercept) reflects the possibility that under the alternative of stationarity, the intercept is not zero. A further variation introduces a time trend into the equation to allow to be trend stationarity. Maximum number of lags are form 1 to 9, which pre-whiten the residuals. We had to give longer lags for more persistent variables like unemployment, housing stock, and housing investment. Reported critical values are based on a response surface developed by Mackinnon (1991). The test for integration has been carried out in PCGIVE[42].

Table A1. Augmented Dickey Fuller Integration test

Sweden	C	L	C&T	L	UK	C	L	C&T	L
Variables					Variables				
ln (PH/P)	-2.75	4	-3.17	4	ln (PH/P)	-2.61	5	-3.31	6
ln (Y)	-1.65	4	-2.30	4	ln (RY)	-1.02	5	-2-00	4
ln (POP)	-2.21	4	-1.86	4	ln (UKPOP)	-2.30	4	-0.78	4
ln (E)	-1.24	8	-2.66	4	ln (UNP)	-0.39	4	-1.82	4
ln (HF)	-0.49	4	-3.44	4	ln (HS)	-1.53	4	-0.77	4
ln (DE)	-2.69	6	-1.84	6	ln (RL)	-0.71	5	-1.69	4
ln (H/Y)	-1.69	8	-0.57	8	ln (HS/RY)	-1.80	5	-1.35	4
ln (WF/Y)	-2.74	4	-2.06	4	ln (RW/RY)	-0.29	2	-2.46	4
ln (DE/Y)	-2.05	8	-2.36	8	ln (RL/RY)	-0.24	3	-1.58	4
R – ln (ΔP/P)	-2.09	8	-.37	8	RB – ln (ΔP/P)	-1.47	4	-2.37	4
ln (IH)	0.57	8	-1.77	8	ln (IH/H)	-2.79	5	-1.77	4
ln (IH/H)	0.49	9	-1.68	8	ln (RL)	-0.79	4	-1.68	4
ln (PH/PB)	-0.94	4	-0.94	4	ln (P)	-2.30	4	-0.94	6
					ln(PH/PB)	-1.69	4	-0.56	5
R	-1.05	4	-1.20	4	ln (IH)	-1.50	4	-1.20	5
ln (P)	-2.46	5	-0.61	5	AMIH	-2.67	1	-3.30	4
Critical values	-2.89		-3.45			-2.89		-3.45	

Note: C denotes Constant, C & T is Constant and Trend and finally L is the number of lags used to carry out the test

Cointegration

The Johansen procedure makes use of two test statistics for cointegration. For the Johansen method, there are two test statistics for the number of co-integrating vectors: the trace and maximum- eigenvalue statistics. In the trace test, the null hypothesis is that the number of co-integrating vectors is less than or equal to r, where r is 0, 1 or 2. In each case the null hypothesis

[42] See Doornik and Hendry (1992).

is tested against the general alternative. The maximum eigenvalue test is similar, except that the alternative hypothesis is explict. The null hypothesis r = 0 is tested against the alternative that r = 1, r =1 against the alternative r = 2. The test results are presented in Table A2 and Table A3 for Sweden and Table A4 and Table A5 for the UK.

Table A2. Johansen's Cointegration demand side test for Sweden

Null Hypothesis	Maximal Eigenvalue test	95% Critical value	Trace Test	95% Critical value
r = 0 ׀ r = 1	42.89*	39.4	132**	94.2
r=1 ׀ r = 2	15.89	33.5	45.88	68.5
r = 2 ׀ r = 3	12.59	27.1	29.99	47.2
r = 3 ׀ r = 4	9.30	21.0	17.40	29.70
r = 4 ׀ r = 5	6.11	14.1	8.11	15.4
r = 5 ׀ r = 6	2.00	3.80	2.00	3.80

Note: The critical values are at 5% and 1% significance level. The asterisks * and ** denote significance at 95% and 99% significance level. The order of the VAR is 6. We have included a constant term and seasonal in the VAR. Inclusion of trend gives similar type of results. This yielded one significant cointegrating vectors. The first row of standardised eigenvectors can be interpreted as the long run demand relationship. Unitary income elasticity restrictions have been imposed on the VAR. The restricted cointegration relationship as given below highlights the important determinants of housing demand for Sweden. This long run in equation (15) has coefficients, which are different in magnitude than in equation (7) because of the different short-term dynamics. The speed of adjustment is 8% for the demand side. The restrictions imposed are rejected according to the LR-test, rank = 1, $\chi 2$ (7) = 51.26**. Nevertheless there is strong convergence.

$$\ln \frac{PH}{P} = 0.1 \cdot \ln \frac{WF}{Y} + 0.5 \cdot \ln \frac{DE}{Y} - 1.0 \cdot \ln \frac{H}{Y} - 2.9 \cdot (RG \cdot (1 - M) - \ln \frac{\Delta P}{P}) \quad (15)$$

Table A3. Johansen's Cointegration supply side test for Sweden

Null Hypothesis	Maximal Eigenvalue test	95% Critical value	TraceTest	95% Critical value
r = 0 ׀ r = 1	31.76**	21.0	34.97*	29.7
r = 1 ׀ r = 2	3.20	14.1	3.21	15.40
r = 2 ׀ r = 3	0.01	3.80	0.10	3.80

Note: The order of the VAR is 4. We have included a constant term and seasonal in the VAR. This yielded only one significant co-integrating vector. The first row of standardised eigenvectors can be interpreted as the long-run Tobin's q relationship. The cointegration relationship as given below imposing the restriction that the interest rate does not matter for the supply side. The restrictions are rejected according to the LR-test, rank = 1, $\chi 2$ (1) = 31.14. Equation (16) highlights the important determinants of housing investment for Sweden. Analogous to the demand side we obtain a higher value for Tobin's q compared to equation (9), due to the different short run dynamics within the single equation framework.

$$\ln \frac{IH}{H} = 5.36 \cdot \ln \frac{PH}{PB} \quad (16)$$

Table A4: Johansen's Cointegration demand side test for the UK

Null Hypothesis	MaximalEigenvalue test	95% Critical value	Trace test	95% Critical value
r = 0 ׀ r = 1	38.73**	33.5	80.39**	68.5
r = 1 ׀ r = 2	18.33	27.1	41.66	47.2
r = 2 ׀ r = 3	15.99	21.0	23.32	29.7
r = 4 ׀ r = 5	7.31	14.1	5.33	15.4
r = 5 ׀ r = 6	0.02	3.80	0.02	3.80

Note: The order of the VAR is 6. We have included a constant term and seasonal in the VAR. Unemployment variable has entered the VAR unrestricted. This yielded one significant cointegrating vectors. The first row of standardised eigenvectors can be interpreted as the long run demand relationship. The unemployment variable entered the long-run relationship unrestricted. The cointegration relationship derived by imposing restrictions is given below, highlights the important determinants of housing demand for the UK. The restrictions are rejected according to the Likelihood ratio (LR-test), rank =1, $\chi 2$ (1) = 57.71**. The long run has different coefficients than in the single equation framework because of different specification of the short run dynamics in (8).

$$\ln \frac{PH}{P} = 0.3 \cdot \ln \frac{RW}{RY} + 0.1 \cdot \ln \frac{RL}{RY} - 1.0 \cdot \ln \frac{HS}{RY} - 0.6 \cdot (RB - \ln \frac{\Delta P}{P}) \qquad (17)$$

Table A5. Johansen's Cointegration supply side test for the UK

Null Hypothesis	Maximal Eigenvalue test	95% Critical value	Trace Test	95% Critical value
r = 0 ׀ r = 1	38.49**	14.1	38.75**	15.4
r =1 ׀ r = 2	0.25	3.8	0.26	3.8

Note: The order of the VAR is 4. We have included a constant term and seasonal in the VAR. This yielded only one significant cointegrating vector. The first row of standardised eigenvectors can be interpreted as the long-run Tobin's q relationship. The cointegration relationship as given below highlights the important determinants of housing investment for UK. The Tobin's q for UK is approaching 1 compared to equation (10). The out of sample estimates are ex post forecasts. We conclude that for both Sweden and the UK forecasting accuracy of the structural models is better than those of their the naive auto-regressive counterparts.The restrictions are rejected according to the LR-test, rank =1, $\chi 2$ (3) = 31.86**.

$$IH = 0.79 \cdot \ln \left(\frac{PH}{BH}\right) - 0.72 \cdot AMIH \qquad (18)$$

Appendix 2. Data and data sources for Sweden

PH: is the nominal house price. *PH* (1991 = 1) is the weigted mean of (fastighetsprisindex) of primary and leisure homes (fritidshus). The market price index covers only direct ownership including second homes, not indirect ownership, Statistics Sweden.

P: denotes the consumption deflator (1991 = 1), Statistics Sweden.

PH/P: is the real house price.

Y is real disposable income, Statistics Sweden.

WF: is the households net financial wealth defined as the sum of notes, coins, bank deposits and the National Saving Scheme (Allemanssparande), bonds and treasury discount notes, private insurance savings, listed and non-listed shares and other assets, minus total direct debt, Financial Accounts, Statistics Sweden.

DE: is the household debt. The annual stock figures for household financial assets and liabilities were from Financial Accounts Sweden, (Financial Accounts 1970-1997). Financial Accounts, Statistics Sweden.

H: is the stock of private homes i.e. the sum of stocks of primary and second homes computed according to the stock method approximately equal to Statistics Swedens gross stock. In the perpetual inventory stock, all construction of so called Small homes including secondary homes is treated as owned by households. Apartments (or flats) are regarded as rental Housing, Statistics Sweden.

