THE TWO-WAY 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 in 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 there is significant two-way interaction between housing prices and housing loan stock in Finland, just like the theory suggests. Furthermore, housing appreciation has a notable positive impact on the amount of consumption loans withdrawn by households.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 it is likely to augment boom-bust cycles in the economy and increase the fragility of the financial sector.

Keywords: borrowing, credit, dynamics, housing.

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.[1] 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).

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 wealth 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 increases 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, which enhances 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. Nevertheless, the strength of the two-way interaction between housing prices and borrowing as well as the direction of the causality between household borrowing and housing prices 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. That is, the sample period is longer than in the previous related empirical studies and models are derived separately for housing loans and consumption loans. Furthermore, specification of some of the variables utilized in the analysis differs from the previous studies. In addition, also the interaction between stock prices and credit is investigated to study if the interaction between housing market and household borrowing is, indeed, notably stronger than that between the stock market and credit as predicted by the theory.

[1] See e.g. Barakova (2003).

Finally, recursive analysis is conducted to test if the long-run relation has changed significantly due to the number of institutional alterations that have taken place during the sample period.

The results show that there is a cointegrating long-run relation between household borrowing, housing prices, gdp and interest rate. The analysis indicates that housing prices influence substantially the amount of both housing loans and consumption loans. Only housing loans appear to have a notable impact on housing prices. Moreover, it is found that the effect of stock price movements on household borrowing is only faint.

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. The fourth part of the paper describes the econometric methodology used in the analysis. In the fifth section, in turn, the results from the econometric analysis are reported after which conclusions are derived.

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. That is, it is expected that the availability of credit affects household borrowing which, in turn, increases demand for housing.

Furthermore, households' borrowing may reflect households' income uncertainty – the more uncertain the 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.[2]

In theory, growth in demand for housing leads to an overshot in housing prices after which the price level gradually adjusts towards the new equilibrium as the supply of housing reacts to the increased price level. In any case, even in the long horizon the housing price level is expected to be higher than before the positive shock to credit availability, since housing supply curve is upward trending.[3]

On the other hand, housing price movements may influence household borrowing significantly. Goodhart and Hofmann (2007) mention three different channels through which housing wealth may influence households' credit demand. Firstly, households may be borrowing-constrained because of financial market imperfections. As a result, households can borrow more if they can offer collateral, i.e. households' borrowing capacity is a function of their collateralizable net worth. Since the collateral value of housing is typically high, increase in housing wealth loosens the borrowing-constraint faced by households. 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 by affecting the value of bank capital. That is, housing appreciation increases the value of the dwellings owned by the bank as well as the value of loans secured by housing collateral. Therefore, housing price changes influence the risk-taking capacity of banks and thereby banks' willingness to lend more.

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[2] Negative impact of income uncertainty on housing prices is reported e.g. by Haurin (1991) and Diaz-Serrano (2005a, 2005b).
[3] Empirical estimates of the long-run price elasticity of housing supply and of new housing construction presented in the literature vary typically around 1-3 at the national level (see e.g. Poterba 1984, Tobel and Rosen 1988, DiPasquale and Wheaton 1994, Blackley 1999, Malpezzi 2001, Meen 2002, Harter-Dreiman 2004).

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 markets. A positive shock to the availability of credit increases household borrowing and causes higher demand for housing. Increased housing prices loosen the borrowing constraints even more, which leads to even better availability of credit. Naturally, the mutually reinforcing cycle can begin also from the housing markets. A rise in housing prices caused, for instance, by more optimistic expectations about future economic conditions raises borrowing-capacity of households. Loosening in the borrowing-constraints, in turn, is likely to increase demand for housing leading to further growth in housing prices. 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 price movements. The interaction between stock market and borrowing is likely to be substantially weaker the relationship 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 likely to greater than that of stock appreciation. This view is supported by the results according to which the wealth effect of housing on consumption is greater than the wealth effect of stocks (see Case et al. 2001). 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.

Recently, Hofmann (2004) and Goodhart and Hofmann (2007) have considered the relationship between bank lending and property prices employing quarterly data over 1980-1999. Hofmann reports a cointegrating long-run relation between real property prices, loan-to-gdp ratio, 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, in turn, 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.

Liang and Chao (2007), in turn, study the causalities between property prices and bank lending in China. Based on quarterly data over 1999Q1-2006Q2 their analysis implies that there exits unidirectional causality running from bank lending to property prices. A potential problem with the analysis is the short sample, though.

