BANK LENDING AND HOUSE PRICES IN SWEDEN 1992-2010

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Abstract

Given the large increase in Swedish house prices and households' indebtedness since the 1990s, it is important to study the seemingly strong relationship between house prices and bank lending. Credit expansion may increase house prices and higher house prices increases the wealth and, thereby, the bank lending. A better understanding of the interrelationship between bank lending and house prices is important on a macro level, e.g., as it influences policy decisions geared towards both the housing and the banking markets. However, it is also important on a micro level. For instance, it may have an impact on credit rating, property valuation and decisions regarding allocating bank funds to households vis-à-vis firms as well as the bank's risk exposure, in particular related to potential bubbles on the housing market, and the bank's exposure to default risks on the housing credit market. Our aim here is to analyze this interaction by investigating the Granger causality in Sweden over the period 1993-2010. The plan is to estimate a structured vector autoregressive model and a vector error correction model and thereby investigate if changes in bank lending causes house prices to change and/or vice versa. If our results indicate that causality goes in both directions, credit expansion and increased bank lending stimulate the housing market at the same time as rising house prices induce more bank lending to the household sector. Hence, in that case mortgage restrictions may have an effect on the housing market with lower prices in the short run. Disequilibrium in the lending market and housing market may also have an effect on the house prices in the long run. This is something that is going to be investigated. There are few studies examining the relationship between house prices and bank lending over time and across regions. Our ambition is to fill this gap. Our results may be of particular interest in the light of the current policy debate in Sweden regarding how to tackle a sharp house price increase in urban areas (partly) due to historically low interest rates.

Keywords: Bank lending, credit expansion, Granger causality, house prices, VAR model

1. INTRODUCTION

House prices in Sweden have increased by about 65 percent in real terms from 1990 to 2010 and by about 135 percent from 1996 when the house prices hit the last bottom. The price increases in the larger metropolitan areas (such as Stockholm Gothenburg and Malmö) were even stronger (Riksbanken, 2011). The large increase in house prices has been accompanied by a corresponding increase in outstanding mortgages, both in absolute terms as well as in relative terms. For instance, the size of the Swedish households' total debt (in which mortgages constitute a major component) in relation to yearly disposable income amounted to 156 percent in early 2010 as compared to 116 percent in 1990, and the debt to GDP-ratio has increased from about 60 percent to 83 percent during the same time period (BKN, 2010 and BKN, 2011). Furthermore, in recent years the loan-to-value ratio has been relatively high for new borrowers, the fixed rate terms of the loans have been short and amortization payments have been low (Riksbanken, 2011).

The large increase in house prices, mortgage lending and households' indebtedness in Sweden, combined with a number of financial and real estate crisis in the past worldwide (including the last global financial crisis of 2007-2009), have energized the debate about the extent and the direction of the relationship between property prices and bank lending.

One reason for the large interest is that shocks to house prices, credit, and money all have significant repercussions on economic activity and aggregate price inflation (Goodhart and Hofmann, 2008; Iacoviello, 2005). For instance, real estate price swings may have significant impact on consumption and investment expenditures since real estate accounts for more than 50 percent of wealth world-wide and houses are the most important collateral in bank lending (Giuliodori, 2005 and Quigley, 2006). Large swings in real estate prices that end in devastating crashes have been witnessed by many countries in the past two decades (Xiao Qin, 2010). Glick and Lansing (2010) found that countries that tended to experience the most severe declines in consumption once house prices started to fall also were the countries which experienced the largest increases in household leverage and the fastest rise in house prices.

The interdependence between the housing and mortgage markets influences boom–bust cycles in the economy and might increase the fragility of the financial sector (Oikarinen, 2009). A combination of falling house prices and an increase in the number of households facing problems of servicing mortgage payments might cause severe solvency problems among banks. However, the mere threat of facing credit losses and solvency problems might cause banks to start withdrawing funding from the market, which in turn can create severe liquidity constraints throughout the entire financial system (Riksbanken 2011).

A better understanding of the interrelationship between bank lending and house prices, in particular in what direction the causality runs and why, is important on a macro level, e.g., as it influences policy decisions geared towards both the housing and the banking markets. However, it is also important on a micro level. For instance, it may have an impact on:

- Credit rating
- Property valuation
- Decisions regarding allocating bank funds to households vis-à-vis firms
- The bank's risk exposure, in particular related to potential housing market bubbles

- The bank’s exposure to default risks on the housing credit market

To a large extent, as long as increased house prices result in increased bank lending the points above constitute no major problems for banks. They may then regard price changes in the housing market as exogenous and act accordingly. However, if the causality (also) runs in the opposite direction, the bank’s behavior on the housing credit market may spur potentially adverse effects. For example, a less strict credit rating may increase bank lending ceteris paribus, which in turn may increase house prices without any underlying changes in the fundamental drivers. The extreme outcome is a housing bubble. Even without a (severe) bubble, the bank’s behavior will influence the value of the bank’s collateral, which may have an adverse impact on the bank’s risk exposure given the lack of fundamental drivers.

