BANK OF FINLAND
DISCUSSION PAPERS

12/98

Bharat Barot – Kari Takala

Economics Department
18.6.1998

House Prices and Inflation: A Cointegration Analysis for Finland and Sweden

SUOMEN PANKIN KESKUSTELUALOITTEITA • FINLANDS BANKS DISKUSSIONUNDERLAG

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ISBN 951 686 582 8
ISSN 0785 3572

Suomen Pankin monistuskeskus
Helsinki 1998

House Prices and Inflation:
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Abstract
Given the emphasis on price stability in monetary policy, the concern caused by recent rapid increases in housing prices are understandable. It is suspected that such rises may provide early indication of mounting inflationary pressure. The purpose of this paper is to formulate and estimate an error-correction system model for housing prices and inflation for forecasting purposes. By using the estimated cointegrating vector, we also get an estimate of the equilibrium level for house prices that might be helpful in analysing the current situation in the housing market and the stance for monetary policy.

Housing prices typically exhibit large cycles, and they are thus predictable to some extent. Volatility is caused by the fact that the supply of houses does not react perfectly to changes in housing demand. However, housing prices and inflation tend to have similar growth rates over the long run. In other words, houses provide a good inflation shelter, but in the long run, the real return to is equal to the explicit or implicit rental income derived from the owning of houses. The estimation results also show that the changes in the general price level are transmitted into house prices rather quickly, but inflation is surprisingly insensitive to housing prices. The equilibrium relationship between housing prices and consumer prices is also affected in the short run by variables such as interest rates, wages and the unemployment rate.

Keywords: House prices, inflation, cointegration

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Tiivistelmä

Asuntojen hintojen viimeaikaisen nopean nousun aiheuttama huoli on ymmär rahapolitiikassa korostetaan hintavakauden tavoitetta. Epäillään, että tällainen nousu ennakoisi kasvavia inflaatiopaineita. Tässä tutkimuksessa muotoillaan ja estimoidaan ennustamiseen soveltuva asuntohintojen ja kuluttajahintojen käyttäytymistä kuvaava ns. virheenkorjausmalli. Käyttäen estimoitua pitkän aika a-painoriippuvuutta (ns. yhteisintegraatiota) asuntohintojen ja kuluttajahintojen välillä voidaan arvioida asuntojen hintojen tasapainotasoa, mistä voi olla hyötyä analysoitaessa asuntomarkkinoilla vallitsevaa

Asuntojen hinnoissa on tyypillisesti suuria vaihteluita, ja ne ovat jossain määrin ennakoitavissa. Vaihtelun voimakkuus johtuu siitä, että asuntojen tarjonta ei jousta ksiin. Asuntojen hintojen muutoksilla on kuitenkin taipumus palautua inflaatiota vastaavaan pitkän aikavälin nousuvauhtiin. Asuntovarallisuus tarjoaa siten hyvän inflaatiosuojan, ja ajan mittaan sen reaalinen tuotto vastaa tosiasiallista tai (omistusasumisen tapauksessa) implisiittistä vuokratuottoa. Estimointitulokset osoittavat, että yleisen hintatason vaihtelut välittyvät asuntohintoihin varsin nopeasti, mutta toisaalta inflaatio on yllättävänkin vähän herkkä asuntohintojen vaihteluille. Asuntojen hintojen ja kuluttajahintojen väliseen suhteeseen vaikuttavat lyhyellä aikavälillä myös sellaiset tekijät kuin korot, palkkataso ja työttömyysaste.

Asiasanat**:** Asuntojen hinnat, inflaatio, yhteisintegroituvuus

Contents

Abstract		3
Tiivistelmä		4
1	Introduction	7
2	Determining house prices	8
	2.1 House price as discounted present value	8
	2.2 The user cost for housing	10
	2.3 Treatment of housing costs in consumer price index	12
3	Basic data description	14
4	Empirical evidence on house price relationship	17
	4.1 General evidence	17
	4.2 House and consumer prices system tests	19
	4.3 Estimation of the error-correction model	21
5	Conclusions	26
References		27
Appendix 1		29
Appendix 2		35

1 Introduction

Growing interest has been focused on the question of how much rising house prices actually signal increasing inflation pressures in Finland and Sweden. In many countries, house prices tend to follow large swings due to changes in housing demand and the fixed supply of housing. This makes house prices more or less predictable (see Englund and Ioannides, 1997). While the business cycle is usually coincident in these countries, the Finnish house price cycle has recently been somewhat ahead the Sweden. The central banks in both countries are keenly interested in the issue of whether large changes in house prices lead to changes in inflation expectations that could accelerate inflation. In this paper, we examine the house and consumer price relationship and address the general questions: What is the essential relationship between house prices and inflation, and to what extent do house prices adapt to inflation in the long run? We also test whether house and consumer prices are cointegrated and whether house prices are useful in predicting overall inflation.

Our enquiry immediately leads us to ask another question. Is the correlation of house prices and consumer prices spurious or do house prices actually cause and predict inflation? Long-run empirical evidence for many countries seems to confirm that housing expenditure shows near unit elasticity with respect to disposable income (Kennedy and Andersen, 1994). Several related equilibrium ratios such as the ratios between housing expenditure and disposable income and housing debt to housing wealth have been used in house price modelling (see Hendry, 1984). Apparently, house prices follow the cost-of-living index, but not the earnings index. In other words, households experiencing rising real earnings tend to increase their quantity and quality of housing. Housing investment costs tend to follow the general price index rather than long-run earnings.

Housing and non-housing consumption are alternative spending items. Consumer utility maximization should lead to a solution where marginal utilities equate and their ratio corresponds to the relative price between them. If cointegration exists, then the only problem is how to estimate the (dis-)equilibrium at individual points in time. To do this, we ask how the adjustment in such prices evolves over time.

Volatility in house prices has resulted in vast changes in household wealth in Scandinavian countries, specifically in Finland and Norway. Through the wealth effect in consumption house prices indicate changes in expectations and affect the business cycle. The effect of capital gains on consumption and saving depends on (a) the extent to which capital gains are persistent, and (b) how fast the economic agents realize the capital gains by selling and borrowing using a house as a collateral. During the last decade a large part of variance in house prices was attributed to the liberalization of the financial market, which led to the credit boom and thereafter increased demand for housing. Under the assumption of inelastic supply of houses, the only consequence of a credit boom would be a price bubble. The house price collapse was especially strong in Finland due to a coincident recession and collapse in exports. The collapse in the Swedish house prices was partly due to the tax reform in 1991, which drastically cut down the after-tax return on housing investments. Generally speaking, however, a constellation of forces conspired to cause the significant drops in housing prices that occurred in both countries.

The importance of the housing as a service, a form of consumption and an aspect of wealth cannot be ignored. In Sweden, housing wealth accounts for about 60–70% of household total wealth (Barot, 1995), while in Finland housing wealth constitutes around 55% of household aggregate wealth. As housing constitutes the largest part of household wealth in both countries, changes in house prices probably have effects that extend beyond the housing market. The owner-occupation rate is very high (around 70%) in Finland, while in Sweden it is less than half. This latter fact is also reflected in the correlation between house prices and indebtedness as household debt is mostly housing debt. Thus, increases of household debt reflect increases in house prices through increased housing demand as the housing supply is rather inelastic in the short run. In Finland, house prices are also more volatile than in Sweden.

There are various reasons for the close connection between house prices and inflation. Indirectly, rapidly rising house prices signal inflation pressures through excess demand for housing. House prices may also be among the most important indicators for signalling the future development of income expectations because of their role as present discounted value of housing services. This view is sometimes described as the affordability aspect. House prices may also be useful in predicting general inflation as well. Their macroeconomic importance is clear: a house is the largest investment good most people ever purchase or sell, roughly one-fifth of household expenditure relates to housing. Another feature deriving from the present value formula is the role of interest rates in determination of house prices. Indeed, changes in lending rates generally drive house price development.

Some difficulty in comparing the relationship between house and consumer prices arises because prices are treated differently in Finland and Sweden in calculation of the private consumption deflator (PCP) and consumer price index (CPI). If inflation is measured according to national income accounts, the private consumption deflator does not depend directly on house prices, since owner-occupied housing cost are measured through imputed rents. Therefore, housing prices do not enter into imputed rents apart from the effect that owner-occupied houses and rented houses are substitutes, which induces correlation between house prices and actual rents. In few countries – among them Finland and Sweden – the CPI applies a different approach to owner-occupied housing cost, where costs are measured based on capital user costs. In these calculations, market prices of houses affect inflation directly through depletion of the housing capital. Moreover, the interest rates of housing loans enter the calculations. As a result of the use of the CPI in wage negotiations it is quite conceivable that house prices have contributed directly to inflation. Capital costs of owner-occupied housing may also have significant effect on inflation expectations of households even though they do not directly affect the consumption deflator. In any case, for our purposes of modelling house and consumer prices, we want to eliminate any ’endogenous effects’ from the CPI, so we use the NSA consumer deflator.

We embark on our country comparisons by utilizing the extended present value formula as a basis for our forecasting system for housing prices and inflation. Since our goal is to specify a forecasting system, we use variables such as interest rate, wage sum, unemployment rate and bank lending as fundamentals underlying housing prices and inflation. We want to structure the explanatory variables in as similar a manner for both countries, but Finnish and Swedish housing markets are clearly separate markets. Thus, we do not take into account interrelations between the two. Some interactions are quite close; for example, major events in the stock market could trigger spillover effects into the housing market as well. Therefore we study also consumer, house and stock prices as a larger system. Our framework is a multivariate cointegrating vector autoregression approach, where long-term cointegration restrictions can be taken into account.

2 Determining house prices

House price determination usually follows one of two theoretical approaches, ie, houses are either treated as consumption goods or as investment goods. How inflation is measured depends on the approach chosen. In the following, we review the approaches to clarify and to justify why we postulate the cointegration between house and consumer prices and how our empirical estimations may be deficient.

2.1 House price as discounted present value

Before modelling housing prices, we need a theory of house value. A house can be seen as a capital (or investment) good which provides a flow of real housing services over time,[1] but there are also many further distinguishing features such as location and connections to communal services that are not related to the building as such. House purchases are partly based on such service features, where no clear distinction with the environment can be made. Indeed, neighbourhood is one of the most important determinants of housing prices. On the other hand, such location constraints further contribute to the inelasticity of housing supply. Other factors could be lags in planning and zoning for land use by communal administrators. Property taxes are effectively indirect payments for communal services, so they should be taken into account in calculating net property income.

Thus, the present value of a house may be defined as a subjective discounted sum of forthcoming housing services

[1] In National Income and Production Accounts (NIPA) and SNA accounting housing is a investment good, not a durable consumer good like cars and boats, which are accounted into consumption by purchases. Therefore housing services are also accounted as a net rent of the invested capital.

$$PV = \sum_{t=1}^{N}[\frac{R_t}{(1+r)^t}] \rightarrow R/r, \text{ when } N \rightarrow \infty \;\&\; R_t = R \qquad (1)$$

where PV denotes the present value, R_t is the net rent (gross rent - expenses) at time t, r is the subjective time preference (or in market equilibrium the interest rate) and N the life span of house in years. When the housing market is competitive, PV = P_h = R/r, where R is the market rent. Here we simply denote house price (P_h) as equal to housing value, since for single dwelling the square price for each housing unit can be thought to be the same. Of course, the size of dwellings varies and the price per unit of floorspace usually declines as a function of size. However, the size of the dwelling does not vary over time, so house price remains proportional to its housing value. It can be seen from the present value formula that nominal interest rates are negatively correlated to house prices through heavier deflation of housing services. Expected increases in interest rates will reduce housing demand. The equilibrium level of housing demand will be affected by the real interest rate, particularly during periods of steady inflation. In a steady inflation regime, it is common that expected and actual inflation match and no effects related to unexpected inflation appear. The value of a house should have a limiting value of ratio between rent and interest rate when time approaches infinity. In other words, the rent should correspond to the alternative return for the housing investment, ie R = r P_h, which may look more familiar. In most cases, the market price or the rent is observable, so an unobservable return rate can be estimated based on them.

