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INTERACTION BETWEEN HOUSING PRICES AND HOUSEHOLD BORROWING IN FINLAND

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ABSTRACT: Housing prices and household borrowing are expected to be tightly connected to each other. Better availability of credit eases liquidity constraints of households, which is likely to lead to higher demand for housing. On the other hand, housing prices may significantly influence household borrowing through various wealth effects. Employing time series econometrics this study shows that since the financial liberalization in the late 1980s there has been a significant two-way interaction between housing prices and housing loan stock in Finland. Before the financial deregulation the interaction was substantially weaker. Furthermore, housing appreciation has a notable positive impact on the amount of consumption loans withdrawn by households. It appears that there is no similar relationship between stock price movements and household borrowing. Understanding the two-way interaction between housing prices and credit is of importance, since the interdependence is likely to augment boom-bust cycles in the economy and increase the fragility of the financial sector.

Keywords: lending, borrowing, housing, stocks, dynamics

JEL classification: E41, E51, R21

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TIIVISTELMÄ: On useampia syitä olettaa, että asuntojen hinnoilla ja kotitalouksien lainanotolla on vuorovaikutussuhde. Parempi rahoituksen saatavuus löysentää kotitalouksien likviditeettirajoitteita, mikä on omiaan lisäämään asuntojen kysyntää. Toisaalta asuntohintojen vaihtelu voi vaikuttaa kotitalouksien lainanottoon erilaisten varallisuusvaikutusten kautta. Tässä artikkelissa tutkitaan empiirisesti aikasarjaekonometrian menetelmin asuntohintojen ja kotitalouksien lainanoton välistä vuorovaikutusta Suomessa. Tulosten mukaan asuntohintojen ja asuntolainakannan välillä on ollut voimakas positiivinen vuorovaikutus 1980-luvulla tapahtuneen rahoitusmarkkinoiden vapauttamisen jälkeen. Ennen rahoitusmarkkinoiden vapauttamista vuorovaikutus oli selvästi heikompi. Asuntojen arvonnousulla näyttäisi olevan positiivinen vaikutus myös kotitalouksien kulutuslainojen ottamiseen. Osakkeiden hinnoilla ja kotitalouksien lainanotolla ei ole tulosten mukaan vastaavaa suhdetta. Asuntomarkkinoiden ja rahoitusmarkkinoiden välisen yhteyden ymmärtäminen ja analysointi on tärkeää, sillä vuorovaikutus asuntohintojen ja kotitalouksien lainanoton välillä on omiaan voimistamaan talouden suhdanteita ja lisäämään rahoitussektorin haavoittuvuutta.

Asiasanat: lainananto, velanotto, asunnot, varannot, dynamiikka

JEL-koodit: E41, E51, R21

1 Introduction

It is evident that housing prices are affected by the availability of credit. In particular, better availability of credit is likely to increase demand for housing if households are borrowing-constrained. The growth in demand will then be reflected in higher housing prices. The causality between housing prices and household borrowing, however, is expected to be two-sided. That is, housing prices may significantly influence household borrowing through various wealth effects. In line with the theoretical consideration, credit cycles have coincided with housing price cycles in a number of countries (see e.g. IMF, 2000; BIS, 2001; Goodhart and Hofmann, 2007).

The linkages between housing prices and household borrowing are of importance for several reasons. Firstly, better forecasts for housing price movements and for changes in household borrowing may be established if the interaction between credit and housing markets is accounted for. This is of significance not only for construction companies and banks but also for the monetary and fiscal policy – the two-way interaction between housing prices and credit is likely to augment boom-bust cycles in the economy and to increase the fragility of the financial sector. Indeed, according to Goodhart and Hofmann (2007) mutually reinforcing boom-bust cycles in housing and credit markets may occur and enhance the likelihood of future financial fragility. Goodhart and Hofmann, therefore, suggest that deviations of both house prices and credit from their long-run trends are useful indicators of future banking sector distress. That is, monetary policy makers must understand the role that the asset markets play in the monetary transmission mechanism in order to appropriately set policy instruments. Nevertheless, the strength of the two-way interaction between housing prices and borrowing as well as the direction of the causality is still a rather unexplored issue.

The aim of this article is to bring further empirical evidence on the linkages between housing wealth and borrowing. A quarterly dataset from 1975 to 2006 is employed to examine the long-run relation as well as short-run dynamics between household borrowing and housing prices in Finland. The article includes several contributions to the previous empirical literature. One contribution lies in the data utilized in the study. The sample period is longer than in the previous related studies and models are derived separately for housing loans and consumption loans. Furthermore, interdependence between stock prices and credit is investigated as a comparison for that between housing and credit markets. Finally, the effect of financial liberalization on the interaction between housing wealth and credit is investigated.

The empirical results show that there is a cointegrating long-run relation between household borrowing, housing prices and GDP. The analysis indicates that housing prices substantially influence the amount of both housing loans and consumption loans. Housing loans, in turn, appear to have a notable impact on housing prices. The found significant interaction between housing prices and credit in Finland is in contradiction with the results presented by Hofmann (2004) that are based on a substantially shorter sample period and somewhat different variables. Moreover, it is found that the effect of stock price movements on household borrowing is only faint. In line with Cecchetti (2006), the findings suggest that the effect of housing wealth on the boom-bust cycles in the overall economy is greater than that of the stock market.

Next section discusses the linkages between housing prices and household borrowing and reviews previous empirical evidence on the theme. Then, the empirical model and data used in the study are outlined. In the fourth section, in turn, the results from the econometric analysis are reported after which conclusions are derived.

2 Linkages between housing prices and household borrowing

Bank lending may affect housing prices through various liquidity effects. The price of housing, just like price of any asset, is determined by the discounted expected future stream of cash flows. An increase in the availability of credit may lower lending rates and stimulate current and future economic activity. Growth in the economic activity, in turn, is likely to increase demand for housing. Consequently, better availability of credit may lower discount rates and increase expected future cash flows leading to higher housing prices.

Perhaps even more importantly, increase in the availability of credit is likely to augment demand for housing directly if households are borrowing-constrained. The growth in demand will then be reflected in higher housing prices. The importance of credit constraints on housing prices is outlined e.g. by Stein (1995). The life-cycle model derived by Ortalo-Magné and Rady (2006), in turn, proposes that credit constraints faced by young household, in particular, are of great importance to housing price dynamics. Ortalo-Magné and Rady provide empirical evidence in support of their model. The importance of the credit constraints on housing demand has been established empirically also by e.g. Barakova et al. (2003) and Yamashita (2007).

Moreover, the general equilibrium model by Jin and Zeng (2004) proposes that monetary shocks have a powerful impact on housing prices because of the liquidity constraints.

