Are Swedish Houses Overpriced?*

Carl Andreas Claussen†

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Abstract

Swedish house prices have risen rapidly since the mid 1990s. How can this be explained? Are houses overpriced? In this paper I try to answer these questions. I estimate a Error Correction Model (ECM), and see if the model can explain the house price developements. The model suggests that increasing household disposable income and falling mortgage rates are the most important factors behind the upswing in prices. There is no evidence of overpricing. Compared to earlier Swedish studies, this study is based on new data and new variables. Furthermore, the estimation period is restricted to the more recent period when Swedish credit markets have been unregulated.

1 Introduction

Since Swedish house prices bottomed out in the mid-1990s, real house prices have risen by more than 130 per cent. How can this be explained? Are houses overpriced, and if so, to what extent? Can we expect a bubble to burst? In this paper I present an empirical model of the Swedish housing prices, and see how the model cast light on these questions.

The model is a one-equation error-correction model (ECM). With an error-correction specification I can make a distinction between a long run equilibrium price, the 'fundamental price', and a short-term equilibrium price. The model is estimated on quarterly data from first quarter 1986 to second quarter 2011. Swedish credit markets were deregulated in the mid-1980s, so the period from 1986 corresponds to a period with deregulated credit markets. Furthermore, 1986 is the first year when a quarterly house price index is available. After testing for a larger set of explanatory variables I arrive at a simple model which includes the after tax mortgage rate, disposable income and net financial wealth as the only explanatory variables.

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†Sveriges Riksbank. *Email*: carl-andreas.claussen@riksbank.se

The estimated model fits the data very well. If we interpret the coefficients of the model as elasticities, the model explains the rise in house prices since 1996 by two coinciding trends; the rapid increase in real disposable income, and gradually lower after-tax real interest rates. As much as 25 percent of the rise in the fundamental house-price since 1996 is explained by a fall in the real mortgage rate. Another 62 percent is explained by the increase in real disposable income. Household real financial wealth plays a limited role, explaining only 8 percent. By the third quarter of 2011, actual prices are at the fundamental price. Thus, current prices are explained by fundamentals, and Swedish houses are – according to the ECM – not overpriced. The ECM and reasonable forecasts for the explanatory variables suggest that real prices will be unchanged over the coming years as the negative effects of increasing real mortgage rates offset the positive effects of income- and financial wealth growth. To get a significant fall in real house prices, the ECM requires a significant increase in the real rates together with weak income- and wealth growth.

ECM modeling has a long tradition in housing economics, and remains the dominating modeling technique in the empirical housing market literature. Nellis and Longbottom (1981) and Hendry (1984) was the first to use the error-correction form.[1] Overviews of subsequent studies are found in Meen (2001), Leung (2004), Girouard, Kennedy, van den Noord, and André (2006) and Borowiecki (2009). Recent international examples of studies using an error-correction framework to analyze house prices are Adams and Füss (2010) and Francke (2010). Heiborn (1994), Hort (1998), Barot (2000), and Barot and Yang (2002) use ECMs to study the Swedish housing market. The elasticities in my model are in line with elasticities found in many international studies, but not directly comparable to the Swedish studies mentioned above. The earlier Swedish studies are based on different data definitions, include other variables, and are estimated on data including periods when the Swedish credit markets were heavily regulated.

The paper is organized as follows. I describe the data, the estimation method, estimate the model, and perform an evaluation of its forecasting performance in Section 2. Here I also discuss my model in light of earlier studies. In Section 3 I use the model to discuss the questions posed in the very beginning of this introduction. I conclude by Section 4.

2 The empirical model

2.1 The general ECM

For the purpose of this paper we may think of the house price as determined by the intersection of a demand and a supply relation. Housing supply depends on house prices, construction costs, etc. Housing demand depends on house prices, households real disposable income, cost of funds, etc. By combining the two relations, assuming that demand equals supply, we can eliminate the

[1] An unpublished version of Hendry's paper was available already by 1981.

house-volume measure and arrive at a reduced-form equation for the house price. The explanatory variables in the reduced-form equation are the exogenous variables in the supply and demand relations. The coefficients in the relation will then be 'net coefficients' giving the net effect of an exogenous variable on house prices. Suppose, for instance, that wages is an exogenous variable in the demand relation (as it influence household disposable income) and in the supply relation (as it influence production costs). Then an increase in wages will increase housing demand but reduce long run housing supply. The coefficient on wages in the reduced form equation will give the total (net) effect on house prices from such a wage increase. Meen (2001) provides an overview of different theories and models of house price determination.

I follow the literature and assume that the log of the long run equilibrium price, denoted p_t^*, can be described as a linear function of a set of k explanatory variables (or 'fundamental factors'), i.e.

$$p_t^* = \beta_0 + \beta_1 X_{1,t} + ... + \beta_k X_{k,t}, \tag{1}$$

where $\beta_0, \beta_1, ..., \beta_k$ are coefficients to be estimated and $X_{1,t}, ..., X_{k,t}$ are the values for the k explanatory variables at time t. Equation (1) should be understood as the reduced form equation of the house-price model. If each of the variables $X_1, ..., X_k$ are non-stationary but their first differences are stationary, and the linear combination of variables in (1) is stationary, then the coefficients $\beta_1, ...\beta_k$ form a so called *cointegrating vector*.

