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IS HOUSING OVERVALUED

IN THE HELSINKI METROPOLITAN AREA?

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ABSTRACT: This paper studies the housing price dynamics in the Helsinki Metropolitan Area (HMA) using quarterly data from 1975Q1 to 2005Q2. First, the long-run relationship between housing prices and a number of fundamental variables likely to affect the level of housing prices is examined. Several specifications of potential long-run equilibrium relations to which housing prices adjust are estimated. The estimated models are utilized to estimate error-correction and vector error-correction models. Furthermore, the results of the analysis are used to evaluate, whether residential property in the HMA is currently overvalued (or undervalued). The results imply that current housing prices in the HMA correspond to the fundamentals. Based on the econometric analysis, main determinants of the real housing price level are the real lending rate together with current disposable income and income expectations. At present, the biggest fear for a decline in the real housing price level in the HMA comes from the interest rates. The analysis implies that a permanent one percentage-point increase in the real lending rate reduces real housing prices approximately by 4.6% in the long run. The study also shows that the adjustment process of housing prices towards their long-run equilibrium is sluggish, only about 10%-15% per quarter. Furthermore, the response of real housing prices to a shock in the interest rate and income level seems to be cyclical.

Keywords: Housing prices, dynamics, cointegration, error-correction model, bubble

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TIIVISTELMÄ: Tässä tutkimuksessa tarkastellaan empiirisesti pääkaupunkiseudun asuntohintojen dynamiikkaa vuodesta 1975 vuoteen 2005 ulottuvan neljännesvuosiaineiston pohjalta. Tutkimuksessa estimoidaan lukuisia mahdollisia pitkän aikavälin tasapainosuhteita asuntohintojen ja teorian mukaan asuntohintoihin keskeisesti vaikuttavien muuttujien välillä. Estimoitujen tasapainosuhteiden perusteella asuntojen hintataso on tällä hetkellä lähellä pitkän aikavälin tasapainoaan, eli kuplaa ei asuntomarkkinoilla näyttäisi oleva. Reaalikoron nouseminen saattaisi kuitenkin pudottaa pääkaupunkiseudun asuntohintoja huomattavasti. Tulosten perusteella pysyvän yhden prosenttiyksikön suuruisen reaalisen asuntolainakoron nousun negatiivinen vaikutus asuntojen hintatasoon on pitkällä tähtäimellä noin 4.6 prosenttia. Reaalikoron ohella tärkeimmät asuntohintoihin vaikuttavat tekijä ovat tulotaso sekä tulo-odotukset. Estimoituja tasapainosuhteita hyväksi käyttäen asuntohintojen lyhyen aikavälin dynamiikkaa analysoidaan virheenkorjausmallien avulla. Asuntohintojen sopeutuminen kohti pitkän aikavälin tasapainotasoa vaikuttaisi olevan hidasta, vain 10-15 prosentin luokkaa neljännesvuodessa. Tulokset osoittavat lisäksi, että asuntohinnat reagoivat korko- ja tulotasoshokkeihin syklisesti.

***Asiasanat*:** asuntohinnat, dynamiikka, yhteisintegroituvuus, virheenkorjausmalli, kupla

1 INTRODUCTION

Over the last few years there has been a lot of debate all over the world on the existence of bubble in several housing markets. It has been constantly claimed that housing is overvalued in a number of countries, including Australia, Belgium, France, The Netherlands, Ireland, Italy, Spain and the United States. Also in the biggest cities in Finland housing prices have risen rapidly after the mid-nineties. In the Helsinki Metropolitan Area[1] (HMA) the real housing price level has increased by about 75% from the end of 1995 to the second quarter of 2005. Although the real price level has not yet reached the peak level of the bubble that arose in the end of the 1980s and burst in the beginning of the 1990s, the question has lately occurred on whether the housing prices in the HMA are at an unsustainably high level.

History has shown that big bubbles can develop in the housing markets just like in the stock markets. The fact that the real housing prices are currently almost at the level of the peak of the 1980-90s bubble does not, however, necessarily imply that housing in the HMA is overvalued at the moment. Even though the present real housing price level in the HMA is almost at record high, some have argued that it is not particularly high taking account of the fundamentals. There are a number of factors that may cause a growing trend in the fundamental value of housing in the HMA. Additional evidence that relates the current housing price level to the fundamental determinants is required to properly assess if housing is overvalued at present.

As Leung (2004, p. 250) puts it, "conventional housing economics and urban economics for its part virtually ignores interaction between housing markets and the macroeconomy". Housing price movements, however, are not only affected by the general economic conditions but are also likely to have substantial effects on the macroeconomy. There are a number of reasons why policy makers should be concerned about housing prices. Firstly, housing composes the majority of many households' wealth, and the "wealth effect" of housing on consumption is significant (see e.g. Case et al., 2001; Benjamin et al., 2004; Campbell and Cocco, 2004). Hence, a decline in housing price level leads to less consumption. Secondly, a drop in housing prices is likely to have a negative effect on housing construction, and thus on aggregate output. In addition, a notable fall in housing prices would affect the banking sector by inducing unanticipated losses for mortgage lenders, which would strain the financial system.

In Finland these factors together could lead to substantial adverse consequences on the macroeconomy even if the housing prices were to decrease considerably only in the HMA, since the HMA comprises one fifth of the Finnish population. Furthermore, housing price movements are likely to diffuse from the HMA to the other parts of the country relatively rapidly (see Oikarinen, 2005). Therefore, it is of great interest and importance to study the dynamics of price movements and to evaluate the existence of overvaluation in the HMA housing market. The dynamics of housing price movements are also interesting because they throw light on the operation of the housing market.

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[1] The Helsinki Metropolitan Area consists of the capital city of Helsinki and three other municipalities (Espoo, Kauniainen and Vantaa).

It is reasonable and empirically supported to assume that there exists a long-run equilibrium relationship between housing prices and a number of fundamental variables. In this paper the existence of a long-run equilibrium relationship between housing prices in the HMA and a number of variables likely to affect housing price level in the long-run is examined by employing cointegration analysis. Based on the cointegration analysis the existence of overvaluation in the HMA housing prices is evaluated. In addition, an error-correction model and a vector error-correction model are estimated to study the short-run adjustment dynamics.

The next section proceeds with a brief overview of the theory behind housing price formation. This is followed by a review of the relevant literature after which the data used in the empirical part is described. The fifth part presents the results from the econometric analysis. Finally, the conclusions are derived.

2 HOUSING PRICE FORMATION IN THE SHORT AND LONG RUN

In many studies the dynamics of national level housing prices are examined. It is usually more reasonable to focus on a single metropolitan area in an empirical analysis, however. This is because dwellings within a metropolitan area can be considered as relatively close substitutes for one another. Thus, housing prices within a metropolitan area should react similarly to changes affecting the overall market. In other words, metropolitan area is a reasonable definition for a housing market.[2] By contrast, within a country there are many distinct metropolitan areas whose dwellings are not close substitutes for each other. Therefore, this study concentrates on examining the housing price formation within a single metropolitan area.

2.1 Simple theoretical framework

The stock-flow approach has traditionally been used in macroeconomic modelling of housing markets. The stock-flow model is a reasonable basis also for the needs of this study. According to the stock-flow theory the demand for housing in a metropolitan area can simply be given by:

$$H^d = f(P, U, R, D), \tag{1}$$

where

P = real housing price level;
U = expected real cost of owning a dwelling;
R = real rental price level; and
D = other fundamental variables affecting housing demand.

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[2] For further reasoning behind the appropriate geographical definition of a property market, see e.g. DiPasquale and Wheaton (1996), pp. 24-25.

Similarly, market supply can be defined as:

$$H^s = f(P, S), \quad (2)$$

where
S = other fundamental variables affecting housing supply.

In equilibrium $H^d = H^s$ so that the reduced form equation for the housing price level is:

$$P = f(D, S, U, R). \quad (3)$$

The expected real user cost for housing ownership, U, depends on the real after-tax mortgage rate and on the opportunity cost of the capital tied in housing. Higher mortgage rate, lower tax-deductibility of mortgage payments and higher opportunity cost of capital increase the user costs. U naturally includes also other costs incurred by owning housing, especially real estate taxes and housing depreciation or equivalently the maintenance costs.[3] Furthermore, the expected rate of future price appreciation decreases the expected user cost because of the expected capital gains.

The existence of the expected future housing appreciation in U is of great importance. The expected appreciation is naturally dependent on the expectations concerning the fundamental variables driving housing prices. Hence, even though the presented equations are static, the expectations concerning future values of the fundamental variables influence current housing demand. In addition, it is obvious that housing construction today, and thereby housing supply a couple of quarters from today, is affected by the expected price level and hence expected values of the fundamental variables.

Furthermore, the influence of the expected price appreciation on user costs may generate price bubbles. High expectations regarding price growth, and thus price level, can fulfill themselves by augmenting housing demand through lower expected user costs. This can happen even if nothing has changed in the market fundamentals. This corresponds to the definition of a bubble. According to Stiglitz (1990, p. 13) "if the reason that the price is high today is *only* that the selling prices will be high tomorrow – when 'fundamental' factors do not seem to justify such a price – then a bubble exists".

Based on the reasoning above, assuming that the real interest rate stays constant regardless of the speed of inflation and that the opportunity cost of capital equals the after-tax mortgage rate, the user cost can be expressed as:

$$U = [(r + i)(1 - t) + T + d - (g + i)]P, \quad (4)$$

where
r = real mortgage rate;
i = inflation rate;
t = rate of tax deductibility of interest payments for mortgages;
T = real estate tax rate;
d = depreciation and maintenance as a percentage of P; and
g = expected growth rate of real housing prices.

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[3] It is reasonable to believe that the expected values (for the next quarter) of the other factors than price appreciation determining the user cost equal their current values.

It can be seen from (4) that due to the tax deductibility of mortgage payments the inflation rate influences U negatively. Thus, also inflation rate enters (3). Higher inflation reduces user costs because while nominal mortgage interest payments are tax deductible, the capital gains are essentially untaxed.[4] For example Poterba (1984) presents empirical evidence supporting the positive influence of inflation on real housing prices.

The rental price level is incorporated in (3) for two reasons. First, for owner-occupiers the rental level exhibits the cost they would face if they did not own the dwelling. In other words, rental price is the implicit return for housing investment of owner-occupiers. Second, for investors rent represents the incoming cash flow from the housing investment. Hence, the rental price level affects the demand of both owner-occupiers and investors positively.