Furthermore, households' borrowing may reveal information concerning some of the variables that are expected to drive housing prices. For one, borrowing in likely reflect households' income uncertainty – the more uncertain households are, the less they are expected to borrow (precautionary saving). In addition, it is reasonable to assume that current and expected level of interest rates affect household borrowing. Hence, movements in household borrowing are expected to give information about both income and interest rate expectations as well as on income uncertainty. This information is of relevance, since the expectations and uncertainty are expected to affect housing demand significantly.[1]

On the other hand, housing price movements may notably influence household borrowing. Goodhart and Hofmann (2007) mention three different channels through which housing wealth may affect households' credit demand. Firstly, since the collateral value of housing is typically high, increase in housing wealth loosens the borrowing constraints faced by households. Iacoviello (2004), for instance, discusses the impact of an increase in housing wealth on the household borrowing capacity through the collateral effect. Leung (2004), in turn, provides a summary of empirical studies confirming the importance of the collateral value of housing. Note, however, that in general mortgage equity withdrawals similar to the U.S. (see e.g. Feldstein, 2007, pp. 6-7) are not available in Finland. This is expected to weaken the impact of housing appreciation on household borrowing to some extent. Secondly, changes in housing wealth may have significant effects on households' perceived lifetime wealth. Increase in perceived lifetime wealth induces households to spend more today to smooth consumption over the life cycle, thereby augmenting demand for credit. Thirdly, housing price movements have an impact on credit supply through the so-called balance sheet effect. Housing price growth raises the value of bank capital thereby augmenting banks' possibilities and willingness to grant loans.

As Goodhart and Hofmann (2007) note, the two-way causality between borrowing and housing prices, explained above, may give rise to mutually reinforcing cycles in credit and housing

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[1] Negative impact of income uncertainty on housing prices is reported e.g. by Haurin (1991) and Diaz-Serrano (2005a; 2005b).

markets. In line with the theoretical consideration, credit cycles have coincided with housing price cycles in a number of countries (see e.g. IMF, 2000; BIS, 2001; Goodhart and Hofmann, 2007)

Also stock prices may have significant interaction with household borrowing. Reasoning for the potential effect of stock price movements on household borrowing are similar to the one presented above in the case of housing appreciation. The interaction between stock market and borrowing is likely to be substantially weaker than that between housing and credit, however. Firstly, the collateral value of equity is typically notably lower than that of housing. Secondly, because of the large value and indivisibility of single dwellings, household portfolios are typically dominated by housing. Hence, the effect of housing appreciation on the households' perceived lifetime wealth and thereby on current consumption and saving rate is expected to be greater than that of stock appreciation.[2] In addition, availability of credit is expected to affect housing demand substantially, since debt, typically, accounts for a major share of the financing of purchase of a house. This is the case especially with the first-time home-buyers. In general, households do not use as significant debt financing when operating in the stock market.

Despite its potential importance, empirical research on the interaction between credit and property markets is still scarce. Some empirical studies support the existence of a causal linkage from the credit market to property prices, whereas some other studies find that there is a unidirectional causality from the property market to the credit market.

In an early study, Borio et al. (1994) find that adding the credit-to-GDP ratio to an asset pricing equation improves the fit of the model in most countries. According to Collyns and Senhadji (2002) credit growth has a significant contemporaneous impact on housing prices in Hong Kong, Korea, Singapore and Thailand. Liang and Cao (2007), in turn, study the causalities between property prices and bank lending in China. Their analysis implies that there exists a unidirectional causality running from bank lending to property prices. The causality runs through a cointegrating long-run relation that includes also GDP and interest rate. A potential problem with the analysis is the short sample (1999Q1-2006Q2). According to Gerlach and Peng (2005), instead, short- and long-run causality runs from property prices to lending, rather than the other way round, in Hong

[2] Overall, the empirical evidence on the hypothesis that the wealth effect of housing is greater than that of equity is inconclusive, however (for a review of the empirical results, see Mishkin 2007, pp. 14-15; Carroll et al. 2006, pp. 9-10). For other factors suggesting greater wealth effect of housing than of equity, see e.g. Mishkin (2007, p. 10) and Altissimo et al. (2005, p. 11). Mishkin (pp. 10-11) and Altissimo et al. (p. 9), however, also state reasons against the greater wealth effect of housing.

Kong. To study the long-run causality, Gerlach and Peng estimate a cointegrating long-run relation between real bank lending, real GDP and real housing prices.

Hofmann (2004) and Goodhart and Hofmann (2007) consider the relationship between bank lending and property prices employing quarterly data over 1980-1999. Hofmann reports a cointegrating relation between real property prices, real credit to the private sector, real GDP and the real interest rate in all of the 16 developed countries (including Finland) incorporated in the analysis. The property price index used in the study is a combination of housing and commercial property. Goodhart and Hofmann, using a set of 18 industrialized countries, find a significant two-way causality between housing prices and bank lending. In the Finnish case the response of loan stock to a shock to housing prices is found to be insignificant, though.

Furthermore, Lamont and Stein (1999) find that in cities where households are highly leveraged housing prices react more sensitively to city-specific shocks. This suggests that changes in loan-to-value ratios may affect housing price dynamics, the volatility of housing prices in particular. On the other hand, using annual panel data from Swedish urban areas over 1967-1994 Hort (1998) finds that the ratio of households' net lending to disposable income does not affect housing prices notably. Hort treats the lending-to-income ratio as an exogenous variable even though the literature suggests that household lending is likely to be endogenous with respect to housing prices.

Research on linkages between stock prices and borrowing are even scarcer. Indeed, it appears to be difficult to find more than one study that empirically examines interaction between stock market and borrowing. The study by Goodhart and Hofmann (2007) indicates that in line with prior expectations the two-way relationship is stronger between real estate (both housing and commercial) and credit than between equity and credit.

In summary, the results are mixed and scarce. This paper contributes to the previous literature in a number of ways. Firstly, the interaction between housing prices and credit is compared to that between stock prices and credit. Secondly, the interdependence is examined using both housing loans and consumption loans. Thirdly, recursive analysis is conducted to test if the long-run relation has changed significantly due to the several institutional alterations that have taken place during the sample period. Fourthly, the effect of financial liberalization on the short-run dynamics between housing wealth and credit is investigated. Furthermore, the specification of some of the variables utilized in the analysis differs from the previous studies.

3 Empirical model and data

3.1 Long-run model

Following Hofmann (2004) and Goodhart and Hofmann (2007) the empirical long-run relation is estimated between real housing prices (P), real GDP (Y), outstanding loan stock divided by GDP (L) and the real interest rate (IR):

$$P_t + \beta_1 * Y_t + \beta_2 * L_t + \beta_3 * IR_t + e_t = 0 \quad (1)$$

In (1) the long-run relation is normalized with respect to housing prices, and betas are the coefficients for the other variables in the relation. The error term, e_t, is expected to be stationary, i.e. the four variables in the model are expected to be cointegrated so that the deviation from the long-run relation cannot drift away from zero in the long run. Both β_1 and β_2 are expected to be negative, since Y and L are anticipated to affect housing prices positively. Furthermore, β_1 is expected to be smaller than one in absolute terms – it is implausible to assume that housing prices would grow constantly faster than income.

Note that the expected sign of β_3 in not obvious, even though Liang and Cao (2007), for example, find their result, according to which β_3 is positive, to be problematic. Evidently, rise in the interest rate should affect both housing prices and lending negatively. Housing prices should decrease because of the increase in the discount factor of expected future rental cash flows. L, in turn, is expected to react adversely to a positive shock to IR because of the increase in the price of credit. If the sign for IR in (1) was positive, the model would imply that the long-run response of P to a change in IR is greater than the response of L multiplied by β_2. Naturally, $\beta_3 > 0$ would suggest just the opposite. In fact, it is not certain that IR should enter the relation at all – if the reaction of P to an interest rate change equals the reaction of L multiplied by β_2, then β_3 is expected to equal zero. In the Finnish case Goodhart and Hofmann (2007) report a small (positive) and statistically insignificant coefficient for interest rate.