In the short run, prices might deviate from the long run equilibrium price. Denote the realized house price in period t by p_t. Let $\triangle$ be a one-period difference operator such that $\triangle p_t = p_t - p_{t-1}$, $\triangle p_{t-1} = p_{t-1} - p_{t-2}$, and so on. With the error-correction specification the short run dynamics of house prices is described by

$$\begin{aligned} &\triangle p_t = \alpha + \phi \left(p_{t-1} - p_{t-1}^*\right) + \textstyle\sum_{z=1}^{T_p} \gamma_z \triangle p_{t-z} + \\ &\textstyle\sum_{z=0}^{T_{x_1}} \delta_{1,z} \triangle X_{1,t-z} + ... + \sum_{z=0}^{T_{x_k}} \delta_{k,z} \triangle X_{k,t-z} + \varepsilon_t, \end{aligned} \tag{2}$$

where α, ϕ, the γs and the δs are parameters to be estimated and ε_t is an iid error. I leave it open for the estimation to decide how many lags of the differences to include (i.e. the Ts). The coefficient ϕ is called the *short run adjustment parameter*. It says how much of the difference between the current price and the long run equilibrium price – the 'error' – that is corrected for in each period. Its expected sign is negative and the estimated value should lie in the interval between -1 and zero. Equation (2), where p_{t-1}^* is given by (1), is the error-correction model to be estimated.

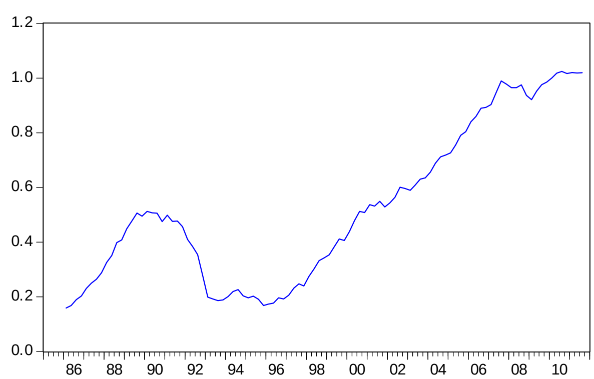
The model is called an 'error-correction model' as it has the built in mechanism that gradually corrects the error, i.e. the difference between the current price and the long run equilibrium price. A possible theoretical justification for the ECM is the fact that it takes time to build new houses, and the fact that the number of new houses that is added to the housing stock each year is very small compared to the existing stock. Thus, in the short run the supply of houses is very price inelastic, and a sudden increase in housing demand will lead to temporary increase in house prices. Over time the stock grows as new houses flow into the housing market, and the more so the higher is the price above its long run equilibrium level. Thus, in the short run prices may overshoot, but in the long run prices will grow in line with fundamental price determinants.

2.2 Data

The model is estimated on a dataset that covers the period 1986q1 to 2011q2. It starts in 1986, as this is the first year when a quarterly housing-price index is available. Furthermore, Swedish credit markets were deregulated in the early 1980s, so the period after 1986 corresponds to a period with deregulated credit markets. I include 5 fundamental factors (explanatory variables) in the dataset; the log of household real disposable income, the log of household real financial wealth, after tax real mortgage rates, and the log of real construction cost. All variables are seasonally adjusted.

Real house prices are measured by the Statistics Sweden's real-estate price index (fastighetsprisindex) deflated by the consumer price index with fixed interest rates (CPIF). The real-estate price index measures the price of constant quality one- and two-dwelling buildings for permanent living. The index measures prices on actual sales that took place a few months before the actual registration date. It is therefore arguable whether we should understand the index-value for quarter t as measuring the price at quarter t or at quarter $t-1$. I choose to interpret the price index for quarter t as measuring the price at quarter $t-1$. Figure 1 shows the development of real house prices. Real house prices grew rapidly during the late 1980s, fell dramatically in the early 1990s and have more than doubled since 1996.[2]

Figure 1: Real house prices 1986q1 to 2011q3 (in logs)



Household real disposable income is provided in the national accounts, and

[2] $e^{(\ln(\text{house price}_{2011q3})-\ln(\text{house price}_{1986q1}))}-1=1.33$. Thus, the real price has increased by 133 per cent over this period.

defined the usual way.[3] Except from the first half of the 1990s, when nominal income decreased somewhat, real disposable income has grown, c.f. Figure 2.

Real construction cost is Statistic Sweden's construction cost index (Faktorprisindex) deflated by the CPIF. This variable does not include the price of land.

Real mortgage rate is defined as the after-tax real interest rate

$$r_t\,(1-\tau_t)-\pi_t,$$

where r_t is a weighted average of a 3-month treasury bill, 2-year and a 5-year government bond interest rates. The weights are the historical share of household mortgages that are on respective floating, fixed up to 5 years, and fixed more than 5 years interest rates. I use the treasury bill and government bond interest rates because data on mortgage interest rates are not available for the whole sample period. The variable τ_t is the share of mortgage interest payments that is tax deductible. The last term, π_t, is inflation measured by the 4-quarter growth in CPIF.[4]

Real financial wealth measures households gross financial wealth and is deflated by the CPIF. Gross financial wealth is the market value of households' financial assets including holdings on bank accounts and some insurance. The measure does not include the value of houses and some of the households' savings in pension funds. Also this variable shows an upward trend over the period, but it is more volatile than household real disposable income, c.f. Figure 2.