The aim of the research we propose here is to provide a better understanding of the interrelationship between bank lending and house prices on the Swedish markets. Even though it will be based on a theoretical ground, our approach is basically empirical and we are especially interested in how the interrelationship varies over time and across space. As discussed above, our research is important both from a policy perspective and for banks. In addition, it will add to a literature that currently is far from consensus, as will be discussed in the next section.

Section 2 presents a brief literature review on the relationship between bank lending and house prices. In Section 3, we discuss the used methods in the paper including the basic concepts of the vector autoregression and vector error correction models, and in Section 4, we present the data together with some descriptive and pre-test statistics. In Section 5, we give the econometric analysis, and Section 6 ends this paper with a conclusion.

2. LITERATURE REVIEW

Several studies have discussed possible theoretical links between credit and house prices (see Gerlach and Peng, 2005, Goodhart and Hofmann, 2008 and Koetter and Poghosyan, 2010). Houses are often used as collateral for bank lending and their prices affect bank’s capital positions and lending capacity (Gerlach and Peng, 2005, and Koetter and Poghosyan, 2010). An increase of housing price (wealth) has collateral effects on credit demand and credit supply; housing wealth leads to an increase in household spending and borrowing capacity (Goodhart and Hofmann, 2008; Iacoviello, 2005). Similarly, a decline of property prices reduces housing wealth and increases borrowers’ mortgage burden (Hott, 2011). Niinimäka (2009) discusses the impact of house price fluctuations on bank lending behavior when banks finance risky projects against collaterals and overestimate their future appreciation. Hott (2011) claims that there is positive feedback between real estate prices, mortgage loans and bank profits.

The empirical relationship between house prices and lending, and particularly if there exist any direction of causality between them, has also been subject to attention in the literature. A (non-exhaustive) list of published papers and their conclusions is presented in table 2.1. As can be seen, no clear and distinctive agreement of direction of causality is found. While Gerlach and Peng (2005) conclude that property prices drive bank lending, a number of articles find evidence that bank lending affects house prices in a unidirectional way (see e.g. Englund, 1999, Koh et al., 2005 and Liang and Cao, 2007 as well as Mora, 2008 and Hott, 2009). However, some articles find evidence for that there exist differences in the direction of causality depending on whether the analysis is applied for short or long-run. For instance, Brissimis and Vlassopoulos (2009) argue that the causality goes in both directions in the short-run, but in the long-run house prices do not react to the mortgage lending market. Furthermore, Park et al. (2010) find that short-run influence of bank lending is present in "cold" submarkets within a major city (here Seoul) but not in "hot" submarkets. On the other hand, they also find that the long-run influence is stronger in "hot" areas than in other submarkets.

The complexity of the subject is further emphasized in Goodhart and Hofmann (2008), who find a multidirectional link between house prices, private credit, and the macro-economy. Their analysis of 17 industrialized countries indicates that the link is stronger in more recent sub-samples. This is claimed to reflect the effect of financial system liberalization in these countries. According to Oikarinen (2009), the liberalization of the financial markets has resulted in a stronger interaction between lending and house prices. Housing wealth has affected the amount of housing loans only after the credit markets were liberalized. At present, there is a strong two-way interaction between housing prices and housing loan.

Household expectations regarding future income and demographic changes also seem to have explanatory power on the unidirectional relationship where house price influence bank lending (Gerlach and Peng, 2005; Brissimis and Vlassopoulos, 2009). Furthermore, reductions of interest rate have also been suggested to explain such relationship where enhanced present value of future income flows and subsequent expected higher house price would influence bank lending (Brissimis and Vlassopoulos, 2009).

The underlying forces that cause house prices to influence bank lending are different from those that cause bank lending to influence house prices. Bank lending practices, macroeconomic factors, and monitoring policies are among some of the plausible explanations why bank lending influences house prices. Koh et al. (2005) suggest that under-pricing of real estate loans caused inflated asset price above their fundamental value. Excessive bank lending to housing due to lack of other lending alternatives such as corporate borrowers led to price increases (Mora, 2008 and Hott, 2009). Macroeconomic factors such as GDP and income may also contribute to the influence of bank lending on house prices (Liang and Cao, 2007 and Park et al., 2010). Deregulation of credit and financial markets could explain both the direction and intensity of the interaction between house price and bank lending (Englund, 1999 and Oikarinen, 2009).

Table 2.1 Review of literature that study the direction of causality between bank lending and house prices.

Article	Direction of influence	(Suggested) explanations
Gerlach and Peng (2005)	Property prices determine bank lending, but bank lending does not appear to influence property prices.	Changing beliefs about future economic prospects led to shifts in the demand for property for investment and bank lending naturally responded.
Brissimis and Vlassopoulos (2009)	No direction of causality from housing loans to housing prices in the long-run. Bi-directional dependence exists between housing loans and housing prices in the short-run.	Improvement in household expectations regarding their future income. Reduction in interest rates. Demographic factors such as influx and gradual integration of immigrants and reduction in the size of households. Low or negative real returns offered by most financial assets.
Liang and Cao (2007)	Unidirectional causality exists running from bank lending to property prices in the long-run.	Bank lending, GDP (income) and interest rate Granger cause property prices; causality run interactively from GDP (income), bank lending and interest rate to property prices.
Goodhart and Hofmann (2008)	Multidirectional link between house prices, broad money, private credit, and the macroeconomy.	Money growth has a significant effect on house prices and credit, credit influences money and house prices, and house prices influence both credit and money.
Gimeno et al., 2009	Long-run parameters indicate the existence of interdependence between house purchase loans and house prices.	Borrowing capacity of households is positively related to house prices and thus determine collateral available. House price determine housing wealth and change in prices can affect spending and borrowing capacity.
Oikarinen, 2009	Strong two-way interaction between house prices and housing loan after the financial liberalization Substantially weaker interaction before the financial deregulation in 1980s.	The interactions is likely to boost boom-bust cycles in the economy Housing price movements appear to have notable positive effects on consumption loans. Housing market affects macroeconomic cycles through this interaction channel.