Departing from Hofmann (2004) but similar to Borio et al. (1994), the loan-to-GDP ratio is used as a measure of bank lending (L) in this study. The outstanding loan stock of households is divided by the GDP to avoid multicollinearity problems in the data. The model is estimated separately employing housing loan-to-GDP ratio (L^h) and consumption loan-to-GDP ratio

(L^c). The utilized loan data measure the whole outstanding housing and consumption borrowing of Finnish households. Both loan and GDP data are provided by Statistics Finland.

Also two different measures of interest rate are used. In the estimation including L^h the *after-tax* lending rate (IR^a) is utilized, whereas the *before-tax* lending rate (IR^b) is employed in the model incorporating L^c.[3] This is due to the fact that mortgage interest payments are deductible in the taxation but interest payments on consumption loans are not. IR^a might be better explanatory variable for *P*, though. Anyhow, the Hannan-Quinn and Schwartz Bayesian information criteria suggest that overall IR^b is more informative than IR^a in the model employing L^c.

Ideally, the housing price index itself should be quality-adjusted. Unfortunately, hedonic housing price 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.[4] The use of average transaction prices prior to 1987 may be problematic if the average quality of dwellings sold in different quarters differed notably during the early sample period. Nevertheless, it seems reasonable to believe that the price movements displayed by the average sales prices track the true price development well. The housing price statistics are published by Statistics Finland and both indices are based on transactions of privately financed flats in the secondary market. The indices based on flats represent the housing price movements in Finland well, since the share of flats of all the dwellings in the country is high (in the end of 2005 the share was some 75%).

As a comparison to the interaction between housing prices and household borrowing, models in which *P* is replaced by stock prices (*S*) are estimated. The OMX Helsinki CAP index

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[3] The average lending interest rate of deposit banks in Finland 1975-2002 concerning the whole outstanding loan stock (source: Statistics Finland) and the average lending interest rate of deposit banks and other credit institutions in Finland 2003-2006 concerning the whole outstanding loan stock (data source: Bank of Finland) are utilized in the analysis. 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 rates are computed by subtracting the inflation rate, measured by the change in cost of living index, from the nominal after-tax or before-tax lending rate. The source for the national average marginal income tax rate during 1975-1976 is Salo (1990), whereas the data over 1977-1992 is provided by the Finnish Ministry of Finance.

[4] Another option would have been to use the average sales price index throughout the sample period. It seems reasonable 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; quarterly correlation is .90 even between the differenced series.

(OMXHCAP) is employed to depict the price development of the publicly traded stocks in the Helsinki Stock Exchange (HEX).[5] In OMXHCAP the weight of one company is restricted to be 10% at the most. OMXHCAP is used because of the significant role of Nokia in HEX since the mid 1990s. At the maximum the market value of Nokia accounted for 70% of the total market value of HEX in 2000Q4. That is, in the OMX Helsinki index (OMXH, formerly HEX index), where the weight of Nokia is not restricted, changes in the share price of Nokia dominate the movements in the index. Hence, it is reasonable to employ OMXHCAP, which represents the general development of the Finnish stock market better than OMXH. Note that only before-tax lending rate is employed in the estimations including *S*.

The estimated model does not contain any supply side variables of the housing market. Potential changes in the supply side, such as alterations in the zoning policies, are extremely hard to take into account in an econometric time series analysis. Therefore, it often has to be assumed in empirical research that there have not been significant changes in the supply side that would affect the long-run relation for housing prices. In the literature, typically, the only supply variable included in the empirical models is construction cost index. The influence of construction costs on housing price growth in Finland has been negligible during the sample period, since the real construction costs have been almost constant. Furthermore, the inclusion of construction cost index to the long-run relation would not lead to sensible results. Hence, it is assumed in the econometric analysis that housing demand (represented by *Y*, *L* and *IR*) has driven housing prices in the long-run and that the supply curve has not altered notably. This assumption is supported by the fact that the estimated model appears to work well.

Obviously, there are complications in the data as discussed above. These complications may distort the estimated coefficients slightly. Nevertheless, it is reasonable to believe that the data approximates well for the true behavior of the variables incorporated in the analysis.

Note that all the variables employed in the econometric analysis are deflated by the cost of living index, i.e. only real variables are used. Furthermore, natural logs of *P*, *S*, *Y* and *L* are used. Table A1 in the Appendix presents the summary statistics of the differenced series employed in the econometric analysis. Table A2 in the Appendix, in turn, exhibits results from the Augmented Dickey-Fuller (ADF) unit root tests. Note that even though the ADF test

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[5] OMXHCAP was formerly called HEX-portfolio index. Prior to 1990 OMXHCAP corresponds to the Unitas index.

suggest that IR^a is stationary, also IR^a is treated as an I(1) variable in the econometric analysis. This is because the Johansen procedure implies that none of the variables alone forms a stationary vector.[6]

3.2 Short-run model

Vector error-correction models (VECM) are estimated in the empirical section to study the short-run dynamics between the variables. These models take account of the adjustment towards the long-run relation as well as of the other short-run dynamics. Equation (2) presents the VECM that is estimated:

$$\Delta X_t = \alpha' e_{t-1} + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \mu + \Psi D_t + \varepsilon_t, \qquad (2)$$

where X_t is a four-dimensional vector containing P_t or S_t, Y_t, L_t and IR_t, and ΔX_t is $X_t - X_{t-1}$, $t = 1,\ldots,T$. Γ_i, in turn, is 4 x 4 matrix of coefficients for the lagged differences of the stochastic variables at lag i, k-1 is the number of lags of the differenced variables included in the model, μ is a four-dimensional vector of intercepts, D_t is a three-dimensional vector of centered quarterly seasonal dummies, Ψ is a 4 x 3 coefficient matrix and ε_t is a four-dimensional vector of independently and identically distributed errors. Finally, $\alpha' e_{t-1}$ caters for the adjustment of the variables towards the long-run relation. α is a vector of speed of adjustment parameters of which at least one has to be different from zero if the variables are cointegrated. e_{t-1}, in turn, is one period lagged deviation of housing (or stock) prices from the estimated long-run relation, i.e. $e_{t-1} = P_{t-1} - \beta_1 {*} Y_{t-1} - \beta_2 {*} L_{t-1} - \beta_3 {*} IR_{t-1}$.

The maximum lag (k) is set so that the Hannan-Quinn (HQ) information criteria are as small as possible and the residuals in the VECM do not exhibit significant serial correlation based on the LR(1) and LR(4) tests. Furthermore, since many of the series seem to exhibit seasonal variation, the need for seasonal dummies is detected in all the tests. The inclusion or exclusion of seasonal dummies is decided based on HQ.