Earlier studies on Swedish data include other explanatory variables. Hort (1998) includes the number of people aged 25-44 to years take account of the fact that demand for single-family houses tend to be particularly high in these age groups. I have not tried this variable because quarterly data is not available. Furthermore, the share of people in this age group relative to the population older than 25 years have fallen over the estimation period, in particular in the period from 1996 when house prices rose the most. Data on the number of households is used in some international studies, but for Sweden data series on the number of households are only available for 2004 to 2009, and only on a yearly basis. As a measure of credit availability, Hort (1998) includes the net lending ratio, i.e. the ratio of net lending to real disposable income for the housing sector. Barot and Yang (2002) use household total debt as a measure of credit availability. These credit-availability variables may be reasonable explanatory variables when there is credit rationing or other frictions in the credit markets. Both studies cover such periods. However, in a liberalized credit market credit accommodates house prices. My study covers only the period after the liberalization of the credit market, and I have therefore not included a credit variable.[5]

[3] Households' gross income less taxes, and deflated by a consumption expenditure deflator.

[4] Some studies deflate the after-tax nominal interest rate with the expected house price inflation. In Sweden there is no quarterly measure of house-price inflation expectations covering the whole estimation period.

[5] I have tested this variable in the long-run equation. In these estimations H_0 of no cointegration cannot be rejected with the Engel-Granger tests. The Hansen instability test is more mixed, but the H_0 of cointegration is rejected for some specifications.

Figure 2: Explanatory variables (in logs)

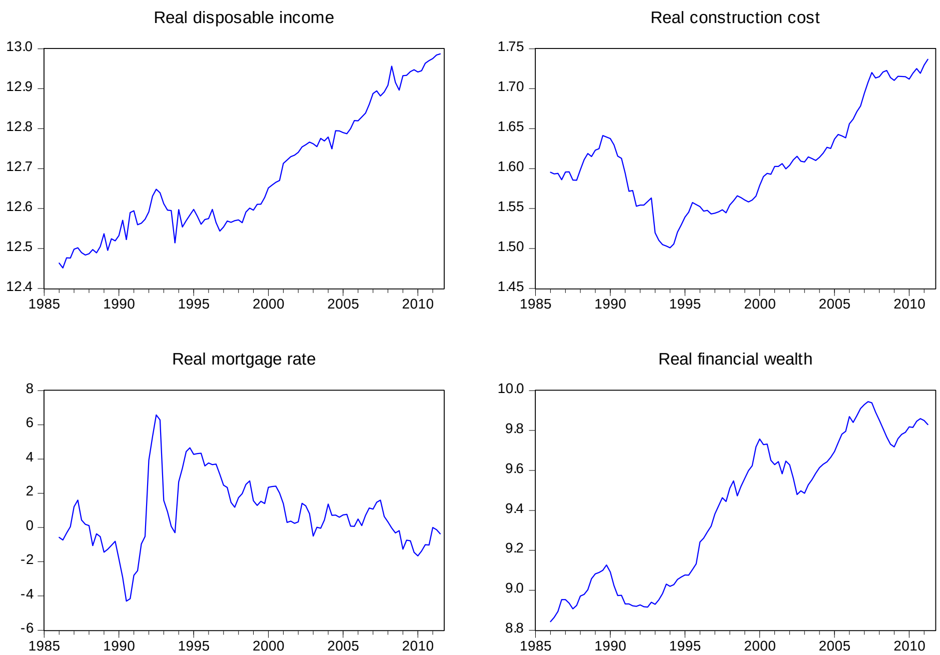


Table 1: Unit root tests

	I(1)		I(2)	
	t-value	p-value	t-value	p-value
Real house prices				
ADF	−0.44	0.90	−3.09	0.03
Phillips-Perron	−0.33	0.91	−6.50	0.00
Real disposable income				
ADF	0.34	0.98	−14.5	0.00
Phillips-Perron	0.46	0.98	−15.1	0.00
Real Construction cost				
ADF	0.20	0.97	−7.42	0.00
Phillips-Perron	0.05	0.96	−7.69	0.00
Real mortgage rate				
ADF	−1.89	0.33	−8.10	0.00
Phillips-Perron	−2.39	0.15	−8.60	0.00
Real wealth				
ADF	−1.01	0.75	−7.36	0.00
Phillips-Perron	−1.06	0.73	−7.59	0.00

I test the variables for the order of integration using the Augmented-Dickey-Fuller (ADF) and the Phillips-Perron (PP) unit root tests.[6] A priori, I expect real house prices, real disposable income, construction cost and real wealth to be increasing and non-stationary. In the very long run the real mortgage rate must be stationary, but in the shorter run it may very well be non-stationary. In the literature, a common finding is that a null hypothesis of a unit root in real interest rates cannot be rejected, see Neely and Rapach (2008) and Beechey, Hjalmarsson, and Osterholm (2008). The results of my tests, which are given in Table 1, confirm the hypothesis that real house prices, real disposable income and real wealth are I(1). For the real mortgage rate the results are more mixed. The ADF-test strongly supports the hypothesis that real mortgage rate is I(1), while the PP-test reject this hypothesis at the 15 percent significance level. I leave it for Section 2.3.1, where I estimate the long run models, to determine whether to interpret real mortgage rate as stationary or not.

[6] Explanations of all statistical tests and methods used in the paper are found under 'Help' in the e-views econometric package. See also Charemza and Deadman (1997) and Hamilton (1994) for a description of most of the statistical tests and methods used.