Park, Bang and Park (2010)	Short-run influence of bank lending is present in “cold” submarkets within a city, while not in “hot” submarkets. But long-run influence is stronger in “hot” areas than in other submarkets. Price stabilization attempts such as lending restrictions on loan-to-value ratio and debt-to-income ratio may have little effect in a ‘hot’ market and a greater effect in ‘cold’ markets in the short run.	Income and wealth differences between buyers in hot and cold submarkets. Buyers in hot markets are not wealth or income constrained
Mora (2008)	Bank lending affects real estate prices.	When banks lost corporate borrowers (blue-chip customers – keiretsus) to the public capital markets, banks increased their property lending instead.
Koh et al (2005)	Excessive bank lending affected house prices.	Underpricing of real estate loans (here, underpricing of the borrowers put or “walk away” options).
Englund (1999)	Excessive bank lending affected house prices.	Deregulation of credit markets after 1985 stimulated a competitive process between lending institutions resulting in credit expansion.
Hott (2009)	Bank lending influence real estate price.	Banks provide increasing levels of financial resources for real estate purchases and thus create a price bubble.

3. MODELING STRATEGY

We use a series of econometric modeling approaches in order to investigate the relationship between house prices and bank lending. In particular, we apply a vector autoregression model (VAR) and a vector error correction model (VECM). Basically, the empirical procedure employed involves the following steps:

(1) Data transformation
(2) Pre-test of data (stationarity and white noise)
(3) VAR and VECM
(4) Granger causality
(5) Impulse-response function (IRF)

PRE-TEST OF DATA

One of our central concerns is to test the data concerning stationarity. Stationarity is defined as a variable where the mean, variance, and covariance are constant over time. A stationary variable is integrated of order zero and a variable that must be differentiated once to become stationary is said to be integrated of order one. A Dickey–Fuller (ADF) test for a unit root is going to be utilized in order to detect non-stationarity. Ljung and Box test (Ljung and Box, 1978) are used in order to detect for white noise in the stationary series. The reason for this being important is to avoid, so called, spurious regression which may occur when non-stationary series are regressed on each other.

VAR AND VECM

The concept of VAR models was first introduced in a seminal article by Christopher Sims (Sims, 1980). The basic idea is that an univariate autoregressive model such as AR(1) is extended with more variables where each variable is explained by its own past values and the present value of all other variables. In Sims' model there is no assumption regarding which variables are endogenous or exogenous or any restrictions, that is, the modeling approach is very *atheoretical* (Charemza and Deadman, 1997). We can put more or less structure on the VAR model by assuming exogeneity and putting restrictions on some of the variables. Stock and Watson (2001) concludes that "this simple framework provides a systematic way to capture rich dynamics in multiple series". However, they also conclude that the method is more suited for data description and forecasting than for drawing inference and policy implications. The basic objection is that the method is purely statistical and cannot distinguish between correlation and causation. We are going to put more structure on the model by estimating both a structured VAR and a VECM. The ECM approach is based on Engle and Granger (1987). The idea is to estimate a long run and a short run equation in order to capture the disequilibrium on the market, that is, to take account of adjustments towards the long run relation. If the series have a common trend, that is, if the series are co-integrated, an ECM can be estimated. In this case we are going to investigate if house prices and bank lending is co-integrated or not. Both VAR and VECM will be used in order to investigate the Granger causality and to construct a model for different kinds of simulations. As VECM requires the variables to be co-integrated, we test for co-integration by investigating whether the error component from the long run equation have a unit root or not.

The first basic VAR model we estimate is an unrestricted VAR where both house prices and bank lending are endogenous. The model consists of two equations. First, current bank lending is regressed on previous bank lending and previous house prices and, second, current house prices is regressed on previous house prices and previous bank lending. See equation (1), where *BL* denotes bank lending and *HP* house prices.

$$\begin{aligned} BL_t &= \alpha + \sum_{j=1}^{k} \beta_1 HP_{t-j} + \sum_{j=1}^{k} \beta_2 BL_{t-j} \\ HP_t &= \alpha + \sum_{j=1}^{k} \beta_1 BL_{t-j} + \sum_{j=1}^{k} \beta_2 HP_{t-j} \end{aligned} \tag{1}$$

