Dynamics of a Protected Housing Market: The Case of Switzerland

Karol Jan Borowiecki and Clemens Struck

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Abstract

We analyze the determinants and dynamics of a highly protected housing market. Based on Swiss data for the time period 1990 to 2009 we model house prices and construction activity. We find that house prices exhibit a positive association with construction price, working age population as well as GDP and a negative with interest rates, whereas construction activity is positively related to working age population and GDP and negatively with construction price and interest rates. These estimates are broadly consistent with previous theoretical and empirical research.

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JEL Classification: R21, R31

Contact: Trinity College Dublin, Department of Economics, Dublin 2, Ireland. E-Mail: borowiek@tcd.ie.

1. Introduction

The recent global financial crisis has been unforeseen, of unexpected global dimensions and to some extent caused by the collapse of the United States housing bubble. However, this has been neither the first real estate crisis in the U.S. nor has America been the only country where a national property crisis coincides with the distress of the entire economy. Property crises are notoriously recurring and leveraging economic downturns. The recent financial crisis led to distress in most developed economies leveraging property price drops. There are however exceptions. The Swiss housing economy is such exception and remains mostly unaffected by the recent 'Great Recession'.

That level of robustness of the Swiss housing market is possibly a result of its very high protectionism in international comparison. The market is difficult accessible for foreign investors and it provides several disincentives for domestic speculators. Due to rigid taxation of home owners and conservative mortgage lending schemes the market is dominated by tenants. The formation of the Swiss housing market has been shaped by several factors, most significantly however by a substantial real estate economy crisis in the early 90's that has stimulated the introduction of several protective regulations and practices. An arising question of potential interest for today's policy makers is how well is the Swiss housing sector shed from economic turbulences.

The underlying study offers an analysis of the dynamics of the Swiss housing market in the time period between 1991 and 2009. We model the housing price and construction activity in order to establish their interdependence as well as to identify their main drivers. Focusing on a period just after the recent global economic crisis allows to shed some light on the performance of a protected and conservative market in times of turbulences on international property markets. We construct a vector autoregressive model and find that house prices are positively related with construction price, working age population as well as GDP and negative with interest rates. Construction activity is stimulated by the size of working age population and GDP; it discloses however a negative relationship with construction price and interest rates. The results are in accordance with theoretical as well as recent empirical research. Furthermore, the recent financial crisis has barely had any effect on the Swiss housing market.

The remainder of this article is organized as follows. In the next section, the Swiss housing market is presented. In the third section, related literature is discussed. In the fourth section, the data sources are disclosed and the methodological approach introduced. In the fifth section, the empirical findings are presented, and in the last section, concluding remarks are provided.

2. The Swiss Housing Economy

As can be seen in Figure 1, the Swiss Housing economy has been in an upward trend since the release of the major Swiss house price index (SWX IAZI Private Real Estate Price Index). Furthermore, there can be detected some indication for a 25-year-long housing price cycle. The greatest increases can be observed during the Swiss construction boom of the early eighties, which was further leveraged in 1987 by the introduction of the Swiss Interbank Clearing System that led to a substantial money supply extension. Nonetheless, the bubble burst when the speculative belief of the market was confronted with an unexpected economic downturn of the early nineties.

Those events have forced the Swiss policy makers to introduce urgent sanctions on real estate speculation. While the timing of those sanctions has been sometimes criticized, their long-term benefit is mirrored by the extraordinary stability of the housing economy in Switzerland during the recent financial crisis. There has been introduced a 5-year blocking period for selling of non-agricultural land and buildings, more stringent regulations for pension fund investors and stricter mortgage underwriting criteria. The taxation of real estate transaction has been tightened and there have been introduced relatively high progressive taxes, which are negatively related to the duration of ownership (another policy preventing speculation), on realized capital gains. In addition, the Swiss financial center implemented changes in governance, risk management and compliance. In particular, the major Swiss banks became more cautions and conservative with credit lending.

The Swiss housing market is also well isolated from foreign investments. It is not possible for foreigners to acquire residential properties in Switzerland, due to the 'Lex Koller' legislation. The significance of this legislation became visible after it has been recently loosened, allowing acquisition of holiday homes by foreigners and resulting in substantial price inflation in this sub-market. Next, the Swiss housing economy is dominated by tenants. Switzerland's home ownership rate at 34.6 per cent is the lowest among developed countries. As argued by Bourassa and Hoesli (2006) this is primarily caused by high house prices relative to rents and relative to household incomes and wealth. Furthermore, discriminatory taxation of home owners and regulations that favor tenants provide further disincentives for house buyers. Finally, the Swiss topography plays an important role. Mountainous terrain accounts for around 70 per cent of the country which, in combination with conservative building authorization policies, limits new construction and results in a heavily constrained supply.