Empirical long-run relation and data

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*):

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

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 expected 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. 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 the 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.

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 average *after-tax* lending rate (IR^a) is utilized, whereas average *before-tax* lending rate (IR^b) is employed in the model incorporating L^c.[4] 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.[5] 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 as well. The OMX Helsinki CAP index (OMXHCAP) is employed to depict the price development of the publicly traded stocks in the Helsinki Stock Exchange (HEX).[6] 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*.

Obviously, there are complications in the data as discussed above. These complications may distort the estimated coefficients slightly. However, 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*, *Y* and *L* are used. Table A1

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[4] 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.

[5] 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 (see Figure A1 in the Appendix): quarterly correlation is .90 even between the differenced series.

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

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 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.[7] Figure 1 presents the series included in the analysis (except for the interest rates).

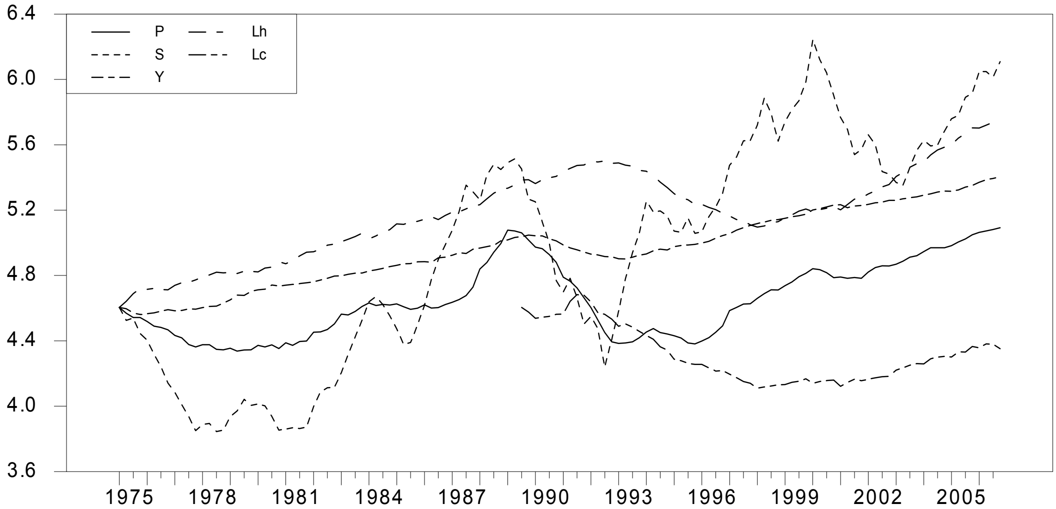

Figure 1: Real housing price (P), stock price (S), and gdp (Y) indices together with and housing loan-to-gdp ratio (Lh) and consumption loan-to-gdp ratio (Lc)

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 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 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 bubble.

Eventually the bubble burst 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 been constantly negative.

The maturities of housing loans have kept increasing 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. The importance of the income, wealth and credit constraints on housing demand has been established e.g. by Barakova et al. (2003) concerning

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

the US market. Despite the changes in credit availability, the econometric analysis implies that the estimated long-run relation has stayed relatively stable.

Econometric methodology

The existence of a long-run relation between Y, P, L and IR is tested in the next section by employing the Johansen Trace tests. Lack of cointegration implies that the dynamics are only short-run in nature. Cointegrating relationship, instead, indicates that also long-run interrelations exist. Cointegration is tested and vector-error correction model (VECM) is estimated in the case cointegrating relationship is found due to the fact that important information concerning long-run dynamics is lost if only differenced variables are used in the analysis.

In the Johansen test the following vector error-correction model is considered:

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

where X_t is a four-dimensional vector containing P_t, Y_t, L_t and IR_t, and X_t is X_t - X_{t-1}, t = 1,…,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 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 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.

The selection of the number of cointegrating vectors (r) is done by comparing the estimated Trace statistics with 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. The LR test described in Johansen (1996) is used to test for the weak exogeneity of the variables. In these LR tests Bartlett small-sample correction by Johansen (2000) is used.[8] The stability of the estimated long-run relation is checked using the recursive estimation method employing the program CATS2 (see Dennis 2006, pp. 95-112).