2.3 The estimated ECM

2.3.1 The long run equilibrium relationship

I use Dynamic OLS (DOLS) to estimate the long run equilibrium relationship. DOLS is an approach to constructing asymptotically efficient estimators advocated by Saikkonen (1991) and Stock and Watson (1993). It involves augmenting the cointegrating regression with leads and lags of the first differences of the variables in the cointegrating vector.

Construction cost does not work well in the model. In any estimation, including estimations where I instrument by using lags of construction costs or have less explanatory variables, construction cost gets a very high elasticity. In the estimation including all variables, the elasticity is 1.5, meaning that an increase in construction cost by one per cent gives an increase in housing prices by almost 1.5 per cent, c.f. the first column in Table 2. This elasticity is implausible. If construction cost is exogenous and there is competition in the construction industry, plausible construction cost elasticities are weakly smaller than 1. The high elasticity may therefore be due to construction costs accommodating house prices because there is limited competition in the construction sector. A bivariate Granger-causality test strongly supports the hypothesis that housing prices (Granger-) cause construction costs, suggesting that construction costs accommodates house prices. Furthermore, the Swedish Competition Authority (2009) find that competition is weak in parts of the construction sector and in the retail market for building materials. National Housing Credit Guarantee Board (2010b) show that profitability for housing contractors has been very good over the last 10 years. I also tried with some components of the construction cost index. Neither of these functioned well in the model; they came in with wrong signs or had marginal impact on the other coefficients of the model. I therefore decided to drop construction cost from the model.[7]

As it was not clear from Section 2.2 whether real mortgage rate is stationary or not, I estimated the long run relation both with and without real mortgage rate. The long run model without real mortgage rate does not display cointegration. Furthermore, Johansen System Cointegration tests indicate that there are zero cointegrating vectors in this case.

The estimated long run model/cointegration vector including real mortgage rates is given in Table 2. In this case the hypothesis of no cointegration can be rejected under the Engle-Granger test, but not under the Phillips-Ouliaris tests. The hypothesis of cointegration cannot be rejected under the Hansen instability test. I therefore choose to interpret real mortgage rate as integrated of order

[7] Analytically, we may think of the underlying house-price model as consisting of three equations; a demand relation, a supply relation and a construction cost relation where construction cost depends on house prices. To arrive at the reduced-form relation we plug the construction cost relation into the supply relation. This eliminates construction costs from the system. We then equate the resulting supply relation with the demand relation to arrive at a reduced form model of house prices (where house volume variable is eliminated). The coefficients in (1) are the net coefficients giving the net effect on house prices including the effect via construction cost.

Table 2: Long-run (cointegrating) relationship. p-values in brackets

	a		*b*		*c*	
Leads/lags of expl. variables	1		1		2	
Constant	−14.1 (0.00)		−17.04 (0.00)		−17.7 (0.00)	
Real disposable income (in logs)	0.88 (0.00)		1.30 (0.00)		1.40 (0.00)	
Real mortgage rate	−0.03 (0.00)		−0.06 (0.00)		−0.06 (0.00)	
Real wealth (in logs)	0.10 (0.08)		0.12 (0.8)		0.06 (0.43)	
Construction cost (in logs)	1.55 (0.00)					
Adjusted R^2	0.98		0.95		0.96	
Cointegration tests Engle-Granger[1]/Phillips-Ouliaris						
	EG	*PO*	*EG*	*PO*	*EG*	*PO*
τ - statistic	−4.21 (0.11)	−3.62 (0.30)	−4.20 (0.05)	−3.45 (0.23)	−4.20 (0.05)	−3.45 (0.23)
	EG	*PO*	*EG*	*PO*	*EG*	*PO*
z - statistic	−40.41 (0.01)	−21.93 (0.34)	−43.92 (0.00)	−21.90 (0.20)	−43.92 (0.00)	−21.90 (0.19)
Hansen instability						
Lc - statistic	0.013 (> 0.2)		0.01 (> 0.2)		0.012 (> 0.2)	

Note. 1. Automatic lag specification based on Akaike Info Criterion.

1, and continue with a specification of the model where real mortgage rate is included in the long run relation. Low p-values for the wealth coefficient may suggest that this variable should be excluded from the regression. However, as the Johansen System Cointegration tests indicate that there is only one cointegrating vector if wealth is included, and no cointegrating vector if wealth is excluded, I keep the variable in the model, and conclude that the variables are cointegrated.

As can be seen from Table 2, the coefficients in the long run model depend on how many lags and leads of the explanatory variables that are included in the DOLS regression. Experiments with up to 5 lags suggests that all of the three explanatory variables are relevant for house prices, but real financial wealth becomes less important and the other two variables become more important with more leads and lags in the (DOLS-) estimation. The wealth-coefficient

Table 3: Coefficients in previous one-equation long-run (cointegration) models

	Country	Real income[1]	Real rates[1]
Hort (1998)	Sweden	0.6 to 0.97	-2.5 to -2.9
IMF (2005a)	8 euro countries	0,65	-1 to -2
IMF (2005c)	UK	1.5 to 1.9	-6.0
IMF (2005b)	Netherlands	1.5	-9.42
Oikarinen (2005)	Finland	0.8 to 1.3	-2.2 to -7.5
Francke (2010)	Netherlands	1.4	-3.5
Adams and Füss (2010)	Sweden	0.99	-4.5

Note. 1. Definitions of Real income and Real rates differ between the studies. The coefficients give the per cent change in house prices resulting from a change in the real rate of one percentage point.

becomes negative if three or more lags and leads are included. It is not obvious how many lags to include. I settle for model *b* as that displays, arguably, the most reasonable coefficients (see Table 3 for coefficients in some earlier studies). The coefficient on the real mortgage rate implies that an increase in the real mortgage rate of one percentage point is associated with a reduction in the long run equilibrium level of the house price by 6 percent. A one percent rise in real disposable income is associated with a 1.3 percent increase in real house prices. The effect of real financial wealth is more limited, with a one percent increase associated with a 0.12 percent increase in real house prices.