Thus, while the value of a house can be interpreted as present discounted value of housing services, the present value theory reflects a basically long-run equilibrium approach that smooths over short-run changes in house prices. It should be remembered that all assets have two components of return, namely capital income and appreciation (price changes) ie in case of housing (Varian, 1987):

Housing yield = Rental capital income (explicit or implicit rent) + appreciation,

which is analogous to stock market yield composed of dividends and price appreciation. With assets such as houses, land and stocks, price changes tend to dominate the short-run development of the total yield. For pure financial assets (deposits, debt), nominal appreciation is by definition zero and compensation for inflation is incorporated into the capital income (interest payment) component. With stocks, for example, both the price change and dividend are directly measurable. For owner-occupied houses, however, the rent return is neither directly observable nor realized in money terms; total yield has to be calculated. Further, unlike profits, dividends are usually smoothed and compensated, so stock price changes and dividends correlate negatively very strongly. Thus, we do not analyse the total return of housing, but instead concentrate on the relationship between house prices and inflation. In fact, one of the major arguments put forward in this paper is to show that the expectation of house price appreciation is zero in the long run.[2] This means that the expected capital gains on housing are not only stationary, but also a zero mean variable. Therefore, the only permanent return component left in the long run for owner-occupied houses is imputed rent – keeping a dwelling empty can be profitable only if there is short-run price appreciation.

We adopt an approach analogous to Villani (1982) with slight modifications to make it more suitable for our purposes. We define the house price consisting of three present value components namely; housing services, home ownership tax advantages and mortgage finance. Basically, we need to form a capital user cost expression for home ownership and calculate real return for home ownership net from financing expenses and taxation. To simplify the presentation, we do not take into account any specific financing arrangements available in Finland and Sweden, rather we assume that the lending rate equals the opportunity cost of capital. Several assumptions need to be made before we are able to present the equilibrium house price as the supply price for housing services.

We postulate a long-run relationship between consumer and house prices. Since our models are based on cointegration analysis of house and consumer prices, we have to provide explanation for this equilibrium mechanism between these variables. In the user cost calculations consumer goods and housing are

[2] In fact the same applies for stock prices also, since eg in Finland the mean of real stock prices (deflated by cost-of-living index) does not differ significantly from zero for period 1922-97.

alternative expenditure items and by cointegration their relative price is assumed to be stable. Consumption capital asset pricing model (CCAPM) implies marginal utility of consumption to be equal to real return for housing (eg Breeden 1979, Kazemi, 1988). Briefly, cointegration follows from the fact that marginal utilities from different kinds of consumption tend to equate, which leads to a stationary marginal rate of substitution. As marginal utilities equal real after-tax return in the long run, indirectly appreciation of houses equals inflation, and no excess real return emerges. Equal expected returns will also lead to cointegrated price indices.

2.2 The user cost for housing

In order to comprehend the relationship between house and consumer prices, we have to consider the choice between consumption on housing and on other goods, and their price formation. The cointegration between these two prices is not self-evident, since in general there is no obvious economic forces that will converge prices of two separate goods.[3] Markets are usually defined for single homogenous goods. As an analogue to the stock market, there is no guarantee that stock prices of two separate firms will develop in the same way. Firms can also be bankrupted and their shares may turn out to be worthless. As stock market indices usually account the prices of limited number of firms, there might be bias due to the bankrupted firms. However, when we aggregate and diversify our holdings between firms, their development will soon converge to the behaviour of the overall stock market index. When we are comparing two wide markets like housing market and stock market in general, there may be some strong long-run relationship between them.

As a result of positive demand shocks in the housing market, eg due to demographic factors, tax changes, the house prices will increase since the supply of houses is fixed in the short run. Housing production will take time and significant lags appear also because of land restrictions, planning and financing time lags, shortages in building material etc. The consequence is that housing market adjusts sluggishly to changes in demand. The only policy recommendation to smooth house prices changes seems to be affecting the variability of the demand.

The calculation of the cost of housing services is not totally straightforward, since the costs and benefits of home ownership do not always appear in money form. Since house is a durable asset, we have to use present value calculations to approximate what consumers truly expect. A house will produce a long lasting stream of housing services with adjustment costs, therefore housing consumption is a dynamic problem. First we have to list and measure all the income and expenses due to owner-occupied housing. For owner-occupants costs are largely unobservable and the imputed income have to be computed. Especially we have to decide how to treat possible capital gains and how to import the whole tax code into calculations.

Broadly speaking the alternative use for housing services supplied by a dwelling is simply consumption to other goods. In practice, renting a dwelling is a direct alternative to buying a dwelling. In technical terms owner-occupied housing services are supplied by a durable housing stock, while non-durable consumption is a flow (Van Order and Villani, 1982). These two different dimensions of the problem makes it suitable to analyse it in an optimum control analysis framework. Buying a large durable item such as a house forces the consumer to finance part of the purchase through lending. It is possible to separate two different interest rates applied to different types of capital. Formulating an optimal control problem does not take into account indivisibilities and treats housing capital as a continuous variable. It is possible to increase housing capital by making housing investment, but housing capital is also subject to technical consumption that depreciates the real housing capital at an almost constant rate. Households can also make financial savings through excess income over consumption and save in the form of amortizations. In this model, financial savings deposited to banks produces interest return, which is lower than the borrowing rate. In analogue to depreciation faced by housing capital, financial saving is subject to inflation, which depreciates the purchasing power. The real return for savings is approximated therefore as nominal

[3] However generally, price indices for goods grouped by use do not converge in the long run; preferences may change, tax treatment may be indexed, etc.

interest subtracted by inflation. In addition nominal interest is subject to capital income taxation. In this sense government taxes also purely nominal return caused by inflation.

It can be derived that the user cost of housing capital equals the marginal rates of substitution (MRS) between housing capital and consumption

$$\frac{u_h}{u_c} = [(1 - t_c)r - \pi + \delta]p_h / p, \quad (2)$$

where u_h and u_c are marginal utilities with respect to housing and consumption, p_h and p house and consumer prices respectively, t_c is currently the capital rate (due to tax rules in Finland and Sweden), r is the interest rate (lending and borrowing rates are equal), π is expected house price inflation (appreciation) and δ is real depreciation, which can be assumed to include property taxes and transaction cost (see Brown et al 1997, p. 534).

The marginal rate of substitution reflects the amount of money that has to be given to the consumer to compensate for one lost unit of housing (eg one unit of floorspace). This equation is based on comparison of alternative costs. In the capital market equilibrium, the real rental price of housing must equal the real user cost and clear the market for housing services and housing capital markets. The expression presents a measure of housing cost with respect to prices of other consumer goods. Housing cost is an increasing function of the after-tax nominal interest rate, while inflation decreases the opportunity cost of housing. If 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. In a similar way, an increase in the capital tax rate for other assets (capital gains on houses are tax exempt) will raise real house prices as the value of the tax advantage increases.[4] Thus, an important implication concerning the regime for permanently low inflation is that it will lead to lower relative house prices (Holly and Jones, 1997 p. 554).

Naturally, depreciation is also an expense to the homeowner. As said, this formula indicates that when we aggregate different goods across the market, marginal utilities tend to equate as consumers are maximize their utilities (see eg Varian, 1984). Over time the price vector between house and consumer prices forms a stable temporal equilibrium. Assuming asset market equilibrium, the real rental price of housing (R_t/p) equals the real user cost. The rental price R_t clears the housing services market, which gives us

$$\frac{R_t}{p} = \frac{u_h}{u_c} = [(1 - t_c)r - \pi + \delta]\,\frac{p_h}{p}, \quad (3)$$

For owner-occupied houses true rental price R_t is unobservable, but can be approximated as a function of some income measure (permanent, disposable income or wages), added with possible demographic variables and existing stock of houses. Therefore, the rental price is determined by variables that affect the demand and supply of housing (Breedon and Joyce 1993, Brown et al 1997). The nominal house prices can be written as function of consumer prices, income, demographic variables (DEMO), housing stock (HW) and the user cost expressed in the specification below

$$\ln P_h = f\{\ln(P), \ln(Y), \ln(DEMO), \ln(HW), \ln[(1-t_c)\, r - \pi + \delta)]\}. \quad (4)$$

This specification can directly be estimated either by linear regression or, eg a time-varying coefficient model. Cointegration between house and consumer prices can be modelled using error-correction models (ECM). In empirical models, the user cost variable can be conveniently decomposed into nominal user cost and a capital gains variable as these components are likely to behave very differently.

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4 In principle capital gains are taxed in Finland and Sweden. In Finland, owner-occupied dwellings are tax exempted after two years holding. Capital gains on non-owner-occupied houses are taxed effectively with lower rate than other capital income, since houses are held on average almost 10 years, which postpones the tax payment (Varian, 1987 p. 204). Due to special tax rules owner-occupied houses are effectively tax exempted in capital income and capital gains taxation.

2.3 Treatment of housing costs in consumer price index

The treatment of housing costs for owner-occupied housing is based on capital user cost formulas in few countries like Finland, Sweden and the UK. The problem arises with the measurement of the unobserved imputed rent for homeowners. For rented flats and houses, gross rents are directly observable and no ambiguity could arise. In national accounts, measurement of home ownership costs is based on corresponding rental expenses, which are likewise also not observed, but could be more reliably evaluated than capital costs.

Applying the user cost formula above, we can rewrite the nominal housing costs for owner-occupiers as

$$\begin{aligned} C &= M + r_A(1-t)((1-\delta)H-L) + r_L(1-t)L - \Delta P_h \\ &= M + r_A(1-t)((1-\delta)H-L) + r_L L - t r_L L - \Delta P_h \qquad (5) \\ &= M + (1-t)r_A(1-\delta)H + (1-t)(r_L-r_A)L - \Delta P_h, \end{aligned}$$

where C = housing costs, M = maintenance costs, r_A = alternative return, r_L = lending rate for housing loans, L = housing loans, t = marginal tax rate, H = gross housing wealth, δ = depletion of housing capital and ΔP_h = appreciation of the housing capital.

Housing costs are a sum of maintenance costs, alternative costs accruing from ownership of the housing capital, borrowed capital interest payments and possible appreciation/depreciation of the housing capital. Housing capital is also subject to constant depletion that erodes the housing wealth. All the components except return of the ownership, ie imputed housing income, are observable. In the SNA statistics, only actual money transactions are measured.

Buying large durables such as houses usually involves using external financing and thereby making it necessary to divide capital into own and borrowed capital. In most cases, the lending rate exceeds the return from the alternative investment. If perfect capital markets are assumed (r_L-r_A) disappears as lending rate is assumed to be equal to return of the alternative use. In this case, the equation reduces to

$$\begin{aligned} C &= M + (1-t)r_A(1-\delta)H - \Delta P_h \\ &= M + (1-t)\delta H + (1-t)r_A H - \Delta P_h, \end{aligned} \qquad (6)$$

This assumption would eliminate the need to include separate interest payment costs into the formula. Maintenance cost can be defined as the cost that keeps the capital value of the housing wealth intact. In this sense the items M and $(1-t)\delta H$ are similar. Assumption of perfect capital markets is however unrealistic. Calculations performed in the National Statistical Offices are based of other kinds of simplifying assumptions. We can first write the previous equation into a form

$$C = M + (1-t)r_A(1-\delta)H + (1-t)(r_L-r_A)L - \Delta P_h \qquad (7)$$

(7)

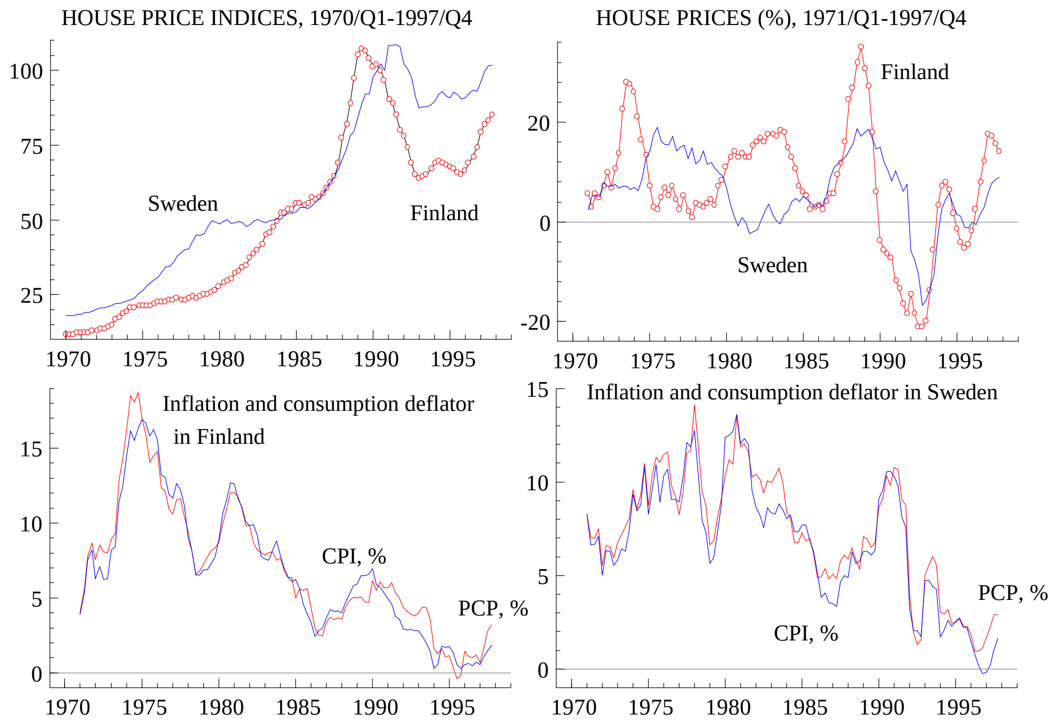
$$= M + (1-t)\delta H + (1-t)r_A H + (1-t)(r_L-r_A)L - \Delta P_h.$$

In Finland, the third component, which measures the imputed return of the housing capital, and the appreciation term measuring the changes in the value of housing capital are assumed to eliminate each other, ie $(1-t)r_A H - \Delta P_h = 0$ (Lehtinen and Koskenkylä, 1988).