After being tested for cointegration, time series models examining the dynamics between regions are estimated. In the cases where the hypothesis of no-cointegration is accepted, a VAR model is estimated to study the dynamics. The number of lags in the VAR models is decided based on the Sim's small-sample corrected Likelihood Ratio test and the LM(1) and LM(4) tests. If cointegration is found, instead, VECM is estimated. Using the estimated VEC and VAR models, impulse responses and variance decompositions are derived.

Empirical results

In this section cointegration analysis is employed to investigate if there exists a stationary long-run relation between real housing prices, loan-to-gdp ratio, gdp and lending rate. Cointegration means that there exists a stationary linear combination between the (non-stationary) variables, so that the variables cannot drift apart in the long run. After the investigation of the long-run relation, short-run housing price dynamics are examined. Both error-correction (ECM) and vector error-correction models (VECM) are estimated. In addition, innovation accounting is conducted and forecasts are derived based on the estimated models.

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[8] According to a Monte Carlo analysis conducted by Canepa (2006), the Bartlett corrected LR test provides, with some caution, a reliable inference when testing linear restrictions of the cointegrating vectors.

Interaction between housing prices and housing loans

The small-sample corrected Johansen Trace test statistics based on a VECM that includes P, L^h, Y and IR with four lags in differences are reported in Table 1.[9]

Table 1: Johansen Trace test statistics

Hypothesis	**r=0**	**r≤1**	**r≤2**	**r≤3**
Trace statistics	46.4	20.2	10.0	3.6
P-value	.07	.42	.29	.06

The Trace statistics clearly suggest that there is one stationary linear vector between the four variables. The long-run relation appears to be more sensible without IR in it. Interest rate can be excluded from the relation and restricted to be weakly exogenous.[10] The exclusion of IR is in line with the results reported by Hoffman (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 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 above).

Also Y is treated as a weakly exogenous variable although the LR test would not accept the restriction. The alfa of Y would have the wrong sign. Moreover, it is reasonable to assume that it is housing prices and loan stock that adjust, not gdp.

Giving support to a strong two-way interaction between housing prices and credit, both P and L^h appear to adjust towards the long-run relation. The estimated long-run relation is as follows (standard errors in the parenthesis):

$$P - \underset{(.166)}{.334}{*}Y - \underset{(.140)}{.385}{*}L^h = 0$$

The relation suggests that a 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), whereas Hofmann reports a notably larger coefficient (.6) for credit. Note, however, that in his analysis Hofmann uses a broader loan stock measure and includes also commercial property into the real estate index, so that the results are not perfectly comparable.

As Hoffman notes, the start of the European Monetary Union (EMU) may have given rise to a structural break in the system. Furthermore, as discussed in the previous section, there have been also other institutional changes that may have altered the long-run relation. Hence, both recursive and backward recursive estimations are employed to investigate the stability of the long-run relation and the adjustment speeds of P and L^h. The recursive estimation does not show 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 institutional changes during the sample period.

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[9] The model also includes a dummy variable, which takes value one in 1988Q. 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.

[10] P-value is .12 in the small-sample corrected LR test.

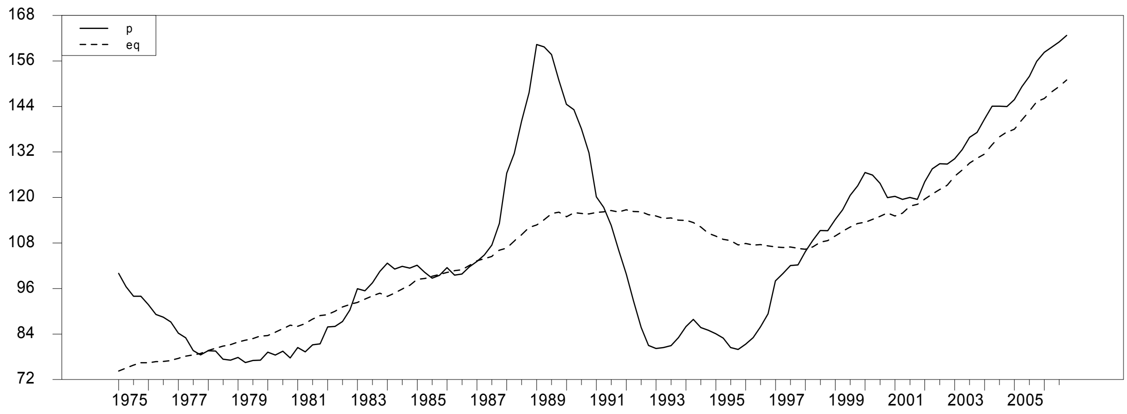

Figure 2: Actual real housing price index (p) and the fit from the estimated long-run relation (eq)

With the exception of the mid 1970s, price level was relatively close to the long-run relation until the late 1987 (see Figure 2). The financial market liberalization resulted in overheating in the housing market and in 1989Q1 real housing price level peaked being some 40% over the long-run relation. Eventually, the price bubble burst 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 about 40% below the estimated long-run level.