The other variables (D) affecting housing demand, such as demographic variables, income and unemployment, are factors that are often assumed to be exogenous with respect to housing prices. An increase in the number of households or a rise in the level of income obviously augments the demand for housing. It is often assumed that real permanent income is the income variable that should be included in the model. Nevertheless, the demand for housing is expected to be dependent also on current income. This is mainly because of the downpayment requirements of the lenders. Furthermore, empirical studies have shown that the structure of households may affect housing demand at least in the short run. In particular, the age distribution of households is thought to be an important demand determinant because mobility and growth in housing consumption differ between age groups. Results confirming the importance of the age distribution in the HMA are presented e.g. by Laakso and Loikkanen (1995) and Kuismanen et al. (1999).

Although the variables incorporated in D are often thought to be exogenous, some of the variables may in fact be endogenous. The number of households in a metropolitan area is likely to be negatively affected by the level of housing prices. For example Hämäläinen and Böckerman (2004) have found that housing prices affect net migration negatively in Finland. Also the level of income can be endogenous, since higher housing prices are likely to lead to claims for higher wages.

Similarly, the factors in S are often supposed to be exogenous with respect to housing prices. Construction costs should obviously affect housing prices. The higher the construction costs, the lower the level of new construction and thus future supply. Lower supply, in turn, increases the price level. Construction costs can be endogenous, however. Higher price level augments housing construction and the growing demand for construction workers and material can then raise construction costs. The leading role of housing prices with respect to construction costs is implied e.g. by Takala and Pere (1991). Also the value of land affects housing prices. In the long run real housing prices are expected to rise in a growing metropolitan area because as the metropolitan area grows, the value of land in it rises. The higher the value of land is, the higher the housing prices are. Therefore, a growing population is likely to lead to growing housing prices, even in real terms and quality adjusted. Generally included in S are also various interest rates. In addition, zoning can affect housing supply. The restrictions on supply caused by zoning are hard to take account of in empirical time series analysis such as the one conducted in this study, though.

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[4] In Finland the capital gains are untaxed if the owner of the dwelling has occupied the dwelling for at least two years on end.

2.2 Short- and long-term dynamics

Traditionally it was assumed that the housing market clears quickly. Nevertheless, there is substantial empirical evidence starting from Case and Shiller (1989) showing that it may take a long time for the housing market to adjust to the equilibrium. In fact, slow market clearing may be due to rational behavior. The anticipated sales time for a dwelling can be long and exhibit significant variance (see e.g. Chinloy, 1980; Wheaton, 1990). Individual sellers are not able to determine easily if an overly long sales time indicates an anticipated downturn in the markets or if it is only due to random misfortune. Rapid price adjustment may not be rational within this environment (DiPasquale and Wheaton, 1994, p. 6).

Due to the inflexible supply in the short horizon, short-run housing price movements are mainly determined by demand conditions. In the longer horizon the role of supply factors becomes more significant. Because of the sluggish adjustment of the housing market, variables lagged several quarters are often needed when estimating the dynamics of housing price movements. Another reason why lagged variables are required comes from the fact that many of the variables in (3) are highly autocorrelated even in differences, e.g. the change in the number of households.

It is reasonable to assume that there exists a long-run equilibrium relationship between housing prices and a number of fundamental variables. The so-called fundamental factors that affect the long-term equilibrium level of real housing prices are expected to include the number of households in the metropolitan area, real (permanent) income, real construction costs, real after-tax interest rate, the real rental price level and possibly some other variables such as the inflation rate. The long-term equilibrium level of housing prices can then be given by:

$$P^e = f(N, Y, C, A, R, O), \tag{5}$$

where
P^e = long-run equilibrium real housing price level;
N = number of households;
Y = real permanent income;
C = real construction costs;
A = real after-tax interest rate; and
O = other variables affecting housing price level in the long run.

The actual price level can deviate from the long-term equilibrium level for a number of reasons. In fact, because of the inability of prices to adjust rapidly, the price level is usually somewhat different from (5). In addition, the price expectations included in U can push prices away from their long-run fundamental level as mentioned earlier. The price level naturally tends towards the long-run equilibrium so that, in general, the difference between actual price level and the long-run equilibrium should not grow too large and in the long run housing prices must reflect market fundamentals. In the short run, however, flawed beliefs concerning the fundamental value of housing as well as speculation in the market based on expected price changes are likely to have a significant effect on housing price movements, sometimes causing possibly large deviations from the long-run equilibrium price level.

In empirical work the existence of a long-run equilibrium relationship between housing prices and fundamental variables can be examined by cointegration analysis. In addition, if a long-run relation exists, the speed of price adjustment to this equilibrium together with other short-run dynamics of housing price movements can be analyzed based on error-correction models. This kind of empirical analysis is carried out in section five of this paper using the following partial adjustment model for housing prices:

$$\Delta P_t = \mu + \gamma_1 \Delta P_{t-1} + \ldots + \gamma_i \Delta P_{t-i} + \delta_1 \Delta X_{t-1} + \ldots + \delta_j \Delta X_{t-j} + \alpha(P_{t-1} - P^e_{t-1}) + u_t, \qquad (6)$$

where
μ = drift term;
γ_i = coefficient for the value of ith lag of ΔP;
X = vector of variables affecting the short-run housing price movements;
δ_j = vector of coefficients for the jth lag of ΔX;
α = speed of adjustment parameter; and
u = white noise error-term.

In (6) $P_{t-1} - P^e_{t-1}$ is the one period lagged deviation of the existing housing price level from its long-run equilibrium level. α shows the speed of adjustment of housing prices to the long-term equilibrium level. The speed of adjustment parameter is expected to be negative since the price rise should be the smaller the higher the existing price level compared with the long-run fundamental level. The number of lags, i and j, in the model are set so that the error-term does not exhibit autocorrelation. Estimating the kind of error-correction model in (5) fits well the underlying theory and the goals of this study, since it enables one to study the long-run determinants of housing prices and their short-run dynamics at the same time.

2.3 Effects of institutional changes

Various regulations by the public sector, such as credit rationing of housing loans, tax regulation and rent control, may also affect the demand for housing significantly.

Credit rationing may influence the way housing demand reacts to changes in the fundamental variables and the abolition of credit rationing is likely to have a direct impact on housing prices. During credit rationing the effect of expected future income is likely to diminish and the importance of current income to grow due to high down payment requirements and short loan maturities. Muellbauer and Murphy (1997) claim that the impact of a growth in income expectations on housing demand may be even negative during tight credit constraints. The significance of current income is further strengthened by quantitative restrictions on borrowing if the restrictions are a function of household income.

In addition, the sensitivity of housing demand on interest rate changes is likely to be significantly weaker during credit rationing. This is because the lower the mortgage rate is compared with the cost of capital for the financial institutions offering mortgage loans, the smaller is the amount of mortgages offered in the market. Hence, many of the households willing to borrow to buy a dwelling may be unable to get a mortgage. Furthermore, nominal lending rate may be more important than the real lending rate during credit rationing, especially if the loan maturities are short. If maturity cannot be lengthened, then the income constraint tightens as the nominal lending rate rises. Hence, nominal lending rate is more closely related to income constraint in the short run than real lending rate.

The development of the financial sector can ease the financial constraints faced by households thus augmenting housing demand. First, longer maturities make the income constraint less binding, which is likely to encourage households to take larger mortgages. Smaller down payment ratios, in turn, loosen the wealth constraint. Hence, longer maturities and smaller down payment requirements may shift the housing demand curve, at least temporarily. The importance of the income, wealth and credit constraints on housing demand has been established e.g. by Barakova et al. (2003) concerning the US market.

Also the existence and abolishment of rent control may affect housing demand through multiple channels. Tightening of the rent control can influence the demand on owner-occupied housing positively – lower returns on housing compared with alternative investments causes decline in the supply of rental dwellings. On the other hand, the investors are willing to pay the less for housing the stiffer the control. In markets dominated by owner-occupiers, such as the Finnish housing markets in general, tighter rent control is likely to lead to a higher price-to-rent ratio. Because of the time taken by dismissal of rental contract and by the change of residence the effect may well be lagged.

The abolishment of rent control may have a twofold influence on the relationship between housing prices and rents. The possibility and expectations of loosening in the rent control is likely to lead to high expected growth in the rental level. This will capitalize in the housing prices so that the price will be higher relative to current rents. Hence, when there are expectations of future dismantlement of rental control, it is expected that the equilibrium price-to-rent ratio is larger than when the rental prices are determined freely by supply and demand. On the other hand, households may view the risks involved in tenancy higher when the market is not controlled. This could increase the demand for owner-occupied housing and raise the price-to-rent ratio compared with the regulated situation. Hence, the effect of a deregulation in the rental market is essentially an empirical question.

Decrease in the tax deductibility of mortgage payments naturally leads to higher real after-tax mortgage rate and lower demand on housing. Furthermore, tax rules may strengthen the link between current income and housing demand. This is the case if the deductibility of mortgage payments is based on marginal income tax rate.

The effects of institutional changes are of relevance in this study, since there have been substantial transformations in the housing finance, in the tax deductibility of mortgage interest payments and in the rental markets in Finland during the sample period, as explained in part four of the paper.

3 RELEVANT PREVIOUS STUDIES

Most studies analyzing metropolitan or national housing price dynamics have their basis in the stock-flow model of the housing sector. The traditional stock-flow assumption was that the housing market clears quickly. Recently, however, most empirical studies have allowed for gradual price adjustment. The change has taken place due to the strong empirical evidence of sluggishly adjusting housing prices found in many papers.

The often cited results of Case and Shiller (1989 and 1990) implied that housing markets are often inefficient and adjust slowly to changes in market conditions. The latter paper also implied that the ratio of construction costs to the housing price level, change in population between the ages of 25 and 44, and income growth are positively related to changes in metropolitan housing prices.

The paper by Mankiw and Weil (1989) highlighted the importance of demographic variables, the age distribution of the population in particular, on housing prices. In line with the findings of Case and Shiller, Mankiw and Weil detected that housing prices respond slowly to changing demographic forces.

In their empirical models the studies mentioned above did not take into account the possible existence of a long-run equilibrium between housing prices and a number of fundamental variables. The perceived slow adjustment of housing prices, however, brought forth the idea that there exists a long-run equilibrium to which housing prices adjust slowly. Among the first to question the traditional stock-flow assumption that the housing markets clear quickly and to cater for the existence of a long-run relationship in empirical analysis were DiPasquale and Wheaton (1994). Employing two-stage least squares estimation on nationwide annual data from the US from 1963 to 1990 they found evidence that it takes several years for the market to adjust to its new long-run equilibrium. Assuming backward-looking price expectations their results implied that the price level adjusts only 29 percent of its deviation from the long-run equilibrium value in the first year after the shock. Using rational expectations the estimated figure was as small as 16 percent.