Both house prices and bank lending must be stationary in order to estimate the 2-equation system. The system of equations is estimated by OLS. It is important that all relevant variables are included in the VAR model in order to make correct inference. Therefore, we are also proposing a more structured VAR model where some of the variables are endogenous and some other exogenous, following Engle and Granger (1987). Thus, we specify a model that includes more determinants such as macroeconomic variables, which we are assuming to exogenous to the system. Thus yields a VECM model consisting of the following equation system:

$$\begin{aligned} HP_t &= \alpha + \sum_{j=1}^{k} \beta_1 BL_{t-j} + \sum_{j=1}^{k} \beta_2 HP_{t-j} + \beta_3 GDP_t + \beta_4 IR_t + \beta_5 CON_t + \beta_6 POP\_Ratio_t + \beta_7 STOCK_t \\ BL_t &= \alpha + \sum_{j=1}^{k} \beta_1 HP_{t-j} + \sum_{j=1}^{k} \beta_2 BL_{t-j} + \beta_3 GDP_t + \beta_4 IR_t + \beta_5 CON_t + \beta_6 POP\_Ratio_t + \beta_7 STOCK_t \end{aligned} \tag{2}$$

where *GDP* denotes the gross national product, *IR* denotes interest rate, *STOCK* denotes stock market index, *CON* denotes construction and POP-Ratio denotes the ratio of population that is age between 25 to 45.

It is important in both the VAR and the VECM model to analyze the optimal number of lags. We are using AIC and BIC in order to determine the optimal lagging structure. Furthermore, there is no reason to believe that the relationships are constant across regions and over time. This potential parameter heterogeneity is examined by including a set of interaction variables.

Granger Causality

Granger's (1969) definition of causality can be stated as: Y is a Granger cause of X (denoted as $Y \rightarrow X$), if current X can be predicted with better accuracy by using previous values of Y rather than by not doing so. The so-called Granger test suggested by Granger (1969) was first utilized by Sargent (1974). The Granger test can only be used when all the variables are integrated of order zero. We use both VAR and VECM in order to analyze Granger causality. The Granger causality will be tested through an F-test.

Impulse-Response Analysis

The impulse-response analysis is utilized in order to answer the question: what is the most likely response of future house prices to an exogenous shock in current bank lending? The analysis is derived in terms of the effect in the error term (see Charemza and Deadman, 1997). The impulse-response function will show the time paths to a shock in bank lending on house prices and the time paths to a shock in house price on bank lending. By estimating the impulse-response function (IRF) it is possible to simulate and evaluate different type reforms and regulations (such as the Basel regulations and restrictions on LTV-ratios) even if we are using the VAR framework.

4. Data and Descriptive Analysis

The data consists of quarterly data covering the period 1992-2010. The basic variables are house prices on single family houses and bank lending to the household sector from banks and mortgage institutes. The data consist of variables measuring the cost of capital (e.g., t-bill and/or t-bond), macro-economy (such as GDP and disposable income), construction of multi- and single-family houses, indicator of the stock market movements (e.g., OMXS30) as well as demographics (such as population and the proportion of 25-40 years old). Data concerning house prices, bank lending, GDP, population and demographics, and construction are gathered from Statistics Sweden. The source of data concerning cost of capital is from Riksbanken (the central bank of Sweden) and OMXS30 comes from NasdaqOMX.

Table 1 defines the variable used in this analysis and exhibits some descriptive statistics. House prices, bank lending and gross domestic product are all measured in real term (deflated with consumer price index). The series are index and 1993 is equal to 100. House prices have been at most 147 percent higher than in 1993 and on average 55 percent higher. The average bank lending is a little lower, but the maximum bank lending has been 181 percent higher than in 1993. GDP shows the lowest range between minimum and maximum. The coefficient of variation is also lowest concerning GDP compared to bank lending and house prices. It is obvious that GDP cannot alone explain the volatility in house prices.

Table 1, descriptive statistics

Variable	**Description**	**Unit**	**Mean**	**Std. Dev.**	**Min**	**Max**
HP	Real Housing Price	Index	154.9055	49.35062	97.98064	247.2496
BL	Real Bank Lending	Index	147.9804	57.18484	92.43934	281.4862
GDP	Real Gross Domestic Production	Index	93.44182	16.37552	75.56026	134.6448
IR	Interest rate (5-year Treasury bill)	Percentage	6.460423	2.953011	3.016109	15.62274
CON	Construction of new single-family houses	Units	2041.107	1144.885	709	6605
STOCK	OMX 30	Index	730.4936	308.025	191.72	1383.66
POP_Ratio	Population ratio Between age of 25 to 40	Ratio	.2163752	.0066169	.2041446	.2221746