This assumption simplifies the measurement of owner-occupied housing costs significantly since it avoids estimating the unobserved imputed housing income. It also allows us to get rid off the very volatile appreciation component in housing capital. The house price development is not washed out entirely, however, since market house prices are used in valuing the depletion of the housing capital. These simplifications are by no means harmless, at least in the short run. If we think that the total return of the gross housing is compounded of two components, namely return and appreciation, it is more realistic to assume that in the long run there is no real appreciation, which means that appreciation of houses equates to inflation. In this sense, housing capital affords a perfect shelter for inflation, but not much else.

In real terms, only the imputed return is left as a return for housing wealth. This accords better to what we have in mind when we are buying houses and expect return in form of housing services. This imputed rent makes the basis of the housing wealth as an asset, not the expected rise in value due to price changes that may be negative also. Anyway, the formula used in Finnish CPI calculations for owner-occupied housing costs reduces into

$$C = M + \delta H + r_L L, \tag{8}$$



which leaves us only maintenance cost, depletion and interest payments of housing loans as housing costs. In Sweden cost of owner-occupied houses include similarly interest payments, depreciation, insurance, maintenance and preparation costs plus real estate taxes. Up to 1984 value of net housing capital was based on purchasing prices, which were updated by maintenance costs reduced with borrowed capital. The return of own capital has been based on average deposit rate and for borrowed capital the average bank rate accordingly. From 1984 onwards in Sweden depreciation has been calculated from market values of houses with 1.4 percent depreciation rate.

The problem with our forthcoming estimations about the relationship between house prices and inflation makes CPI a slightly endogenous to house prices. Therefore, we prefer to use private consumption deflator (PCP) as a measure of inflation in cointegrating relation. Figure 1 shows the difference in CPI and PCP caused by treatment of houses as either consumption or investment goods. The PCP calculation treats owner-occupied housing as consumption goods and calculates imputed rents for owner-occupied houses. In these calculations, house prices do not directly affect the housing costs.

For the Swedish data we also use a consumption deflator that does not include CPI-type calculations for home ownership. In Sweden, this problem is not as serious as in Finland, since the share of owner-occupied housing is much smaller than in Finland. In Sweden, however, the vast subsidies devoted to housing may affect the efficiency of housing markets. In Finland, subsidies to housing are also considerable, but they are mainly directed at rental housing production. The volatility in housing prices is something that arises from a rigid supply of houses that does not react to rapid changes in housing demand. If we want to reduce house price volatility, we have to smooth directly housing demand.

Figure 1. **House prices and inflation in Finland and Sweden**

3 Basic data description

In both countries, house prices were affected by the lending boom due to financial liberalization of the late 1980s (Figure 1). The figure also presents house price effects on difference between CPI and PCP. In Finland, the collapse in house prices was most severe during the recession and matches the actual decline in economic activity and household disposable income. During 1990–93, GDP fell altogether 14% in Finland. In Sweden, house prices fell by 20% in a short period (about 18 months), while in Finland nominal house price decline was almost 40% and extended to 1996. In Finland, the volatility in house prices measured from peaks and troughs has also been somewhat larger, which may relate to the higher share of owner-occupied housing and higher variance in economic activity. The possibility to move to rental housing tends to smooth the variation in house prices, since they are substitutes to owner-occupied housing. In both countries, the latest upward swing started in 1996. It is very likely that current swing may persist for at least 3-4 years as in both countries house prices were significantly below their long-run equilibrium levels. Households are still rather cautious in using debt finance in housing purchases and investment.

Shortly after financial deregulation, the Swedish economy began to slide into recession. 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. After devaluation in Finland 1991, Sweden followed a similar route in 1992 with a decline in domestic consumption and investment demand. By 1993, house prices had dropped by 30% across the country. Englund et at (1995) estimate that about one-half of a per cent of this fall in house prices was due to the effects of the tax reform 1991, while 8% was caused by the fall in real GDP. The 1991 tax reform implied that the previous prevalent subsidies were removed both for the households and the suppliers ie the builders in the building industry. In addition the debt deflation process were prevailing in the Swedish economy up to late 1993. The boom in consumption was originally financed by equity withdrawals and households borrowed against rising housing wealth and used the proceeds to finance consumption, therefore a collapse even in nominal prices was possible. The basic story behind house prices is rather similar both in Finland and Sweden.

The relationship between house prices and consumer prices may look at first hand rather weak in Finland and Sweden, but instantaneous correlations are still high in both countries. In Finland, correlation between annual change in nominal house prices and inflation reaches 0.58; in Sweden it goes as high as 0.35 (Figure 2). There are many reasons for house price collapse in early 1990s both in Finland and Sweden including smaller tax deductions, higher real interest rates and tighter bank lending policy. This led to a slowdown in bank lending in both countries, as it was correspondingly one of the reasons for house price overheating as well. Monetary expansion is one of the main background factors for asset price inflation. At the same time companies found it more reasonable to raise funding from the capital markets, households increased their bank lending. While the bank lending constraints were eased it allowed households to use the tax benefits related to borrowing. Financial liberalization together with tax distortions triggered the boom in house loans.

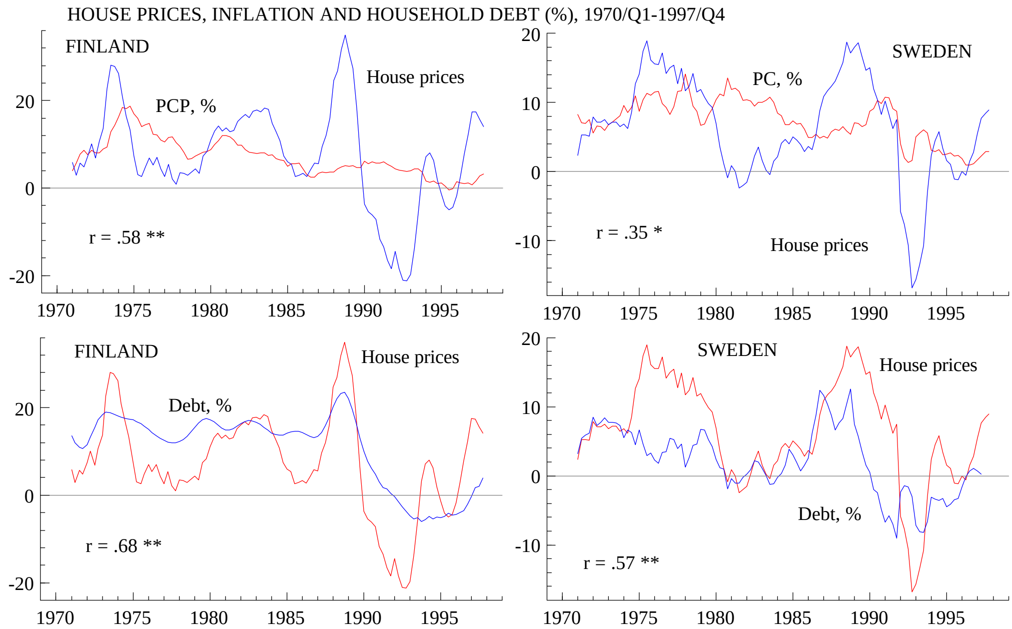
By treating houses as assets we can also compare house and stock prices for evidence of cointegration as well (Takala and Pere, 1991). In Finland, the relationship between house and stock prices has been closer than in Sweden (Figure 3). Stock market prices in Helsinki and Stockholm have diverted from domestic asset markets mainly because of increase in telecommunication share prices and their globalized ownership. Therefore, cointegration, for example, between stock market prices and house prices based on capital market efficiency is rather difficult to demonstrate at the moment.

The affordability aspect to housing ownership can be clarified by looking at the house wealth valuation with respect to disposable income (Figure 4). The affordability aspect has frequently been related also to house price ratio to disposable income. In the long-run housing wealth should be proportional or at least stationary to disposable income as housing services consumption is expected to be near unit elastic with respect to total household expenditure. Our time period is however unique in this respect. In Sweden the indebtedness ratio has not yet normalized very much after the deregulation of the credit market in 1980s, while in Finland the indebtedness ratio has declined remarkably. The increased indebtedness in late 1980s has affected also the ratio between market house prices and disposable income. It should be noted that there is statistically significant declining trend in house prices-disposable income ratio in both countries, which is related to increasing standard of living as earnings index has increased faster than cost of living index.[5]

One reason behind the decrease in the popularity of debt financing after 1990s recession has been the increase in after tax real interest rates. In both countries real after tax rates have become strongly positive during the 1990s (Figure 5). In Finland the deductions of housing interest payments were restricted severely by the introduction of new capital income tax in 1993 that limited the interest deduction rate first to 25%, while the benefit rate had been on average close to 50 earlier when income tax rates were applied. In Sweden similar changes in the tax code had taken place already from the beginning of 1988 and 1989. The tax wedge between real market interest rate and effective after-tax of housing borrowing contributed therefore significantly on the asset price boom and crash. By theory, the size of the tax wedge becomes larger with higher inflation and with higher income tax rate.

In the short run, house prices are largely demand determined. House price development in both countries was also affected significantly during early 1990s by a slowdown in real disposable income. With increased income expectations in the last couple years, house prices have started to rise again.

Figure 2. **House prices and private consumption deflator, %**



[5] In the UK however, real house prices and real disposable income have followed similar trends. UK changes in income and house prices have also correlated strongly (Brown et al, 1997).