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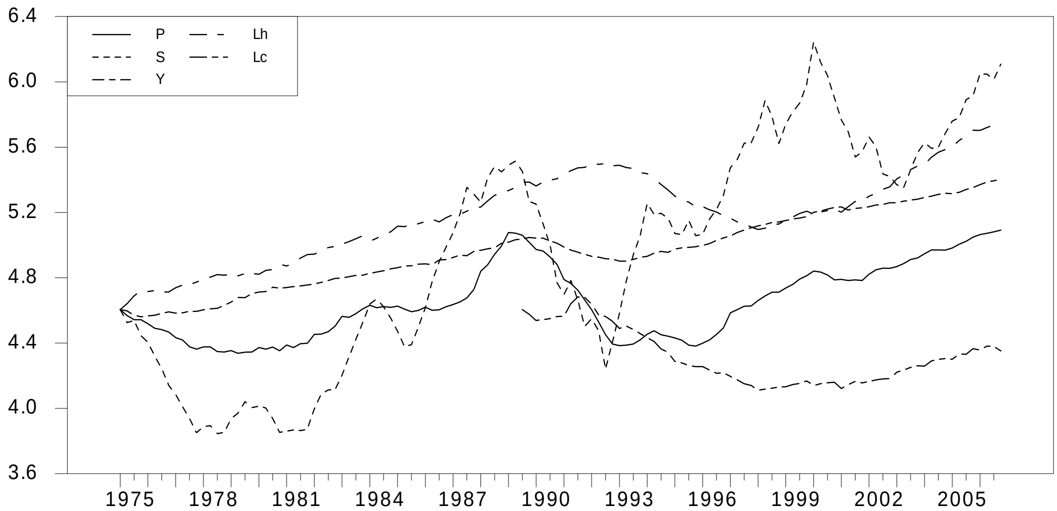
[6] Note also that IR^a cannot be stationary if IR^b is non-stationary.

3.3 Changes in the credit market and development of the variables

Housing finance in Finland has traditionally been dominated by a small number of banks. Up to the mid-eighties 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 credit 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 required down payment ratio was as high as 20%-30% 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 overshot (see Figure 1).

Figure 1 Real housing price (P), stock price (S) and GDP (Y) indices together with



housing loan-to-GDP ratio (Lh) and consumption loan-to-GDP ratio (Lc)

Eventually housing prices collapsed at the beginning of the 1990s. This phenomenon can well be seen from Figure 1. Several reasons contributed to the drastic drop in housing prices. Supply increased notably as the construction that responded to the increased housing price level started to enter the market. At the same time demand for housing started to decline. In the early 1990s demand collapsed due to the rising real interest rates and because of the deep recession of the Finnish economy.

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 financial markets. As the inflation rate decreased at the same time, the real after-tax lending rate became permanently positive. In the 1970s and 1980s the real after-tax lending rate had constantly been negative.

The maturities of housing loans have kept increasing and the required down-payment ratios decreasing since the late 1980s. Consequently, the liquidity constraints of households have eased, which has lead to a sharp growth in the housing loan-to-GDP ratio during the last ten years. Lately, the loosening of liquidity constraints has been further emphasized by low inflation rate and, thereby, low nominal interest rate. This study assumes that data on household borrowing caters for the impacts of the increased credit availability and loosening in the liquidity and wealth constraints on the demand for housing. The alterations in the credit market, however, may have changed the dynamics between asset prices and household borrowing. The econometric analysis implies that while short-run dynamics between housing prices and credit have changed, the estimated long-run relation has remained relatively stable.

4 Empirical results

In this section cointegration analysis is employed to investigate if there exists a stationary long-run relation between real housing (or stock) prices, loan-to-GDP ratio, real GDP and real lending rate. After the investigation of the long-run relation, short-run dynamics are examined.

4.1 Interaction between housing prices and housing loans

The Johansen Trace test statistics based on a VECM that includes P, L^h, Y and IR^a with four lags in differences and three centered seasonal dummies are reported in Table 1.[7] The p-

[7] The model also includes a dummy variable, which takes value one in 1988Q1. Due to the financial market liberalization by far the sharpest real housing price rise (13.6%) in the sample took place in 1988Q1. Without the dummy the residual of the housing appreciation equation is extremely large in 1988Q1. The dummy variable is needed in order to get residual series whose normality cannot be rejected. According to the Monte-Carlo analysis by Doornik et al. (1998) a dummy variable that takes value one only in one point in time and is zero otherwise is usually asymptotically negligible.

values are based on the quantiles approximated by the Γ-distribution (see Doornik, 1998). Because asymptotic distributions can be rather bad approximations to the finite sample distributions, the Bartlett small sample corrected values, suggested by Johansen (2002), are employed.

Table 1 Johansen Trace test statistics

Hypothesis	r=0	r≤1	r≤2	r≤3
Trace statistics	44.0	21.5	10.3	3.9
P-value	.10	.34	.27	.05

The Trace statistics suggest that there is one stationary linear vector between the four variables. The long-run relation appears to be more sensible without IR^a in it. Interest rate can be excluded from the relation and restricted to be weakly exogenous.[8] This is in line with the results reported by Hofmann (2004). The exclusion of IR^a from the long-run model may seem surprising at first sight. However, since growth in IR^a is expected to influence both P (discount rate effect) and L^h (price of credit) adversely, it is not evident that the coefficient of IR^a should differ from zero (see the discussion in section 3.1 above). The estimated long-run relation is as follows (standard errors in the parenthesis):

$$P - .354 * Y - .282 * L^h = 0$$
$$(.144) \qquad (.122)$$

The relation suggests that one percent increase in GDP leads to .33% higher housing prices. The coefficient of the mortgage-to-GDP ratio is slightly larger. The coefficient of Y is similar to the one estimated by Hofmann (2004).

As Hofmann notes, the start of the European Monetary Union (EMU) may have given rise to a structural break in the system. Furthermore, as discussed in section 3.3, there have been also other institutional changes that may have altered the long-run relation. Hence, both recursive and backward recursive estimations (see Dennis 2006, pp. 95-112) are employed to investigate the stability of the long-run relation. The recursive estimation does not show

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8 The LR test described in Johansen (1996) is used to test for the weak exogeneity and exclusion of the variables. In these LR tests Bartlett small-sample correction by Johansen (2000) is employed. The p-value in the joint test for weak exogeneity and exclusion of IR^a is .15.

evidence of structural break due to EMU or to any other reason. Thus, it seems reasonable to assume that the estimated long-run relation holds despite the several institutional changes during the sample period.

Figure 2 shows that real housing price level has deviated substantially from the estimated long-run relation during the sample period. With the exception of the mid 1970s, price level was relatively close to the long-run relation until the late 1987. The financial market liberalization resulted in overheating in the housing market and in 1989Q1 real housing price level peaked being almost 40% over the estimated long-run relation. Eventually, the price started to decrease drastically, and housing prices overreacted downwards in the early and mid 1990s. This overreaction was amplified by the delayed adjustment of supply. Three years after the peak of the bubble, i.e. in the end of 1992, *P* was over 30% below the long-run level.