Also Abraham and Hendershott (1996) developed a model that allows for lagged adjustment process. They divided determinants of house price appreciation into two groups: one that explains changes in the equilibrium price level and another that accounts for the adjustment dynamics and deviation from the equilibrium price. They included changes in the real income, in the real construction costs and in the real after-tax interest rate in the former group. The latter group consisted of lagged real appreciation and the difference between the actual and the equilibrium price level. Both groups were able to explain a little over two-fifths of the variation in real housing price movements in 30 US cities using annual data and a sample period from 1977 to 1992. Together the groups were able to explain three-fifths. They also found that the coefficient for lagged real price appreciation is positive and highly significant in explaining current real price growth.

Recently, cointegration analysis has been utilized in some studies to examine the existence and composition of a long-run equilibrium relationship between housing prices and fundamental variables. Furthermore, error-correction models have been used to take account of the slow adjustment of housing prices to the long-term equilibrium when modelling the price dynamics. Employing cointegration analysis Hin and Cuervo (1999) found a long-run equilibrium relationship between housing prices, GDP, lending rate and the number of housing starts in Singapore. More recently Meese and Wallace (2003) studied house price dynamics in Paris using monthly data from 1986 to 1992. They found that housing prices adjust to a long-run equilibrium that includes construction costs, real income, employment and interest rate. The study implied that the speed of adjustment of housing prices to the equilibrium is as fast as one-third per month. Riddel (2004), in turn, contributed to the literature by constructing a multiple error-correction model. This approach made it possible to decompose disequilibrium into that generated by supply-side disturbances and that arising from changes in demand conditions. Riddel included a number of variables in the long-term equations: rent index, income and user costs in the long-run housing demand model, and short-term interest rate, GDP, vacancy rate and construction costs in the long-term supply model. Price level was naturally included in both demand and supply equations. Using annual US data from 1964 to 1998 the results implied that prices adjust relatively fast to demand-generated disequilibrium but do not respond to supply-generated disequilibrium.

Case and Shiller (2003) as well as McCarthy and Peach (2004) have taken part in the ongoing debate on whether there is a price bubble in the US housing markets currently. Both articles criticize the views according to which it is evident that housing is overvalued. The importance of taking into account the relevant fundamentals when evaluating the possible overvaluation in the market is emphasized in both papers. Case and Shiller also present a method rarely used when studying the threat of a bubble, a questionnaire survey. Their conclusions are mixed – on one hand fundamental variables have driven the housing price appreciation, on the other hand there are some signs indicating overvaluation in some markets. McCarthy and Peach employ a version of the standard stock-flow model incorporating an error-correction process to take account of the slow adjustment of the housing market. They include housing stock, permanent income (proxied by consumption) and user cost in the long-run equilibrium. Their main conclusion is that the most widely cited evidence of a bubble is not persuasive because it fails to take account of developments in the housing market over the past decade. According to McCarthy and Peach the recent price appreciation in the US can be explained by decline in the interest rates and strong economic growth.

There is also relevant literature using data from the Finnish housing markets and even from the HMA, the very area focused in this study.

Papers by Takala and Pere (1991), and Koskela et al. (1992), using quarterly data of 1970-1990 and 1970-1989, respectively, indicated that the changes in the Finnish financial system during the 1980s affected housing prices significantly. In addition, the results of Koskela et al. were consistent with a view that rising marginal tax rate increased housing prices by increasing the rate of return on housing in the 1970s and 80s.

Kosonen (1997) employed a framework similar to Abraham and Hendershott (1996). Kosonen, however, interpreted the dynamics as an error-correction model. Employing quarterly data from the Finnish housing market from 1979 to 1995 Kosonen found a long-run relationship between real housing price level, real disposable income and real after-tax interest rate. The results implied that approximately 15% of the deviation between current housing prices and the equilibrium prices is removed within a quarter due to housing price adjustment. The interest rate was also showed to have a significant short-run effect on housing prices. Furthermore, similarly to Koskela et al. (1992), the results of Kosonen indicate that the financial market deregulation has had a major impact on housing markets. Specifically, the study shows evidence that house prices have become responsive to real after-tax interest rates only after the deregulation. This result is in accordance with the findings of Muellbauer and Murphy (1997), whose analysis implies that income growth expectations and real interest rates became significantly more important with respect to the housing price formation in UK after the financial deregulation in the early 1980s.

Kuismanen et al. (1999) examined the determinants of housing prices in the HMA. The results indicate that demographic variables as well as income, user costs and the unemployment rate affect prices significantly. The signs are expected – positive for the two former and negative for the two latter variables. Non-stationary variables in levels were used in the analysis. The existence of cointegration between the variables was not tested, however.

Laakso (2000), in turn, using annual panel data of 85 Finnish sub-regions from 1983 to 1997, found that regional housing price movements are positively affected by job and income growth and negatively influenced by an increase in the real after-tax interest rate and vacancy rate. The model for the Helsinki region, nevertheless, implied that only changes in the number of jobs and vacancy rate affect housing price movements statistically significantly. This surprising result is probably due to the small number of observations in the estimation.

Recently Huovari et al. (2005) claim that housing prices in the HMA relative to income and interest rates are currently high compared with history. Thus, they predict that the real price level in the area will decrease by some 13 percent from 2004 to 2007. Similarly to Kuismanen et al. (1999), Huovari et al. use level variables but do not test for the existence of stationary long-run equilibrium relationship.

To summarize, the relationship between housing prices and fundamental variables has been relatively widely studied. In general, the research supports the theory presented in section two.[5] In some papers the existence of a long-run equilibrium between housing prices and some fundamental variables has been assumed, and slow adjustment to this equilibrium has been allowed in the empirical analysis. Nevertheless, usually the existence of a long-run equilibrium between non-stationary variables has not been tested appropriately. Studies where cointegration has been studied formally are e.g. Hin and Cuervo (1999) and Kosonen (1997). Furthermore, most of the studies suffer from a small number of observations.

The aim and contribution of this paper is to utilize relatively long data sample, 122 quarterly observations, and cointegration analysis to formally test the existence of a long-run equilibrium between housing prices and a number of fundamental variables and to identify the composition of the possible cointegrating relationship. Some specifications for the long-run equilibrium relationship that have not been used before are also tested. Furthermore, error-correction and vector error-correction models are estimated to study also the short-run dynamics.

4 DATA

Ideally, a quality-adjusted housing price index should be used in the time series analysis. Unfortunately, such index exists for the HMA starting only from 1987. Therefore, similarly to DiPasquale and Wheaton (1994) and Riddel (2004) an average sales price (per square meter) index and a hedonic price index are joined to have a substantially longer sample period, i.e. series starting from 1975Q1.[6] It is reasonable to believe that the price movements displayed by the average sales prices from 1975 to 1986 do not differ significantly from the true price development. The housing price statistics are published by Statistics Finland and both indices are based on transactions of privately financed[7] flats in the secondary market. The indices based on flats represent the housing price movements in the HMA well, since the share of flats of all the dwellings in the area is high (in 2003 the share was 75 percent).

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5 It is natural that some of the variables that should influence housing prices from the theoretical point of view have not been found to affect housing prices statistically significantly in the empirical work. This is because the measurement of some variables is difficult and there is probably multicollinearity between different explanatory variables, which is likely to lead to smaller t-values.

6 Another option would have been to use the average sales price index throughout the sample period. It is better to use quality-adjusted index for part of the sample period than not to use it at all, however. In any case, there is no significant difference between the average sales price series and the hedonic index series: correlation is .94 even between the differences of the two series (see also Figure A1 in the Appendix).

7 In Finland the housing market is divided into two sectors. Privately financed housing can be bought and sold at market prices without any restrictions. This sector covers approximately 80 percent of the market. In the publicly regulated sector, instead, selling prices and rental prices are controlled.

The data used to study the long-run equilibrium relationship between housing prices and fundamental variables as well as short-run adjustment dynamics are quarterly time series over 1975Q1-2005Q2. The variables included in the analysis are as follows:

- Number of households in the HMA (*HH*)
- Share of population between the ages of 20-29 of the total population in the HMA (*AGE*)
- Inflation rate (*INF*)
- Household consumption per capita (*CONS*)
- Disposable income per household in the HMA (*Y*)
- Rental prices (*RENT*)
- Construction costs (*CC*)
- Real after-tax lending rate (*IR*)
- Nominal after-tax lending rate (*IRN*)
- Stringency indicator of the financial markets (*IRS*)
- Government bond rate (*BOND*)
- Twelve month Euribor rate (*EUR12*)
- Housing loan stock divided by GDP (*LOAN*)

All the variables except for *AGE*, *INF*, *IRS* and the various interest rates are indexed with the value being 100 in 1975Q1. Furthermore, all the variables other than *HH*, *AGE*, *IRN*, *IRS*, and *LOAN* have been deflated by the cost of living index. Lower case letters denote natural logarithms of the corresponding capitals. The composition and sources of the data are explained in more detail in the Appendix.

According to the theoretical framework expected permanent income should be incorporated into the analysis. In empirical work permanent income is usually proxied by consumption. Consumption should work as a good proxy for the income expectations, since households save the less, i.e. they consume the more, the higher is their expected future income (see e.g. Campbell 1987).

There is no long time series concerning consumption in the HMA available. Therefore, the consumption variable in this analysis is the national total household consumption per capita. The current income per household, in turn, is taken account of by *Y*. The unemployment rate is absent from the analysis. It is assumed that *Y* takes account of the effect of unemployment to a great extent.

Similarly to e.g. Koskela et al. (1992) and Holly and Jones (1997) the proportion of population aged 20-29 is included in the econometric analysis. This is because 20-29 year olds have a key role in the housing market – at that age mobility is high and housing consumption increases the fastest. Concerning the HMA this is empirically supported by Kuismanen et al. (1999).

In the empirical part the average lending interest rate is used instead of the average mortgage interest rate because the average lending rate series is substantially longer. The lending rate proxies well for the mortgage rate.[8] Furthermore, it is assumed that *BOND* and *EUR12* proxy well for the opportunity cost of the capital.

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[8] The correlation coefficient between the average lending rate and the average mortgage rate (source: Bank of Finland) is .99 from 1989Q3 to 2005Q2. Correlation between the differences is .89.

Unfortunately time series data on loan maturities is not available. Therefore, housing loan stock divided by the GDP is incorporated in the analysis. It is assumed that the *LOAN* variable takes the effect of the changes in the loan maturities and in the down payment ratios into account to a large degree. It must be emphasized, however, that bank lending is not a true causal factor itself.

Although depreciation and maintenance (d) are included in equation (4), they are not included in the empirical analysis. The depreciation and maintenance series is short and it is assumed that d has been constant during the sample period. In addition, the variation that has existed in d in reality is to a great deal taken into account by the variation in real construction costs.