R: is the long government interest rate (5 years). Central Bank Sweden.

RS: is the treasury bill rate three months or short interest rate.

E: is employment rate (regular / labour force inclusive programs), in thousands. (**1**-**E**) is the unemployment rate, Labour Force Survey, Statistics Sweden.

IH: is the gross investment in private (small) homes in 1991 prices. Statistics Sweden.

PB: is the building cost index in 1991 prices. Statistics Sweden.

GDP: is gross domestic product in 1991 prices. Statistics Sweden.

91 TR: is the 91 Tax Reform Dummy. It is 0 up to 1990 and 1 after.

POP: is the total population of Sweden in millions, Statistics Sweden.

DREG: is a Dummy for credit deregulation in Sweden in 1986.

HF: is the rental stock.

USER COST: for Sweden can be calculated using the formula: **User cost** = (1-**M**)***R** + **TFE** — capital gains, where **M** is the marginal tax rate, **R** is the long term interest rate, **TFE** is the property tax rate and finally capital gains is defined as the annual change in house prices. **M** is the marginal tax rate

Appendix 3 Data and data sources for the UK

PH: is the index of mixed-adjusted nominal house prices (1995=100), Department of the Environment.

PH/P: is Index of mixed adjusted real house prices, Department of the Environment.

RY: is real personal disposable income (£m), (Monthly digest of Statistics) Economic Trends.

P: is the consumer expenditure deflator (1995=100), Economic Trends.

RL: is the outstanding debt in 1995 prices, financial statistics.

RW: is the financial net wealth, deflated by PC in 1995 prices, financial statistics.

HS is the number of owner-occupied dwellings, (000s), Housing and Construction statistics.

RB: is the real building society interest rate, Bank of England.

IH: is the private sector investment in dwellings (£mn)-Source national Statistics, UK Economic Trends.

BH: is the building cost index is a factor cost index. The quantity weightings for the index were derived for a house and site works by preparing an approximate bill of quantities in the normal way. The bill items were split down into their labour and material contents using constants given in the Measured Rates section. The house used in the index is a two-storey, three bedrooms, and semi-detached house of traditional construction. As such, it's held to be representative of the majority of houses being constructed. For details see Building Cost Information service of the Royal Institution of Chartered Sureyors (RICS), 7 April, 1978.

UNP: is the unemployment rate in UK, Office for National Statistics.

POP: is the total population in UK, Economic Trends.

AMIH: is the London clearing banks' base rate, Bank of England.

GDP: is the gross domestic product in 1995 prices. Economic Trends.

Chapter V

The accuracy of European growth and inflation forecasts

1. Introduction

Macroeconomic forecasts attract the interest of the general public, for obvious reasons, but only as long as they refer to the future. Few care about old forecasts of events in the past. But if we do not know the past record of a forecaster, how are we to judge his/her last statement about the future? It should be the responsibility of all serious forecasters to regularly publish reports with an analysis of their forecast records using adequate statistical methods. Granger (1996) suggests that point forecasts should be supplemented by confidence intervals, based on past performance.

The forecasts of large international organisations, such as the IMF and the OECD, and of some national forecasting institutes are occasionally scrutinised, cf. Artis (1996), Ash et al. (1998), Mills and Pepper (1999) and McNees (1992) for some of the most recent reports. This study compares the accuracy of real annual output growth and inflation forecasts made by the OECD for 13 European countries and forecasts made by an institute in the country studied[43].

The first hazard one encounters is becoming lost in dimensionality. There are many forecasters, and each forecasts many variables for several horizons. Different periods can be studied, there is a multitude of ways to assess accuracy, compare forecasters, etc. In order to keep the analysis manageable, we will study just two variables: *growth*, as measured by the annual percentage change in GDP, and *inflation*, measured by the annual percentage change in the consumption deflator. The horizon is one year ahead.

The next obstacle involves the very definition of accuracy. Assessing the accuracy of a forecast *ex post* may seem to be a simple problem: one just measures the distance between the forecast and the "known" outcome. But in forecasting GDP, the outcome is not known in the sense of aiming a weapon at an immobile target. All national statistical offices first publish a preliminary figure, which can best be described as an informed guess, i.e. it is also a forecast. Successive revisions, some many years later, will reduce the share of approximation in the figure, but they never eliminate it completely. Hence, comparing forecasters according to how close they come to a published figure is also a comparison of the “outcome” data. McNees (1989) describes forecasting and revising as a continuous process that starts long before the period concerned, and continues long after.

In Ash et al. (1998)[44], forecasts made by the OECD of G7 countries and 20 macroeconomic variables are studied and tested, using forecast records from the period 1967-1987, and three forecast horizons: ½, 1 and 1 ½ years ahead. Taking ordinary differences of seasonally adjusted GDP, their main result is that what they call “quasi-forecasts”, (i.e. forecasts for the current half-year or a forecast that is not a forecast in real time), generally are useful, in the directional sense. When the horizon is extended to one year ahead, there still is some indication that growth forecasts are valuable to users, but only in the case of France, the UK and the US. When the horizon is 1½ years, only the UK forecast is better than a naive alternative. Stekler (1994) analyses three organisations that have forecasted quarterly GNP for the United States for the period 1972-1983. Direction and rough size of change are studied. Again, the main conclusion is that current quarter quasi-forecasts are useful, while the results for one-quarter-ahead forecasts are ambiguous. Note that our comparison will use *annual* figures.

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[43] For a recent comparison of (mainly) US and UK forecasts, cf. Fildes and Stekler (1999).
[44] This contains an excellent list of references.

The data are presented in Section 2. In Section 3, we look at root mean squared errors *(RMSE)* and we test for improvement on two naive alternatives using the Wilcoxon signed rank test of Diebold and Mariano (1995). In choosing a naive alternative, we have endeavoured to reconstruct the situation in which the forecast was made. Hence, if the naive alternative is the average growth or the previous value of the series, we have only used data that were available to the forecaster. Consequently, the current year figure will be the forecast made in the autumn of the same year. We also test for accuracy improvement over time. A t-test is used to determine if inflation forecasts are significantly more accurate than growth forecasts. Weak form informational efficiency, i.e. bias and/or autocorrelation, is studied in Section 4. Non-parametric measures of accuracy based on direction allow for a different assessment. In Section 5 we look at acceleration/deceleration and test against a naive variant using a standard contingency table. In Section 6 we take a brief look at revisions and Section 7 summarises and discusses the results. Appendix 1 plots growth and inflation forecasts with the outcomes. Appendix 2 contains the contingency table test of directional accuracy.

2. Data [45]

OECD annual growth and inflation forecasts have been collected from the December issue of the *OECD Economic Outlook,* 1971-1998. When these forecasts were made, preliminary data for the first half of the current year were the latest data available. Table A.1 in the Appendix 1 lists the European forecasting institutes that have kindly provided us with their forecast data. The dates of publication vary among institutes and even within the same institute, but they take place in the autumn[46], and treat the current and the following year. As can be seen in the last two columns, many institutes have forecasts only for more recent periods (an unbalanced panel). This has necessitated separate studies of the sub-periods. OECD inflation forecasts have been published for all involved countries only from 1975 onwards. Table1a contains graphs of the growth forecasts and Table 1b shows the inflation forecasts (see Appendix 1). Generally speaking, the national institute and OECD forecasts are very close to each other; the coefficients of correlation for the 13 countries are in the interval 0.74 to 0.99 for growth and between 0.61 and 0.98 for inflation forecasts; so that the two are in most cases jointly good or bad. Note also the general reluctance to forecast negative growth. Some forecasters report no negative figures, although all economies have experienced contractions; some as serious as –7 %, as in Finland and Switzerland, but in both cases forecasts were non-negative. These forecasters may have had an asymmetric loss function of the "linex" type, according to which negative growth forecast errors carry a much larger penalty than positive ones[47]. Inflation forecasts have smaller errors and the falling tendency has been captured quite well by the forecasters.

Outcome (for both the OECD and institutes) is defined as the figure published in the December issue of the *Economic Outlook* one year later. This is probably the figure most forecasters are aiming for, because it is sufficiently near the time when the forecast was made to be regarded as relevant to the debate[48].

3. Root mean squared errors and naive forecasts

The most common average error measure, *RMSE,* is shown in Table 2a for growth and Table 3b for inflation in Appendix1. Panel A contains the country forecasts of the OECD and Panel B shows those from the national institutes. We treat the growth forecasts first. For the entire period 1971-1997, the *RMSE* is in the range of 1.3 % for the OECD's forecast of growth in France, and

[45] The data can be supplied upon request.
[46] ISCO/ISAE's inflation forecasts are issued in February and July. We used the February figures.
[47] Cf. Varian (1975).
[48] Cf. OECD Economic Outlook (1995) and Ash et al. (1998).

2.6 % for both forecasts for Finland. Even the minimum is above one percentage point, which must be considered unacceptably large. Still, they are of the same order as reported in other studies, see e.g. Zarnowitz (1992) for the US as well as Artis (1996) for the G7 countries; but the errors are smaller than for more volatile quarterly growth forecasts, cf. e.g. McNees (1986).

The standard deviation *(SD)* of the outcome is larger for Finland than for the other countries, which indicates that this variable is more difficult to forecast. In the second column, *RMSE* has been divided by *SD*. Now the most accurate growth forecaster is IFO.