Table 3 gives coefficients found in a selection of studies estimating one-equation ECMs. As different studies use different numbers of explanatory variables and somewhat different definitions of the variables, the numbers are not directly comparable. Nevertheless, they may serve as a reference point. As can be seen, the coefficients in my estimated long run equation are by no means outliers. The real income coefficients range from 0.6 to 1.9. The real rate elasticities range from -1 to -9.42. If we look at the Swedish studies, Hort (1998) estimates a one-equation ECM for Swedish house prices using panel data for 20 urban areas in the period 1967-1994. Her model(s) does not include financial wealth, but include the ratio of net lending to real disposable income for the household sector, interest subsidies, construction costs, and the size of the population aged 25 to 44 years. In the long run equation including all of these variables, her estimated coefficient on real mortgage rate is -2.9, about half of my estimate. Her real disposable-income coefficient is 0.6, also about half of my estimate. Hort (1998) also estimates a version of the model where interest rate subsidies, the net lending ratio and the population parameter is excluded. In that model the coefficient on real mortgage rate and real disposable income is $-2,5$ and 0.97, respectively. Her estimate of the coefficient of construction cost is quite low, at around 0.5 in both models. Adams and Füss (2010) perform a panel cointegration analysis on a dataset consisting of 15 OECD-countries covering a period of 30 years. They also include construction cost as an explanatory variable. Their elasticities on real income and real rates are somewhat smaller than in my model, but they find much higher coefficients for some of the other countries in their sample. Their estimated coefficient on real construction cost is 0.59 for Sweden, close to Hort's (1998) estimate. The two-equation model in Barot (2000) and Barot and Yang (2002) is not comparable to my one-equation model.

2.3.2 The short run relationship

As the residuals obtained from the long run relationship are mean-zero stationary, the short run dynamics can now be explored. I use the estimated residuals from the long run equation as estimates of the error term $\left(p_{t-1} - p^{*}_{t-1}\right)$ when estimating the ECM (equation (2)). I start by including four lags of the differences of all variables in the system and then gradually take out variables, only one at the time, starting with the variable with the highest p-value. I stop when all variables are significant at the 5 percent level. The final ECM is reported in Table 4.[8] The short run adjustment parameter in the ECM is -0.08, indicating that about 30 percent of the gap between the short and the long run price is closed within a year. If we look at the other studies on Swedish data, Hort's (1998) estimates are higher than mine, ranging from -0.67 to -0.84. Adams and Füss (2010) does not report the short run adjustment parameter for individual countries, but their estimate for the whole panel is quite low at -0.04.

2.3.3 Evaluation of model: Forecasting

To get a picture of how well the estimated ECM squares up with the realized price, I subtract p_{t-1} from the estimated equation and get an expression for the price in levels. Figure 3 gives the fitted prices based on one-step ahead forecasts from that equation together with actual prices. Under this forecasting procedure, realized values of the house price are used for the lags of the house prices in the model. The forecasts fit the realized price very well. However, with an ECM model, a large share of the house price today is determined by the price in the previous period. This means that with the one-step ahead forecast-exercise the forecast will never drift far away from the actual development of house prices; in each period the forecast is put back on track as we use the actual values of the house price for the lagged house prices in the equation.

A more demanding test of the forecasting performance of the model is therefore a forecast excersise where the model is not put back on track in each period. This is a so called 'dynamic' or 'multi-step' forecasting procedure. Under this procedure the previous period forecasted values of the house price –as opposed to the realized values under the one step ahead procedure – are used as lagged variables in the model. This method corresponds to a normal forecasting situation where we make a multi-period forecast, assuming that we know the actual development of all exogenous variables, except the house price. Figure 4 gives the result of a dynamic forecast starting in 1987. As can be seen, the model is not able to fully predict the rapid upturn in the late 1980s. But, it does predict

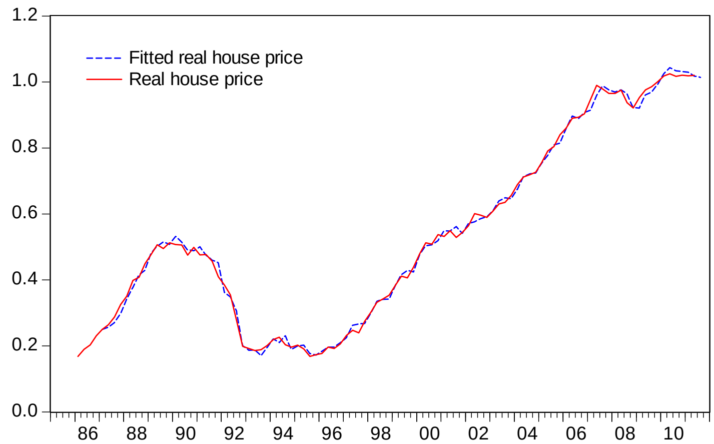
[8] Recursive estimation show that the coefficients are stable from the mid 1990s.