It is assumed in the empirical analysis that the expectations concerning future housing price movements are backward-looking – the only information that the agents are assumed to use in their expectation formation are past changes in housing prices. Strong evidence of this kind of (irrational) household behavior has been provided in a number of studies, starting from Mankiw and Weil (1989) and Case and Shiller (1989). In this paper it is thought that the expectations follow a simple AR-process. Hence, lagged price change variables in the empirical analysis take the effect of expected appreciation on user costs into account and a specific expectations variable is not needed. This assumption is reasonable since even an AR(1)-model can explain 45 percent of the variation in real housing price movements in the HMA. Similarly to Muellbauer and Murphy (1997) a model for expected appreciation with semi-rational forecasting rule based on the information which consumers are likely to have (recent price changes together with current and lagged values of Δy, Δhh and Δir) was estimated separately for periods 1975Q1-1987Q4 and 1988Q1-2005Q2. This model, however, gave only marginally better fit than a simple AR(1) model, strengthening the assumption of backward-looking expectations.

Because there have been major changes in the Finnish financial markets, tax regulation and rental markets during the sample period, it is worthwhile to review the development of the institutional environment shortly.[9]

Housing finance in Finland has traditionally been dominated by a small number of banks. Up to the mid-nineties the banking system was highly regulated with tightly controlled and rigid lending rates. Low, administratively controlled, lending rates together with foreign capital controls caused credit rationing. This system was fairly stable until the early 1980s. In 1986 the Bank of Finland gradually deregulated the banking system and the ceilings on average lending rates were abolished. Availability of housing loans for households became significantly easier than earlier.

During the credit rationing housing loans had relatively short repayment periods. Still at the beginning of the 1980s the average loan maturity was 8-10 years and the down payment ratio as high as 20-30 percent of the purchase price. The financial deregulation resulted in lower down payment ratios, induced a huge growth of credit and led to a housing market boom and finally to a housing price bubble. Eventually the bubble burst in the beginning of the 1990s. This phenomenon can well be seen from Figure 1.

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[9] The review is mainly based on Koskela et al. (1992, pp. 550-552) and Laakso (2000, pp. 40-44).

Capital gains on owner-occupied dwellings have been practically tax-exempt during the whole sample period. Interest payments on mortgages were wholly tax-deductible up to 1974, after which the rules of tax deductions have been changed several times by setting an upper limit or excess limit to the sum of annual deduction. Until 1992 the interest payments were deductible in income taxation. Hence, the after-tax interest rate was determined by marginal income tax rate. Since the tax reform in 1993, instead, a taxpayer can in practice deduct the interest expenditure multiplied by the capital income tax rate from her taxes. The capital income tax rate, which has varied between 25% and 29%[10], has been substantially lower than the average marginal income tax rate increasing the real after-tax interest rates on housing loans.[11]

After the deregulation the importance of market based interest rates increased and the interest rates on housing loans became more and more dependent on international housing markets. As the inflation rate decreased at the same time, the real after-tax interest rate became permanently positive. In the 1970s and 1980s the real after-tax interest rate had been constantly negative. According to Kosonen (1997) housing prices have been affected significantly by interest rates only after the deregulation.

Also the rental market has been regulated in Finland for long periods. Due to the rent control real rents declined in Finland continuously from the beginning of the sample period to the late 1980s. Rent regulation was finally released in several stages during 1992-95 and real rents have risen substantially during the last ten years.

The effect of the credit rationing is tested in the empirical analysis using the so-called financial market stringency or the “shadow” interest rate variable *IRS*. The influence of the rental control is more problematic to be taken account of in the time series analysis. Salo (1990) uses a “stringency indicator” based on the difference between bond rate and rental income rate. Then, however, housing prices are explained partly by themselves, since housing price level is included in computing the rental income rate. No specific variable taking the effect of rental control into consideration is included in this study.

The real housing price indices together with some of the variables included in the analysis are presented in Figures 1 and 2.

The over- or undervaluation in the housing market is often analyzed based on simple ratios between housing prices and fundamental variables, such as the price-to-income ratio or the price-to-rent ratio. Figure 3 exhibits the housing prices per m^2 divided by the quarterly disposable income (P/Y) together with the housing prices per m^2 divided by monthly rent per m^2 (P/R). The dotted lines show the average level of the ratios during the sample period.

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[10] For the first-time dwelling-buyers the deduction rate has been 30 percent.

[11] During 1972-1992 the average marginal income tax rate varied between 41.4% and 52.8%.

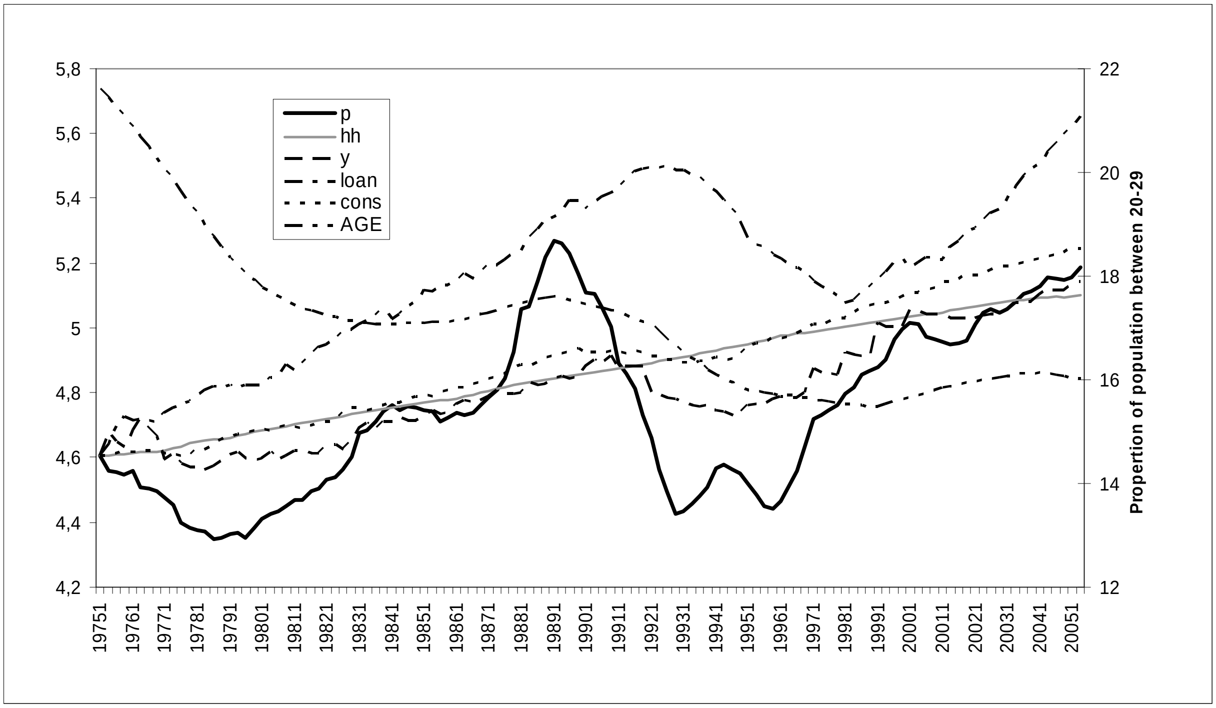

Figure 1 **Real housing price, real disposable income, real permanent income, housing loan stock / GDP and the number of households indices together with the share of population aged 20-29**

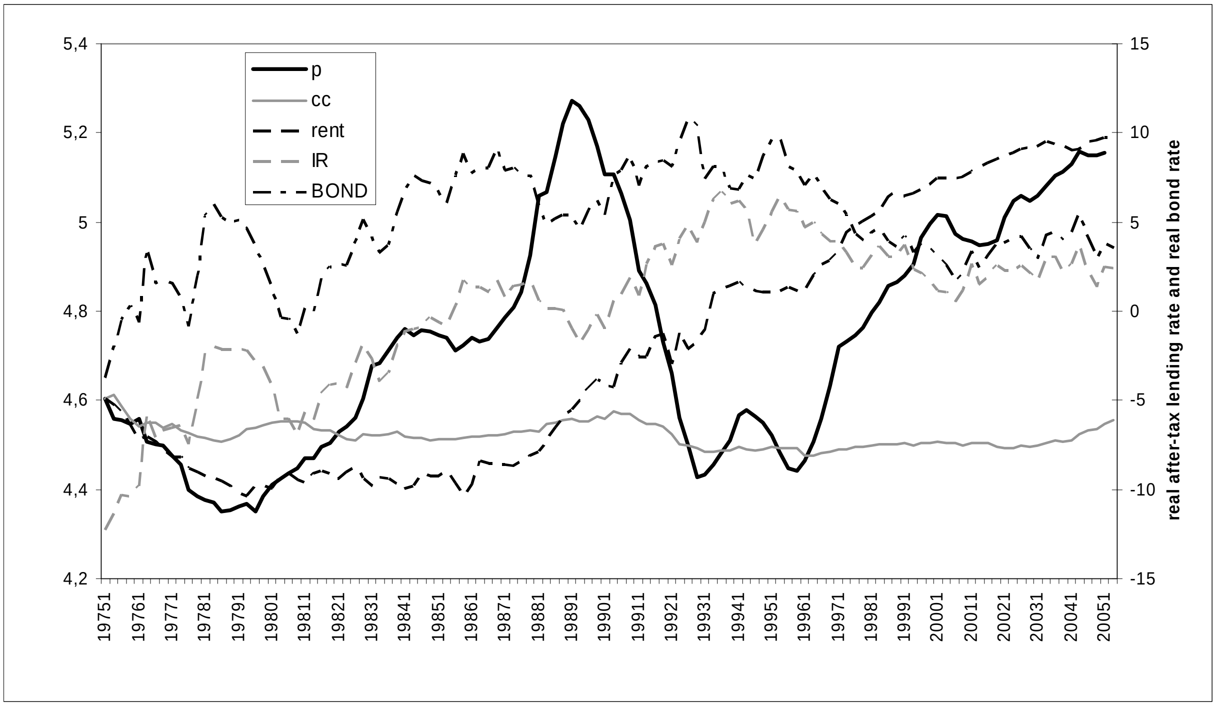

Figure 2 **Real housing price, real construction cost and real rent indices together with the real after-tax interest rate and the real government bond rate**

During the "bubble" of the late 1980s both ratios were substantially above the average level. Then, in the beginning of the 1990s, the ratios dropped well below their long-run averages. Since then the price-to-income ratio has climbed up indicating slightly overvalued housing. However, the price-to-rent ratio is below its long-term average. Thus, these two often used measures give different answers to the question whether housing is currently overvalued. This is one reason, why more formal analysis is needed to make reliable conclusions. Another reason is that, as explained in part two of the paper, there are also other factors affecting the housing price level in the long run. Furthermore, due to the institutional changes during the sample period there might have been structural changes in the long-run relationships between housing prices and income and housing prices and rental prices. In addition, due to the bubble during the sample period the average values exhibited in Figure 3 may be somewhat too large. Consequently, one cannot make reliable conclusions on whether housing is fairly priced or not based on simple ratios such as those exhibited in Figure 3.