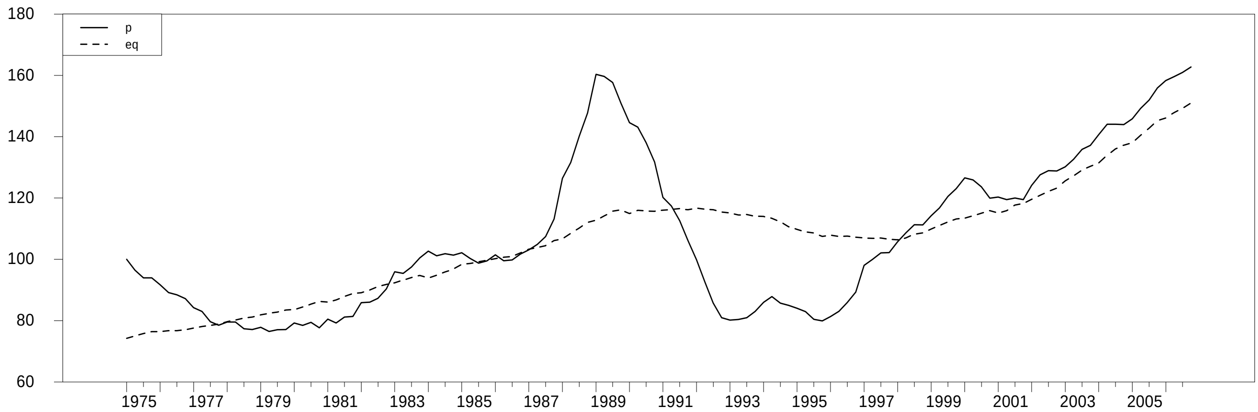

Figure 2 Actual real housing price index (p) and the fit from the estimated long-run relation (eq)

In 1996 real housing price level started to rise again. Since then *P* has approximately doubled (the situation in 2006Q4). The real price level has been slightly over the long-run relation continuously since 1998Q2. In 2006Q4 *P* was little over 10% over the long-run relation.[9] The deviation from the relation is not larger than that, even though *P* has climbed to the level of the peak of the bubble in the late 1980s, since real income has grown substantially and because the liquidity constraints have eased notably due to smaller down-payment ratios, longer loan maturities and lower mortgage rates. Of course, there may have been structural

[9] Based on the preliminary information regarding housing appreciation in 2007, *P* was still about 10% above the estimated long-run relation in 2007Q4.

changes in the supply side that are not catered for by the estimated model. The recursive analysis, however, implies that the estimated relation still holds in the long run.

Note that the estimated model does not automatically suggest that the real housing price level should drop in the future in order to get back to the long-run relation. Real housing prices can, for instance, stay still, and the divergence from the long-run relation can vanish due to (possible) growth in Y and L^h. At least in nominal terms housing prices are typically rigid downwards. Since 1975 the only period when nominal housing prices have notably dropped in Finland is after the bubble of the late 1980s. Note also that the complications with the data may lead to slightly flawed coefficient estimates in the long-run model.

The coefficients of the long-run relation exhibited above indicate what happens to the real housing prices in the long horizon if one of the explanatory variables changes by one unit and all the other explanatory variables are held constant. However, the explanatory variables are likely to be dependent on each other and also on housing prices. 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 relationship.

To take into account the interrelations between the variables VECM including P, Y, L^h and IR^a is estimated. Also Y is treated as a weakly exogenous variable in the model. Since the financial market liberalization in the late 1980s may have altered the short-run dynamics between the variables, the sample is divided into two sub-periods, i.e. 1970-1987 and 1988-2006. The long-run model, instead, is the one presented above during both sub-samples, because the long-run relation appears to be reasonably stable. The early-sample model has two lags in differences whereas the VECM based on the second sub-period includes only one lag.[10] The models also contain seasonal dummies.

The financial liberalization may have fortified the response of credit growth on housing price movements. During the credit controls housing prices probably influenced household borrowing to a substantially smaller extent, because the availability of credit was limited and not sensitive to housing prices.

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[10] The fact that the sub-sample models require less lags than the full-sample model is in line with the assumption that there has been a break in the dynamics during the sample (see Juselius, 2007).

Granger non-causalities (GNC) between the variables are tested by a standard F-test. Table 2 presents the GNC test results.

Table 2 Granger non-causality test results employing housing loans

Dependent variable	Explanatory variable					
1975Q4-1987Q4						
	ΔH	ΔL^h	ΔGDP	ΔIR^a	eqe	Adj. R^2
Δ Housing	**.00**	.83	.92	**.00**	**.06**	.53
Δ Credit	.68	.82	.81	.62	.70	-.18
Δ GDP	.71	.45	.96	.94		-.15
Δ Lending rate	**.01**	.83	.77	.11		.50
Δ Credit (exo)	.69	.78	.80	.62		-.16
1988Q1-2006Q4						
	ΔH	ΔL^h	ΔGDP	ΔIR^a	eqe	Adj. R^2
Δ Housing	**.00**	**.01**	**.01**	.29	**.00**	.64
Δ Credit	.52	**.01**	.15	.65	**.00**	.50
Δ GDP	**.00**	.57	.11	.73		.45
Δ Lending rate	**.08**	.64	.47	**.00**		.50

A major implication of the GNC analysis is that P has affected L^h only after the financial market liberalization. This in line with the prior expectations and with the results of Gerlach and Peng (2005) according to which more restrictive lending rules (in the form of introducing maximum loan-to-value ratio) led to a diminution in the influence of property prices on lending in the Hong Kong market.

After the late 1980s the impact of P on L^h has capitalized through the long-run relation. Housing loans, in turn, have affected housing prices both through the long-term relation and through short-term dynamics. The estimated speed of adjustment of P is 6.8% in the first and 5.5% in the second sub-sample. The 5.5% quarterly adjustment speed of housing corresponds to an adjustment of about 20% during a year or 35% during two years. That is, housing price adjustment is highly sluggish. The alfa of L^h is 4.9% in the latter period. Notice that because of the interaction between housing price and housing loans L^h appears to be highly predictable.

Innovation accounting confirms the findings of the GNC tests. The ordering of the variables in the innovation accounting is done similarly to Hofmann (2004) and Goodhart and Hofmann (2007), i.e. the ordering is the following: Y, P, L^h, IR^a. It is therefore assumed that aggregate income does not respond contemporaneously to innovations in any of the other variables, but may affect all the other variables within the quarter. This ordering also assumes that housing prices are rather sticky, so that they are not influenced contemporaneously by changes in household borrowing or the mortgage rates. Real interest rate is allowed to respond within a quarter to shocks in any of the other variables. The ordering reflects the common assumption that interest rate changes are transmitted to the economy with lag.

Figures 3 (first sub-sample) and 4 (second sub-sample) plot the impulse response curves of Y, P and L^h to one percent positive shock to the aggregate disposable income, to the loan-to-GDP ratio and to the housing prices themselves as well as to a one %-point shock to the real after-tax lending rate. The responses are shown up to 40 quarters from the initial shock.

The impulse response curves show that there has been notable interaction between housing prices and housing loans only after the financial deregulation. It appears that currently the two-way interaction between housing prices and lending is strong. The impulse response functions (from now on impulses after 1987 are discussed unless mentioned otherwise) indicate expectedly that it takes a long time for the housing market to fully adjust to a shock. After a positive shock housing prices underreact at first, failing to fully incorporate the new information. After a shock to Y, P or L^h price level keeps rising for a long time and at some point overshoots. Eventually, as the supply responds to the housing price growth, housing prices start to gradually adjust towards the new long-run equilibrium.

It also appears that the momentum effect in housing prices has grown due to the increased interaction between housing prices and credit. The increase in credit augments housing demand, which, in turn, further amplifies lending. A direct shock to L^h can occur, for instance, due to loosening in the households' borrowing constraints (e.g. lower down-payment ratios or longer maturities) or because of changes in expected lending rate. Because of the two-way interaction between borrowing and housing prices and of the fixed housing supply in the short run, housing prices overreact in the short horizon. That is, in the longer run housing supply is able to react to the higher demand, which leads to decline in housing prices.

Interestingly, the estimated impulse response of L^h after a shock in P differs remarkably from the one reported by Goodhart and Hofmann (2007, p. 152). The estimations of Goodhart and Hofmann do not show notable influence from housing prices to lending in the Finnish case. The divergence between the results may be due to the difference in the sample periods. Goodhart and Hofmann employ a sample over 1980-1999. The impulse responses of P to a shock in L^h, instead, are close to the ones presented by Goodhart and Hofmann.