Inflation forecasts in Table 2b generally have lower *RMSE* (1.6) than growth forecasts[49]. MIFF has the lowest *RMSE/SD,* followed by the OECD forecast for inflation in France and in the UK and the NIESR[50] forecast. Note in Figure 1b the overall high volatility in the beginning of the period. *RMSE* appears to generally fall towards the end of the period, but not sufficiently to prevent a rise in *RMSE/SD* in the last period.

The ratio *RMSE/SD* can be interpreted as an approximation of the *Theil U_2 Index*[51]. A value above unity means that the forecast is no more accurate than a ”naive” average change forecast and hence has no more value to the user than a simple naive projection. We have also compared the forecasts to a naive alternative of "same change as last year". Both measures are approximations. Instead of the mean growth over the entire period, one should use only the information available at the time of the forecast. The notation * means significantly more accurate than in the first naive alternative. The average growth rate estimates were calculated using data known at the time of forecasting. The test against the naive alternative "latest growth/inflation" is based on the *forecast* for the current year, where † denotes significance. In both cases we have used the Wilcoxon signed-rank test (S_3) in Diebold and Mariano *(DM)* (1995).

The naive trend growth would be the best possible forecast for change in a variable y_t, if it would be close to a random walk with drift, and if nothing else would be known about y_t than its own history. A random walk with drift can be written:

$$\Delta y_t = \mu + \varepsilon_t \tag{1}$$

where Δ is percentage growth, $\mu > 0$ is average (percentage) change and the errors ε_t are i.i.d. $(0,\sigma^2)$. For testing if the forecasts are more accurate than what can be generated by (1), μ must be estimated recursively as a time varying mean.

The naive "latest change" would be optimal if y_t would be close to a random walk in percentage changes:

$$\Delta y_t = y_t + \varepsilon_t \tag{2}$$

when testing against (2), we project the autumn growth forecast for the current one year ahead.

In Table 2a both growth forecasts for Norway have *RMSE/SD* ratios above unity for the period 1971-97. A possible explanation is the unpredictability of the offshore economy of Norway[52]. In

[49] This is not the case for forecasts made by the EU, for which Keereman (1999) reports: RMSE (growth) = 1.3, wheras RMSE (inflation) = 1.5.
[50] Holden & Peel (1985) present a thorough analysis of NIESR forecasts.
[51] See Holden et al. (1994), p. 338.
[52] For a study on Norwegian macroeconomic forecast accuracy, see Bjønnes et al. (1998).

Table 2b we find ratios above unity only for the last period for both forecasts for Ireland and for the one by FPB.

As in McNees (1978) we have tested published forecasts against naive alternatives, pooling all forecasts as if the same person had made them all. The null hypotheses of no better accuracy were rejected (last row), both using the binomial test suggested in ibid. and when applying the *DM* test. Note that we study one-year-ahead forecasts, calculated as *annual* growth rates, not as successive differences of semi-annual or quarterly figures as in Ash et al. (1998) and Stekler (1994), where forecasts quickly lost their accuracy. Using the *DM* test, we also checked if there is a difference in accuracy between the OECD and national institutes, but we found no significant difference.

The *DM* test shows that 6 OECD growth forecasts (Table 2a) were significantly more accurate than projections of the average growth one year ahead. All but the OECD forecasts for growth in Norway and Switzerland were better than the naive alternative "current year forecast". For the national institutes, the corresponding numbers were 10 and 7. Note that some tests are based on fewer observations, because of lack of historical data from some institutes. All inflation forecasts with full length records were significantly better than both naive alternatives.

We did not expect that so many forecasters would prove better than naive projections, given the relatively large forecast errors. In Öller and Barot (1999) we used growth *outcomes* for the current year as naive alternatives. As correctly pointed out by the referees, this makes the comparison unfairly difficult for the forecasters, since they did not know the outcome for the current year when they made their forecasts for the next year. Indeed, by that comparison, only a few forecasters would have been significantly better than the naive alternative.

Could the two time series be regarded as random walks, generated by (1)? We tested to see if mean growth deviations could be regarded as white noise applying a Breusch-Godfrey LM-test. A triangle after the country name in Panel A of Table 2a and Table 2b marks where this hypothesis could be rejected (we used longer data series, where available). In Table 2a (growth) we see that the hypothesis could be rejected for all but five countries, and in Table 2b (inflation), it is rejected for all countries. Hence, using (1) as a forecasting model, it should not have been difficult to dominate. For the shorter periods (1980-97 and 1985-97), tests were made only in cases where no data were available from the beginning of the period. The figures under the totals show the results when the forecasts are compared to the *final* outcome. In most cases forecasts are closer to the figures released in December the following year than to the final value[53]. However, the overall message of Table 2 remains unchanged, so we decided not to report these results. Also, note the arbitrariness of the concept "final". The point in time when a figure is "final" may vary from country to country. Furthermore, all figures from the 1990s may still be revised.

Comparing Tables 2a and 2b, one immediately notices the much smaller *RMSE* and *RMSE/SD* for inflation than for growth; the inflation ratio is only one-half the size of that for growth forecasts. This is an interesting result from the policy viewpoint, and one would like to test to see if the difference in accuracy is statistically significant. The number of error observations being 647 and 568 for growth and inflation, respectively, we used an asymptotic t-test[54] for the null hypothesis that *RMSE/SD* is the same for growth and inflation. A t-value of 9.4 shows that the difference in accuracy hardly can be regarded as a result of pure chance.

The Mean Absolute Errors *(MAE)* were calculated, but are not reported here. The error distributions were found to be close to normal, in which case a rule of thumb is that *RMSE* ≅

[53] Comparing errors from a simple econometric model using preliminary figures on the one hand and final ones on the other, Denton and Oksanen (1972) found no improvement in overall fit from using final instead of preliminary, figures.

[54] This test was suggested to us by Michael Andersson.

1.25*MAE*, see Granger (1996), and hence *MAE* does not contain much additional information.

Has the development of forecasting methods during a quarter of a century resulted in improved forecast accuracy? Looking at aggregate *RMSE/SD* at the bottom rows of Tables 2a and 2b, we find that there is little change (for the better). Treating the country/institute observed errors as a random sample the absolute errors made by each forecaster were regressed against a constant and a time trend[55]. Only the OECD growth forecasts for Italy and Sweden improved significantly over time. We may note in passing that Kennedy (1969) reports the following characteristics of the NIESR forecasts of growth 1959-1967: *RMSE* = 1.4, *SD* = 1.8 so that *RMSE/SD* = 0.8, which is the same figure as in Table 2a.

Testing for improvement over time in inflation forecasts showed that all had improved significantly, except the OECD forecasts for the Netherlands and Norway and those by IFO and CPB. Not only are inflation forecasts more accurate than the growth forecasts, they also improve over time, but only in absolute terms, not in relation to *SD*.

4. Weak form informational efficiency

If one finds that a forecaster has a tendency to over-estimate or under-estimate the outcome, this is a systematic error (bias) that could easily be corrected, making the forecast more accurate. There is also another type of systematic error. If over-estimating is more likely to be followed by another forecast above the target, and the same tendency applies to under-estimating, then the forecaster is rigid and this shows up as auto correlated one-step-ahead forecast errors. If autocorrelation is known to exist it is systematic and could be taken into account before releasing the final forecast. The absence of bias in one-step-ahead forecasts and no autocorrelation in forecast errors is called "weak form informational efficiency". This is regarded as rational forecasting in the limited sense of McNees (1978). The limitations are that:

(1). The forecaster's error loss function must be symmetric. As noted in Section 2, a higher penalty for negative errors makes it perfectly rational to make forecasts that are positively biased, cf. Clements and Hendry (1998) and Zellner (1986), and

(2). In case of a symmetric loss function, unbiased ness and absence of autocorrelation are only necessary conditions for rationality. If information that could have reduced *RMSE* was available, but not utilised, the forecast is irrational.

In short, forecast errors should be innovations towards all available information. This will not be tested here, and we avoid the term "rational".

The conventional test method for bias in forecasts goes back at least to Theil (1966). The actual are linearly regressed on the forecasts and a constant. The null hypothesis is that the regression coefficient is 1 and the constant is 0. The problem with this test is that the residuals will often be positively auto correlated, thus inflating (biasing) the test of the null hypothesis. Autocorrelation is a measure of the rigidity of forecasters and should thus be included in the same test as pointed out by many authors. Instead of applying a Cochrane-Orcutt type transformation (McNees, 1978), or postulating an error-process as in Brown and Maital (1981)[56], we suggest testing both types of systematic errors simultaneously by regressing the forecast error on a constant and as many lagged errors as necessary to whiten the residuals:

$$e_t = \gamma_0 + \sum_{j=1}^{p} \gamma\, e_{t-1} + \varepsilon_t \qquad (3)$$

[55] Thus the test does not discriminate between the case of improved forecasting techniques and that of the task becoming easier because of smaller volatility in the data to be forecasted.
[56] See also Mills & Pepper (1999).

where e_t is the forecast error at t and the γ_i ..$(i = 0,1, ..., p)$ are coefficients to be estimated. In macroeconomic applications one would expect p to be one or two. No bias or autocorrelation can be tested as a t-test for $\gamma_0 = 0$ and an F test that any of the other $\gamma's$ are different from 0, respectively. Figures 1a and 1b suggest that both types of systematic errors may be present.