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 less than 8% over the long-run relation. 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 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 term 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. The VECM, including four lags in differences and seasonal dummies, incorporates the slow adjustment of housing prices and bank lending towards the long-run relation as well as the short-run linkages between the variables and autocorrelation in the variables.

The speed of adjustment of real housing prices towards the long-run relation is estimated to be 8.5% per quarter. This indicates that it takes two years before half of the deviation of housing prices from the long-run relation is vanished due to the adjustment of *P*. That is, housing price adjustment is highly sluggish.

Also the loan-to-gdp ratio appears to adjust towards the long-run relation. This is not surprising, since there is likely to be a significant two-way interaction between housing prices and bank lending. The estimated adjustment speed of L^h is 2.2% per quarter. The figure is somewhat smaller than the corresponding value of 5.8% reported by Hofmann (2004).

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.

Figure 3 plots the impulse response curves of Y, P and L^h to one percent positive shock to gdp, 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.

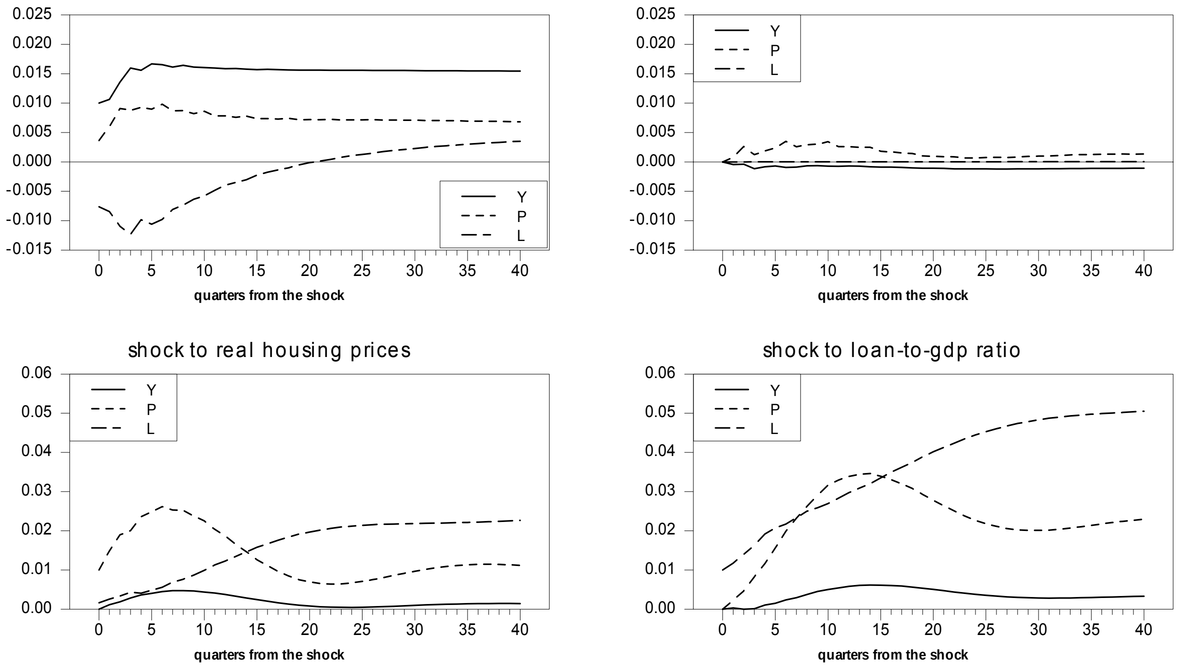

Figure 3: Impulse response functions

In line with the suggestion of Lutkepohl (1994), in many cases the long-run impacts of the shocks differ notably from the ones implied by the coefficients of the long-run relation. The impulse response functions 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 P or L^h price level keeps rising for a long time and at some point overshoots. Eventually, housing prices start to gradually adjust towards the new long-run equilibrium.