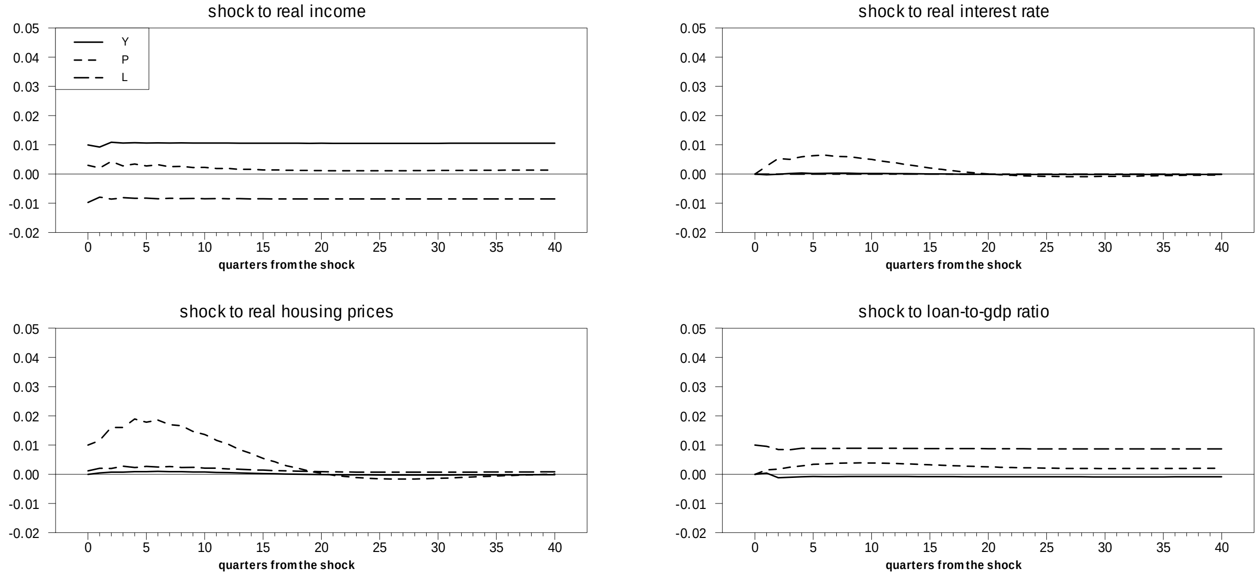

Figure 3 Impulse response functions of real housing prices and housing loan-to-GDP ratio to a one unit shock in each of the variables in the 1975-1987 model

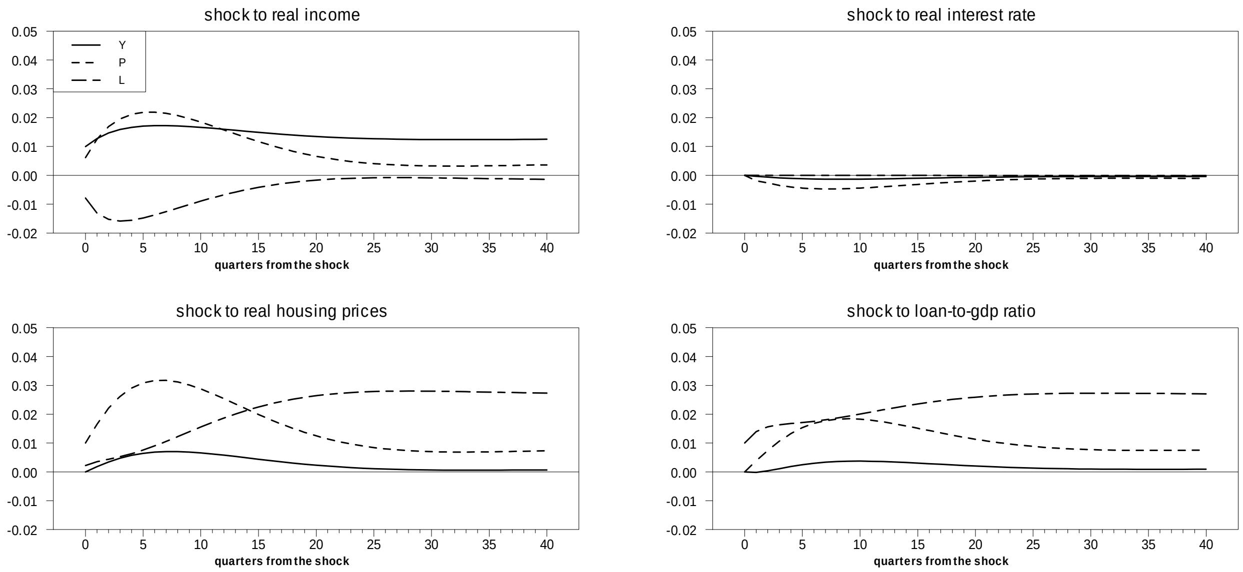

Figure 4 Impulse response functions of real housing prices and housing loan-to-GDP ratio to a one unit shock in each of the variables in the 1988-2006 model

An income shock, as expected, appears to have a positive impact on housing prices both in the short and in the long run. It is anticipated that the initial impact of positive GDP shock on the housing loan-to-GDP ratio is negative – after all, GDP is in the denominator of the ratio. However, in the longer run, as the positive income shock materializes to housing prices and effects households' future income expectations, the impact turns positive. The impulse responses further suggest that the effect of one %-point increase in real housing prices on GDP is approximately .1%.

One would expect that a positive interest rate shock would have an adverse effect on all of the other variables. Hence, it is somewhat surprising that based on the impulse curves shocks to the lending rate do not appear to affect the other variables notably.[11] Partial explanation may be the fact that movements in real lending rate are often caused by changes in the inflation rate while the nominal interest rate stays constant. Therefore, changes in the real lending rate often do not affect liquidity constraints of households in the short run. Nevertheless, in the long run growth in IR that takes place due to decline in the speed of inflation should have a negative impact also on the liquidity constraints, since lower inflation rate leads to slower (nominal) income growth.

Note that, as Goodhart and Hofmann (2007, p. 37) state, real interest rate is usually considered to be mean-reverting. Hence, if the role of the expected interest rate movements on housing price level is notable, i.e. if housing prices include notable forward-looking components regarding the real interest rate, it is anticipated that the effect of current interest rate is relatively small. That is, if IR^a indeed is mean-reverting, then the housing demand of forward-looking agents with long planned holding period of housing should not react strongly to changes in the prevailing level of real interest rate. In line with this argument, Shiller (2007) writes: "*People's opinions about long-term decisions, notably how much housing to buy and what is a reasonable price to pay, change in the short term only because their opinions about long-term change*".

To get additional information concerning the importance of different variables in the determination of housing prices and loan-to-GDP ratio, variance decomposition is conducted based on the VECM (the decompositions for P and L^h are shown in Tables A3 and A4 in the

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[11] The impulse responses do not change notably even if IR^a is included in the long-run relation.

Appendix).[12] Just like in the case of the impulse responses, the difference between the two sub-periods is dramatic. The influence of financial liberalization can be seen in the decomposition for L^h in particular: since 1988 housing prices have been a major driving force of the housing-loan-to-GDP ratio, whereas before 1988 the impact of a shock to P on L^h was negligible. In any case, the variance decomposition confirms that housing price movements and changes in the housing loan-to-GDP ratio affect each other substantially.