Figure 3. **House, consumer and stock price indices**

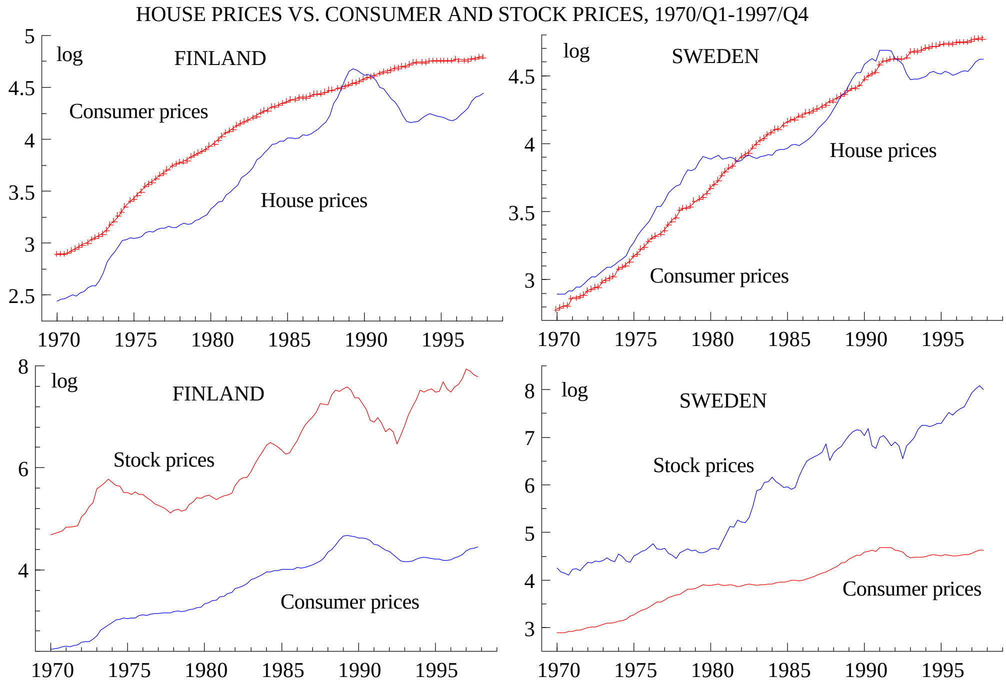


Figure 4. **Housing wealth, house price and indebtedness ratios**

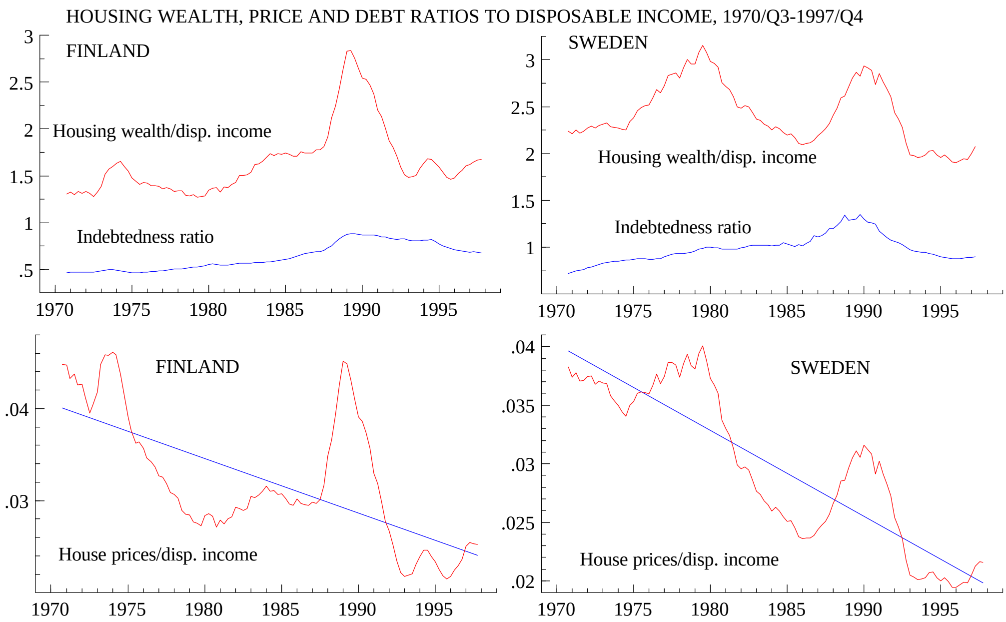
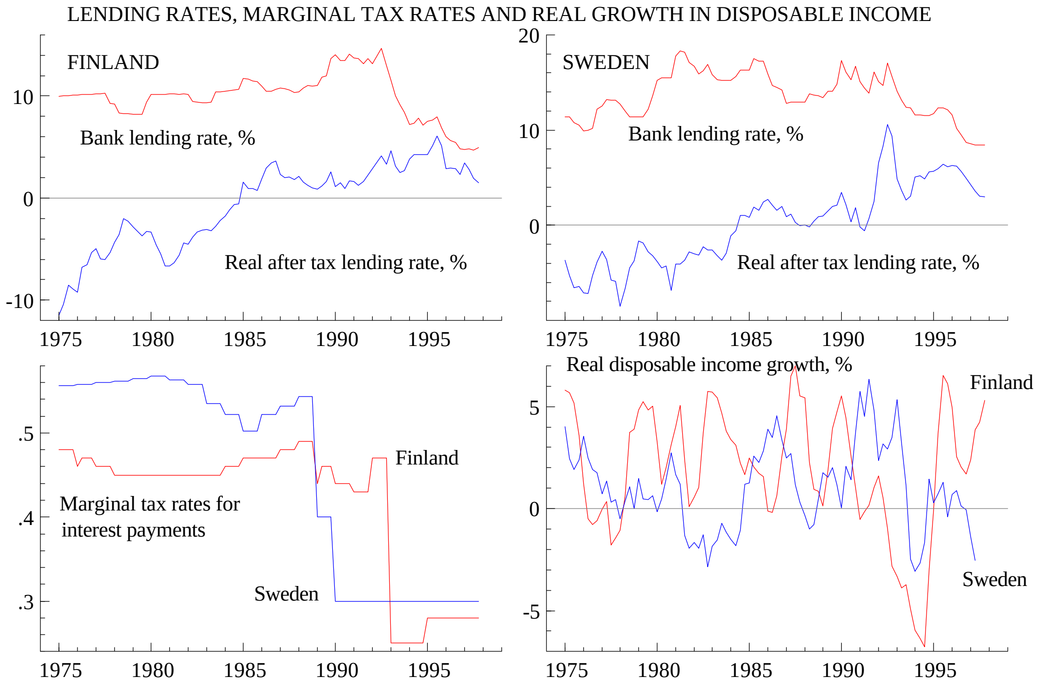


Figure 5. **Lending rates, tax rates and income growth**



4 Empirical evidence on house price relationship

4.1 General evidence

Table 1 provides and compares the basic statistics for Finnish and Swedish house prices and inflation from the beginning of 1970 up to the second quarter of 1997. The means and standard deviations are surprisingly close to each other for each country, even though our estimation period is not particularly long. Even though means of house price changes are rather close to inflation in both countries, the individual price changes are even closer for each country over the period. For comparison table 1 reports also price changes in housing investment and stock prices.

From the theoretical point of view, it is not surprising that old house prices and housing investment prices converge to each other as housing stock is naturally renewed by housing investment. Although new houses are better outfitted, and there is a quality difference between them, old and new houses are close substitutes, and this keeps their price development tied together (Figure 6). Indeed, old house prices and housing investment prices are also cointegrated. Also, while stock market price changes have been much more volatile than house prices during the sample period, the mean of stock prices is rather close to that of house prices.

Figure 6. **House prices and housing investment prices and shock profiles**

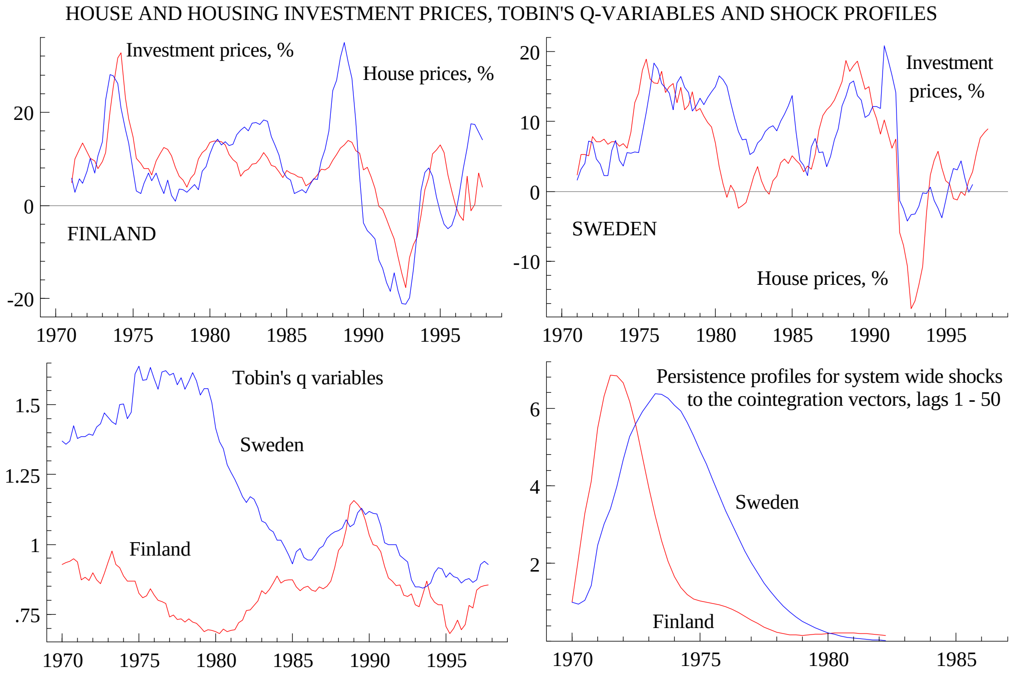


Table 1 (in Appendix 1) reveals that for Sweden the normality of house prices is rejected. This is due to outliers in the data during the period 1990–91. In Finland, inflation includes surprises during early 1970s oil crises. More significant from our viewpoint, however, is the observation that excess return from houses seem not to be different from zero in the long run.

Rising house prices will make the house purchase more difficult for average families. This affordability aspect will limit demand for owner-occupied housing and eventually slows the increase in house prices. The restriction caused by affordability limit becomes even more severe for very small dwellings due to indivisibility and for very large houses because of total value. The consequence of this affordability limitation is stickiness in the house prices. House prices do seem to have a unit root, but there is predictable inertia in these prices that cannot be overlooked. Intuitively this inertia could arise from the production lags in the housing supply.

A variety of unit root tests showed unanimously that the null hypothesis of a unit root cannot be rejected for the indices of house and consumer prices. The same tests applied to log differences of these indices show that house and consumer prices are most likely integrated of order one. Possible cointegration between house and consumer prices prerequisites that these series are integrated.

Additional clarifying information about the nature of the data generating processes can be get through analysing these series by structural time series models (see Harvey 1989). The decomposition of the house prices into trend, seasonal and irregular components reveals that there is no significant drift in house prices and a pure random walk in levels is a more proper description of the process for both countries. There are weak signs of seasonal variation in house prices, but seasonal terms are not statistically significant at the 5% confidence level. It is as hard to try to identify any significant irregular components from the univariate house price processes, which points out that the shocks to house prices are more likely permanent. These results seem to convince us that housing markets are rather efficient and that house price adjustments do not indicate large deviations from market equilibrium as such. House prices are determined by other fundamental factors like income, interest rates, but house prices work efficiently in equating the demand and supply (see also Kosonen, 1997).

In general, the same observations apply to quarterly consumer prices. They are also close to pure random walk processes that do not include any drift, irregular or seasonal components. It must be emphasized, however, that monthly consumer price indices usually exhibit a clear seasonal pattern, due eg to tax changes at the beginning of the year and seasonality of some food commodities.

The system estimations were started by looking at bivariate house and consumer price systems. The first decision in cointegration testing is the selection of the VAR order used in system rank identification. Frequently model selection criteria would suggest different choices of order. For Swedish house and consumer price system, Akaikes information criterion (AIC), Hannan-Quinn criterion (HQC) and Schwarz's Bayesian criterion (SBC) proposed unanimously that five lags should be optimal. For Finnish price systems VAR orders 2 and 5 were both likely candidates. The diagnostics of the residuals, however, suggested that five lags should be selected to confirm the white noise properties. As the adjustment of house prices with respect to consumer prices seems to be slow due to slow reaction of housing supply selection of a high VAR order seems also more appropriate.[6] There is slight risk choosing the order too high for overparametrization, but we also know that the adjustment of house prices is rather sluggish.[7]

Another important task before getting into actual cointegration testing is to find out what kind of deterministic components are included in the house and consumer price system. Testing the existence of deterministic components such as intercepts and trends in the data or cointegration relations would have important implications for the asymptotic distributions of the rank statistics. Certainly, the choice of the cointegration rank is one of the most important single decisions to be made in system modelling, since all the inference on hypothesis is conditional on the chosen rank. In economic applications, a trend is rarely needed in the cointegration space and more likely test results of that kind would rather indicate from other important missing variables. A constant could be included into system to allow a drift in nonstationary series and a overall mean in stationary variables. Including trend would be harder to explain, since we do not expect to find any linear or quadratic trends among price indices or in particular within the cointegrating vectors. Our series also had the same base year, although the means for Finnish house and consumer prices are quite different. For Swedish series, the means were almost identical.

It is thus quite unrealistic to assume that house or consumer prices include any deterministic trends, even though consumer prices look rather linear in logs. However, it remains an empirical matter to include a constant term in the cointegration relations as the differenced series have almost equal means. The selection of the rank and deterministic component should be made jointly (see Hansen and Juselius, 1995 p. 68). For Finnish and Swedish bivariate price systems, in particular, the rank of one and model without deterministic component were chosen, although for Finnish data separate system deletion tests for constant and trend this seemed to cause doubts.