International comparison of risk-return profiles for a selection of seventeen countries illustrates in Figure 2 the consequences of the above discussed restrictions.[2] Switzerland

[2] Figure 2 has to be compared under the caveat that data on residential property prices are not strictly

exposes the lowest standard deviation of house prices among all studied countries that have positive house price growth rates. Given its risk profile, it clearly provides the highest annual return of around 2.6 per cent.

3. Literature Overview

A standard approach in the literature expressed by Poterba (1984) is to model the housing market as an asset market. Case and Shiller (1990) notice, however, that the housing market is not very efficient and that it is possible to forecast house prices. They find that a change in real housing prices predicts its own change in the following year. Additional evidence in that respect comes from Mankiw and Weil (1989) who reject the random walk hypothesis for house prices. Malpezzi (1999) confirms these results.[3]

Intuitively, housing demand is negatively related to interest rates as higher interest rates make investing into houses (by borrowing) more expensive and other interest-bearing assets more attractive. Viewed through the lens of asset pricing, an increase in mortgage interest payments lowers future returns on a house and, hence, lowers demand for this asset leading to a fall in prices. The influence of interest rates on house prices is among other factors formalized under the label of the user costs of housing. Employing this concept, Poterba (1984) argues that inflation – a substantial part of the real interest rate - reduces the effective cost of homeownership.

Kahn (2008, 2009) attributes house price changes to productivity growth. The channel through which productivity growth affects house prices is income. Productivity growth increases lead to current income growth and, if persistent, raise the expectations for higher future income. As a consequence, the demand for housing rises and this increases the price of housing ceteris paribus.

On the demand side, it is important to incorporate the idea that demographics could substantially drive housing demand. As Mankiw and Weil (1989) find, the baby boom of the 1950s led to a rapid growth in housing demand in the 1970s in the United Stated. Moreover, they find that housing demand rises sharply between ages 20 and 30 and declines slowly after the age of 40. Certain age cohorts (below 20 and above some upper threshold) have, thus, little impact on the demand of housing. In conclusion, any effect related to a baby boom is markedly delayed and distorts a direct relationship. The idea that only a part of the population demands houses and hence influences housing prices through the demand channel is also shared by Levin et al. (2009).

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comparable across countries due to differences in definitions.

[3] See also HM Treasury (2003): 'Housing, Consumption and EMU' for a detailed review.

On the supply side, construction activities depend on the profitability of house building and, hence, should be positively correlated with the level of real house prices. Because the market participants are forward looking, house prices should contain some (if not all) information about future developments in the market, including information about future construction activities. In an analysis of the UK housing market, Ball (2010) finds that regulatory controls on the supply of housing results in low responsiveness of housing supply towards changes in market activity. It is likely that the sluggishness in the market causes a change in current housing supply to be correlated with past changes in supply. Remaining influences on the profitability of new house building include the costs of house building.

Housing demand is therefore defined by the following equation:

$$D=f(P, Y, r, X_D), \quad (1)$$

where housing demand (D) is a function of real house prices (P), real income (Y), real interest rates (r) and a vector of other demand factors (X_D) like demographics or expected return on housing.

$$S=f(P, X_S) \quad (2)$$

Equation (2) states that the housing supply is a function of real house prices and a number of factors (X_S) that influence the profitability of house building like construction costs. We assume throughout the paper that the housing market is in equilibrium and derive from Equations (1) and (2) an expression for real house prices:

$$P=f(Y, r, X_D, X_S) \quad (3)$$

The empirical research in this area has a strong US focus. Poterba (1991) examines the changes in the construction costs, demographic factors and the real after-tax cost of homeownership as possible determinants of shifts of demand and supply in the housing market. Case and Shiller (1990) study the persistence of price changes of single-family homes in U.S. cities. More recent research investigates also the markets of other countries. Examples of these studies are Meese and Nancy (2003) for the French and Meen (2002) for the British market. Cross country studies usually focus on advanced economies, see Englund and Ioannides (1997) among others. For the Swiss housing market the list of academic publications is rather short. Bourassa and Hoesli (2006) identify the key determinants of the Swiss home ownership rate. Borowiecki (2009) models Swiss house prices and investigate

overvaluation of the market. Degen and Fischer (2010) investigate the impact of immigration on Swiss house prices.

4. Data and Methodology

4.1 Data Description

To model house prices we follow several articles in the literature that model housing supply and demand. Assuming that the market is in equilibrium (i.e. supply equals demand), we regress house prices and construction activities on a set of independent variables that have been identified as drivers of supply and demand in previous studies. We also include lagged values of house prices and construction activities as independent variables, since these lags are often found to contain predictive power for current house price growth. Our measure for house price growth is derived from IAZI Swiss Exchange Private Real Estate Price Index.[4] The index is based on information from banks, insurers and pension funds on actual changes of ownership. The house price index covers more than 60 per cent of the property transactions concluded in Switzerland. Because we are particular interested in the real fluctuations in the housing market, we deflate our variables with the CPI deflator. As a proxy for construction activities we use the number of apartments under construction each year.[5] Since the Swiss home ownership ratio is very low in international comparison, apartments play a relatively large role and should therefore explain a substantial part in residential property price variation. The data for apartment construction is obtained from the Swiss National Bank (SNB). We further augment our model with a couple of independent variables.