After a shock in L^h, it appears that it takes as long as approximately three years before the downwards adjustment of housing price level begins. It appears that the two-way interaction between housing prices and lending is strong. While the response of Y to a shock to P or L^h is relatively small, P and L^h seems to be influenced substantially by changes in the other variable. The increase in household lending 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' liquidity constraints (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 substantially shorter sample period, i.e. 1980-1999, than the one in this paper. The impulse responses of P to a shock in L^h, instead, are close to the ones presented by Goodhart and Hofmann.

Income shock, as expected, appears to have a positive impact on housing prices both in the short and in the long run. It is expected that the initial impact of positive gdp shock to 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 influences 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 real lending rate do not appear to affect the Y, P or L^h 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.

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 Table A2 in the Appendix).[12] The variance decomposition confirms that housing price movements and changes in the housing loan-to-gdp ratio affect each other substantially. On the contrary, the importance of income changes on P appears to be surprisingly small.

If housing price series is replaced by the stock price index, a cointegrating 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.

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, interest rate and gdp are restricted to be weakly exogenous and IR^b is excluded from the long-run model.

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

[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.

Table 2 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

Both P and L^c appear to adjust towards the long-run relation. The estimated long-run relation, whose stability over the sample cannot be rejected, is as follows (standard errors in the parenthesis):

$$P - .848^*Y - .580^*L^c = 0$$
$$(.238) \quad (.202)$$

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 instead (eq1), as can be seen in Figure 6.

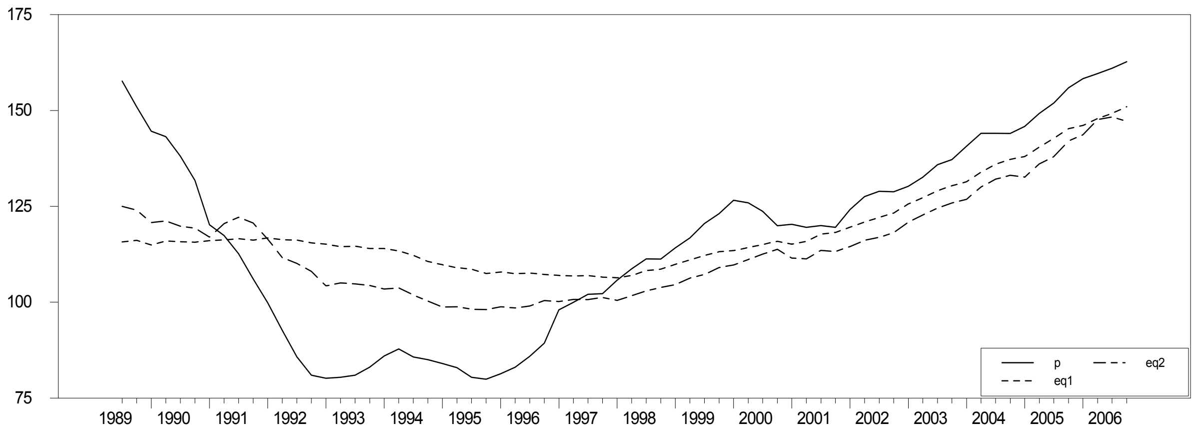

Figure 4: Actual real housing price index (p) and the fits from the estimated long-run relations (eq1 & eq2) over 1989Q3-2006Q4

To take into account the interrelations between the variables VECM including P, Y, L^c and IR^b is estimated. The VECM, including two lags in differences and seasonal dummies, incorporates the slow adjustment of housing prices and consumption loan stock towards the long-run relation as well as the short-run linkages between the variables and autocorrelation in the variables.

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 7 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.

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 shock appears to be similar to the one exhibited already in Figure 2. The response of housing price level to a income shock, instead, is substantially greater based on the model that does not include housing loans.

Expectedly, housing prices appear to influence also borrowing for consumption notably. The effect of an increase in consumption loans, on the contrary, seems to have only a faint effect. Also this is expected, since the theory does not predict similar strong two-way interaction between P and L^c as between P and L^h. Finally, the impact of an interest rate shock appears to be negligible also in this case.