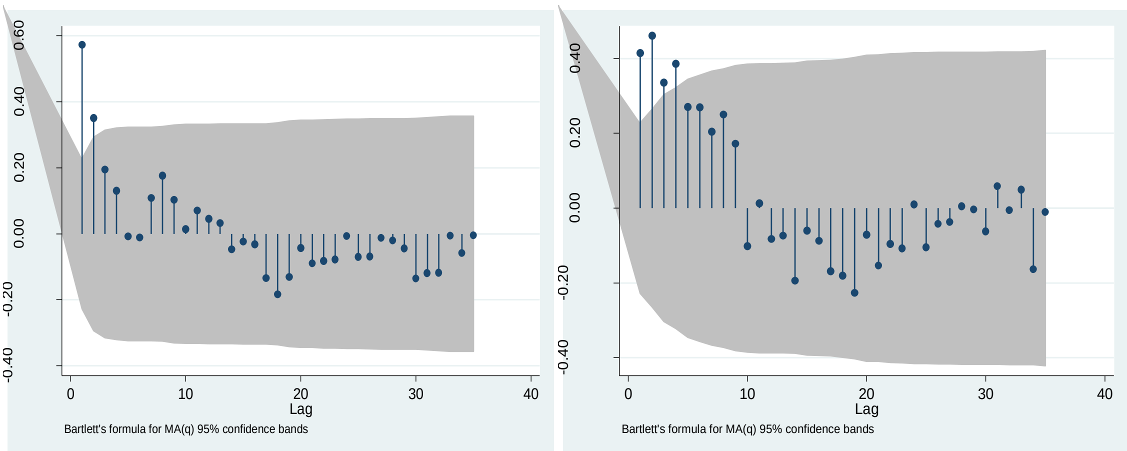
Mortgage interest rate is obviously important explaining house prices and bank lending. We have used the 5 year ´treasury bill as a proxy for cost of capital. The t-bill has on average been around 6.5 percent with a standard deviation of almost 3 percent. That is to say, the coefficient of variation is very high and it seems that t-bill may be important explaining both house prices and bank lending. House prices are negatively related to construction, that is, if construction of single-family houses increases, house prices is expected to decrease. The volatility in housing construction has been very high. The standard deviation is around 1100 unit per quarter and the average is around 2000 units. We are also using OMXS30 as a determinant and here we can observe a large range over period from an index number of 192 to 1384. Finally, around 22 percent of the population is in the age group 25 to 40 years. The variations around the mean are low, hence, we do not expect that the population proportion can explain a large part of the variation of bank lending and house prices.

As outlined above, we begin the analysis by conducting a pre-test on the data. This is done in order to investigate whether the variables are integrated of order zero and/or order 1 and to test for white noise. The results are shown in Table 2. We see that all variables are stationary in first difference. One of the variables is stationary in levels (t-bill) but all the other variables are integrated of order one. If we are analyzing the Ljung-Box test or the autocorrelation plots we can observe that only the change in GDP, t-bill, and OMXS30 are white noise. That is, all the other variables in levels and as a first difference are autocorrelated.

Table 2. Pre-test of the data

Variable	ADF	Ljung-Box
HP	0.0126	0.0000
ΔHP	0.0002	0.0031
BL	0.7353	0.0000
ΔBL	0.0000	0.0000
GDP	0.2291	0.0000
ΔGDP	0.0000	0.9792
IR	0.0370	0.0000
ΔIR	0.0000	0.1619
CON	0.1782	0.0000
ΔCON	0.0000	0.0000
POP_Ratio	0.9969	0.0000
ΔPOP_Ratio	0.0000	0.0000
STOCK	0.4102	0.0000
ΔSTOCK	0.0000	0.2459

Figure 1 shows the autocorrelation in the two main variables, house prices and bank lending, respectively. For both variables, the values are the first difference in logs. For house prices, panel 1a indicates that current house prices have a significant and positive correlation with house prices the two last periods. As the data is quarterly, this means that the autocorrelation stretches over half a year. A similar pattern is seen for bank lending, see panel 1b. Although for bank lending, significant correlation is found over four periods, i.e., a full year.



Panel 1a – House prices

Panel 1b – Bank lending

Figure 1. Autocorrelation house prices (Panel 1a) and bank lending (Panel 1b)

5. ECONOMETRIC ANALYSIS

Having discussed the data and conducted some pre-tests in the previous section, we now turn to the econometric analysis. Our first objective is to establish the optimal number of lags to include in the models. The AIC and BIC-values are shown in Table 3.

Table 3. Optimal number of lags

Lag	**AIC**	**BIC**
1	-12,82	-12,62
1-2	-12,98	-12,64
1-3	-12,92	-12,45
1-4	-13,05	-12,44
1, 4	-13,01	-12,67*
1, 2, 4	-13,13*	-12,66

From the table we see that the two measures yield similar, but not identical, results. The AIC suggests the best lag structure involves including one, two and four quarters in the mode, while the BIC suggests only one and four quarters. As including two quarters only marginally reduces the absolute BIC-value, we will use 1, 2 and 4 quarters in the subsequent analysis. Using this lag structure, we may estimate the basic VAR model defined in equation (1) above. The results are shown in Table 4.