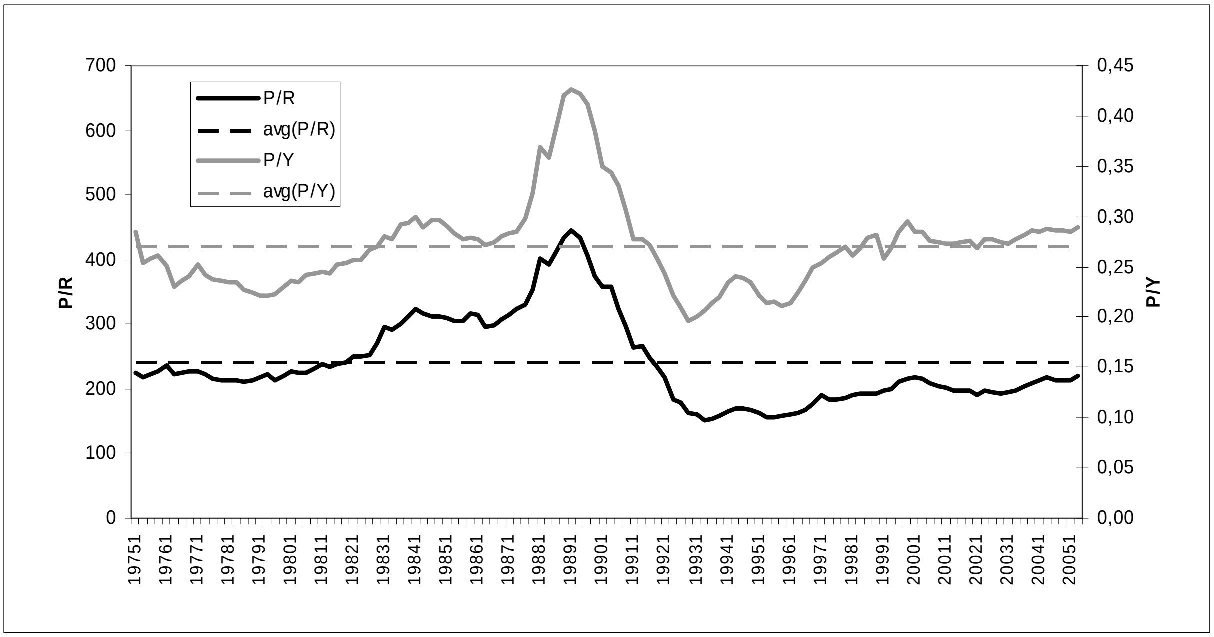

Figure 3 Price-to-income ratio and price-to-rent ratio

Before turning into the analysis of the long-run equilibrium relation, the order of integration of the variables is examined by conducting augmented Dickey-Fuller (ADF) unit root tests.[12] It is obvious based on the graphs and theory that a constant term should be included in the ADF test for *p*, *hh*, *cons*, *y*, *rent*, *loan* and *AGE*.[13] In the ADF tests for *cc*, *INF*, *IR*, *IRN* and *IRS* constant is not included. At the five percent level of significance the ADF test

[12] The number of lags included in the ADF tests was decided based on the general-to-specific method.

[13] According to the graphs and theory it is obvious that deterministic regressors are not needed when testing the stationarity of the differences. The number of households in an exception to this, however.

indicates that all the series, except for *IRS* and surprisingly *INF*, are non-stationary.[14] The inability to reject the unit root may in some cases be due to structural break in the level or in the slope of the series. Therefore, the Perron (1989) test for a unit root allowing for a one-time change in the slope or the level of the series is performed for *p*, *hh*, *cons*, *y*, *rent* and *IR* with a large number of different possible break points. According to the Perron test *IR* seems to be stationary, which is also theoretically sensible. The breakpoint and the test value are 1990Q1 and -4.46, respectively. The corresponding critical value at 5% level is -3.96.

Expectedly, for all the differenced series non-stationarity can be rejected. The ADF test statistics reported in Table 1 imply that Δ*hh* might be random-walk, though. Since it seems that the Δ*hh* series exhibit moving average components, the Phillips-Perron (PP) test is used to study the order of integration of *hh*, further. Regardless of the lag length PP test rejects the unit root of Δ*hh* clearly.

Table 1 Augmented Dickey-Fuller test results[15]

Variable	Level (lags)	Difference (lags)
Real housing prices[c]	-1.76 (2)[s]	-3.59* (4)
Number of households[c]	-2.23 (9)	-2.60 (4)[c]
Share of 20-29 aged[c]	-2.31 (5)	-2.57* (4)
Real household consumption per capita[c]	-.26 (6)	-2.19* (3)
Real disposable income[c]	-.06 (4)	-3.44* (3)
Real construction costs	-.51 (1)	-8.14* (0)
Real rent[c]	-.04 (7)	-2.27* (6)
Real rent 1992-[c]	-1.10 (5)	-3.56* (3)
Real after-tax lending rate	-1.72 (5)	-5.72* (4)
Real after-tax lending rate 1988-2005	-.88 (5)	-5.18* (4)
Nominal after-tax lending rate	-.95 (4)	-6.12* (3)
Nominal after-tax lending rate 1975-1987	-.31 (1)	-5.59* (0)
Financial market stringency	-4.72* (4)	
Inflation rate	-2.11* (5)	
Bond rate	-.68 (5)	-6.26* (4)
Loan stock / GDP[c]	-2.09 (6)	-3.28* (2)

5 EMPIRICAL RESULTS

Originally the aim was to study the existence of one or more long-run equilibrium relationships between housing prices and the fundamental factors by employing the Johansen test for cointegration. The Johansen methodology has many advantages over the Engle-Granger (1989) method. Firstly, the Johansen methodology allows to test if there are multiple cointegrating vectors between the variables. Secondly, the Johansen method enables to test restrictions on the cointegrating vectors to identify the long-run relations in detail.

[14] The KPSS-test, in which stationarity is the null hypothesis, is employed to verify the result concerning *INF*. The KPSS-test rejects the stationarity of *INF*. Hence, the results of ADF and KPSS tests are in contradiction with each other.

[15] * denotes for statistical significance at the five percent level of significance, [c] indicates that constant was included in the test for the level and [s] means that three seasonal dummies were included in the ADF test.

Furthermore, the use of Johansen test offers rigorous methods to study the stability of the long-run relations.

Eventually the Engle-Granger method was used in the analysis, however. This is because the institutional changes during the sample period seem to necessitate the inclusion of variables taking account of the structural breaks in the econometric analysis. This, together with the fact that six lags are needed in the Johansen test to extract significant residual autocorrelation, leads to a large number of variables in the test compared with the number of observations, which is likely to create notable size-distortions. Furthermore, the inclusion of dummy variables alters the quantiles used in detecting the number of cointegrating vectors in the Johansen test.

The Engle-Granger method first involves the estimation of a long-run relation between variables of which at least two are I(1). Then the stationarity of the residual series from the estimated equation is tested. The estimated relation can be regarded as a long-run equilibrium relationship if the residual series is stationary. The long-run equilibrium relation can then be used to estimate error-correction model (ECM) for housing price movements and cointegrated vector autoregressive model (CVAR) in which also the short-run dynamics are studied.

A large number of possible long-run equilibrium models were estimated. Some of the models are presented in Table 2. Unexpectedly, current income is in general a better explanatory variable for the housing price level than permanent income. The models including *y* fit the data better and are preferred by the Akaike (AIC) and Schwartz (SBC) information criteria. As a comparison, however, also one specification (model 2) including *cons* as the only income variable is reported.

The importance of current income implies that for many households the income and wealth constraints are still binding. On the other hand, even if future income expectations are high, the uncertainty concerning future income may weaken the influence of the income expectations on housing prices.[16] The data also gives some support to the hypotheses that current income was more important during the credit control than after the deregulation of the financial market and that the effect of permanent income has been greater since the liberalization (see models 4, 5, 6 and 8).

[16] Negative relationship between income uncertainty and homeownership is reported e.g. by Haurin (1991) and Diaz-Serrano (2005a; 2005b).

Table 2 **Long-run equilibrium real housing price level estimations (dependent variable *p*, t-values in parenthesis)**

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
intercept	-8.82 (6.9)	-11.8 (7.2)	-6.90 (4.4)	-13.4 (4.7)	-9.00 (5.0)	-11.1 (4.3)	-7.89 (4.7)	-8.65 (3.9)
hh				.867 (3.1)		.569 (2.2)		
AGE		.040 (4.0)						
y	1.32 (23.7)		1.30 (20.3)	.830 (4.2)	1.19 (14.3)	.829 (4.8)	.978 (5.2)	1.34 (14.1)
y (89-)				-.041 (4.1)	-.89 (2.9)	-.035 (3.9)		-1.32 (3.1)
cons		1.45 (18.4)					.447 (2.3)	
cons (89-)					.844 (2.8)			1.25 (2.9)
cc	1.62 (6.1)	1.95 (5.2)	1.10 (3.1)	2.27 (4.3)	1.46 (3.9)	1.75 (3.7)	1.28 (3.6)	1.34 (3.0)
IR			-.009 (2.0)				-.016 (4.1)	
IR(88-)	-.037 (7.0)	-.046 (8.0)	-.033 (5.0)	-.066 (8.5)	-.075 (10.4)	-.070 (10.3)	-.022 (3.2)	-.073 (6.6)
IRN (75-87)	-.030 (6.6)	-.025 (4.7)	-.031 (6.4)	-.053 (5.7)	-.042 (5.1)	-.041 (4.9)	-.034 (6.2)	-.056 (5.4)
loan			.094 (1.7)		.334 (6.9)	.282 (5.7)		.240 (4.3)
t (78Q4-89Q4)	.0062 (13.1)	.0061 (10.6)	.0064 (10.2)				.0082 (13.9)	
SBC	-79.8	-49.1	-75.1	14.1	-15.1	-12.1	-67.0	-27.0
AIC	135.4	161.2	130.4	224.5	190.5	193.4	138.6	232.5
Adjusted R^2	.949	.936	.950	.893	.918	.916	.947	.884
Jarque-Bera	.52	.55	.67	.61	.41	.62	.96	.01
ADF t-value[17]	-4.78 (-4.24)	-4.78 (-4.55)	-4.74 (-4.84)	-3.15 (-4.53)	-3.91 (-4.83)	-4.21 (-4.83)	-5.23 (-4.84)	-4.14 (-4.83)

[17] Critical values at 10% level of significance in the parenthesis. The critical values are counted based on the response surface coefficients estimated by MacKinnon (1996).