The results of the tests are shown in Table 3. We have refrained from testing institute forecasts based on less than full-length records. There is only one significantly auto correlated forecast error record, that of MIFN for growth. Since autocorrelation does not seem to be a general problem here, we also performed a joint likelihood ratio *(LR)* test of actuals regressed on forecasts

INSEE's growth forecasts are biased according to the test based on (3), and inefficient according to the *LR* test. The test based on (3) signals bias in the OECD forecast of inflation for Sweden. OECD's forecasts of growth for Norway are inefficient according to the *LR* test.

Other researchers, e.g. Diebold et al. (1997) have found a tendency to under-estimate inflation during episodes of high inflation and to over-estimate it in periods of low inflation. This tendency should produce autocorrelation. If the tendency exists in European data, with one exception it is not sufficiently strong to trigger significance in tests of autocorrelation. We will return to this question in the next section.

Nothing has been said of heteroscedasticity in errors yet. Indeed, nearly all inflation forecast errors appear to decrease over time (see Figure 1b), which is a sign of heteroscedasticity. Regressing outcomes on forecasts, the positive correlation between forecasts and errors will *inflate* the t-values. We performed ARCH tests, which produced significance only in cases where the test for bias did not signal significance, so that the inference from Table 3 does not change.

5. Directional forecasts

Leitch and Tanner (1995) suggest that the numerical accuracy measures *(RMSE, MAE*, etc.*)* have little relevance for users of forecasts in business enterprises, who are most concerned with the *direction* indicated by the forecast. One reason may be that businessmen examine professional growth forecasts in order to decide whether to invest in expanded production capacity. If the investor receives the wrong signal, the result will be either a loss of market share or over-capacity. A central bank wants to know if inflation will accelerate or decelerate to decide if the interest rate should be raised or lowered. Ibid. presents evidence that the US GNP forecasts of 42 professionals are useful in the directional sense.

Beginning with the growth forecasts, we see from Figure 1a that there have been three major recessions in the period studied: (1) the mid-1970s, (2) the early 1980s[57], and (3) the early 1990s. Did the forecasters issue correctly timed signals? The sad answer is, only in rare cases. IFO saw the first recession coming, but its severity was greatly under-estimated so the warning was of doubtful quality. IFO gave a perfect recession alert for the third recession. The OECD issued an almost correctly timed warning for recession (1) in Italy and a perfect one for recession (2) in the UK. In addition to these warnings, only the forecasts for recession 2 in Norway are worth mentioning. Note that there is a total of 29 episodes of substantial recession. Some negative growth forecasts can be seen, but they are poorly timed (see Section 2). Moreover, there are false recession and boom signals, the most remarkable ones: 1984 in Norway and 1977 in Finland and Sweden. MIFN issued a -2 % warning for 1984, when in fact the economy had accelerated from 3 % the year before to a healthy 4 %. The other case is a boom of 4 % growth forecasted by MIFF to occur in 1977, when in fact, essentially zero growth was recorded. NIER forecasted that

[57] The first two are discussed in Wallis (1989).

growth would accelerate from 0 to 2.7 % for 1976-1977. The outcome was a deceleration from 1.4 % to -2.4 %.

Except for two observations, annual inflation has been positive in all countries considered and growth has almost always been positive. Thus, calculating the number of times that the sign has been correctly forecasted does not make sense for inflation, and for growth there are so few observations that we have chosen to comment on them verbally above. We found the following solution to this problem. At the end of the year, both the OECD and the institutes publish forecasts for the following as well as for the *current* year. This means that the forecasts signal if there will be acceleration or a *deceleration* of production/inflation. We study this second order direction, which is done for prices in Ash et al. (1998).

Table 4a shows the years when the forecasters missed the change in *growth*. The OECD's forecasts for growth in the UK have missed only four times (1975, 1977, 1981 and 1996) during the 27-year period studied. Among the institutes, only MIFF has equally few misses. IFO fares much worse in this comparison than when the criterion *RMSE/SD* is used. In order to compare with a naive alternative, the last column contains ratios of forecast misses to the number of misses that would have occurred with a simple projection of the last acceleration/deceleration one-year-ahead. Again, we used the *forecast* of the current year and the autumn statistics for the previous year's outcome, to place ourselves into the position of the forecaster. In an analogy with the Theil Index, it can be said that if the ratio is not below unity, the direction was not predicted better than by a naive forecast. There are eight ratios at or above unity, if sub-periods are also considered: the OECD forecast for Germany, Belgium, the Netherlands and Norway as well as those made by DEC, CPB[58], MIFN and KOF.

For ratios below unity, we have performed a simple contingency table test, see Appendix 2. An asterisk in the last column of Table 4a shows where growth forecasts are significantly correlated with the outcome, which is in only one-half of the cases. This contradicts the claim in Leitch and Tanner (1995) that macroeconomic forecasters may be better at direction than at numerical accuracy. When we tested the pooled data, the accuracy as a whole was significantly better than a naive projection.

Acceleration/deceleration forecasts of inflation are shown in Table 4b. Twelve out of 26 of the forecasts are not significantly more correct than the naive alternative, which is almost the same number as for growth forecasts. According to this criterion directional growth and inflation forecasts appear to be equally accurate, but note that overall, the latter are wrong much less often than the former (24 % vs. 29 % for growth). Now both forecasts for the UK and the OECD forecast for Norwegian inflation miss only twice.

The OECD directional inflation forecasts for the Nordic countries, except for Norway, stand out as being particularly poor. The naive alternative (same acc./dec. as the year before) would have missed only three accelerations/decelerations of inflation in Finland, while the OECD emitted wrong signals in 10 cases! The naive variant would have proven better than DEC by 8 - 6 and NIER by 8 - 7. These forecasters may have had a cost function in mind, where wrongly predicting accelerating inflation carries a much higher penalty than wrongly predicting decelerating inflation. Considering that these countries had highly centralised labour markets with strong government involvement in this period, forecasters close to government would have an incentive to issue forecasts of decelerating inflation so as to ward off too high wage claims. Indeed, comparing over-predictions and under-predictions, one gets the following scores: OECD: Finland 10 - 0, DEC 6 - 2 and NIER 8 - 1.

Could acceleration/deceleration be particularly difficult to forecast for certain years? The year

[58] A report on the accuracy of CPB forecasts is given in Donders & Kranendonk (1999).

1988 stands out as the most difficult for forecasting growth. It is not difficult to guess why; in October 1987, too many forecasters still believed in positive and unavoidable correlation between the stock market and production. More surprising is the contrast between the years 1994 and 1995. Here it is difficult to find the reason. Again, inflation forecast misses behave quite differently; there is no exceptionally bad year.

6. Statistical errors[59]

To understand why errors are so large, we refer to what was said in the introduction about measuring forecast errors as the difference between the forecast and a preliminary figure. Despite the importance of GDP and the consumption deflator as indicators, their measurement is uncertain. In Table 5 we have calculated the *root mean squared revision (RMSR).* This is a measure of the errors detected in the official statistics, as of December, after one revision has already been made. The error measure is biased downwards also because the last observations will be further revised. Moreover, there are all kinds of errors, e.g. from sampling. Assume that two thirds are detected and removed. Then the average statistical error would be only slightly smaller than the average *RMSE* (1.9) of growth forecasts and 40 % of inflation *RMSE* (1.6). This simple calculation shows that forecasters may be able to share the blame for bad forecasts with the statistical authorities[60]. Table 5 also reveals that some revisions are significantly biased. As already noted by Denton and Oksanen (1972), preliminary figures underestimate.

A rational forecaster dealing with uncertain data avoids big shifts in forecasts; he/she is rigid in the sense discussed in Section 4, inducing positive autocorrelation. There was very little evidence of autocorrelation in Table 3, which means that forecasters were quite efficient when dealing with uncertain data, compensating for the negative autocorrelation that would appear in the forecasts if they would accept their model (real or intuitive) forecasts based on revised data, but using preliminary data as the starting point[61].

7. Conclusion and discussion

In summary, we have found that:

(1). Average errors in forecasts of both growth and inflation are large, in terms of both their variance and the importance of these variables. European macroeconomic forecasts for the following year, of both growth and inflation are as a whole (pooled) significantly more accurate than two naive alternatives. Significant superiority was also found for directional (acceleration/deceleration) forecasts. However, we found no significant difference in accuracy between the OECD and institute forecasts.

(2). Accuracy, as measured by *RMSE* is significantly higher for inflation than for growth forecasts. There are fewer directional misses in inflation forecasts than in growth forecasts.

(3). The following individual forecasts of growth (full-length records) are significantly better than all naive alternatives tested here: average growth, latest growth and random growth direction: the OECD forecasts for France, UK, Austria[62] and Sweden, and among the institutes, NIESR, MIFF and NIER. The following growth forecasts were found not to be useful according to any criterion: the OECD forecast for Norway, and the institute forecasts

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[59] A classical reference on statistical errors is Morgenstern (1950).

[60] In Klein (1981) the statistical error in US growth figures is reported as 1.5 percentage points and this is regarded as the lower limit of the RMSE of forecasts, cf. also Granger (1996).

[61] See Clements & Hendry (1988), Ch. 8.3.

[62] For Austrian macroeconomic forecasts, see Thury (1986).

[62] We also looked at two-year ahead growth forecasts made by the OECD. They appear to contain (positive) bias, which is in accordance with the result in Milburn (1978) that optimism increases with the forecast horizon. Bias has also been found for shorter horizons, cf. Kirschgassner (1993) who examines German forecasts.

of MIFN and KOF.