Table 4. VAR-results

	ΔHP		**ΔBL**	
ΔHP(t-1)	0,1402	(1,03)	-0,0724	(-1,03)
ΔHP(t-2)	-0,0906	(-0,75)	-0,0414	(-0,66)
ΔHP(t-4)	-0,3019	(-2,58)	0,0370	(0,61)
ΔBL(t-1)	0,5775	(2,41)	0,2143	(1,72)
ΔBL(t-2)	0,6566	(2,70)	0,5217	(4,13)
ΔBL(t-4)	0,4013	(1,48)	0,0485	(0,34)
R^2	0,3839		0,3414	

In this simple setup, the change in house price can be explained by around 38 percent by the lagged change in house prices and lagged changes in bank lending. Lagged house prices do explain some of the variation in house prices today. Last quarter change have a positive effect on house prices while a positive house price change last year have a negative impact on house prices today. The change in bank lending lagging one quarter, two quarter and one year are all positively related to house prices meaning that bank lending increase house prices. The change in bank lending ion the other hand can be explained by around 34 percent and it seems that house prices changes cannot explain any of the variation in bank lending. Bank lending lagging two quarter have a positive on bank lending today. These numbers can be used in order to say something about causality.

By using F-tests we may now study the Granger causality in the basic VAR setting. That is, to what extent changes in bank lending, in a pure statistical sense, causes changes in house prices and *vice* *versa*. As can be seen from Table 5, bank lending Granger causes house prices. However, there is no evidence of the opposite, i.e., that house prices should Granger cause bank lending. This is a very interesting result as it indicates that an increase in house price **will** not increase bank lending, at least not in the aggregate. However, if the – for some reason exogenous to the housing market – bank lending increases, this will affect house prices.

Table 5. Granger Causality

	$\chi2$	Prob>$\chi2$
BL→HP	19,528	0,000
HP→BL	2,4676	0,489

Still using the basic VAR setup, we may calculate impulse response functions as illustrated in Figure 3. These show the impact over time on house prices and bank lending from an initial exogenous shock. The upper left panel of Figure 3, exhibiting the response on bank lending from a shock in bank lending, shows a positive relationship the wears off over three quarters. After that, the confidence interval, illustrated as the shaded area, covers the zero line, i.e., the effect is not significantly different from zero on the 95 percent level. A stronger but shorter effect is seen for the response in house prices from initial shock in house prices, lower right panel.

Given the objective of the present study, the remaining two panels are more interesting. The upper right panel shows the response in house prices over time from an initial exogenous shock in bank lending. It reveals a positive response that remains significantly different from zero for five periods, i.e., more than a year. It also reveals an interesting pattern in that the response increases for two periods before it starts to wear off. As expected from the Granger causality test, we do not see a corresponding pattern when we look at the response in bank lending on house prices (lower left panel). The small positive effect is insignificant already after one period.