A trend term from 1978Q4 to 1989Q4[18] is needed in the models in order to get stationary residuals. In the models where the trend variable is absent non-stationarity of the residual series can not be rejected. Hence, it is questionable if models 4, 5, 6 and 8 can be interpreted as long-run equilibrium relations. The need for the trend variable implies the existence of a structural brake because of the financial liberalization. The economic interpretation of the variable is somewhat problematic, however. The trend variable probably takes into account some (possibly flawed) future expectations that the other variables are not able to take account of.

In addition to the income variables and the trend term, also the interest rate variables indicate a change in the housing price formation due to the financial deregulation in the late 1980s. The shadow interest rate does not seem to have had effect on the long-run housing price level, nevertheless. Housing prices were considerably inflexible with respect to the real after-tax lending rate before the abolishment of the credit restrictions. Consistent with the theoretical considerations of section 2.3, the results indicate that nominal lending rate was more important factor driving housing prices during the credit control than the real lending rate. After the financial liberalization the nominal rate has not been significant, though. As expected, since 1988 *p* has been much more sensitive to the real lending rate.[19] Similar finding has been reported by Kosonen (1997). The best fitting specifications indicate that a one percentage-point increase in the real lending rate today would lead to a slightly smaller than three percent decrease[20] in the long-run equilibrium level of housing prices, *ceteris paribus*. According to the equations without the trend term the influence of the real lending rate on the fundamental housing price level is substantially greater.

The nominal and real lending rates fluctuate substantially from quarter to quarter. Therefore, households might base their expectations concerning the future lending rates not only on the current lending rates but also on lending rates during a couple of preceding periods. That is why two equations, models 6 and 7, are estimated using four quarter moving averages as the lending rate variables. These models do not differ notably from the other equations, however.

Also the supply side seems to enter the long-run equilibrium housing price level significantly. Construction cost index is significant in all the reported models are the coefficient of *cc* is constantly over one. Hence, it would seem that the three main factors determining the real housing price level in HMA in the long horizon are the level of income and construction costs together with the real lending rate.

There are also other interesting observations. Somewhat unexpectedly the rental price level does not enter the long-run equilibrium relation significantly either before the rental control or after it. The significance of the capital income tax rate and the housing property tax rate was tested as well. Both tax variables are highly insignificant. The demographic variables *AGE* and *hh* are included in only one and two models, respectively. The insignificance of the number of households in most models seems to be mainly due to multicollinearity between the income variables and *hh*. Furthermore, the loan-to-gdp ratio is signifi-

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[18] The length of the trend variable is decided based on AIC and SBC.

[19] The starting point of the after-deregulation *IR* is decided based on AIC and SBC.

[20] A one percentage-point increase in the real lending rate raises the real after-tax interest rate by .72 percentage-points.

cant only if the trend term is absent. Then, however, the residuals do not seem to be stationary. It should also be noted that causality seems to go rather from *p* to *loan* than the other way around.

Based on adjusted R^2 and AIC model 3 is the best fitting model using the actual lending rates, while model 6 is the best fitting model using the moving average lending rates. Both of these models imply that current price level is accordant with the fundamental value.

It should be noted, however, that the use of the income expectations and the loan-to-gdp ratio as explanatory variables is somewhat problematic. Model 3 includes *loan* and model 6 the income expectations. The household income expectations may not be realistic and may not reflect the true market fundamentals. For example, it seems evident that after the financial liberalization in the late 1980s the income expectations were overly optimistic. The loan-to-gdp ratio may contain a flawed expectation component just like *cons*. Furthermore, the loan stock is not a true causal factor itself. It is included in the analysis hoping that it could approximate the effects of the increased loan maturities and decreased down payment ratios on the liquidity constraint faced by households.

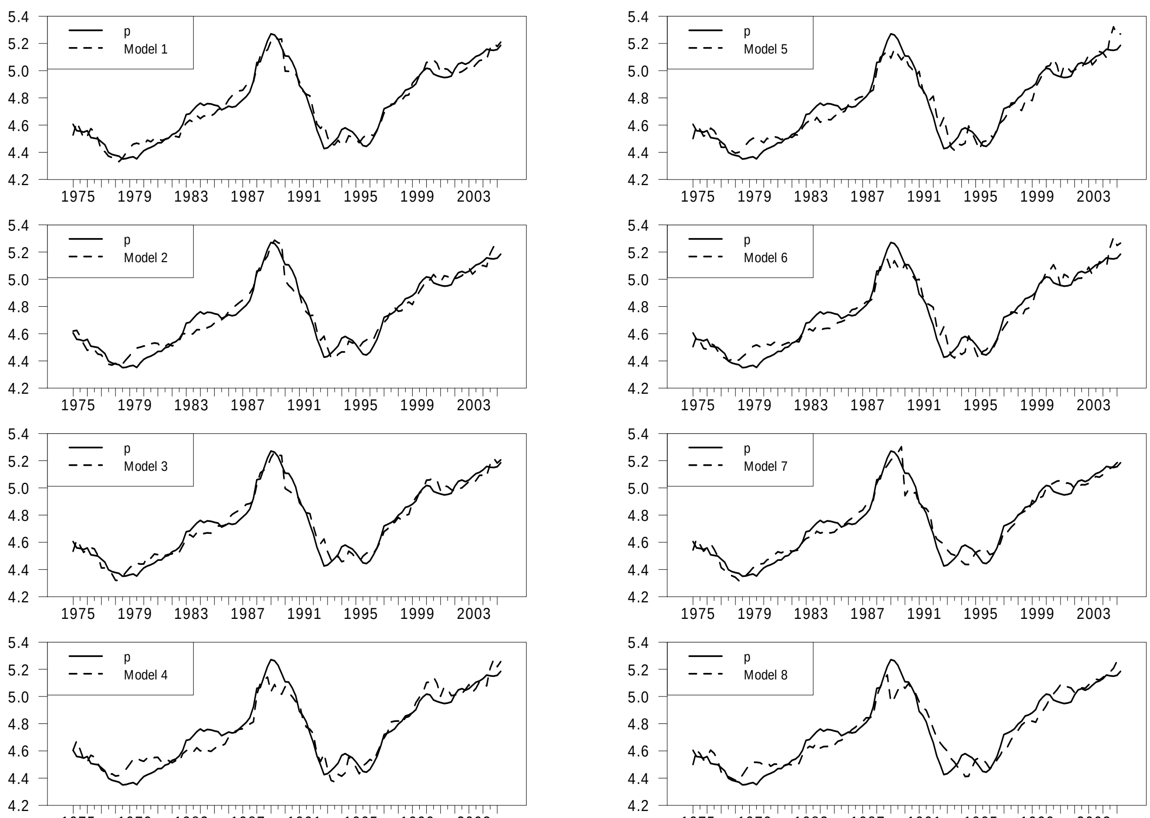

Figure 4 Actual real housing price index and the fits from the models

How can we be sure that the present income expectations are not flawed giving a wrong picture of the sustainability of the current price level? Naturally, there is no way to be definitely sure. This is why the fundamental housing price levels implied by all the models presented in Table 2 are plotted together with the actual housing price index in Figure 4. Most of the time all the relations move close to each other and regardless of the exact specification of the long-run equilibrium price level, it seems that housing prices are currently not overpriced in the HMA. In fact, all the stationary models indicate that the housing price level is close to its long-run equilibrium at present. The models implying notable undervaluation of housing are all nonstationary. Thus, it is concluded that current housing price level seems to correspond relatively well to the fundamental variables driving housing prices in the long horizon. The rapid growth in the real disposable income since 1994 together with the decline in the real lending rate has justified the substantial increase in housing prices during the last ten years.

The results of Oikarinen (2005) imply that there have been some differences between housing price dynamics in the centre and the suburbs of the HMA. Hence, there is a slight possibility that housing is overvalued in the centre even if housing prices seem to correspond to the fundamentals in the whole area. Because of this the possible overpricing of housing in the centre was also studied. The results are similar to those concerning the whole HMA. Therefore, it is not considered necessary to report the results regarding the centre in more detail.

Using model 1 as the long-run equilibrium relation three different ECMs are estimated for HMA housing price movements. These ECMs are shown in Table 3. The first two models are specified based on R^2 and AIC, whereas variables in the more parsimonious third model are decided on the grounds of SBC.

Table 3 Error-correction models for real housing prices

	ECM1		ECM2		ECM3	
Constant	-.017	(2.7)	-.009	(1.3)	-.003	(.9)
Δp_{t-1}	.542	(4.7)	.530	(4.6)	.703	(6.3)
Δp_{t-4} *(1975-87)*	.393	(3.4)	.412	(3.5)		
Δp^2_{t-3}	-2.72	(3.9)	-3.98	(4.3)		
Δhh_{t-3}	3.02	(2.5)	3.10	(2.8)		
$\Delta cons_{t-1}$	.758	(2.2)	.638	(1.9)	.754	(2.0)
$\Delta cons_{t-4}$	.840	(2.5)	.986	(3.1)		
$\Delta y75\text{-}87_{t-3}$	.010	(8.5)	.012	(9.4)		
$\Delta rent_{t-4}$ *(1992-)*	.016	(5.7)	.022	(6.7)		
ΔIR_{t-1} *(1988-)*	-.011	(2.9)	-.010	(2.7)	-.009	(2.3)
ΔNIR_{t-2} *(1975-88)*	-.012	(8.0)	-.012	(7.9)	-.014	(10.2)
$\Delta EUR12_{t-2}$ *(1988-)*	-.009	(3.0)	-.009	(2.7)		
Δt_{t-1} *(78Q4-89Q4)*	-.002	(5.7)	-.002	(6.5)	-.001	(4.9)
$p_{t-1}\text{-}p^e_{t-1}$	-.094	(2.9)			-.153	(4.4)
$p_{t-1}\text{-}p^e_{t-1}$ *(+)*			-.259	(4.4)		
$p_{t-1}\text{-}p^e_{t-1}$ *(-)*			.079	(1.2)		
Adjusted R^2	.645		.659		.559	
SBC	-275.8		-276.9		-281.2	
AIC	-108.5		-114.3		-76.6	
	p-values		p-values			
Reset	.640		.636		.267	
J-B	.034		.001		.131	
LM(1)	.084		.025		.408	
LM(4)	.392		.105		.515	
LM(4)-heter	.001		.021		.007	

All the estimated ECMs seem to exhibit heteroscedasticity. Thus, the covariance matrix is computed allowing for heteroscedasticity, as in White (1980). ECM1 and ECM2 fail the Jarque-Bera test for normality. This is due to the flat tails of the distribution of the real housing appreciation. The explanatory power of the estimated models is relatively good. For example the model of Riddel (2004) explained 54% of the variation in housing price movements in the US, and the model of Meese and Wallace (2003) only 35% of price changes in the Parisian housing market.