(4). According to *RMSE/SD,* all inflation forecasts with full-length record were better than both naive alternatives. The OECD forecasts for the UK and France again fare best in the competition, whereas some forecasters had their rankings reversed in comparison with growth forecasts (e.g. the forecasts for Norway). One-half of the directional inflation forecasts were significantly better than the naive alternative.

(5). The only growth forecasts that had improved over time were those of the OECD for Italy and Sweden. The only inflation forecasts that *did not* improve over time were the OECD forecasts for the Netherlands and Norway and those made by IFO and CPB. The improvement was in absolute terms, not in relation to the standard deviation.

(6). Weak form informational efficiency was rejected in very few cases[63].

(7). We found no support in annual data for the claim in Leitch and Tanner (1995) that macroeconomic *directional* forecasts are more accurate than forecasts measured on an interval scale, and turning points had generally been missed.

(8). Accuracy appears to be higher in annual forecasts than in shorter period change forecasts as reported by Ash et al. (1998) and Stekler (1994). This is in agreement with (British) evidence in Barker (1985) that forecasters with a longer perspective were more successful than those working with quarterly data.

(9). Although errors were too large, growth forecast accuracy could not have been substantially improved without improvement in the accuracy of the statistics. This also applies to a lesser extent to inflation forecasts.

As stated above, one of the most interesting results from this study is that inflation forecasts are better than growth forecasts. According to Figure1b, inflation is falling and there has been a decline in the inflation variance over time (although not uniform). Inflation revisions are smaller than those for growth figures. Taken together, these results support stabilisation policies based on inflation targeting, instead of Keynesian fine-tuning of output, which was a policy still being pursued by many European countries in the 1970s. Economic policy requires accuracy in both statistics and in forecasts. The latter depends on the former, and it seems that we cannot achieve decisively better forecasts (and policy) without first improving the statistics, which today is possible through the use of modern data techniques to produce fast and highly accurate on-line statistics.

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[63] We also looked at two-year ahead growth forecasts made by the OECD. They appear to contain (positive) bias, which is in accordance with the result in Milburn (1978) that optimism increases with the forecast horizon. Bias has also been found for shorter horizons, cf. Kirschgassner (1993) who examines German forecasts.

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Appendix 1. National institutes forecast date

Table A1. National institutes

Initials	Name	Data period		Forecast date
		Growth	Inflation	
IFO	Institut für Wirtschaftsforschung, Germany (D)	1971-97	1975-97	December
INSEE/FM	Direction de la prévision, France / Ministry of Finance (F) 1)	1971-97	1975-97 2)	October
(ISCO) ISAE	Instituto Nazionale per lo Studio della Congiuntura, Italy (I)	1981-97	1981- 97	December/ February 3)
NIESR	The National Institute of Economic and Social Research, UK (GB)	1971-97	1975- 97 4)	November, 1971- 95, and October, 1996-97
WIFO	Austrian Institute of Economic and Social Research, Austria (A)	1971-97	1975- 97	December
FPB	Federal Planning Bureau, Belgium (B)	1983-97	1983- 97	Irregular
DEC	The Economic Council, Denmark (DK)	1974-97	1975- 97	December
MIFF	Ministry of Finance, Finland (FIN)	1971-97	1975- 97	September
ESRI	The Economic and Social Research Institute, Ireland (IR)	1971-76 5)1978-97	1975- 97	October/November/December
CPB	Bureau for Economic Policy Analysis, Netherlands (NL)	1971-97	1975-97	September
MIFN	Ministry of Finance, Norway (N)	1971-97	1975-97	October
NIER	The National Institute of Economic Research, Sweden (S)	1971-97	1975-97 6)	November/December
KOF	Swiss Institute for Business Cycle Research, Switzerland	1976-97	1976- 97	December

Note: 1). INSEE made the GDP forecasts, the Ministry of Finance the inflation forecasts. 2). The OECD forecast for France was used as a substitute for a missing value 1983.3). The inflation forecasts are made in July and February. Since the latter is closer to December it was chosen.4). For 1982 the inflation forecast is missing. As a substitute, we used a quarterly forecast made in the fourth quarter of year t for the same quarter in t+1. 5). The GDP forecast for 1977 is missing. Only figures for 1980 onwards were used.6). In 1975-1980, two alternative inflation forecasts were published. For 1976 and 1978-80, the more likely one was indicated in the text and we chose that one. For the remaining years the forecast is the arithmetic average.

Figure 1a. Growth forecasts and outcomes, OECD and national institutes, continuing

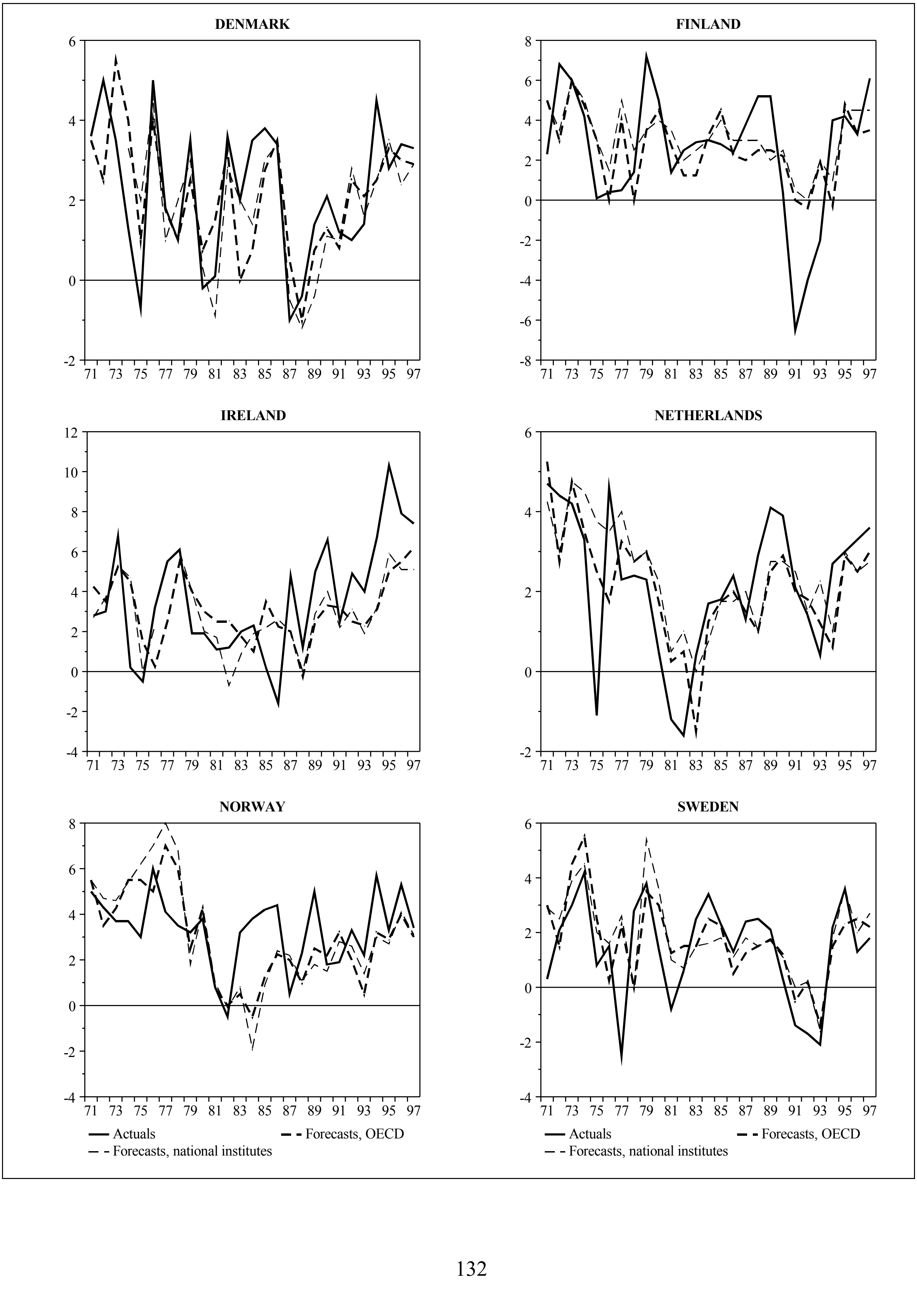


Figure1 a. Growth forecasts and outcomes, OECD and national institutes

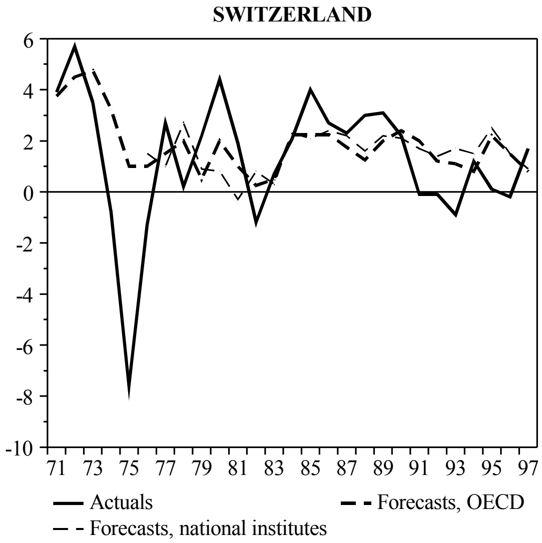


Figure 1b. Inflation forecasts and outcomes, OECD and national institutes, continuing