First, we include real domestic interest rates. Interest rates change the user cost of housing as discussed in the previous section and alter the attractiveness of investing in interest-bearing assets. As the key interest rate we use the Swiss discount rate.[6] In order to account for demographic factors that could potentially drive house prices through the demand channel, we employ working age population (20-64); that is the age group of the overall population that has potentially the highest influence in determining housing demand. To incorporate the house price dependency on income and expectations of future income we include both, the development of Swiss GDP relative to the World and the unemployment rate as a measure of welfare. Using GDP as share of the world instead of regular GDP has the advantage that it captures relative movements in income. This is important since the

[4] The International Securities Identifying Number of this index is CH0030532342. From now on we refer to this index as 'house prices'.

[5] Records on construction of houses are not available. Data availability restricts us also from using a more sophisticated measure, such as the annual change in the number of square meters in residential property.

[6] Data was obtained from the Swiss National Bank statistics. Refer also to Table A1 in the Appendix for data sources of all remaining variables.

underlying theories point to forward looking consumers that make decisions based on their expectations. Borrowing and lending of consumers, however, increasingly depends on the performance of a country relative to the world. This is caused by better access to international asset markets and employment of international investment opportunities for the benchmark of the domestic investor. If, for example, other countries are growing faster, then capital would rather flow abroad instead of being invested domestically. Therefore, inclusion of a measure of GDP relative to the world is required as it would capture these considerations better than an absolute GDP measure could. Unemployment, GDP and CPI data come from the IMF WEO database that collects its information from the national authorities.

The housing supply is expected to be positively related to the profitability of house building and, hence, positively correlated with the level of real house prices. However, this relationship could be distorted in the short-run due to the sluggish nature of housing supply. Hence, we also include two lags of past changes in construction activities in our regressions. Remaining influences on the profitability of new house building include the construction cost. These costs are subsumed in the lagged house prices (that capture changes in the prices of land) and in an additional variable that we include - the CPI adjusted change in construction prices. As a construction price index we use the construction cost index for residential buildings provided by the Swiss National Bank. The selected data set covers the time period from 1991 to 2009 on an annual basis. Table 1 gives a description of the time series.

4.2 Empirical Setup

The results from unit root testing of the underlying variables, which are based on the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, are presented in Table 2. The overall results are fairly coherent with previous empirical findings. According to both tests, all variables but interest rates and population growth are stationary.[7] Due to the relatively low number of observations stationarity tests lack power. It is, hence, difficult to distinguish between stationary and non-stationary time series. If a longer data series of population was employed, the tests would suggest integration of order one. Building on those results and considering recent empirical research (e.g. Oikarinen 2007) we assume real interest rates to be integrated of order zero. All other variables we assume to be integrated of order one and hence we employ their growth rates. Nonetheless, the interpretation of the relationship between real interest rates and house prices requires some caution since the real interest rates have fallen over time and, thus, exhibit a time trend. Both the augmented Dickey-Fuller and the Philipps-Perron test indicate non-stationarity of the real interest rates. This is not so much of a problem in the regression with the change in construction activities as a dependent

[7] For population growth the null hypothesis that the variable contains a unit root is however close to not being rejected (p-value<0.16).

variable - because this variable is highly stationary. However, due to the weak stationarity of the change in the CPI adjusted change in house prices, the estimates might contain some noise due to the underlying time trends.

Since some of the variables in our system are integrated of the same order I(1), testing for cointegration may be desirable. The likelihood ratio trace test fails however to reject the null hypothesis of no cointegration. Similarly, the maximum eigenvalue statistic cannot reject the null hypothesis of no cointegration. As the results point at the absence of a cointegration relationship, we refrain from constructing a vector error correction model and estimate a vector autoregressive model (VAR). Given the aim of this research and in order to keep the estimation feasible we endogenize two variables: house prices and construction activity. Construction price changes, interest rates, population dynamics, relative GDP growth and in some specifications changes in unemployment are allowed only for an exogenous impact on the model. We follow Oikarinen (2009) in that we assume that interest rate changes are transmitted to the economy with a lag. We choose the number of lags based on lag order selection statistics. According to the three main information criteria (i.e. AIC, HQIC and SBIC) two lagged changes of the dependent variables should be included.