Finally the Finnish model was estimated without any deterministic components. Whereas inclusion of a constant did not change the results of the Swedish model much, including a constant into the unrestricted model affected the Finnish results considerably. This is probably due to the near linear trend in the log of consumer prices. Without a constant, cointegration is found; with unrestricted constant, cointegration tests fail. For the Swedish price system, cointegration is found easily with or without an unrestricted constant.

4.2 House and consumer prices system tests

In order to get a closer look to the relationship between house and consumer prices, we start testing by scrutinizing the simple bivariate system. We test cointegration by using the efficient Johansen maximum likelihood approach, which enables us also to identify several cointegration relations simultaneously. Table 2 presents the ordinary cointegration tests and basic tests for stationarity, exclusion and weak exogeneity for both countries. The long-run exclusion test is based on restriction H_o: $\beta_i = 0$, where i indicates the endogenous variable. The test for weak exogeneity is similarly done by imposing H_o: $\alpha_i = 0$ on the adjustment parameter. The common maximum eigenvalue and trace cointegration tests, which are used for testing the number of cointegration relations, are the following

$$\lambda_{maxl}(r, r+1) = -T\ln(1-\lambda_{r+1})$$
$$\lambda_{trace}(r) = -T\ln\sum_{i=r+1}^{n}(1-\lambda_i), \qquad (9)$$

[6] It is obvious in practice that the lag length chosen affects the significance of the cointegration rank tests. When the VAR order is selected too long, the number of identified cointegration relations tends to get smaller. If the rank chosen is too small, the tested hypothesis is rejected too often (Hansen and Juselius, 1995 p. 8).

[7] In most applications with quarterly data, a second order VAR is sufficient.

where λ's are the estimated eigenvalues of the characteristic equations, T is the number of usable observations and r is the rank of the long-run matrix (π). The number of the cointegration vectors (r) is always smaller or equal to the number of the endogenous variables (n).

According to cointegration tests, there is likely one stationary linear combination among prices in both countries and the homogeneity tests more or less confirms that house price and consumer prices do not drift apart in the long run. For Swedish data, the homogeneity restriction ($\beta_1 + \beta_2 = 0$) is rejected at 4.1% significance level, while in the Finnish data restriction remains in power. In a bivariate system, two cointegrating relations would mean that original variables are not trended, ie stationary, which surely is not the case. Price indices are clearly non-stationary and neither of the variables could be excluded from the cointegration relation. For both countries, weak exogeneity is strongly rejected for house prices, while consumer prices are not rejected for weak exogeneity. However, it must be emphasized that results concerning weak exogeneity would easily change depending on the particular system tested or even sensitive to chosen lags in the VAR system.[8]

The theory is not in contradiction with the idea that house prices are endogenous and consumer prices could be exogeneous for both countries. After all, it is more likely that house prices will adapt to consumer prices in the long run than the opposite. Consumer prices reflect the overall expenditure prices, but house prices only the share of housing expenditures. It many countries it has been observed that housing expenditure tends to have unit income elasticity in the long run. In the short run, deviations are bound to exist. In Finland, for example, the share of housing expenditure from total expenditure rose due to recession. In Sweden the share of housing expenditure has been relatively stable around 21–24 percent.

In general, it seems possible to present a system model for house and consumer prices based on cointegration between these series. Cointegration will limit the long-run development of the price series, especially house prices, but we can add an error-correction term into the model as well. This error-correction term should also Granger cause either one of the cointegrating variables. In the short run, there can be a bundle of variables affecting house and consumer prices separately.

Granger causality tests were applied for stationary quarterly differences to find out in which direction the predictive causation runs (Table 3). For Finnish data, Granger causality tests between house and consumer prices revealed little of interest, but in the Swedish data, we found that consumer prices seem to affect house prices strongly in the short run. In both countries, house prices effectively predict changes in the unemployment rate as house prices predict income expectations and income uncertainty. There exists a more direct link between house prices and wages as house prices predict changes in wages. House purchases are based on forthcoming wages as debt financing forms an important part of the transaction. Granger causality tests were also performed for trivariate system blocks. In both countries, house prices were Granger-caused by consumer and stock prices, but there were feedback effects as well in Sweden. Based on these empirical findings, we could formulate a bivariate system model for house and consumer prices. Instead, we will continue to see whether a more general enlarged system might be achieved by adding stock prices into the system.

[8] These results were obtained by using five lags in the VAR; with only two lags, the Finnish results were just the opposite.

4.3 Estimation of the error-correction model

In order to evaluate more broadly the equilibrium house prices, we turn to analysing larger price systems. With three or more variables, there may be more than one cointegration vector, and the presence of multiple cointegrating vectors can be tested only in the Johansen framework.[9] Another motive for doing this was to be sure that house and consumer price relationship is not a part of a larger asset price cointegration system. This framework also allows us to analyse a wider scale of hypothesis and the speed of adjustment of the parameters.

In Tables 4 and 5 we present cointegration results from three variable endogenous system of house and stock prices and consumer prices. The null hypothesis is again non-cointegration, which is rejected also in this larger system. In this system we used bank lending rate for new loans as stationary I(0) exogenous variable for the price system.[10] Adding stationary variables into system would otherwise increase the cointegration rank, although robustness of the system can be tested by adding stationary variables into system. The weak exogenous tests performed showed that this intuitively appealing assumption could be made for both countries. The exclusion tests showed, however, that the lending rate cannot be eliminated from the determination of the long-run equilibrium (which does not entirely accord to our beliefs). Economic theory suggests it would be more likely that the stationary interest rate does not belong to the core of the system of trended price indices.

In the trivariate price system the VAR length selected as five for both countries, though for Sweden even this did not seem to be quite sufficient as can be observed from the system diagnostics. The rank of the matrix is equal to the number of its characteristic roots that differ from zero. Quite clearly according to eigenvalues and cointegration tests only one cointegration vector is found, therefore only one linear 'equilibrium' combination between variables is stationary.

Then the rank of the long-run matrix (π) is one and hypothesis of the matrix of cointegrating parameters (β) and their adjustment parameters (α) can be estimated upon this assumption $\pi = \alpha\beta'$, where α and β are both (n x r) matrices. The rank of the long-run matrix also equals the number of cointegrating vectors. If this relationship is homogeneous, the interpretation would be that income can be either consumed or invested into housing assets or into the stock market.

As we should expect according to present value formula, the lending rate could be seen as one determinant of price in both countries. For both countries a four variable system exclusion tests implied that no variable could be eliminated from determining the β-vector. Nearly the same result was duplicated when lending rate was given a status of weakly exogenous variable included into the cointegration space. For Sweden, though, stock prices were now supposed to be excluded. The deletion of the stationary lending rate from the system was strongly rejected for Finnish data (with p-value of .001 in the LR-test) and for the Swedish data as well (with p-value of .002).

Adding stock prices into the system did not alter the finding about only one cointegration relationship, although as alternative asset prices house and stock prices could be cointegrated separately as well. According to estimation results, the relationship between house prices and consumer prices clearly dominates the cointegrating vector found. Since we are particularly interested in the long-run equilibrium of house prices, we must look at the imposed restrictions on the cointegrating ß-vector, which have the form: H_o: ß = Hϕ.

After testing the zero homogeneity of the β-vector, we found that it somewhat surprisingly rejected Finnish data at a probability level below 1%. Imposing restriction $\beta_1 + \beta_2 = 0$ was also was strongly rejecting in this system. For the Swedish data, zero homogeneity was not rejected below 5.6% probability. Results are seldom as clear as one would hope, especially in system estimations, so we simply have to make choices about which route is the most promising to follow in empirical work. The rejection of the homogeneity is however more related to inclusion of the lending rate, rather than inclusion of the stock prices.

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[9] For instance, adding house investment prices into system would break the weak cointegration between house and consumer prices, since the relationship between house and housing investment prices would dominate the cointegration relation.

[10] Here we have used the Microfit 4.0 package, which allows stationary exogenous variables within the cointegration VAR system (Pesaran and Pesaran, 1997).

Having analysed these trivariate price system tests it appeared that the stock prices could be more properly used as weakly exogenous variables. Stock prices did seem to have a rather minimal effect on the long-run solutions a well. Partly this may reflect the fact that housing and consumer good markets are much broader markets and more important for the whole economy. For example in Finland, the number of individual investors dropped to a half during the recession in early 1990's. In addition in both countries the liberalization of foreign capital movements in late 1980's may have also weakened the inter-relationship between housing and stock markets. Subsequently the internationalization of the stock market during last five years due to telecommunication corporates have likely affected the results.

It is also possible to test, whether adjustment coefficients of system variables adjust significantly to their long-run relationships. The separate zero-restrictions were imposed to α-adjustment coefficients. For Finland zero restriction was strongly rejected for consumer prices, but not for house or stock prices. For Swedish data, zero-restrictions on α-adjustment coefficients were rejected for house and consumer prices, but not for stock prices.

The estimated shock profiles for cointegration vectors tell us that for Finnish data a common shock goes much faster through than for Swedish data (Figure 6). It can be seen, however, that the size of the reaction is initially somewhat stronger in Finland. There may be no obvious reason for this, but the larger share of owner-occupied housing in Finland might be partly responsible.

Before we tackle the problem of estimating an error-correction model for house and consumer prices, it is interesting to look at the estimates of equilibrium house prices. In Figures 7 and 8, we first present equilibrium house price estimates from the bivariate price system with lending rates as exogenous variables. The homogeneity restriction were imposed for this estimation. In Sweden, the result from the estimates in last quarter of 1997 indicates that house prices were under their long-run equilibrium level. In Finland, it seems that the recent house price increases have already raised prices above the long-run equilibrium level.

In the final error-correction system, we included for simplicity only house and consumer prices as endogenous variables. After-tax lending rate, stock prices, unemployment rate and wages were used as exogenous variables. Tables 6 and 7 present finally the estimated EC-models for house and consumer prices. Figures 9 and 11 show the actual series and their fitted values plus standardized residuals.[11] The residual analysis tells us that for Finnish series there is a period in mid 1980's where the model fit is not quite good in house prices. In Sweden, the bivariate model does have some difficulties to follow the collapse in house price in the beginning of 1990s, but otherwise model fits seem appropriate. The model diagnostics for both countries tell us however, that there may be some important dynamic variables missing from our specification, since there is serial autocorrelation in the residuals. Partly this autocorrelation arises from our specification of using annual differences of the endogenous variables to have a more proper scale for coefficients. The normality tests also alarms for Sweden, which indicates that there are few outliers in the model.[12]

The error-correction terms are highly significant and have the right sign for both countries in the house price equations. The overall size of the coefficient is however small suggesting that adjustment to equilibrium will take a long time once the system has been shocked. In Figures 10 and 12, the impulse response functions are plotted to show how asymmetric the shocks coming from house prices and inflation are. It can be seen that a unit shock in inflation has a very strong and long lasting effect on house prices in both countries, while a unitary shock in house price has smaller effect on inflation. Thus, the preponderance of evidence seems to suggest that house prices are more likely to adjust to inflation than the other way around.

Apart from the endogenous variables, exogenous variables have mostly expected signs in the system equations for house prices and inflation. Increasing after-tax lending rate reduces house prices in both countries. Change in unemployment rate had a ’wrong’ positive sign in the Finnish house prices equation, since increasing labour income uncertainty should have a negative effect on housing purchases and therefore to house prices. In the Swedish house price equation, unemployment rate change had a negative sign, but the coefficient was not statistically significant. The timing of increasing and decreasing unemploy-

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[11] The ex post forecast tests performed for last three years showed accurate predicting ability for both countries.

[12] While it is possible to take these outliers into account, we have not done so here.

ment rate as well the changes in the rates are also pretty similar in both countries. This arises of course form the close correlation with business cycles and relatively large foreign trade. In both countries wages were used in the inflation equation as a demand pressure variable and it turned out to be valuable. In the Finnish inflation equation bank lending was used in the house price equation as additional explanatory variable, which turned out significant as expected.