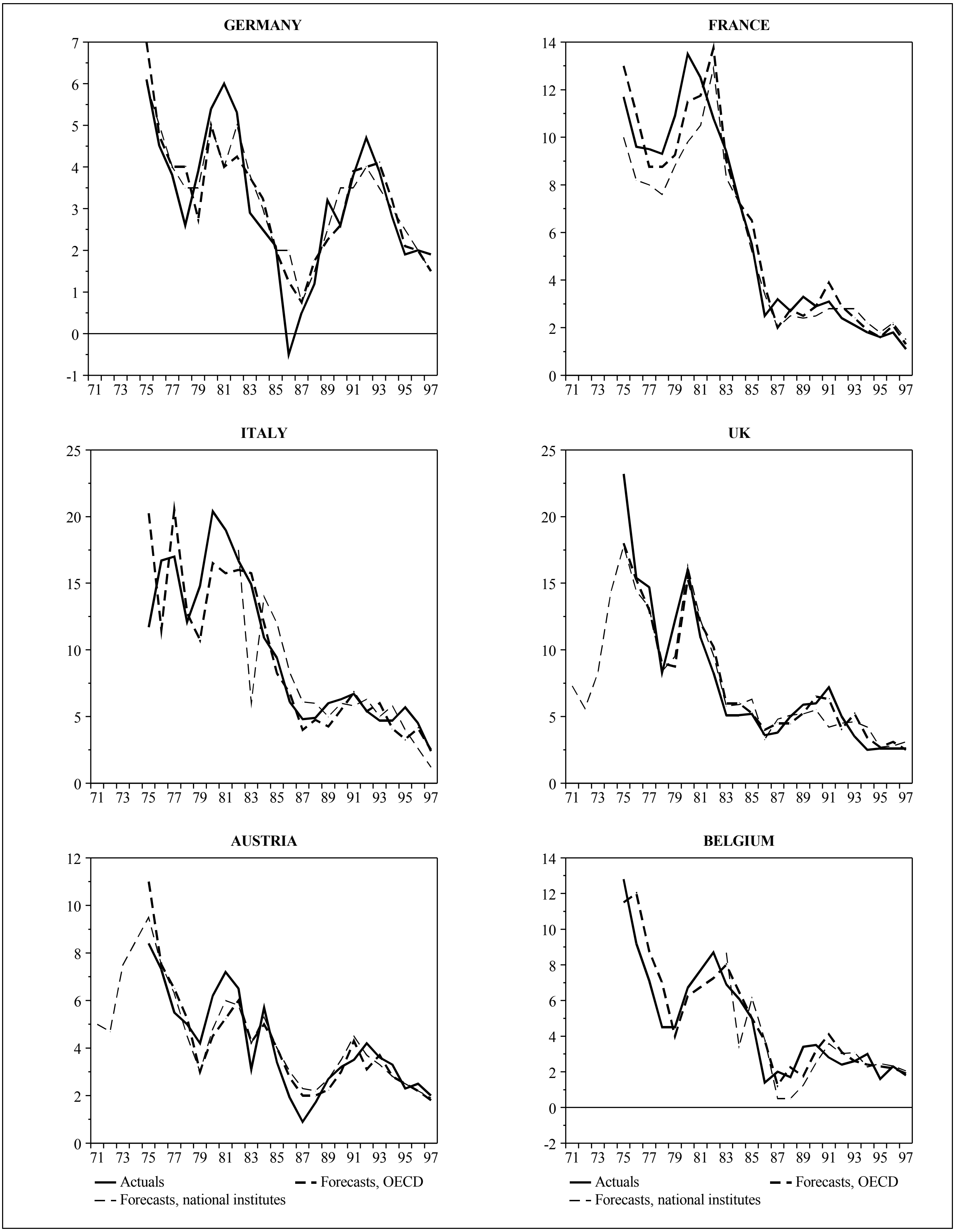


Figure 1b. Inflation forecasts and outcomes, OECD and national institutes, continuing

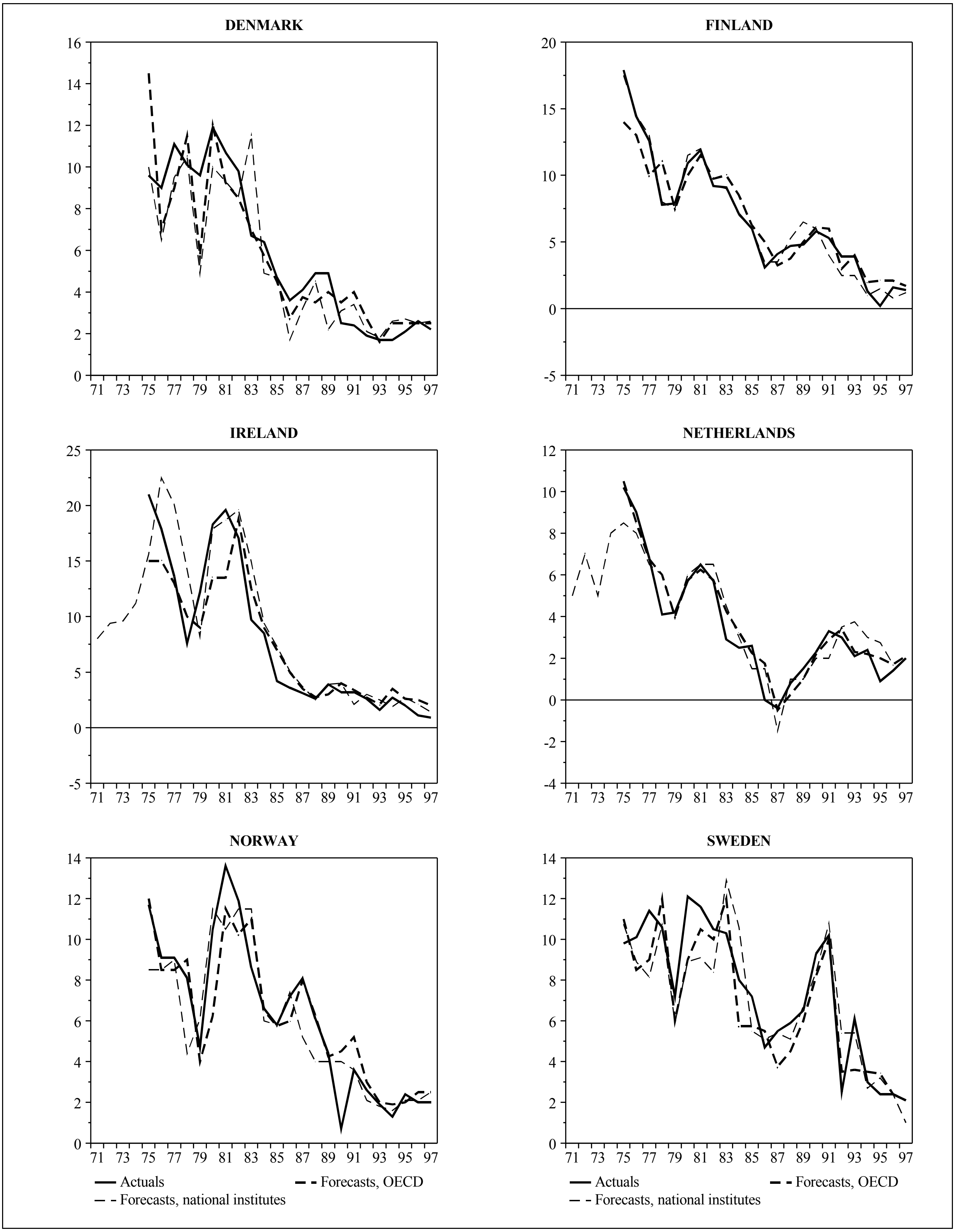


Figure 1b. Inflation forecasts and outcomes, OECD and national institutes

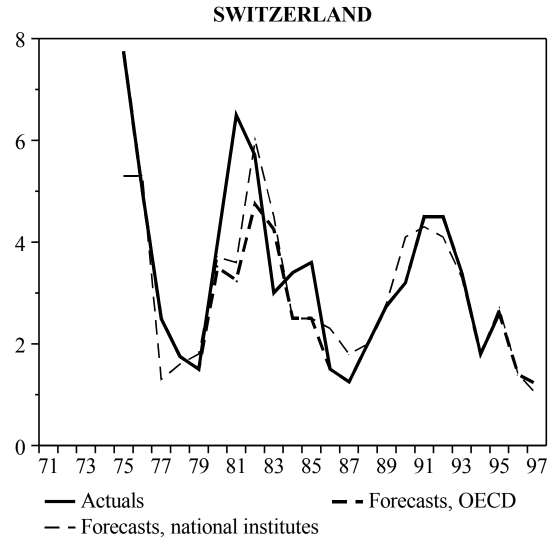


Table 2a. Root mean squared error (RMSE) of output growth forecasts, standardised and tested against naïve projections