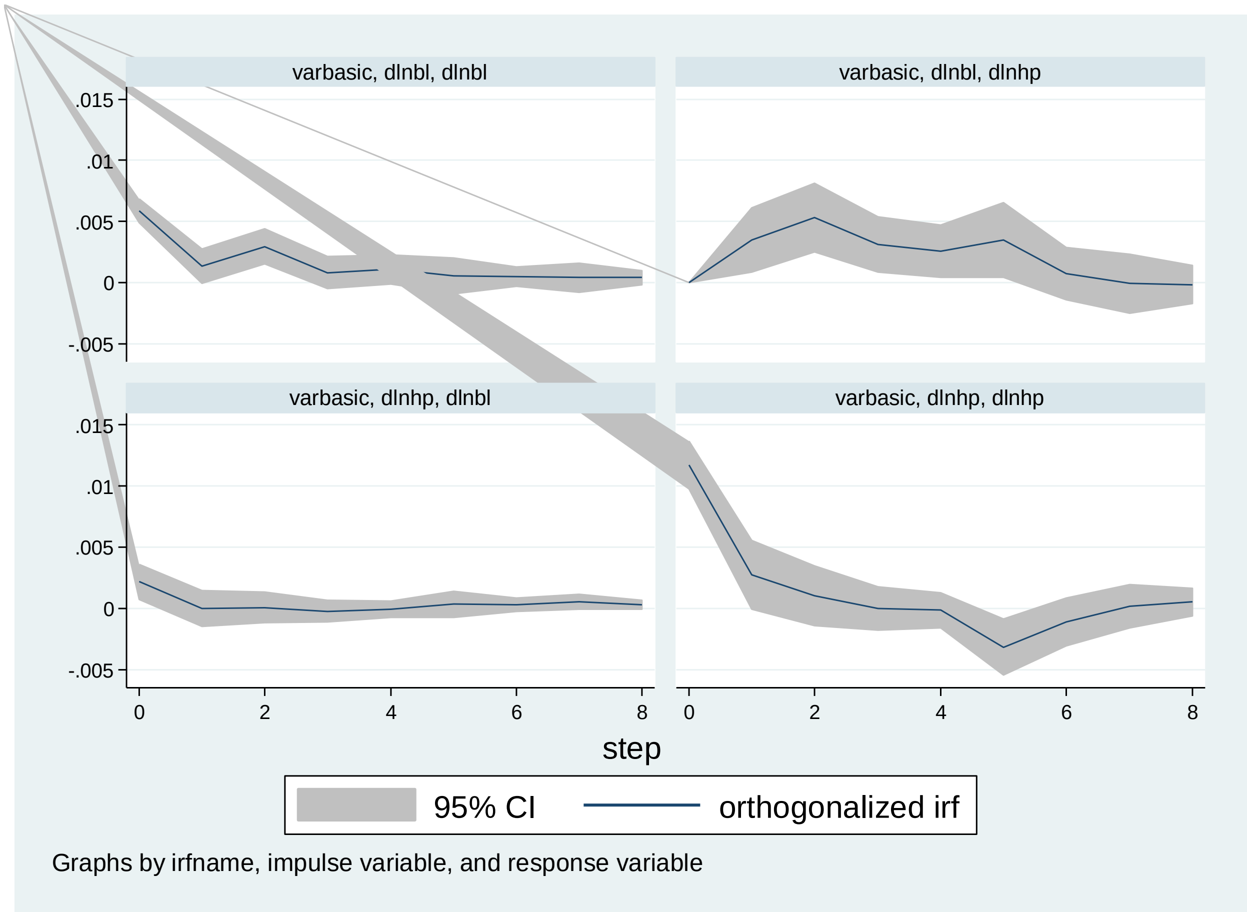


Figure 3. *Impulse-response function*

The next step in the analysis is to extend the basic VAR model to incorporate a series of control variables that may be of importance. This is done in order to reduce the problem that may occur if both house prices and bank lending are affected by other exogenous variables. If this is the case, the basic VAR model above may capture something else than the relationship over time between house prices and bank lending. As discussed above, the exogenous variables included are GDP, 5-year t-bills, OMX30, and the share of the population being between 25 and 40 years old. We also include quarter dummies to capture any seasonal patterns present on market. Table 6 shows the results of the VAR when the exogenous variables are included.

Table 6. VAR with exogenous variables

	ΔHP		ΔBL	
ΔHP(t-1)	0,1683	(1,57)	0,0048	(0,10)
ΔHP(t-2)	0,0111	(0,11)	-0,0484	(-1,03)
ΔHP(t-4)	-0,2167	(-2,50)	0,0800	(1,98)
ΔBL(t-1)	0,3243	(1,70)	0,0377	(0,42)
ΔBL(t-2)	0,7651	(3,70)	0,4230	(4,40)
ΔBL(t-4)	0,3973	(1,95)	-0,0462	(-0,49)
GDP	-0,1041	(-1,33)	0,1287	(3,54)
IR	-0,1123	(-1.17)	-0,0088	(-1,96)
CON	0.0022	(0,39)	0,0013	(0,51)
STOCK	0,0083	(0,78)	0,0067	(1,34)
POP_Ratio	1,7221	(1,15)	-1,3822	(-1.98)
Quarterly trend	Yes		Yes	
R^2	0,5894		0,6718	

From comparing the results in Table 6 with those in Table 4 we see that the explanatory power has increased considerably. This is hardly surprising. Even though the general pattern seems to be similar as in the basic VAR model, several coefficients exhibit a substantial change in magnitude. Some coefficients even show reversed signs. We thus conclude that the exogenous variables are important for explain the relation between bank lending and house prices. In the house price equation the parameter estimates concerning the lagged house prices are more or less the same. However the bank lending estimates are somewhat smaller in magnitude (at least bank lending lagged one quarter). In the bank lending equation, changes in house prices is now significantly different from zero in the one year lagging case. The estimates concerning lagged bank lending are much lower but still statistically significant.

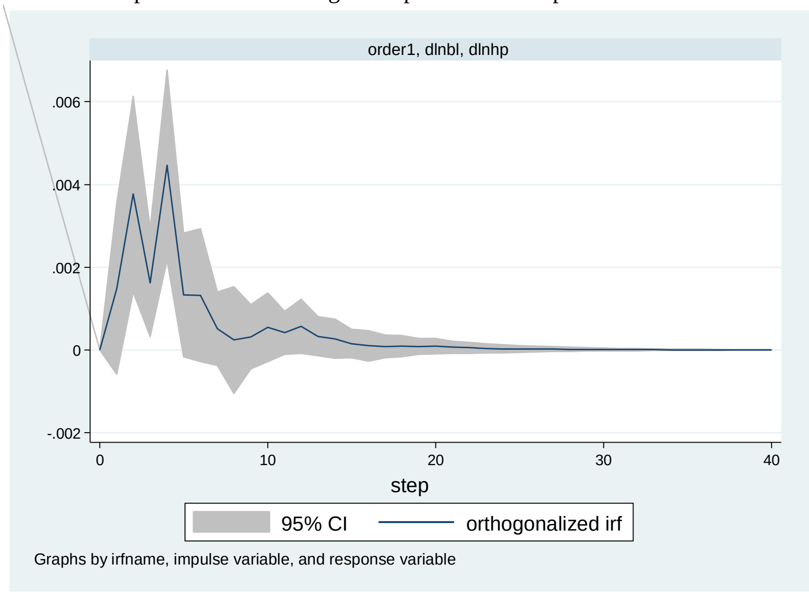
Even so, the Granger causality remains similar when the model is extended. As seen from Table 6, we still have a strong Granger causality running from bank lending to house prices. Just as before, we find no evidence of causality running in the opposite direction.