Table 4: Estimates of the short-run dynamics of real house prices

Model		Coefficient	t-stat	p-value
	constant	0.001	0.80	0.43
	$hprice_{t-1} - hprice^{*}_{t-1}$	-0.08	-3.63	0.00
	$\triangle hprice_{t-1}$	0.21	0.27	0.01
	$\triangle hprice_{t-3}$	0.55	7.29	0.00
	$\triangle dispinc_{-1}$	-0.16	-2.28	0.03
	$\triangle mortgagerate$	-0.005	-3.23	0.00
	$\triangle mortgagerate_{-3}$	-0.005	-2.49	0.01
	$\triangle wealth_{-1}$	0.19	4.22	0.00
Diagnostics[1]				
	Adjusted R^2	0.59		
	DW stat	1.92		
	no. obs	98		
	Autocorrelation		F-stat	p-value
	$F(1, 89)$		0.29	0.59
	$F(2, 88)$		0.55	0.58
	$F(3, 87)$		0.37	0.77
	$F(4, 86)$		0.75	0.56
	$F(5, 85)$		1.16	0.34
	Heteroscedasticity			
	$F_{white}(35, 62)$		0.57	0.96
	$F_{ARCH}(6, 85)$		0.46	0.84

Note. 1. Breusch-Godfey tests are used for the pth order autocorrelation. To test for heteroscedasticity I used Whitte's test. Engle's test is used for sixth order ARCH

Figure 3: Real house prices (in logs). Actual and one-step ahead forecasts.



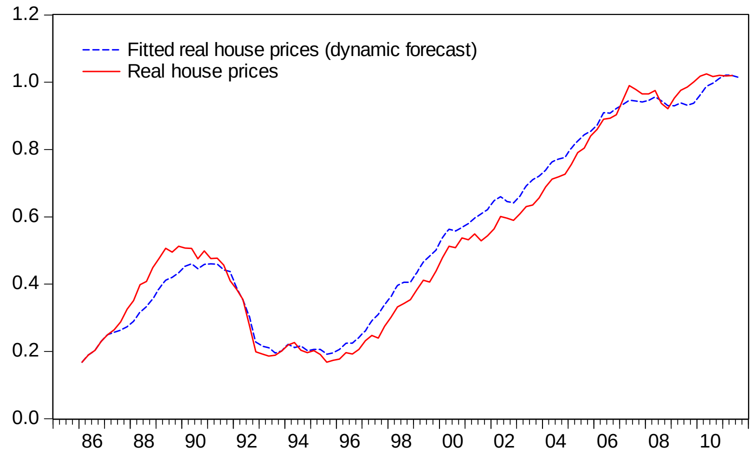
the upturn from the mid-1990s. House prices today are at the level that would have been predicted by the model in 1987 had we known the realized values of all other variables except for the house price.

The selection of the start period of the forecast sample is very important for dynamic forecasting. I therefore also try different starting points. Figure 5 shows the 3-year ahead dynamic forecasts from the first quarter each year throughout the whole data period. As can be seen from the figure, the model is able to predict the house-price developments quite well in most periods. This is particularly true for the period from 1992 up to around 2004. The model has some problems in predicting the upswing in house prices in 1988, and the fall of the prices that started around 1990. Similarly, the model predicted somewhat less rapid upswings in the house prices from around 2004.

Based on this forecasting exercise we may conclude that the model is able to predict house-price developments quite well.[9]

[9] I am sure one-equation econometric models of house prices are widespread among macroeconomic forecasters and house price analysts in Sweden. However, the models are typically not documented or published anywhere. Furthermore, to the extent that they are published, they are not well documented, and can be criticized on methodological grounds, see e.g. National Housing Credit Guarantee Board (2010a) and Sveriges Riksbank (2005).

Figure 4: Real house prices (in logs). Actual and dynamic forecast from 1987



3 Determinants of Swedish house prices 1986 - 2010

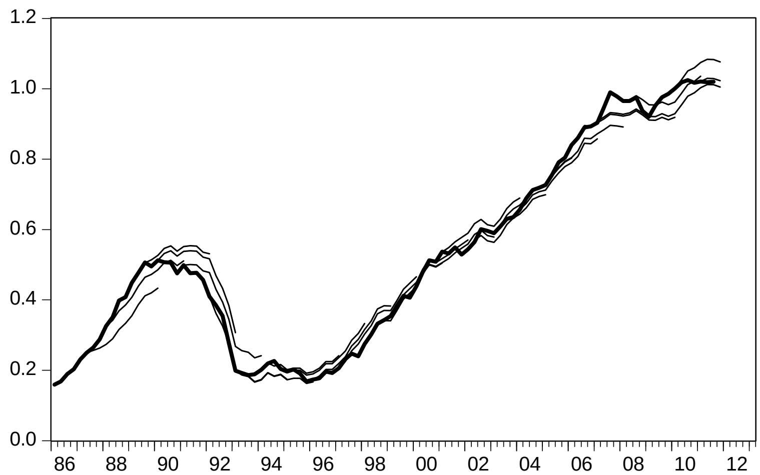
3.1 What explains the recent upswing in house prices?

In the literature it is usual to interpret the coefficients in the ECM-models as elasticities, see e.g. Francke (2010), Hort (1998), Girouard, Kennedy, van den Noord, and André (2006) and references therein.[10] I now follow the literature and interpret the coefficients in the long run model as elasticities. Notice that in the case of the real mortgage rate, the rate is a 'semi-elasticity' as the real mortgage rate is not in logs. This elasticity gives the per cent change in the house price for a one percentage point change in the real mortgage rate.