Figure 7. **Equilibrium house prices in Finland**

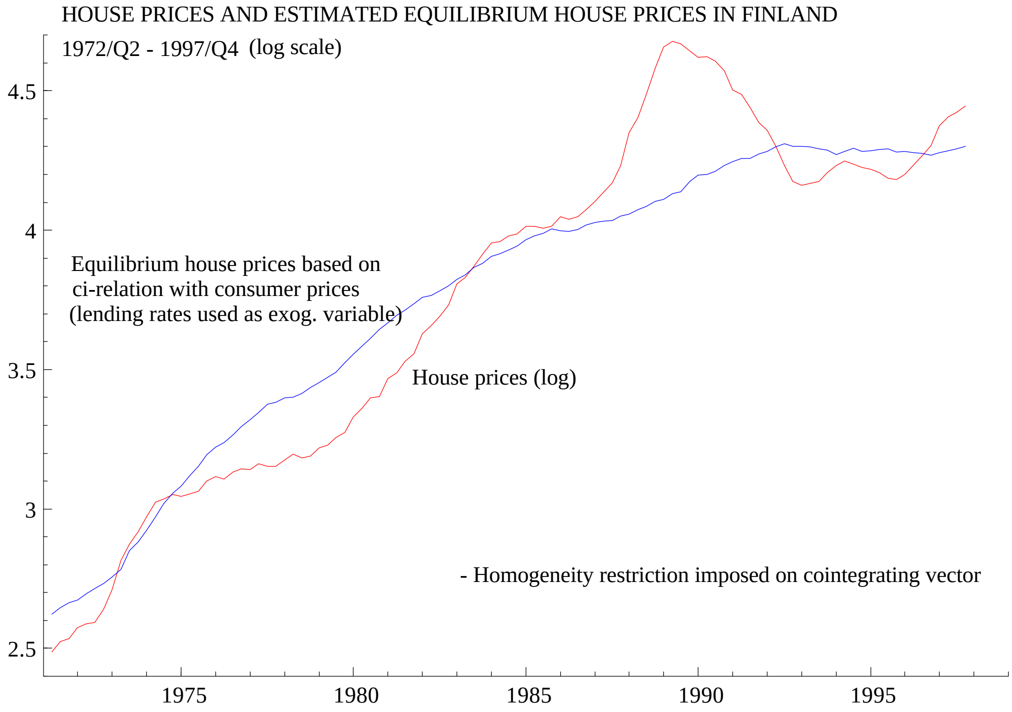


Figure 8. **Equilibrium house prices in Sweden**

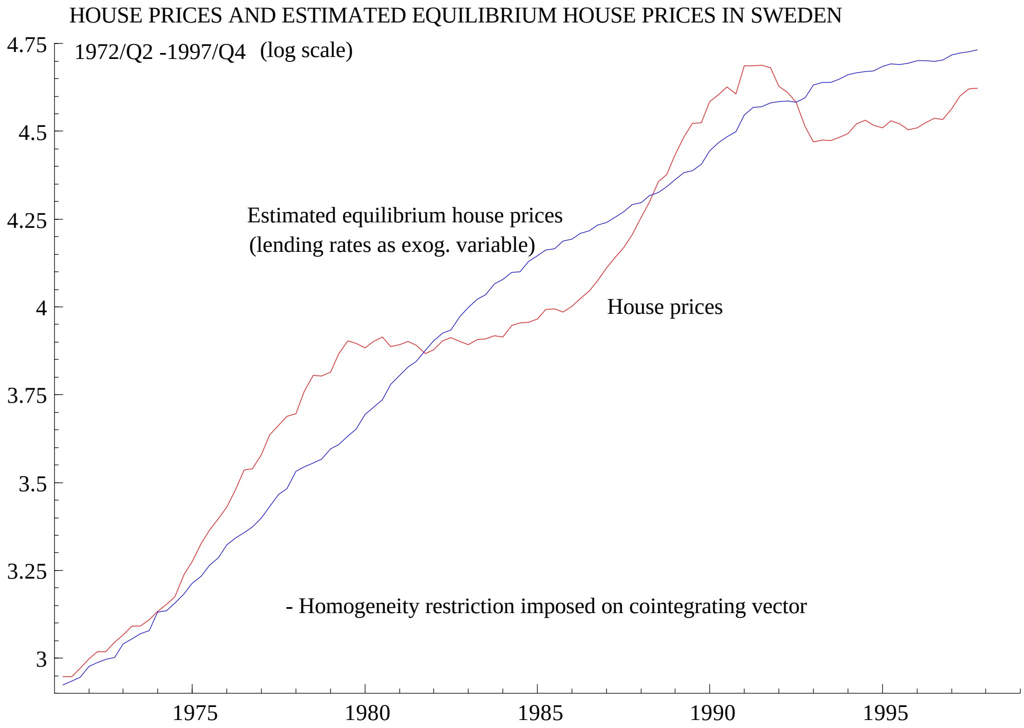


Figure 9. **Finnish house price and inflation system estimation**

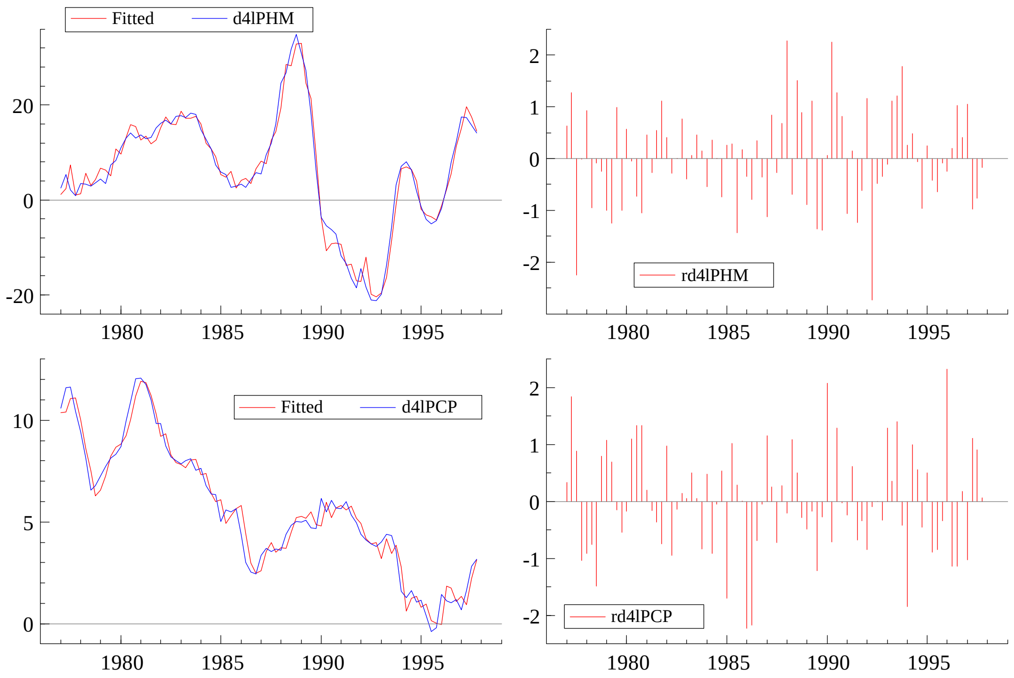


Figure 10. **Impulse responses in Finnish house price and inflation system**

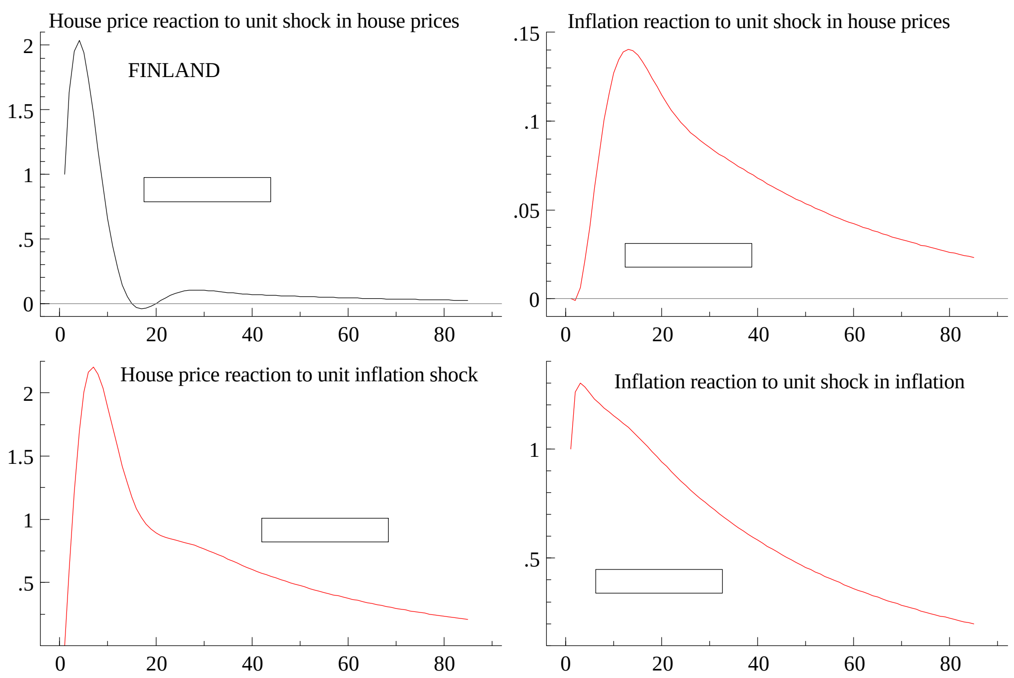


Figure 11. **Swedish house prices and inflation system estimation**

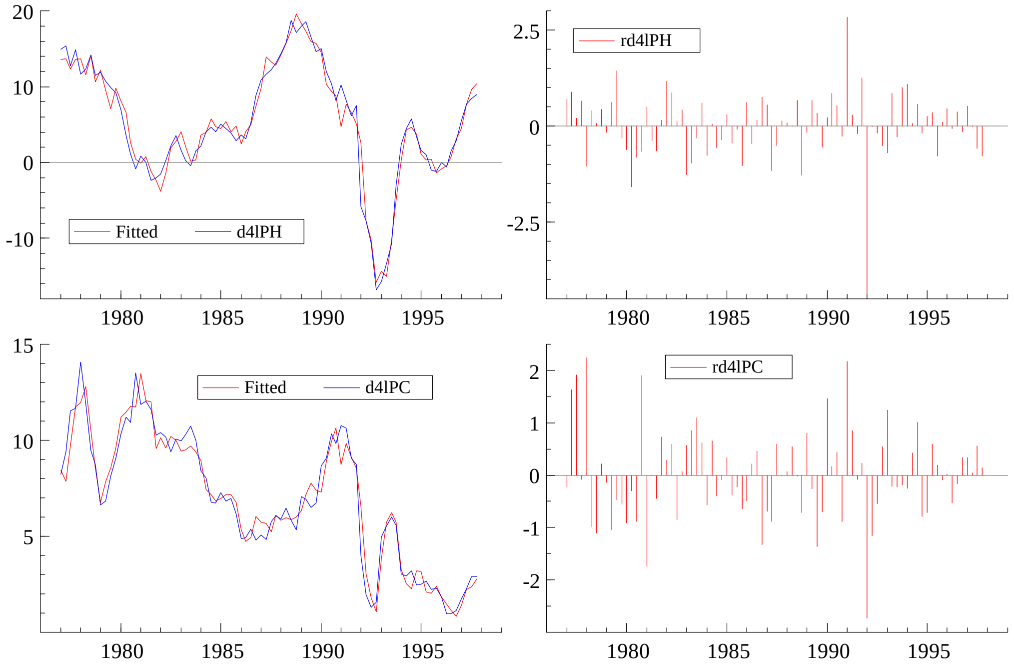
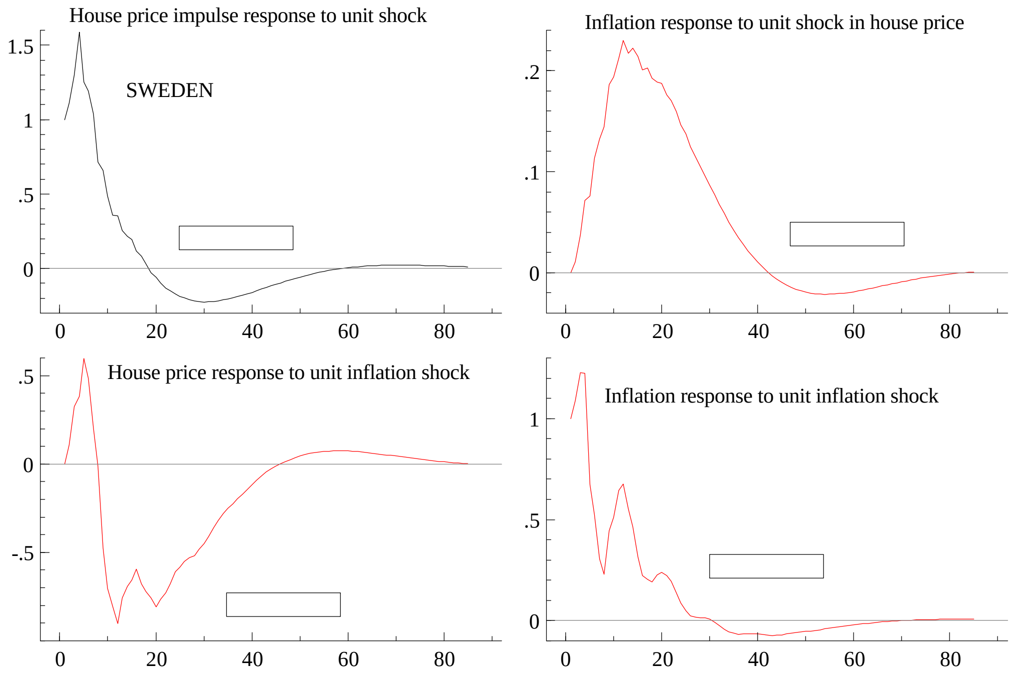


Figure 12. **Swedish impulse responses**



5 Conclusions

The aim of this paper has been to model house prices and inflation in such a way that the long-run property of cointegration between house and consumer prices is maintained. Cointegration between house prices and consumer goods prices may seem puzzling, since in countries such as the UK, real housing prices show a clear trend that matches well with the trend in real disposable income, while we argue here that real house prices are stationary. Our international comparison shows, however, that the UK may be likely an exception rather than a rule in this respect (see Appendix 2). It is important, of course, to distinguish whether house prices follow consumer price index or earnings index in the long run as the trends in these series likely differ. Housing expenditure has near unit income elasticity, but in Finland and Sweden house price ratio to disposable income has had a significant negative trend at least during last 30 years.