	1971-97		1980–97		1985 – 97	
PANEL A	RMSE	RMSE/SD	RMSE	RMSE/SD	RMSE	RMSE/SD
GERMANY (D)**Δ**	1.72	0.86 †	1.31	0.83	1.31	0.93
FRANCE (F)**Δ**	1.32	0.74*†	1.09	0.97	1.16	0.98
ITALY (I)	2.02	0.94†	1.13	0.72	1.04	0.83
UK (GB)**Δ**	1.56	0.75*†	1.37	0.63	1.41	0.73
AUSTRIA (A)	1.85	0.93 †	1.31	0.97	1.45	1.04
BELGIUM (B)	1.60	0.84 †	1.38	0.84	1.44	0.92
DENMARK (DK)	1.35	0.78*†	1.22	0.74	0.97	0.59
FINLAND (FIN)**Δ**	2.62	0.83 †	2.65	0.79	3.04	0.79
IRELAND (IR) **Δ**	2.48	0.86 †	2.55	0.82	2.91	0.87
NETH (NL)**Δ**	1.51	0.79*†	1.40	0.75	1.34	0.91
NORWAY (N)	1.84	1.19	1.89	1.12	1.71	1.10
SWEDEN (S))**Δ**	1.59	0.87*†	1.10	0.64	0.98	0.54
SWITZ (CH)**Δ**	2.47	0.96*	1.80	1.09	1.95	1.24
Aver., OECD	1.89	0.88*†	1.63	0.85	1.72	0.90
	(2.09)	(0.96)	(1.91)	(0.95)	(1.97)	(1.00)
PANEL B						
IFO (D)	1.39	0.69*†	1.18	0.75	1.13	0.80
INSEE (F)	1.57	0.88*	1.30	1.16	1.34	1.14
ISCO (I)	NA	NA	NA	NA	0.87	0.70*
NIESR (GB)	1.71	0.83*†	1.49	0.69	1.44	0.75
WIFO (A)	1.76	0.89 †	1.19	0.88	1.29	0.93
FPB (B)	NA	NA	NA	NA	1.37	0.87*
DEC (DK)	NA	NA	1.08	0.65	1.06	0.64*†
MIFF (FIN)	2.64	0.83* †	2.63	0.79	3.02	0.78
ESRI (IR)	NA	NA	2.36	0.76	2.70	0.81*
CPB (NL)	1.58	0.83*†	1.39	0.74	1.27	0.86
MIFN (N)	2.13	1.37	2.10	1.24	1.77	1.14
NIER (S)	1.59	0.87*†	1.12	0.65	0.88	0.49
KOF (CH)	NA	NA	1.67	1.01	1.47	0.94
Aver., institutes	1.84	0.92*†	1.67	0.87	1.63	0.85
	(1.74)	(0.86)	(1.97)	(0.94)	(1.93)	(0.95)
Average, total	1.87	0.89*†	1.65	0.86	1.68	0.88
	(1.96)	(O.92)	(1.94)	(0.94)	(1.94)	(0.97)

Note: Denoting the forecast by P and the actual by A, RMSE and SD are calculated according to the formulas:

$$RMSE = \sqrt{\frac{1}{n}\sum_t (P_t - A_t)^2} \;, \; SD = \sqrt{\frac{\sum_t (\bar{A} - A_t)^2}{n-1}} \;;$$

where Ã is the recursively calculated average growth and n is the number of observations. Forecasts that are significantly (5 %) better than naive are marked *, if compared to average growth, and by †, when naive is the current year forecast. Significant deviations in GDP growth from random walk with drift is denoted by Δ. NA means that data is not available. Figures in parentheses are comparisons to final outcomes.

Table 2b. Root mean squared errors (RMSE) of inflation forecasts, standardised and tested against naive projections

	1975-97		1980-97		1985 –97	
PANEL A	RMSE	RMSE/SD	RMSE	RMSE/SD	RMSE	RMSE/SD
GERMANY (D) **Δ**	0.83	0.49*†	0.81	0.47	0.63	0.44
FRANCE (F) **Δ**	1.07	0.25*†	1.03	0.26	0.67	0.61
ITALY (I) **Δ**	2.73	0.49*†	1.53	0.28	1.04	0.65
UK (GB) **Δ**	1.57	0.29*†	0.89	0.26	0.74	0.48
AUSTRIA (A) **Δ**	1.00	0.49* †	0.87	0.49	0.61	0.66
BELGIUM (B) **Δ**	1.24	0.41* †	0.97	0.41	0.97	0.97
DENMARK (DK) **Δ**	1.65	0.46*†	0.85	0.26	0.82	0.66
FINLAND (FIN) **Δ**	1.47	0.32*†	0.92	0.28	0.93	0.49
IRELAND (IR) Δ	2.53	0.37*†	2.20	0.36	1.11	1.08
NETH (NL) **Δ**	0.72	0.26*†	0.66	0.35	0.65	0.58
NORWAY (N) **Δ**	1.54	0.40*†	1.70	0.44	1.28	0.52
SWEDEN (S) **Δ**	1.49	0.43*†	1.46	0.42	1.22	0.44
SWITZ (CH) **Δ**	1.38	0.72*†	1.19	0.65	0.94	0.54
Aver., OECD	1.58 (1.64)	0.43*† (0.45)	1.24 (1.26)	0.40 (0.40)	0.92 (0.90)	0.65 (0.61)
PANEL B						
IFO (D)	0.82	0.48*†	0.89	0.51	0.83	0.58
FM (F)	NA	NA	NA	NA	0.60	0.55*
ISCO (I)	NA	NA	NA	NA	0.89	0.56* †
NIESR (GB)	1.63	0.30*†	1.09	0.32	1.13	0.73
WIFO (A)	0.79	0.39 *†	0.78	0.44	0.66	0.71
FPB (B)	NA	NA	NA	NA	1.21	1.21
DEC (DK)	1.85	0.52*†	1.62	0.50	1.07	0.86
MIFF (FIN)	0.74	0.16*†	0.82	0.25	0.95	0.51
ESRI (IR)	2.98	0.44*†	1.71	0.28	1.16	1.13
CPB (NL)	1.06	0.39*†	1.00	0.53	1.05	0.94
MIFN (N)	1.75	0.46*†	1.57	0.40	1.45	0.59
NIER (S)	1.69	0.49*†	1.69	0.48	1.14	0.41
KOF (CH)	1.32	0.69*†	1.09	0.59	0.86	0.50
Aver., institutes	1.60 (1.73)	0.44*† (0.47)	1.28 (1.35)	0.44 (0.45)	1.02 (1.04)	0.75 (0.72)
Average, total	1.59 (1.64)	0.44*† (0.46)	1.25 (1.30)	0.42 (0.42)	0.97 (0.97)	0.70 (0.67)

Note: cf. Table 2a

Table 3. Testing for bias and autocorrelation in forecast errors

	BIAS		AUTOCORRELATION	
	1973 - 1997	1977 – 1997	1973 -1997	1977 –1997
PANEL A	Growth	Inflation	Growth	Inflation
GERMANY (D)	0.54	0.95	0.84	0.85
FRANCE (F)	0.27	0.93	0.73	0.62
ITALY (I)	0.87	0.35	0.19	0.71
UK (GB)	0.74	0.72	0.19	0.53
AUSTRIA (A)	0.27	0.64	0.49	0.38
BELGIUM (B)	0.48	0.57	0.96	0.79
DENMARK (DK)	0.95	0.30	0.11	0.98
FINLAND (FIN)	0.79	0.30	0.45	0.79
IRELAND (IR)	0.35	0.94	0.16	0.11
NETH (NL)	0.71	0.08	0.76	0.61
NORWAY (N) *	0.48	0.99	0.15	0.43
SWEDEN (S)	0.30	**0.03**	0.73	0.47
SWITZ (CH)	0.29	0.37	0.13	0.30
PANEL B				
IFO (D)	0.70	0.75	0.62	0.93
INSEE /FM (F)	**0.05**	0.52	0.95	0.24
ISCO (I)	NA	NA	NA	NA
NIESR (GB)	0.47	0.79	0.07	0.40
WIFO (A)	0.32	0.93	0.26	0.12
FPB (B)	NA	NA	NA	NA
DEC (DK)	NA	0.41	NA	0.90
MIFF (FIN)	0.26	0.79	0.15	0.19
ESRI (IR)	NA	0.13	NA	0.18
CPB (NL)	0.59	0.13	0.56	0.87
MIFN (N)	0.66	0.17	**0.03**	0.62
NIER (S)	0.28	0.42	0.75	0.36
KOF (CH)	NA	0.52	NA	0.88

Note*:* Probabilities (bold = significant, 5%) in Student's t and Fisher's F test of the null hypothesis: $H_{01}: \beta_1 = 0, H_{02}: \beta_2 = \beta_3 = 0$, respectively in: $e_t = \beta_0 + \beta_1 \cdot e_{t-1} + \beta_2 \cdot e_{t-2} + u_t$. An asterisk signals rejection (5%) of the joint hypothesis: $H_{01}: \alpha = 0, H_{02}: \beta = 1$ in $A_t = \alpha + \beta \cdot P_t + \varepsilon_t$.