Table 6. Granger Causality

	$\chi 2$	Prob>$\chi 2$
BL→HP	29,521	0,000
HP→BL	4,301	0,231

Looking at the impulse-response functions, see Figure 4, we also see a similar pattern as derived using the basic VAR approach. For an initial shock in bank lending there is a positive response in house price (panel 4a) that wears off over a period of approximately five periods, i.e., just over a year. The response is more volatile than the one found using in the basic VAR setting. Presumably this follows from the inclusion of the seasonal trend variables. The response from shock in house prices on bank lending (panel 4b) is again instantaneous. Already after one quarter, the effect is not significantly different from zero.

Panel 4a – impulse in bank lending → response in house prices



Panel 4b – impulse in house prices → response in bank lending

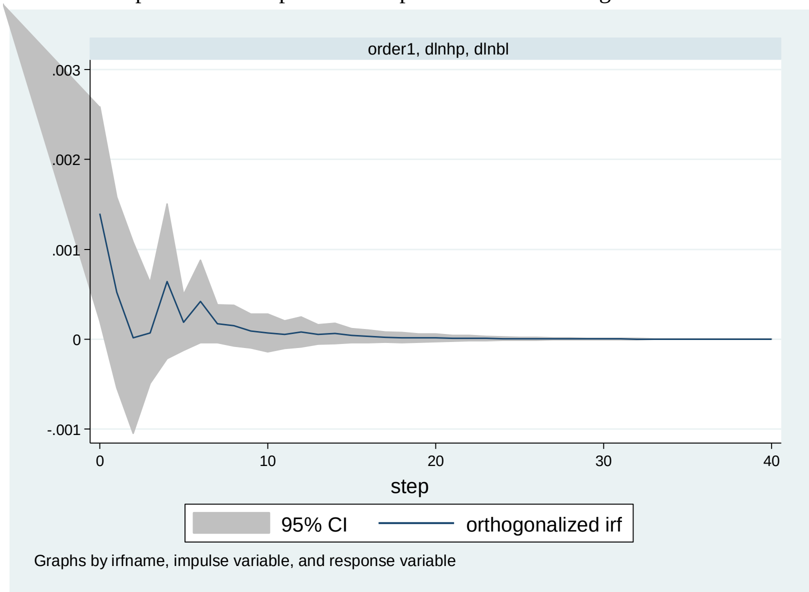


Figure 4. Impulse-response function

PARAMETER HETEROGENEITY

The final part of the analysis is looking at parameter heterogeneity and in this case we are analyzing if the Granger causality is different in different parts of Sweden and in different periods. The VAR model have therefore been estimated in Stockholm, Gothenburg and Malmoe (the main three metropolitan areas in Sweden) and in the period 1992-2000 and 2001-2010, respectively. The period have been chosen in order to test whether before or after the internet stock market bubble have any impact on the Granger causality between house prices and bank lending.

Table 7. Granger Causality (three regions and two periods)

Regions	$\chi 2$	Prob>$\chi 2$
Stockholm		
BL ➔ HP	10,065	0,039
HP ➔ BL	9,9309	0,042
Gothenburg		
BL ➔ HP	11,606	0,009
HP ➔ BL	6,012	0,111
Malmoe		
BL ➔ HP	4,8062	0,187
HP ➔ BL	3,669	0,299
Different time periods		
1992-2000		
BL ➔ HP	38,634	0,000
HP ➔ BL	9,428	0,051
2001-2010		
BL ➔ HP	23,741	0,000
HP ➔ BL	0,743	0,863

It is interesting to notice that the Granger causality is bi-directional in Stockholm but not in Gothenburg and Malmoe. In Gothenburg, bank lending Granger cause house prices but not vice versa. In Malmoe, none of the variables Granger cause the other, that is, both house prices and bank lending can be explained solely by the other determinants. The Granger causality also seems to be different over time. Before the internet crises, the Granger causality was bi-directional, but after the stock market bubble it is quite clear that house prices does not Granger cause bank lending.

6. CONCLUSION

We have in this paper studied the relationship between aggregate bank lending on house prices. Understanding this relationship is important, not least as it may be utilized for policy purposes. If it is the case that aggregate bank lending to the household sector will result in increased house prices, this may create housing market bubble in the sense that even if no real fundamentals have changed, just the fact that more funds are entering the system may spur house prices. Perhaps more interestingly, it opens up for cooling off an overheated housing market through policies that decreases bank lending – a policy option presently discussed in Sweden.

We have employed both a basic VAR model and an extended VAR model that includes several control variables to study the relationship. The main findings are that (1) we find no evidence for a causal relationship from house prices to bank lending, but (2) there is a clear causality running from bank lending to house prices. This is the case both for the basic and the extended VAR models.

By deriving impulse-response functions we see that, regarding the first finding, there seems to be a small instantaneous effect. That is, if an exogenous shock increases house prices in one period, bank lending increase that period but already after one period – which corresponds to one quarter in our data – the effect is insignificantly different from zero. However, an exogenous shock that increases bank lending will result in increased house prices. This effect will remain positive (and significantly different from zero) over five periods, i.e., more than a year. This suggests that bank lending will impact the housing market – and that the effect will remain for some time. The converse is also true. If, for instance due to the implementation of some policy, bank lending is forced to decrease house prices will follow.

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