The system modelling between house and consumer prices showed that the general price level is transmitted into house prices rather quickly, but inflation is surprisingly insensitive to changes in house prices. This matches with the fact that house prices are much more volatile than non-durable consumer goods prices. Adding stock prices into the system does not improve the system considerably. We find that while house prices are clearly not neutral with respect to inflation, inflation is not affected much by shocks in house prices. It was found that in addition to the arbitrage relation between consumer and house prices there are many fundamental determinants of house prices like expected wages, unemployment rate, after-tax interest rates, which divert in the short run the actual house price development from their equilibrium level.

These results contribute a little in the way of operational advice for market participants. House prices exhibit large swings in the market, but in the long run, no excess return remains over inflation rate. Eventually and hopefully increasing information about the market equilibrium will reduce also the volatility of prices in the housing market. For monetary policy, asset price inflation does not express a major threat, but volatility in asset prices could be stabilized by trying to smooth housing demand.

Periods of high expected inflation can profoundly affect people's willingness to get into debt. Unexpected inflation can affect debt burden significantly, so a house buyer must also be careful with respect of the equilibrium in the lending market. In principle, trading takes place only at equilibrium prices, but in the long-run situations vary. During the past decade there has been a significant reduction in the subsidies for home ownership both in Finland and Sweden. The effective tax rate for mortgage interest payments deductions were limited in both countries due to capital income taxation reform. In addition, other housing subsidies have been restricted, which have lowered the present value of these tax reliefs. EMU may also work as an stabilizer for asset prices as it stabilizes inflation expectations and interest rates. Unfortunately, stabilizing interest rates may smooth housing investment, but it does not affect the demand for houses, which remains a problem.

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Appendix 1

Table 1. **House, housing investment, stock prices and inflation in Finland and Sweden, %**

Period: 1971/Q1 - 1997/Q2 [13]

	Mean	Median	Std.dev.	Skewness	Kurtosis	Norm. p-level
House prices						
Finland	7.07	6.60	11.59	-0.26	0.31	.365
Sweden	6.23	6.35	7.45	-0.61	0.58	.037*
Inflation						
Finland	7.07	6.36	4.35	0.64	0.05	.005**
Sweden	7.37	7.23	3.16	-0.31	-0.68	.051
Real house price						
Finland	0.00	0.39	11.13	0.04	0.34	.426
Sweden	-1.14	-0.76	7.00	-0.51	0.06	.061
Housing investment prices						
Finland	7.63	8.18	7.73	-0.30	2.52	.000***
Sweden	7.93	7.47	5.93	-0.10	-0.09	.115
Stock prices						
Finland	11.63	11.75	26.93	0.05	-0.67	.407
Sweden	13.88	11.48	22.29	0.34	0.22	.308

Table 2. **Cointegration tests and basic bivariate ci-system tests for house and consumer prices**

Cointegration tests for Finland with no intercept or trend, in Sweden with no trend component and 5 lags in VAR for 1971/Q2 - 1997/Q2

Hypothesis Null	Alt.	Eigenvalues FIN	SWE	Max Eigenvalue tests FIN	SWE	95%	Trace tests FIN	SWE	95%
r = 0	r=1	.1234	.1548	13.82*	17.65**	11.03	13.89*	18.92**	11.03
r 1	r=2	.0006	.0119	0.65	1.26	4.16	0.65	1.26	4.16

Homogeneity restriction on the bivariate price system ß: ß1+ß2=0

	Statistic	p-value	
LR-test: $\chi^2(1)$ =	2.88	[0.090]	FINLAND
LR-test: $\chi^2(1)$ =	4.19 *	[0.041]	SWEDEN

LR-tests for stationarity, exclusion and weak exogeneity

	EXCLUSION $\chi^2(p-r=1)$ FIN	SWE	STATIONARITY $\chi^2(r=1)$ FIN	SWE	WEAK EXOGENEITY $\chi^2(r=1)$ FIN	SWE	95%	99%
House price	12.55**	8.21**	13.07**	5.21*	13.76**	9.60**	.84	6.65
Cons. price	13.07**	5.21*	12.55**	8.21**	0.19	0.90	3.84	6.65

---

[13] It seems that in most major countries real house prices (deflated by consumer prices) have been relatively stationary during the past thirty years, although the ADF(1) test rejects a unit root strictly only for Germany, Belgium, Ireland and Norway (see also Kennedy and Andersen, 1994 p. 32-35). Real house prices were significantly different from zero only for Japan and Finland during 1970-96 (see Appendix 2). In the UK, however, there is undoubtedly a trend in real house prices which matches rather well with the trend in real disposable income (see Brown et al (1997, p. 530). For instance, mortgage rationing, which was abolished in early eighties, might be responsible for non-stationarity (G. Meen, 1990). In addition in the UK imputed rent and the capital gains on owner-occupied houses is not taxed, therefore increases in the tax advantage may also have affected the positive trend in house prices (Holly and Jones, 1997 p. 553). It is also possible that in other above-mentioned countries some sort of rationing, market failure or financial liberalization was responsible for the non-stationarity of real house prices.

Table 3. **Granger causality tests for house prices and inflation, quarterly changes (%)**

F-test probability levels (p) with different lags
Quarterly data, 1970/Q2 – 1996/Q4

		Quarterly differences		
Independent variable	Dependent variable	1-lag	3-lags	6-lags
Finnish data				
PH	PC	.132	.090	.274
PC	PH	.714	.945	.968
PH	UR	.000**	.001**	.004**
UR	PH	.175	.253	.121
PH	YW	.000**	.016*	.056
YW	PH	.304	.497	.473
Swedish data				
PH	PC	.724	.025*	.507
PC	PH	.008**	.041*	.545
PH	UR	.001**	.005**	.000**
UR	PH	.418	.666	.616
PH	YW	.092	.000**	.177
YW	PH	.680	.259	.540

Granger tests for trivariate blocks (with 5 lags)

Dependent	Conditional	χ^2-test p-value Finland	Sweden
PH	PC, STOCK	.011 *	.008 **
PC	PH, STOCK	.054	.034 *
STOCK	PH, PC	.137	.006 **

Variables:

PC = Private consumption deflator, %
PH = House price change, %
UR = Unemployment rate change, %
YW = Wages change, %
STOCK = Stock prices, %

Table 4. **Cointegration with no intercepts or trends in the VAR(5) for Finland, 1971Q2–1997Q2**

```
Endogenous: LPHM, LPCP, LHEX (FINLAND)
Weakly exogenous I(0) variables: RLBN

MULTIVARIATE STATISTICS

TRACE CORRELATION    =   0.538

TEST FOR AUTOCORRELATION
L-B(26), P²(195)  = 176.093, p-val = 0.83
LM(1),   P²(9)    =  11.522, p-val = 0.24
LM(4),   P²(9)    =   4.590, p-val = 0.87

TEST FOR NORMALITY
P²(6)             =   6.591, p-val = 0.36


TEST FOR EXCLUSION: LR TEST P²(r)
   r  DGF  P²(5)    LPHM    LPCP    LHEX    RLBN
   1   1    3.84    9.96    5.92    5.69    6.60
   2   2    5.99   12.33    7.76    8.07    7.20

TEST FOR STATIONARITY: LR TEST P²(p-r)
   r  DGF  P²(5)    LPHM    LPCP    LHEX
   1   3    7.81   14.05   14.01   14.04
   2   2    5.99    4.20    4.33    4.44

tEST FOR WEAK-EXOGENEITY: LR TEST P²(r)
   r  DGF  P²(5)    LPHM    LPCP    LHEX
   1   1    3.84    3.37    8.15    1.65
   2   2    5.99    3.41    9.99    4.13


List of eigenvalues in descending order:
 .1765    .0812    .0129

                       Max. eigenvalue stat.    Trace statistic
Null    Alternative    Statistic     95% CV     Statistic      95% CV
r = 0      r = 1        20.3934*      17.68      30.6410*       24.05
r<= 1      r = 2         8.8875       11.03      10.2477        12.36
r<= 2      r = 3         1.3602        4.16       1.3602         4.16


Estimated Cointegrated Vectors (free and restricted) in Johansen Estimation
(Standardized in brackets)

                   ß -vector         Rest. ß1+ß2+ß3=0
LPHM                  .82171               -.50998
                   (-1.0000)             (-1.0000)
LPCP                 -.24956                .53481
                     (.3037)              (1.0487)
LHEX                 -.24136              -.024836
                     (.2937)              (-.0487)
                                 LR Test χ²(1)= 11.4885[.001]


Estimated Long Run Matrix in Johansen Estimation
                      LPHM        LPCP         LHEX
 LPHM               -.0104       .0032        .0031
 LPCP               -.0229       .0070        .0067
 LHEX                .0340      -.0103       -.0099

                   LPHM      LPCP      LHEX     t-values
 DLPHM           -0.046     0.021     0.010     2.12
 DLPCP           -0.022     0.010     0.005     3.65
 DLHEX           -0.126     0.059     0.028     1.63


New variables:

LHEX = Log of Helsinki stock exchange price index
RLBN = Bank lending rate for new loans to public, %
```

Table 5. **Cointegration with no intercepts or trends in the VAR(5) for Sweden, 1971Q2–1997Q2**

Endogenous: LPH, LPC, LSWE (SWEDEN)
Weakly exogenous I(0) variables: RUT

MULTIVARIATE STATISTICS

TRACE CORRELATION = 0.471

TEST FOR AUTOCORRELATION
L-B(26), $P^2(195)$ = 234.938, p-val = 0.03
LM(1), $P^2(9)$ = 8.368, p-val = 0.50
LM(4), $P^2(9)$ = 29.757, p-val = 0.00

TEST FOR NORMALITY
$P^2(6)$ = 43.612, p-val = 0.00

TEST FOR EXCLUSION: LR TEST CHISQ(r)

r	DGF	$P^2(5)$	LPH	LPC	LSWE	RUT
1	1	3.84	9.50	10.82	0.00	5.76
2	2	5.99	13.84	14.17	0.06	5.77

TEST FOR STATIONARITY: LR TEST CHISQ(p-r)

r	DGF	$P^2(5)$	LPH	LPC	LSWE
1	3	7.81	13.85	15.66	17.38
2	2	5.99	2.05	3.96	7.42

TEST FOR WEAK-EXOGENEITY: LR TEST CHISQ(r)

r	DGF	$P^2(5)$	LPH	LPC	LSWE
1	1	3.84	4.74	4.70	0.03
2	2	5.99	10.13	10.75	0.53

List of eigenvalues in descending order:
.25316 .065185 .1671E-3

		Max. eigenvalue stat.		Trace statistic	
Null	Alternative	Statistic	95% CV	Statistic	95% CV
r = 0	r = 1	30.0661*	17.68	37.0261*	24.05
r<= 1	r = 2	6.9428	11.03	6.9600	12.36
r<= 2	r = 3	.017212	4.16	.017212	4.16