Table 4A. Years when the acceleration / deceleration of growth was missed and the ratio between these cases and naive forecast misses

PANEL A	Years missed 1971 – 1997	Ratio and 2 × 2 contingency. Table test results.
GERMANY (D)	72, 75, 82, 85, 86, 87, 88, 89, 90, 95, 96	11/11 (1.00)
FRANCE (F)	72, 79, 84, 85, 88, 89, 95	7/10 (0.70) *
ITALY (I)	74, 76, 78, 82, 88, 92, 96	7/15 (0.47) *
UK (GB)	75, 77, 81, 96	4/12 (0.33) *
AUSTRIA (A)	72, 73, 87, 90, 95	5/14 (0.36) *
BELGIUM (B)	72, 73, 78, 79, 80, 83, 86, 88 , 92, 93, 94, 95, 96	13/13 (1.00)
DENMARK (DK)	73, 78, 84, 85, 86, 88,90, 92, 96, 97	10/13 (0.77)
FINLAND (FIN)	73, 82, 85, 88, 89	5/19 (0.26) *
IRELAND (IR)	77, 81, 85, 86, 90, 95	6/14 (0.43) *
NETH (NL)	73, 75, 79, 81, 82, 83, 84, 86, 87, 88, 89 95, 96	13/11 (1.18)
NORWAY (N)	73, 74, 75, 77, 78, 84, 85, 86, 88, 92, 96	11/11 (1.00)
SWEDEN (S)	77, 87, 88, 92, 95	5/13 (0.38) *
SWIT (CH)	72, 73, 79, 85, 88, 89, 92, 93 , 95 , 96	10/12 (0.83)
PANEL B		
IFO (D)	72, 75, 82, 86, 88, 89, 90, 95, 96	9/13 (0.69)
INSEE/ FM (F)	72, 83, 85, 89, 93, 95	6/12 (0.50) *
ISCO (I) (85 -97)	87	1/6 (0.16)
NIESR (GB)	75, 77, 79, 81, 87	5/15 (0.33) *
WIFO (A)	72, 83, 88, 90, 95	5/17 (0.29) *
FPB (B) (85 – 97)	86, 88, 92, 95	4/6 (0.66)
DEC (DK) (80 -97)	81, 83, 84, 85, 86, 88, 89, 92, 93, 96, 97	11/10 (1.1)
MIFF (FIN)	73, 82, 88, 89	4/17 (0.24) *
ESRI (IR) (80 – 97)	80, 81, 82, 86, 90	5/16 (0.31)*
CPB (NL)	73, 75, 77, 79, 82, 86, 87, 88, 93, 95, 96	11/10 (1.01)
MIFN (N)	73, 74, 75, 77, 78, 84, 85, 86, 88, 92, 96	11/11 (1.10)
NIER (S)	77, 84, 88, 92, 93	5/17 (0.29) *
KOF (CH) (80 -97)	85, 88, 89, 92, 93, 95	6/6 (1.00)

Note: Border cases where the forecast expresses no change in growth are classified as correct if the change in the outcome is smaller than one half percentage point. Analogously, a forecast is considered correct if it predicts an acceleration/deceleration of less than one-half a percentage point in cases where the outcome is no change in growth. Remaining cases are registered as wrong. A * means significant on the 5 % level of the contingency test in Appendix 2.

Table 4B. Years when the acceleration / deceleration of inflation was missed and the ratio between these cases and naive forecast misses

PANEL A	Years missed 1975 – 1997	Ratio and 2 × 2 contingency. Table test results.
GERMANY (D)	78, 79, 81 , 84	4/8 (0.50)*
FRANCE (F)	79, 82, 87, 89	4/10 (0.40) *
ITALY (I)	76, 79,88, 89, 90, 93, 95	7/7 (1.00)
UK (GB)	91, 94	2/7 (0.29) *
AUSTRIA (A)	81, 87, 92, 96	4/7 (0.57) *
BELGIUM (B)	79, 82, 87, 88 , 90, 91, 94	7/9 (0.78)*
DENMARK (DK)	77, 78, 88, 89, 91, 92, 94, 97	8/7 (1.14)
FINLAND (FIN)	81, 83, 84, 87, 88, 89, 90, 93, 95, 97	10/3 (3.33)
IRELAND (IR)	81, 90, 95, 96, 97	5/5 (1.00)
NETH (NL)	79, 81, 84, 85	4/9 (0.44)*
NORWAY (N)	77, 96	2/9 (0.22)*
SWEDEN (S)	76,77, 78, 83, 87,89, 91, 95	8/8 (1.00)
SWIT (CH)	78, 81, 84, 85, 90, 91, 97	7/7 (1.00)
PANEL B		
IFO (D)	81, 86, 90	3/8 (0.38)*
INSEE /FM (F)	79, 80, 87, 89, 91, 95	6/10 (0.60)*
ISCO (I) (83 -97)	93, 94, 95	3/2 (1.50)
NIESR (GB)	91, 94	2/6 (0.33) *
WIFO (A)	81, 87, 96, 97	4/7 (0.57) *
FPB (B) (85 – 97)	87, 88, 93, 94	4/6 (0.67)
DEC (DK)	79, 80, 82, 88, 89 , 93, 94, 97	8/6 (1.33)
MIFF (FIN)	76, 77, 79, 84, 87, 96	6/8 (0.75) *
ESRI (IR)	76, 77, 82, 90, 91, 92	6/6 (1.00)
CPB (NL)	79, 81, 85, 89, 91, 92, 93, 95	8/8 (1.00)
MIFN (N)	77, 87, 91, 96	4/9 (0.44)*
NIER (S)	76, 77, 78, 83, 84, 87, 95, 97	8/7 (1.14)
KOF (CH)	81, 84, 85, 91, 97	5/8 (0.63)*

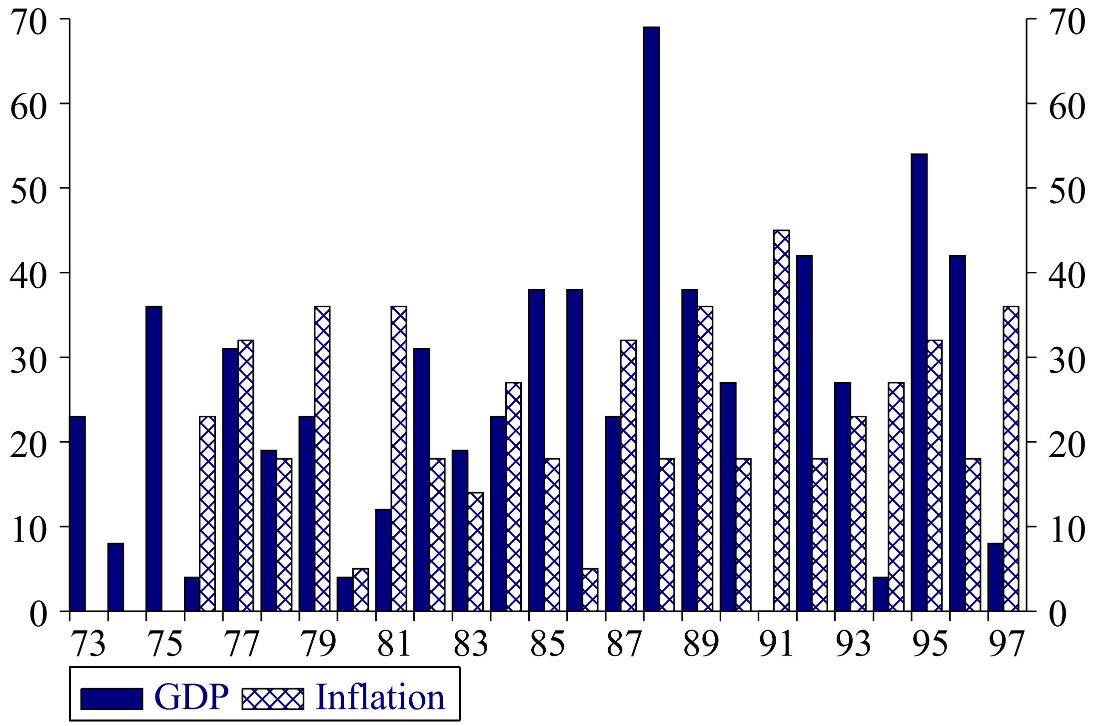
Note: c.f. Table 4a.

Table 5. Root mean squared revisions (*RMSR*) and bias of revisions

	Output growth		Inflation	
	RMSR	Bias t – values	RMSR	Biast – values
Germany (D)	0.65	0.62	0.21	0.09
France (F)	0.86	1.30	0.25	2.48*
Italy (I)	1.22	2.01*	1.16	2.10*
UK (GB)	1.01	2.66*	0.60	3.28*
Austria (A)	0.72	0.48	0.42	2.04*
Belgium (B)	0.87	1.53	0.49	0.63
Denmark (DK)	0.85	0.40	0.71	0.67
Finland (FIN)	0.52	2.27*	0.45	0.87
Ireland (IR)	3.01	0.66*	1.07	1.09
Ned (NL)	0.68	1.75	0.39	0.59
Norway (N)	1.28	2.10*	0.91	0.20
Sweden (S)	0.71	2.21*	0.62	2.58*
Switz (CH)	0.88	0.22	0.39	0.08

Note: Average RMSR: 1.18 for GDP and 0.60 for inflation. Revision = final – preliminary outcome. The column "Bias" shows t-test values of the arithmetic average of revisions, where * denotes 5% significance.

Table 6. Aggregated (OECD and institutes) acc/dec error frequencies in percentages



Appendix 2. The contingency table test of directional accuracy

Table 6. The acceleration/deceleration forecasts were tested for information content using the 2×2 contingency table:

		Forecast		
		Acc.	Dec.	Total
Outcome	Acc.	f_{11}	f_{12}	$f_{1.}$
	Dec.	f_{21}	f_{22}	$f_{2.}$
	Total	$f_{.1}$	$f_{.2}$	$f_{..}$

Note: The test is: $\chi^2 = f_{..}(f_{11}f_{22} - f_{12}f_{21})^2 / f_{1.}f_{2.}f_{.1}f_{.2}$, $df = 1$, where f_{ij}, $i = 1,2$ are the number of cases. Here the null hypothesis is that there is no correlation between forecast and outcome, which here translates into a naïve forecast that is a random choice between acceleration and deceleration.

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