The models imply that housing price level adjusts towards the long-run equilibrium level sluggishly, as expected. According to ECM1 only about 10% of the deviation between the actual prices and the long-run fundamental price level vanishes during a quarter due to the adjustment of p. The parsimonious ECM3 indicates slightly faster adjustment, 15% per quarter. This is substantially faster than the speed of adjustment of 29% a year estimated by DiPasquale and Wheaton (1994) using US data. Meese and Wallace (2003), on the contrary, found that prices adjust surprisingly rapidly, one third per month, towards the long-run equilibrium.

A priori it seems possible that the adjustment process of housing prices towards the long-run equilibrium is more rapid after the financial deregulation. Especially the upwards adjustment may have quickened, since it is easier for the households to get mortgages nowadays. However, ECM1 does not show evidence of faster adjustment since the end of 1980s. According to ECM3 the speed of adjustment coefficient is larger in the latter period but only at 20% level of significance.

Stronger evidence is found supporting an assumption that the adjustment process is asymmetric, i.e. upward adjustment is either slower or faster than downward adjustment. ECM1 is re-estimated in ECM2 so that asymmetric adjustment process is allowed. ECM2 shows that real house prices move towards the equilibrium more rapidly when they are over it than when they are below. This is in line with the results of Holly and Jones (1997) from the UK housing markets. In fact, ECM2 implies that p adjust towards the long-run equilibrium only when it is overvalued. Also according to the more parsimonious model downward adjustment is somewhat faster than upward adjustment, statistically insignificantly though.

It was earlier noticed that current income level has been more important determinant of the long-run housing price level than income expectations. Nevertheless, in the short horizon the effect of income expectations on p seems to be substantially greater than the effect of current income. This is somewhat surprising. In line with the theory is the fact that the coefficient for Δy is bigger before the abolishment of the credit controls than after that.

There are also other signs of structural breaks. As in the long-run equilibrium models IR enters the short-term model starting from the end of the 1980s and the effect of NIR vanishes at the same time. Also a third interest rate variable, the 12 month Euribor rate starting from 1988Q1, is included in the first two ECMs. The negative effect of $EUR12$ may be due to its impact on the opportunity cost of capital as well as on the lending rate. Furthermore, rental price movements do not seem to influence housing price changes before the abolishment of the rental control. Finally, it seems that Δp was more autocorrelated before the financial deregulation.

The perceived real housing price movements together with the fit from ECM 2 are presented in Figure 5.

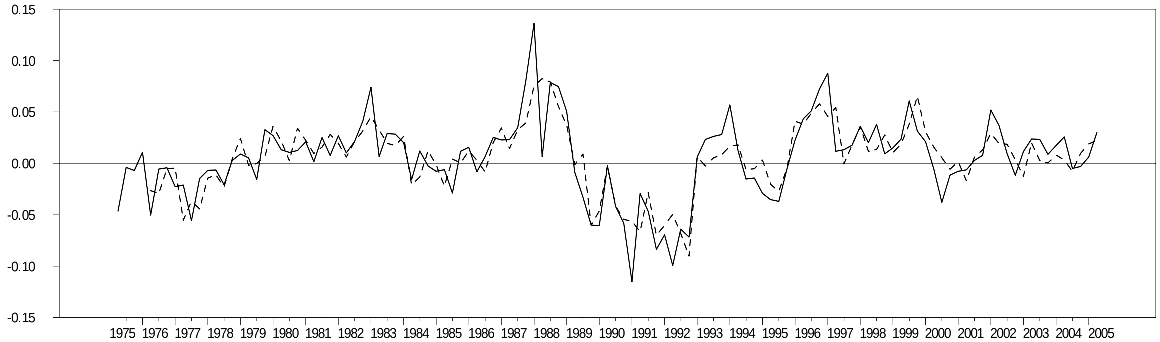

Figure 5 Actual real housing price movements and the fit from ECM 2

The coefficients in the long-run relations exhibited in Table2 show what happens to the real housing prices in the long horizon if one of the explanatory variables is increased by one unit and everything else is held constant. As already mentioned, the coefficients in model1 imply for example that a one percentage point increase in the real after-tax interest rate reduces real housing prices by about 3.7% in the long run if all the other explanatory variables are kept constant. However, some of the explanatory variables are likely to be dependent on each other. Hence, as pointed out by Lutkepohl (1994), it is often unrealistic to assume that in the real world the actual long-run effects are expressed entirely by the coefficients in the long-run equilibrium relationship.

To take into account also the dynamic interrelations between the explanatory variables it is useful to estimate a CVAR-model. Based on the CVAR-model the impulse responses of housing prices to a shock to a fundamental variable driving housing prices can be derived. The impulse responses incorporate also the effects due to the dynamic interdependences between the variables explaining housing prices.

Figure 6 plots the impulse responses of the real housing price level to a one percent change in the current disposable income, to a one percent increase in the income expectations and to a .72 percentage-point change in the real after-tax interest rate, which corresponds to a one percentage-point shock to the real before-tax interest rate. The values in the horizontal axis refer to quarters from the shock. The impulses are based on a CVAR-model including *cons*, *y*, *hh*, *p,* and *cc* as endogenous variables, and *NIR* 1975Q1-1987Q4 together with *IR* starting from 1988Q1 as exogenous variables. *NIR* is restricted to be exogenous since it does not affect the impulses anymore. *IR*, in turn, is exogenous, since it is nowadays mainly determined by the European Central Bank. Furthermore, constant term and the difference of the trend dummy are included as deterministic variables. The long-run equilibrium relation is the one in model1. The CVAR-model includes four lags in differences. Likelihood ratio test has been utilized when deciding the variables and the number of lags to be included in the CVAR.

The impulse responses indicate that it takes a long time for the housing prices to fully adjust to a shock. Furthermore, the response of the real housing price level to a shock is cyclical. Thus, the housing market might offer possibilities to gain superior returns even taking account of the transaction costs and low liquidity of housing if an econometric model based on historical data is utilized.

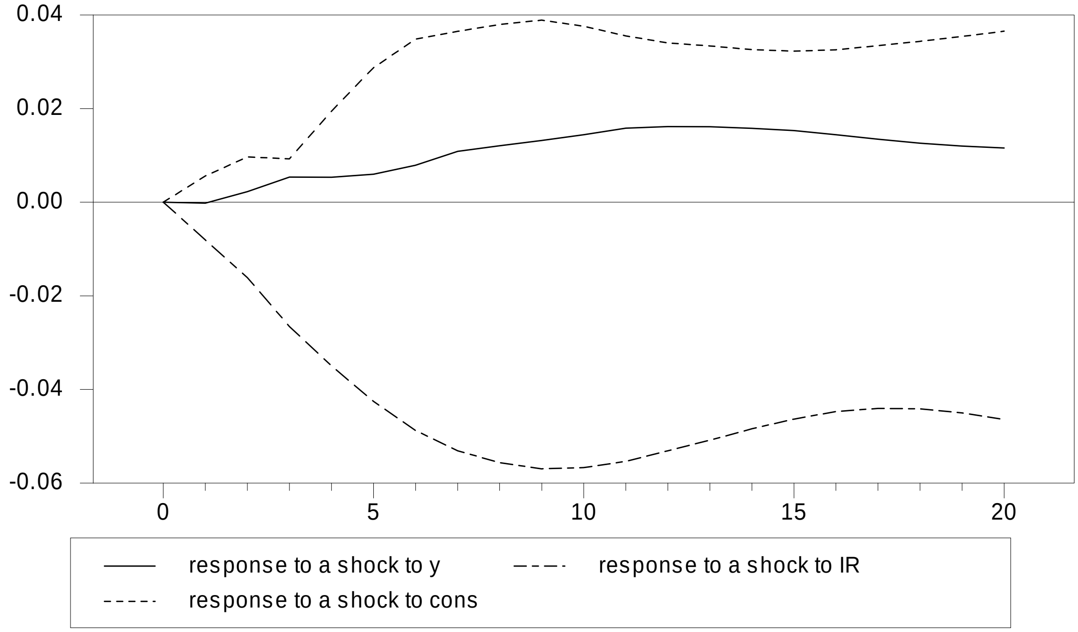

Figure 6 Impulse response functions of real housing prices to a shock to current disposable income, to income expectations and to real interest rate

The impulse responses also show that the actual long-run effects of the shocks are different from the coefficients in the long-run relation because of the interrelationships between different variables. According to the CVAR-model the effect of a one percent shock to *y* is about 1.2% five years after the shock. The negative influence of a percentage-point increase in the real interest rate is 4.6% after five years. After two years the negative impact is as high as 5.6% according to the CVAR.

The substantially larger impact of a shock to *cons* compared with the influence of a shock to *y* is largely due to the strong self-fulfilling nature of the income expectations. Growth in *cons* leads to a notable rise in *y*, which in turn increases *cons*. Similar dynamics occur also after a shock to *y*, but, based on the estimated model, the magnitude is significantly larger if the process starts from a shock to *cons*.

The coefficients of Δp in the CVAR-model are shown in the Appendix. It should be noted that vector autoregressions are, in effect, dynamic reduced forms, not structural relations. Hence, the meaning of the values for the coefficients is not obvious. Furthermore, many of the parameter estimates are not significant in the commonly used significance levels. The goal is to find the important interrelationships between the variables and not the significant parameters.

The examination of the decomposition of variance for Δp, presented in the Appendix, can give some further light to the housing price dynamics. The decomposition of variance suggests that the principal factor driving *p* is *IR*. The significance of *IR* is emphasized in the long run. Other notable driving factors are *p* itself and the income variables. The importance of *hh* and *cc* is negligible. Hence, it seems that housing prices in HMA are mainly driven by demand factors.

6 CONCLUSIONS

The real housing price level has increased by about 75% from the end of 1995 to the second quarter of 2005 in the Helsinki Metropolitan Area (HMA). This, together with the constant claims of the existence of housing price bubbles in many countries all over the world, has raised the question of whether housing is overvalued in the HMA currently. This question is of importance, because housing price movements in the HMA are not only affected by the general economic conditions but are also likely to have substantial effects on the Finnish macroeconomy.

The long-run equilibrium level of housing prices is affected by a number of variables. Often used simple methods to analyze the sustainability of housing price level, such as the price-to-income ratio and the price-to-rent ratio, ignore many of the factors that drive housing prices. Furthermore, institutional changes may change the relations between housing prices and variables, such as income and rent level, driving them. Therefore, more detailed and rigorous analysis is needed to evaluate the existence of overvaluation in the housing market.

In this paper the long-run equilibrium relation between housing prices and a number of fundamental factors is studied using a quarterly dataset from 1975Q1 to 2005Q2. Comparison of the long-run equilibrium price level with the current price level indicates that housing price level is accordant with its fundamental value in the HMA at the moment. The rapid growth in the real disposable income together with the decline in the real lending rate has justified the substantial increase in housing prices during the last ten years.