Estimated Cointegrated Vectors (free and restricted) in Johansen Estimation
(Standardized in brackets)

	ß -vector	Rest. ß1+ß2+ß3=0
LPH	1.0801	-.9923
	(-1.000)	(-1.000)
LPC	-1.3258	.9516
	(1.2275)	(.9589)
LSWE	.1222	.04071
	(-.1132)	(.0410)
		LR-test $\chi^2(1)$= 3.6447[.056]

Estimated Long Run Matrix in Johansen Estimation

	LPH	LPC	LSWE
LPH	-.0688	.0845	-.0078
LPC	.0212	-.0259	.0024
LSWE	-.2280	.2799	-.0258

	LPH	LPC	LSWE	t-values
DLPH	-0.051	0.053	-0.000	-2.924
DLPC	0.028	-0.029	0.000	2.967
DLSWE	0.018	-0.019	0.000	0.198

New variables:

LSWE = Log of Stockholm stock exchange price index
RUT = Bank lending rate, %

Table 6. **House prices and inflation error-correction system for Finland**

The present sample is: 1977/Q1 - 1997/Q4, estimation by FIML

Equation 1 for d4lPHM

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE
d4lPHM_1	1.3733	0.09882	13.896	0.0000	0.10422
d4lPHM_2	-0.5319	0.10145	-5.243	0.0000	0.10338
d4lPCP_2	-0.3391	0.13529	-2.507	0.0143	0.13981
CIfin_4	-0.0444	0.02123	-2.093	0.0397	0.02008
atRLBN	-0.4193	0.45136	-0.929	0.3558	0.37451
d4UR_1	0.2071	0.23802	0.870	0.3868	0.22524
d4lLBH	0.1939	0.05758	3.367	0.0012	0.06082
Constant	2.6365	2.7283	0.966	0.3369	---

σ = 2.3605

Equation 2 for d4lPCP

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE
d4lPHM_4	-0.02632	0.01244	-2.114	0.0378	0.01197
d4lPCP_1	1.03690	0.07222	14.357	0.0000	0.07406
d4lPCP_3	-0.14225	0.06348	-2.241	0.0280	0.06271
d4lYW_2	0.03490	0.02530	1.379	0.1718	0.02814
atRLBN_2	-0.20566	0.11125	-1.849	0.0684	0.10002
d4lLBH	-0.23526	0.12984	-1.812	0.0740	0.11452
d4lLBH_1	0.28712	0.25126	1.143	0.2567	0.24561
d4lLBH_2	-0.02517	0.14760	-0.171	0.8651	0.15558
Constant	1.3481	0.69185	1.949	0.0550	---

σ = 0.6372

loglik = -25.860752 log|\Omega| = 0.615732 |\Omega| = 1.85101 T = 84
LR test of over-identifying restrictions: χ^2(27) = 48.4967 [0.0068] **

correlation of residuals

	d4lPHM	d4lPCP
d4lPHM	1.0000	
d4lPCP	-0.020769	1.0000

Diagnostics summary:		Test statistic	p-value
d4lPHM :Portmanteau 9 lags	=	16.745	
d4lPCP :Portmanteau 9 lags	=	23.628	
d4lPHM :AR 1- 5 F(5, 57)	=	12.690	[0.0000] **
d4lPCP :AR 1- 5 F(5, 57)	=	6.201	[0.0001] **
d4lPHM :Normality χ^2(2)	=	1.348	[0.5096]
d4lPCP :Normality χ^2(2)	=	0.662	[0.7179]
d4lPHM :ARCH 4 F(4, 54)	=	0.230	[0.9199]
d4lPCP :ARCH 4 F(4, 54)	=	0.423	[0.7907]
d4lPHM :Xi^2 F(42, 19)	=	0.918	[0.6047]
d4lPCP :Xi^2 F(42, 19)	=	0.306	[0.9993]
Vector portmanteau 9 lags	=	54.299	
Vector AR 1-5 F(20,130)	=	2.519	[0.0010] **
Vector normality χ^2(4)	=	2.062	[0.7244]
Vector Xi^2 F(126,93)	=	0.968	[0.5703]

Finnish model variables:

PHM = House price index
PCP = Private Consumption Deflator
atRLBN = After tax bank lending rate for new loans, %
UR = Unemployment rate, Statistics Finland, %
LBH = Banks loans to households, Million FIM
YW = Wage sum, Million FIM
CIfin = Error-correction term

Table 7. **House prices and inflation error-correction system for Sweden**

The present sample is: 1977/Q1 - 1997/Q4, estimation by FIML

Equation 1 for d4lPH

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE
d4lPH_1	0.89175	0.037252	23.938	0.0000	0.03899
d4lPC_1	0.14736	0.11912	1.237	0.2198	0.11318
CIswe_4	-0.08791	0.02920	-4.034	0.0001	0.01758
atRUT_1	-0.55529	0.14698	-3.778	0.0003	0.21652
Urswe_4	-0.05600	0.12023	-0.466	0.6426	0.11125
Constant	5.6272	2.0854	2.698	0.0085	---

σ = 2.1596

Equation 2 for d4lPC

Variable	Coefficient	Std.Error	t-value	t-prob	HCSE
d4lPH_5	-0.06308	0.02700	-2.336	0.0221	0.02486
d4lPC_1	0.67041	0.07097	9.446	0.0000	0.07637
CIswe_4	0.04867	0.01363	3.571	0.0006	0.01138
d4lWages	0.04147	0.03642	1.139	0.2583	0.03790
d4lWages_1	0.10653	0.03865	2.756	0.0073	0.04527
URswe_1	-0.13394	0.07162	-1.870	0.0652	0.06450
Constant	1.4768	0.91183	1.620	0.1094	---

σ = 1.0541

loglik = -59.47386 log|\Omega| = 1.41604 |\Omega| = 4.12079 T = 84
LR test of over-identifying restrictions: $P^2(35)$ = 93.4419 [0.0000] **

correlation of residuals

	d4lPH	d4lPC
d4lPH	1.0000	
d4lPC	0.27874	1.0000

Diagnostics summary:		Test statistic	p-value
d4lPH	:Portmanteau 9 lags	= 27.903	
d4lPC	:Portmanteau 9 lags	= 40.014	
d4lPH	:AR 1- 5 F(5,55)	= 11.000	[0.0000] **
d4lPC	:AR 1- 5 F(5,55)	= 7.411	[0.0000] **
d4lPH	:Normality P^2 (2)	= 48.689	[0.0000] **
d4lPC	:Normality P^2 (2)	= 15.853	[0.0004] **
d4lPH	:ARCH 4 F(4, 52)	= 0.946	[0.4448]
d4lPC	:ARCH 4 F(4, 52)	= 3.887	[0.0078] **
d4lPH	:Xi^2 F(46, 13)	= 0.814	[0.7088]
d4lPC	:Xi^2 F(46, 13)	= 0.500	[0.9571]
Vector portmanteau 9 lags		= 77.06	
Vector AR 1-5 F(20,134)		= 3.527	[0.0000] **
Vector normality P^2(4)		= 47.679	[0.0000] **
Vector Xi^2 F(138, 87)		= 1.881	[0.0008] **

Swedish model variables:

PH = House price index
PC = Private consumption deflator
atRUT = After-tax lending rate, %
URswe = Unemployment rate, %
Wages = Wage sum, SKR
CIswe = Error-correction term

Appendix 2

Figure 13. **Real house prices in 12 countries, 1970-1996**

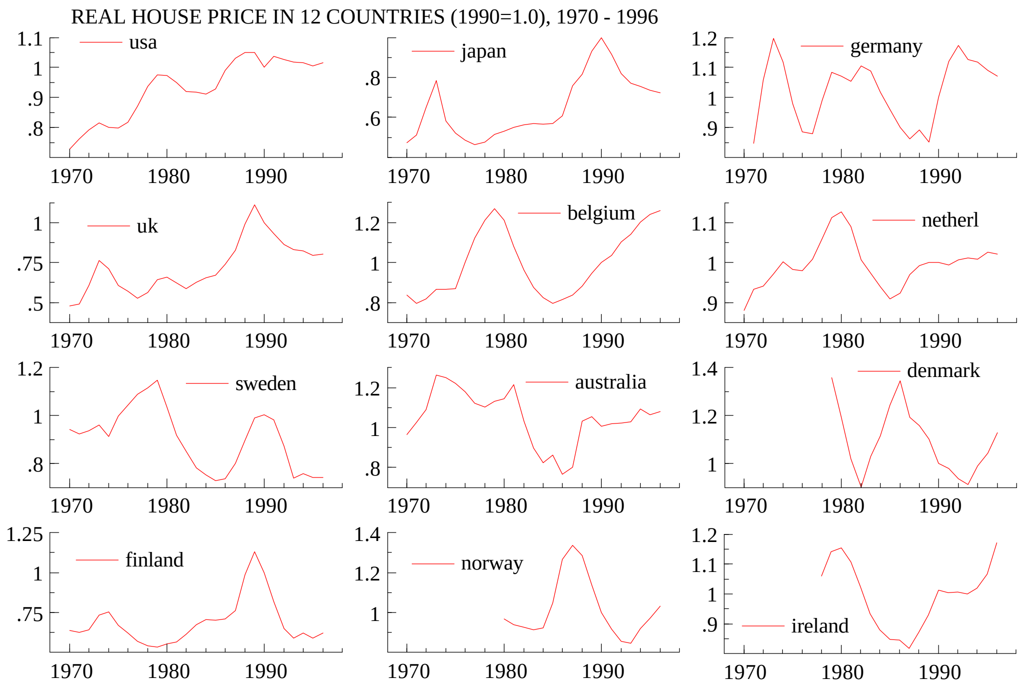

Table 8. **Stationarity of real house prices (deflated by CPI) in 14 countries, 1970–1996**

Country	Period	Mean (α)	Std. dev.	t-value α # 1	Norm.test p-value	Unit root test ρ - coeff.	ADF(1) test	Cointegration test Trace test	ß-homo-geneity p-value
USA	70-96	.931	.097	-0.71	0.025*	.899	-1.76	41.76**	.0009**
JAPAN	70-96	.654	.153	-2.26*	0.056	.817	-1.90	18.28**	.394
GERMANY	71-96	1.020	.104	0.20	0.167	.536	-4.07**	20.72**	.894
UK	70-96	.721	.160	-1.74	0.265	.809	-2.36	29.46**	.0003**
BELGIUM	70-96	.995	.161	-0.03	0.018*	.824	-3.64*	38.67**	.0000**
NETHERLANDS	70-96	.994	.056	-0.11	0.351	.746	-2.97	33.62**	.0000**
SWEDEN	70-96	.904	.125	-0.77	0.435	.787	-2.44	47.51**	.0000**
AUSTRALIA	70-96	1.048	.129	0.37	0.529	.732	-2.13	34.95**	.0000**
FINLAND	70-96	.690	.143	-2.17*	0.001**	.702	-2.90	8.35	.8871
IRELAND	78-96	.995	.106	-0.05	0.734	.856	-3.26*	22.70**	.0002**
NORWAY	80-96	1.017	.146	0.12	0.013*	.649	-4.12**	9.63**	.0000**
DENMARK	79-96	1.091	.134	0.68	0.498	.552	-2.20	21.02**	.0001**
FRANCE	85-96	.915	.069	-1.23	0.523	.669	-4.26*	34.02**	.0000**
CANADA	83-96	.927	.123	-0.59	0.602	.593	-2.41	18.50**	.0003**

The presence of a unit root in real house prices is rejected by the ADF tests for Germany, Belgium, Ireland, Norway and France. The mean on real house prices diverts from unity (here arbitrarily 1990=1.0) only for Japan and for Finland during 1970-1996. Critical values for the ADF(1) tests are -2.985 for 5% significance level and -3.72 for 1% significance level for 1970-96.

The trace test between house and consumer prices has been adjusted with the number of degrees of freedom (T-nm) instead of T available in PcFiml, the critical values 95% significance level (see Doornik and Hendry, 1995). In all countries except Finland, cointegration prevails; homogeneity is not rejected for only a few countries (Japan, Germany and Finland). As can be seen from Figure 13, house price cycles can take a long time and adjustment to various shocks is slow.

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