Figure 6 shows house prices according to the long run equation together with actual house prices. As can be seen, actual prices were roughly in line with the long run price in 1987, 1990, 1996 and 2011 (in addition to several other periods). I now divide the whole data period into three. (i) The period from 1987-1990 when prices rose rapidly. (ii) The period from 1990-1996 when prices fell, and (iii) the latest period of price increases from 1996 until 2011. I then calculate the predicted change in the house price over each of these periods from the long run equation using the actual values of the explanatory variables.

[10] It may be arguable whether this interpretation is valid. First, the explanatory variables may in reality not be exogenous. The real mortgage rate, for instance, may depend on both real house prices and real income. Second, even if the explanatory variables where exogenous, it is not clear that the coefficients in the long run relationship can be interpreted as elasticities. Rather, they are only statistic relationships between the variables that will hold in the long run. In that case we can only talk of statistical relationships between the variables, not causality.

Figure 5: Real house prices (in logs). Actual prices and dynamic 3-year forecasts.



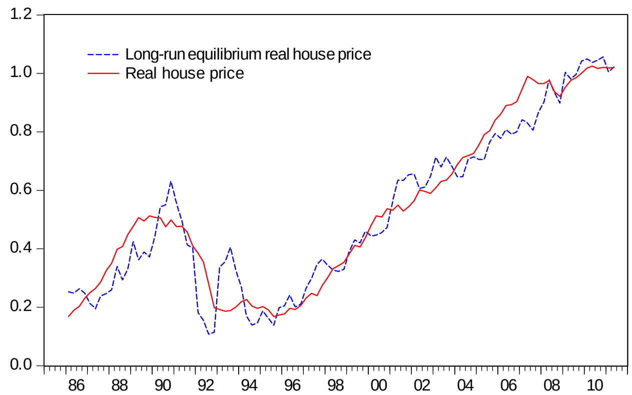
Based on these calculations I calculate the share of the change in the actual price that is explained by the changes in the explanatory variables over the respective period. Figure 7 shows the results of these calculations. Increasing income has pushed prices upwards in all three periods. The contribution from income growth is particularly large in the last period when it accounts for 62 per cent of the increase in house prices. Changes in household net financial wealth explain some of the increase since 1996, but have not been important in the two earlier periods. The most important factor is the real mortgage rate. It explains as much as 64 per cent of the increase in house prices during the first period. Falling real mortgage rates explains as much as 26 per cent of the increase in prices since 1996. Only 4 per cent of the increase since 1996 is unexplained by the long run model.

Thus, if we interpret the coefficient in the long run model as elasticities, the model suggests that the increases in household real disposable income and the fall in the real mortgage interest rate explain the increase in house prices since 1996.

3.2 Are houses overpriced, and can we expect a bubble to burst?

With an error-correction specification we can make a distinction between a long run equilibrium price, the 'fundamental price', and the short-term equilibrium price. If the actual price is above (under) the fundamental price there is talk of overpricing (underpricing). By 2011q3, house prices were at their long run equi-

Figure 6: Real house prices (in logs). Actual and according to the lon-run relation.



librium level. Thus, according to this definition houses are not overpriced. However, as can be seen from figure 6, the long run equilibrium price is very volatile. In particular, it is more volatile than both the short run price and the actual price.[11] A change in the explanatory variables may quickly change the long run equilibrium price, and therefore also the conclusion regarding over/underpricing. For instance, an increase in the real mortgage rate of one percentage point will reduce the long run equilibrium price by 6 percent. This means that this measure of over-/underpricing is not very useful.

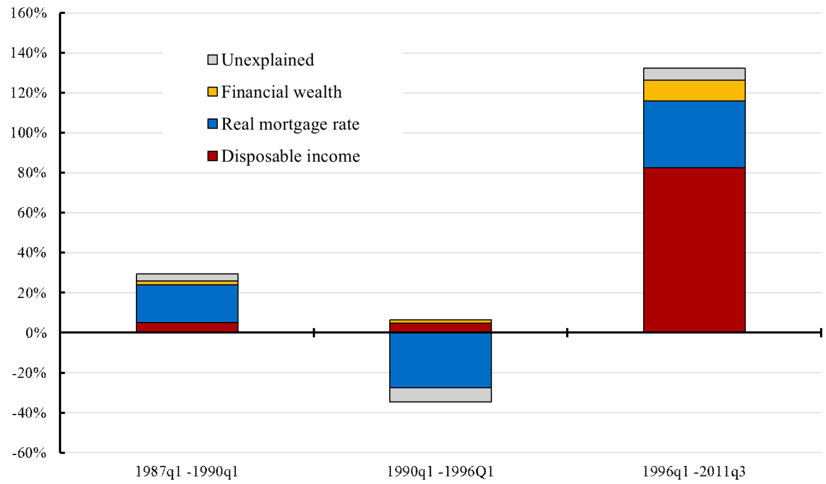
An alternative definition of overpricing is the following: Houses are overpriced if they cannot be explained by the estimated model and the realized values of the explanatory variables. As noted above in relation to figure 7, 96 per cent of the upswing in prices in the period 1996 to 2011q3 is explained by the long run relation in the model. By the third quarter of 2011, actual prices are at the fundamental price. Current prices are explained by fundamentals, and Swedish houses are – according to the ECM – not overpriced.