Notice that, if housing price series is replaced by the stock price index, corresponding long-run relation cannot be found. This is not surprising, since the theory does not suggest similar interaction between housing loans and stock prices as between housing loans and housing prices. Also short-run interaction between ΔS and ΔL^h is negligible based on a fourth-order vector autoregressive model including also ΔY and ΔIR^b.

4.2 Interaction between housing prices and consumption loans

The interaction between consumption loans and asset prices can be studied only from 1989Q3 onwards due to the lack of earlier consumption loan data.[13] The Trace test suggest that there may be two stationary vectors between real GDP, real housing prices, consumption loan-to-GDP ratio and the real before-tax lending rate (see Table 3). Nevertheless, more detailed examination of the potential long-run relations suggests that there is only one sensible long-run relation between Y, P, L^c and IR^b as well. Again, IR^b is excluded from the long-run model.

Table 3 Johansen Trace test statistics in the model including Y, P, L^c and IR^b

Hypothesis	r=0	r≤1	r≤2	r≤3
Trace statistics	56.5	28.4	11.1	1.2
P-value	.01	.07	.21	.27

The estimated long-run relation, whose stability over the sample cannot be rejected, is as follows (standard errors in the parenthesis):

$$P - .848*Y - .580*L^c = 0$$

(.238) (.202)

---

[12] The forecast error variance decomposition shows the proportion of the movements in a series that are due to its "own" shocks versus shocks to the other variables in the model (Enders, 2004, p. 280).

[13] The tested model includes seasonal dummies and two lags in differences.

In this model the coefficient of Y is substantially larger than the one in the model including L^h. Also the estimated coefficient of L^c is relatively large. The magnitudes of the coefficients might be affected by the different sample period to some extent. Note that the coefficient of L^c is similar to the one estimated for credit by Hofmann (2004). The estimated long-run relation including L^c (eq2) greatly reminds the one estimated for the model that includes L^h (eq1), as can be seen in Figure 5.

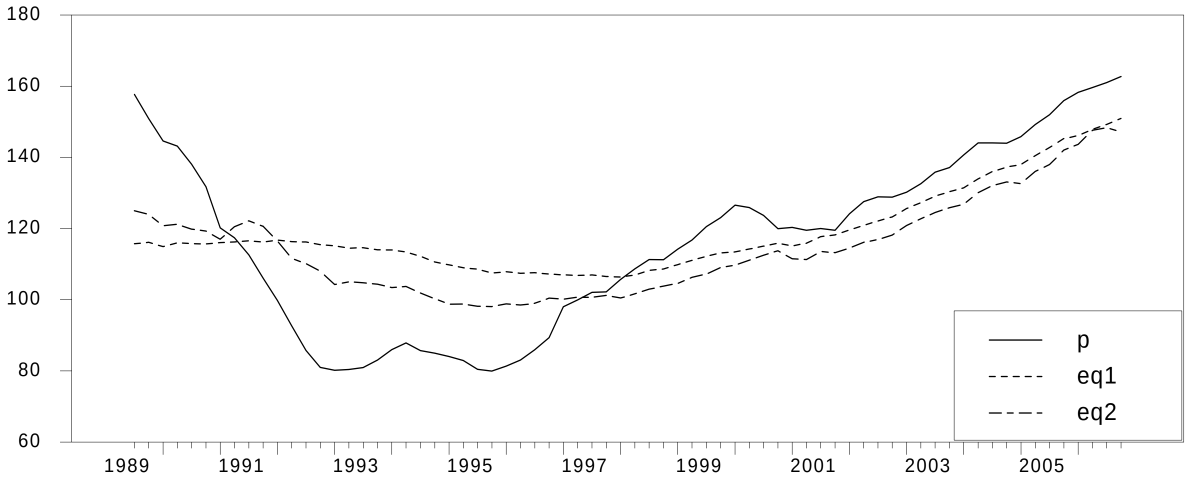

Figure 5 Actual real housing price index (p) and the fits from the estimated long-run relations (eq1 & eq2) over 1989Q3-2006Q4

GNC test results based on the VECM with two lags in differences are exhibited in Table 4. The statistics imply that, just as in the case of housing loans, the impact of P on L^c capitalizes through the long-run relation. While housing loans appear to have predictive power with respect to housing prices through both short- and long-run dynamics, consumption loans seem to predict housing prices only through the long-term relation. In fact, according to the LR statistics and the GNC test it is a "borderline case" whether P is affected even through the long-term relation.[14]

[14] The model appears to explode if housing prices are set weakly exogenous. Therefore, it is assumed that P does adjust towards the long-run relation.

Table 4 Granger non-causality test results employing consumption loans

Dependent variable	Explanatory variable: ΔH	ΔL^c	ΔGDP	ΔIR^b	eqe	Adj. R^2
Δ Housing	**.00**	.46	.22	.32	.16	.61
Δ Credit	.88	.84	.43	.86	**.00**	.33
Δ GDP	**.00**	**.05**	.53	.97		.56
Δ Lending rate	**.01**	.23	.65	**.00**		.58

Figure 6 shows the impulse response curves of Y, P and L^c to one percent positive shock to Y, P and L^c and to a one %-point shock to the real before-tax lending rate. The speed of adjustment of real housing prices towards the long-run relation is estimated to be 3.5% per quarter, whereas the figure for the consumption loan-to-GDP ratio is 6.6%. The ordering of the variables in the innovation accounting is similar to the above analysis incorporating L^h.

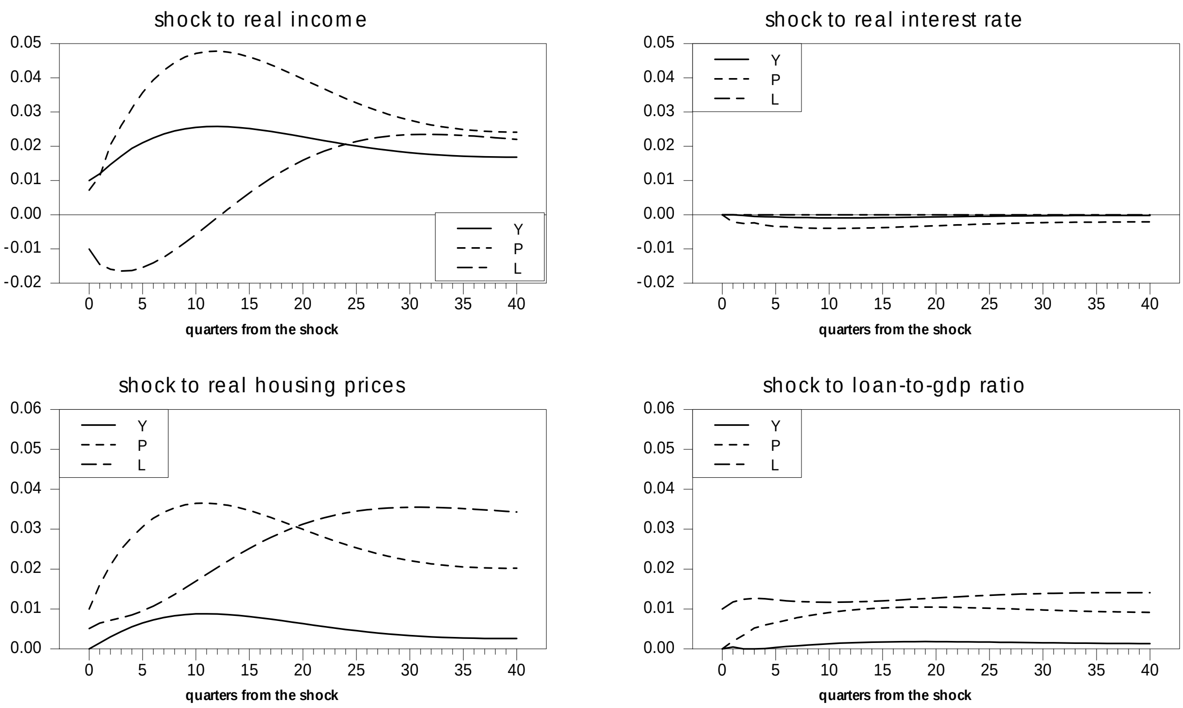

Figure 6 Impulse response functions of real housing prices and consumption loan-to-GDP ratio to a one unit shock in each of the variables in the model