In addition, the empirical results show that there have been structural changes in the relationship between housing prices and the fundamental variables. In particular, the real lending rate has influenced housing prices notably only after the financial liberalization in the late 1980s, while during the credit control the nominal lending rate was an important factor. There is also some evidence indicating that the effect of both permanent income and current income on the long-run equilibrium housing price level has changed. These findings are all in line with the theory. Furthermore, the results suggest that the real housing price level is driven mostly by demand factors even in the long horizon.

The paper also studies the short-run dynamics between housing prices and the fundamental factors. The estimated error-correction model implies that housing prices adjust towards their long-run equilibrium level sluggishly. Only about 10%-15% of the deviation between the actual price level and the long-run fundamental price level vanishes during a quarter due to the housing price adjustment. Downward adjustment seems to be faster than upward adjustment. The cointegrated VAR-model, in turn, shows that the response of the real housing prices to a shock in the fundamental variables is cyclical.

At present, the biggest fear for a decline in the real housing price level in the HMA comes from the interest rates. At some point in the quite near future the real interest rates are likely to rise from their current relatively low level. The Finnish housing markets are extremely vulnerable to the interest rate movements since most of the mortgages are tied in relatively frequently changing interest rates.[21] With raising interest rates many households

[21] In Finland mortgages are usually annuity loans. Mortgage rates are typically tied to the 12 month Euribor rate and are revised every 12th month.

might not be able to meet their mortgage payments, which would cause selling pressure in the market. At the same time increase in the lending rate would naturally impair demand for housing. If the interest rate increase is not accompanied with strong macroeconomic conditions, influences on the Finnish economy might be severe. Obviously, it would be safer for the Finnish economy, if more mortgages were tied to fixed interest rates.

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APPENDIX

THE DATA

- Number of households in the HMA (*HH*)
  - data source: Statistics Finland
  - annual end of year figures; quarterly values estimated based on the quarterly changes in the total population in the HMA
  - seasonally smoothed
- Share of population between ages 20-29 of the total population in the HMA (*AGE*)
  - data source: City of Helsinki Urban Facts
  - annual, quarterly values are estimated by interpolation
  - the values for 2005Q1 and 2005Q2 are based on extrapolation
- Total population in Finland
  - data source: Statistics Finland
  - end of year figure, quarterly values by interpolation
- Total nationwide household consumption (*CONS*)
  - seasonally adjusted purchases of nondurables and services per capita
  - source of consumption data: The Research Institute if the Finnish Economy (ETLA) database
  - used as a proxy for permanent income / income expectations
- Disposable income per household (*Y*)
  - (income – paid taxes)/households
  - taxed income of Helsinki residents in the state taxation; data source: City of Helsinki Urban Facts; annual 1975-2003; quarterly variation according to the nationwide income level index provided by Statistics Finland
  - state, municipal and church taxes plus employees' social security payments paid by Helsinki residents; data source: City of Helsinki Urban Facts; annual 1975-2003; quarterly variation according to the nationwide income level index
  - the movements of the disposable income index for 2004Q1-2005Q1 are based on the nationwide income level index
  - seasonally smoothed
- Average rental price level per square meter in the HMA (*RENT*)
  - data source: City of Helsinki Urban Facts 1975-1984, Statistics Finland 1985-
  - the average rental prices are only for Helsinki from 1975 to 1989
  - the values concerning the whole HMA in 1975-1989 are estimated as: $RENT(HMA)_t = (RENT(HMA)_{1990} / RENT(Helsinki)_{1990}) * RENT(Helsinki)_t$
  - annual; quarterly values 1975-1999 based on the "living, heating and light" part of the nationwide cost of living index, quarterly values 2000- based on the "rental cost" part of the nationwide cost of living index
  - seasonally smoothed
- National construction cost index (*CC*)
  - data source: Statistics Finland
- Real average lending interest rate (*IR*)
  - average lending interest rate of deposit banks in Finland 1975-2002 concerning the whole outstanding loan stock; data source: Statistics Finland

- average lending interest rate of deposit banks and other credit institutions in Finland 2003- concerning the whole outstanding loan stock; data source: Bank of Finland[22]
- after-tax nominal mortgage rate is counted as i(1-T), where T is the average marginal income tax rate in Finland from 1975 to 1992 and the capital tax rate from 1993 onwards. The real rate is computed by subtracting the inflation rate, measured by the cost of living index, from the nominal after-tax lending rate.
- national average marginal income tax rate (1970-1976, data source: Salo, 1990;[23]; 1977-1992, data source: Finnish Ministry of Finance)

- Inflation rate (*INF*)
  - change in the national cost of living index; source: Statistics Finland
  - seasonally smoothed
- Real rate for ten year goverment bonds (*BOND*)
  - average of daily values
  - data source: ETLA database
- Twelve month Euribor rate (*EUR12*)
  - twelve month Helibor 1975-1998
  - twelve month Euribor 1999-
  - data source: ETLA database
- Stringency indicator for the financial market 1975-1987
  - the difference between “market” lending rate and actual average lending rate
  - data source for the “market” rate: Salo (1990)
- Housing loan stock divided by GDP (*LOAN*)
  - housing loan stock in Finland 1979-
  - housing loan stock in 1975-1979 is estimated based on the changes in the total household loan stock
  - data source: Bank of Finland (1979-); Statistics Finland (1975-1979)
  - seasonally adjusted GDP; data source: ETLA database

[22] Due to the regulations laid down by the European Central Bank the compilation of average lending interest rate statistics include also lending from other credit institutions starting from 2003. Because of this there is approximately a 0.3 percentage-point increase in the average rate since 2003. Therefore, 0.3 percentage-points are decreased from the figures starting from 2003Q1.

[23] The series presented by Salo (1990) are based on: Edgren (1980) *Tuloverotuksen automatiikan kvantifioinnista*. The Research Institute of the Finnish Economy, Discussion Paper No. 74: Helsinki.

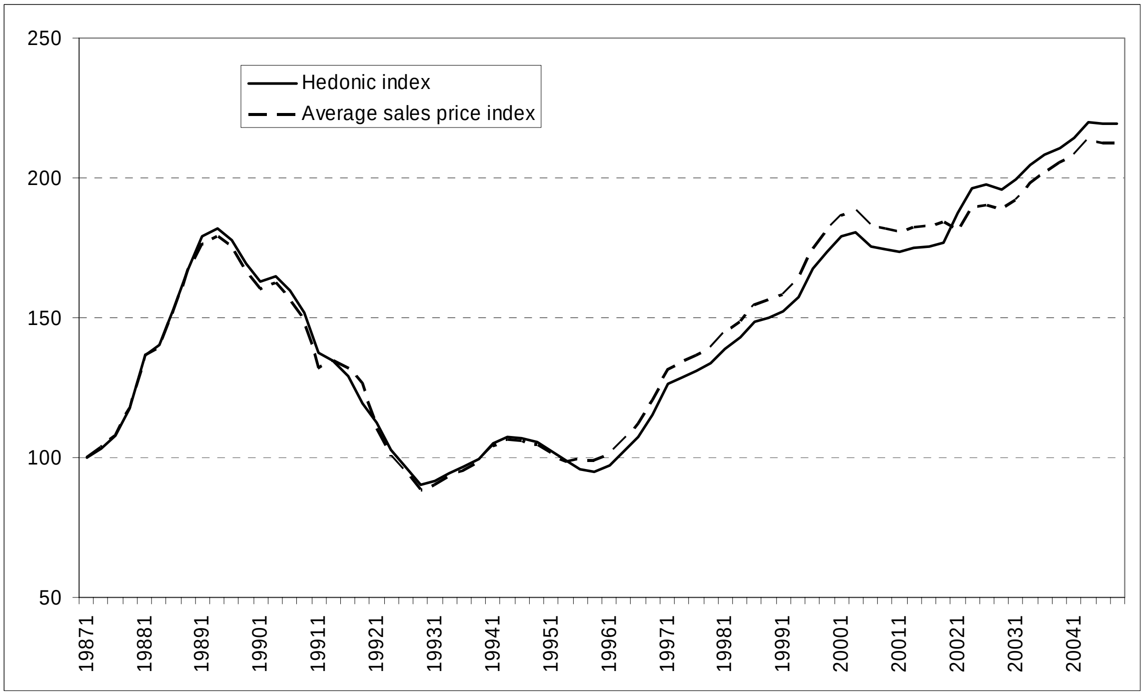

Figure A1 Hedonic price index and average sales price index from 1987 to 2004

Table A1 Coefficients of real housing price movements in the CVAR-model

Variable	Coefficient	(t-stats)
constant	-.010	(.9)
$P_{t-1} - p^e_{t-1}$	.153	(3.2)
$\Delta cons_{t-1}$	.565	(1.5)
$\Delta cons_{t-2}$	-.010	(.0)
$\Delta cons_{t-3}$	-.371	(1.0)
$\Delta cons_{t-4}$	1.02	(2.7)
Δy_{t-1}	-.203	(1.5)
Δy_{t-2}	.054	(.4)
Δy_{t-3}	-.034	(.8)
Δy_{t-4}	-.319	(2.4)
Δhh_{t-1}	-.255	(.1)
Δhh_{t-2}	-.103	(.6)
Δhh_{t-3}	.212	(1.0)
Δhh_{t-4}	.247	(.1)
Δp_{t-1}	.784	(7.8)
Δp_{t-2}	.158	(1.4)
Δp_{t-3}	-.106	(1.0)
Δp_{t-4}	.078	(.8)
Δcc_{t-1}	-.126	(0.3)
Δcc_{t-2}	-.405	(1.0)
Δcc_{t-3}	.065	(.2)
Δcc_{t-4}	-.261	(.7)
ΔIR_{t-1} *(1988-)*	-.006	(1.2)
ΔIR_{t-2} *(1988-)*	.002	(.3)
ΔNIR_{t-3} *(1975-1987)*	.020	(3.6)
ΔNIR_{t-4} *(1975-1987)*	-.012	(2.1)
Δt *(78Q4-87Q4)*	-.002	(2.7)
Adjusted R^2	.611	
J-B	.666	
LM(1)	.132	
LM(4)	.226	

Table A2 Decomposition of variance for real housing prices movements

Step (quarters)	$\Delta cons$	Δy	Δhh	Δp	Δcc	$\Delta IR88-$
1	.000	1.00	.000	.000	.000	.00
2	.008	.000	.000	.936	.000	.056
5	.022	.012	.001	.665	.001	.299
10	.075	.035	.004	.266	.004	.614
15	.082	.063	.003	.155	.018	.680
20	.088	.071	.002	.129	.019	.688

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