An third way to see if prices are in line with the model – where we need not define the coefficients as elasticities – is to pursue a dynamic forecast starting from 1996. Figure 8 gives the result of this exercise. As can be seen, the model forecast the upswing in prices, but it suggests that prices should have risen somewhat less than what they did from 2005 to 2011. The 2011q3 price level predicted by the model is 2 percent below the actual house price level, suggesting a slight overpricing.

The question of overpricing may also be approached by looking at forecasts

[11] This runs somewhat counter to the intuition that the long-run equilibrium price is a slow-mowing variable while the short run variable should move around the long-run equilibrium price. Similar results are obtained also in other studies of the housing market, see e.g. Francke (2010).

Figure 7: Model explanations for house price changes in three periods.

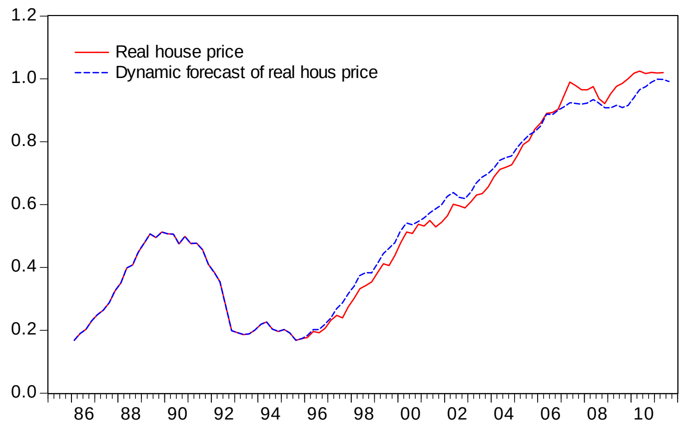


for the house prices. If the model, under reasonable assumptions regarding the development for the explanatory variables, predicts that prices will fall in the future, we may talk of overpricing. I have therefore made forecasts with the model based on two different scenarios for the explanatory variables.

Figure 9 shows the model predictions under a scenario where the explanatory variables develops roughly in line with the forecasts in the Sveriges Riksbank October 2011 Monetary Policy Report. In the scenario the real mortgage rate increases gradually from 0 percent in 2011q4 to 3 percent in 2014q4. Real disposable income increases with 1.7 percent and real wealth by 1.2 percent on average per year in 2012-2014. Under these assumptions real house prices will fall by 5 per cent from 2011q3 to 2014q4. However, by December 2011, the market expectations of the future rates are significantly lower than the Riksbank forecast. Using these expectations the model predicts an increase of roughly 5 per cent in the real house price during the period. Summarizing, we may conclude that the ECM and reasonable forecasts for the explanatory variables suggest that real house prices will stay more or less unchanged over the coming years. To get a significant fall in real house prices, the ECM requires a significant increase in the real mortgage rate together with weak income and wealth growth.[12]

[12]In the long run the log of real user cost is likely to be stationary. In my estimation I have assumed that this variable is I(1), as that is the case in the sample period, c.f. Figure 2 and Table 1. The model is therefore likely to not fit data very well over longer samples. Unfortunately, we do not have quarterly data for the house prices over a longer period, but

Figure 8: Real house prices (in logs). Actual and dynamic forecasts starting 1996.



4 Summing up

House prices in Sweden have risen considerably since the mid-1990s, and there is a big debate about why they have risen so much and whether houses are overpriced. The aim of this paper has been to shed light on these questions by applying the standard tool of an econometric error correction model (ECM). Such models have a long tradition in housing economics, and remain the dominating modeling technique in the empirical housing market literature.

The paper shows that it is possible to build a well performing ECM on Swedish data from 1986. The estimated model performs well on all standard statistical tests, and is able to explain the developments in house prices very well. The model explains the rise in house prices since 1996 by two coinciding trends; the rapid increase in real disposable income, and gradually lower after-tax real interest rates. As much as 25 percent of the rise in the fundamental house-price since 1996 is explained by a fall in the real mortgage rate. Another 62 percent is explained by the increase in real disposable income. Household real financial wealth plays a limited role, explaining only 8 percent. By the third quarter of 2011, actual prices are at the ECM fundamental price. With reasonable forecasts for the explanatory variables the ECM suggest that real house prices will be roughly unchanged over the coming years. Taken together this suggests that houses are currently not overvalued.

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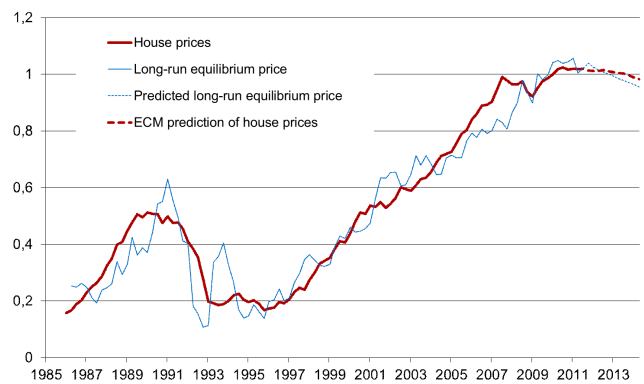
this indicate that we should be somewhat cautious when using the model to make forecasts about future house prices.

Figure 9: Real house prices (in logs). Actual prices, prices according to the long-run equation, and forecasts under a scenario corresponding to the main scenarioin the Riksbank Oktober 2011 Monetary Policy Report.



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