The variance decompositions (see Tables 5 and A6 in the Appendix) confirm that the influence of housing price movements on the consumption loan-to-gdp ratio is substantial, whereas changes in L^c do influence housing price determination notably. 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.

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 negligible as well based on a third-order vector autoregressive model including also ΔY and ΔIR^b.

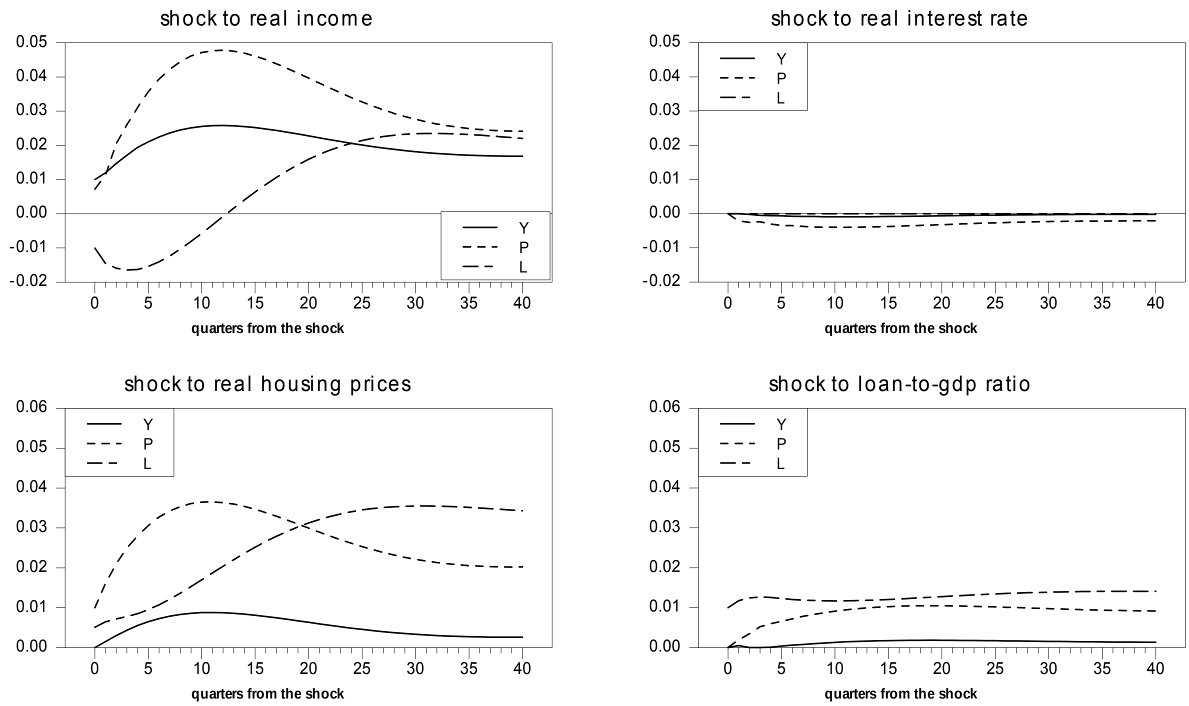

Figure 5: Impulse response functions

Conclusions

The theory predicts that there is 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. Furthermore, the impact of stock prices on household borrowing is examined as a comparison. Quarterly data from Finland over 1975-2006 is employed in the empirical analysis.

Based on a vector error-correction model including real gdp, real housing prices, loan-to-gdp ratio and real lending rate 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 increase the fragility of the financial sector. 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.

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Appendix

Table 1 Summary statistics of the differenced series[14]

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	-.015	.049	.172	.353**
Real after-tax lending rate	.001	.055	.195	-.276**
Real before-tax lending rate	.001	.058	.198	-.268**
Real stock prices	.048	.197	.446	.420**

Table A2 Augmented Dickey-Fuller test results[15]

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
1	.019	.981	.000	.000
2	.022	.970	.006	.002
5	.025	.919	.051	.006
10	.017	.786	.189	.008
20	.015	.557	.421	.007
40	.018	.477	.499	.006

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

Step	Y	P	L^h	IR
1	.171	.053	.776	.000
2	.158	.076	.766	.000
5	.133	.102	.756	.009
10	.066	.155	.772	.009
20	.017	.303	.672	.009
40	.004	.337	.651	.008

Table A5 Decomposition of variance for real housing price level

Step	Y	P	L^c	IR
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
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

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