Again, the long-run impacts differ notably from the ones implied by the coefficients of the long-run relation alone and the impulse response functions indicate that it takes a long time for the housing market to fully adjust to a shock. The reaction of L^c to income and housing price shocks appears to be similar to the one exhibited already in Figure 4, i.e. housing prices appear to influence also borrowing for consumption notably. Note that the responses to a shock in Y should be taken cautiously, since it is not reasonable to assume that an income shock leads to a greater rise in housing prices than in income itself in the long-run.

The long-run effect of a consumption loan shock to P is close to that of housing loan shock. This can be partly explained by the fact that in some cases changes to L^c and L^h are likely to reflect the same shocks in the economy: a shock to households' future expectations or a general credit market shock are likely to influence L^c and L^h similarly. Nevertheless, according to the variance decomposition (see Tables A5 and A6 in the Appendix) L^h is substantially more important driving force behind P than L^c. This is expected, since the theory does not predict similar strong interaction between P and L^c as between P and L^h. In fact, the decomposition suggests that almost 90% of the movements in ΔL^c can be explained by shock to P in the long horizon, whereas the figure is only 6% the other way round. Finally, the estimated impact of an interest rate shock appears to be negligible also in this case.

Again, sensible long-run relation including stock price series and L^c cannot be found. The short-run interaction between ΔS and ΔL^c appears to be negligible as well based on a third-order vector autoregressive model including also ΔY and ΔIR^b.

5 Conclusions

The theory predicts that there is a tight two-way interaction between housing prices and household borrowing. This article contributes to the existing empirical literature on the subject by studying separately the interaction between housing prices and housing loans borrowed by households and between housing prices and consumption loans taken by households. The impact of financial deregulation on the interaction between housing prices and housing loans is also investigated. In addition, the effect of stock appreciation on household borrowing is examined as a comparison. Quarterly data from Finland over 1975-2006 is employed in the empirical analysis.

The econometric analysis indicates that interaction between housing prices and credit has substantially increased after the financial deregulation that took place in the late 1980s. In particular, it appears that housing wealth has affected the amount of housing loans only after the tight credit market control was abolished. Based on a vector error-correction model including real GDP, real housing prices, loan-to-GDP ratio and real lending rate, at present there is a strong two-way interaction between housing prices and housing loan stock. This interaction is likely to augment boom-bust cycles in the economy and to increase the fragility of the financial sector. Moreover, housing price movements appear to have a notable positive impact on consumption loans as well. Housing market affects macroeconomic cycles also through this channel. On the contrary, based on the estimations there is no notable interaction between stock prices and household borrowing.

The findings give rise to the question of what can be done with the problem of reinforcing cycles between housing and credit markets. Goodhart and Hofmann (2007) suggest that the capital adequacy requirement on mortgage lending could be related to housing appreciation: the requirement could be increased in times with rapid housing appreciation and decreased during housing market bust. This would restrain bank lending and build up reserves during housing price booms. These reserves could then be released during housing price depressions. Obviously, this kind of changing capital adequacy requirement on mortgage lending would be likely to diminish interaction between housing prices and credit thereby undermining cycles in the housing market and in the economy as a whole.

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Appendix

Table A1 Summary statistics of the differenced series[15]

Variable	Geometric mean (annualised)	Standard deviation (annualised)	Jarque-Bera (p-value)	1st order autocorrelation
Real housing prices	.015	.062	.000	.627**
Real GDP	.025	.020	.000	.375**
Housing loan-to-GDP ratio	.037	.038	.058	.470**
Consumption loan-to-GDP ratio (1989-)	-.015	.049	.172	.353**
Real after-tax lending rate	.001	.055	.195	-.276**
Real before-tax lending rate	.001	.057	.198	-.268**
Real stock prices	.048	.197	.446	.420**

Table A2 Augmented Dickey-Fuller test results[16]

Variable	Level (lags)	Difference (lags)
Real housing prices[c,s]	-1.49 (5)	-3.68** (4)
Real GDP[c]	-1.00 (3)	-2.52* (2)
Housing loan-to-GDP ratio[c]	-.20 (3)	-2.98** (2)
Consumption loan-to-GDP ratio[c]	-1.33 (2)	-3.92** (1)
Real after-tax lending rate	-2.79** (4)	-6.33** (3)
Real before-tax lending rate	-1.42 (4)	-6.62** (2)
Real stock prices[c]	-.84 (5)	-4.63** (4)

Table A3 Decomposition of variance for real housing price level

Step	Y	P	L^h	IR^a
		1975-1987		
1	.033	.967	.000	.000
2	.020	.920	.005	.055
5	.015	.835	.008	.141
10	.011	.802	.016	.172
20	.011	.784	.028	.177
40	.013	.770	.039	.177
		1988-2006		
1	.047	.953	.000	.000
2	.064	.915	.016	.005
5	.063	.871	.057	.009
10	.055	.840	.095	.011
20	.048	.813	.128	.011
0	.044	.795	.150	.011

[15] * and ** denote for statistical significance at the 5% and 1% level, respectively.
[16] [c] and [s] indicate that a constant and seasonal dummies, respectively, were included in the test for the level.

Table A4 Decomposition of variance for housing loan-to-GDP ratio

Step	Y	P	L^h	IR^a
		1975-1987		
1	.387	.015	.598	.000
2	.347	.033	.620	.000
5	.354	.058	.584	.003
10	.351	.070	.577	.002
20	.361	.053	.584	.003
40	.373	.031	.588	.008
		1988-2006		
1	.145	.084	.771	.000
2	.176	.097	.727	.000
5	.180	.146	.673	.000
10	.110	.326	.562	.002
20	.030	.583	.382	.005
40	.009	.665	.319	.007

Table A5 Decomposition of variance for real housing price level

Step	Y	P	L^c	IR^b
1	.065	.935	.000	.000
2	.062	.923	.002	.008
5	.117	.854	.022	.007
10	.151	.814	.028	.006
20	.169	.785	.040	.006
40	.166	.769	.060	.006

Table A6 Decomposition of variance for consumption loan-to-GDP ratio

Step	Y	P	L^c	IR^b
1	.121	.232	.647	.000
2	.148	.240	.611	.001
5	.161	.275	.562	.001
10	.108	.442	.447	.003
20	.036	.738	.221	.005
40	.043	.882	.129	.006

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