Hence, the VAR takes the following form:[8]

$$\Delta hp_c_t = \beta_1 \Delta hp_c_{t-1} + \beta_2 \Delta hp_c_{t-2} + \beta_3 \Delta constr_{t-1} + \beta_4 \Delta constr_{t-2} + \\ + \beta_5 \Delta cp_c_t + \beta_7 rir_{t-1} + \beta_8 \Delta pop_t + \beta_9 \Delta gdp_{/w,t} + \beta_{10} \Delta unempl_t + u_{hp,t} \quad (4a)$$

$$\Delta constr_t = \gamma_1 \Delta hp_c_{t-1} + \gamma_2 \Delta hp_c_{t-2} + \gamma_3 \Delta constr_{t-1} + \gamma_4 \Delta constr_{t-2} + \\ + \gamma_5 \Delta cp_c_t + + \gamma_6 rir_{t-1} + \gamma_7 \Delta pop_t + \gamma_8 \Delta gdp_{/w,t} + \beta_{10} \Delta unempl_t + u_{constr,t} \quad (4b)$$

5. Results

The estimation results from equations (4a) and (4b) are reported in columns 1 to 6 of Table 3. We run three different specifications. Columns 1 and 2 show the results of our first specification that includes all fundamental variables but unemployment, as it might be potentially endogenous to the construction price index or working age population. The estimation reveals that a one per cent increase in the lagged change in the construction price is associated with an increase of an around 0.34 per cent in the house price index. This potentially reflects that an increase in construction price growth decreases profitable of construction and therefore drives up housing prices. A one percentage point higher lagged

[8] The description of the variables can be found in Table A1 in the Appendix.

real interest rate is associated with a decrease of house prices by around 1.9 per cent. This possibly indicates that a decrease in the interest rate makes housing more affordable and therefore drives up the demand for it. House prices are found to be most responsive to a change in demand related demographic factors: a one per cent increase in the working age population is associated with a 7.3 per cent increase in house prices in the following year. Also, when the Swiss economy is growing relatively faster than the world, house prices tend to increase. The estimated coefficient implies that a one per cent increase in Switzerland's growth relative to the world is associated with a rise in house price of approximately 0.61 per cent. A one per cent increase in house prices two years before is associated with a decrease of approximate the same magnitude of current house prices. This might be an indication that the Swiss housing market is indeed inefficient. Moreover, the coefficient could also reflect the stability of the housing market: acceleration or slow down in house price inflation will revert after two years. Furthermore, the significance of the other lagged endogenous variable suggests forecastability of house prices. A change in the first lag of the construction activity is negatively correlated with the change in house prices; the coefficient is however equal to 0.13 and thus relatively small. Moreover, a change in the second lag of the same variable has the opposite coefficient, suggesting that the house price adapts quickly to any changes in housing supply. This result could be also leveraged by the protected and highly regulated character of the Swiss housing economy as well as the constrained supply.

On the supply side, we find that a one per cent increase in the change in construction prices results in a 1.9 per cent decrease of the construction activities. Construction activities are also negatively related to lagged real interest rates: a one percentage point increase in the interest rate corresponds with a 6 per cent lower construction activity.[9] Once again, the strongest effect comes from population changes. A one per cent increase in the working age population leads to an almost 17.7 per cent increase of the construction activity.[10] The results further indicate that relative income growth is positively related to the change in the construction activities. The causal relationship between those two variables is however particularly unclear. On the one hand, higher relative income could lead to higher construction activity, on the other hand however, bustling construction activity could stimulate GDP. Increasing housing price has in the short-run a negative association with the number of apartments under construction. This relationship could possibly originate from the increased incentive to sell the property earlier to the market. It is likely that a rising house price stimulates the developers to earlier sales of the housing units that are under construction,

[9] We also employed current interest rates. The sign of the coefficient on this variable is equivalent to the results of Table 3. However, these results are not significant suggesting some sluggishness in the reaction of house prices.

[10] Table 1 indicates that the average growth rate in population over the sample period was only 0.77 per cent.

yet not finished. The positive coefficient on the lagged construction activity indicates the delayed responses of the construction firms to any changes on the market. It requires time to, for example, decrease the employment or liquidate unused machinery.

Next we attempt to investigate how cyclicality affects the findings presented above. As pointed out Mankiw and Weil (1989), cyclicality is an important determinant of housing investments. In the baseline specification cyclicality might not be adequately captured by some of the used variables, for example, if variations in the GDP were synchronized across countries, relative GDP would not change. Therefore, we extend the baseline model by including the unemployment rate and report the results in columns 3 and 4 of Table 3. The point estimate on the additional variable is negative and significant only for the house price specification. The result indicates that a one percentage point higher unemployment rate leads to a one per cent decrease of house prices. Given that prices are linked to unemployment through the Phillips curve, this is not surprising. It can be also observed that the inclusion of the unemployment rate decreases the estimate on construction price, which is now not significant anymore at the conventional confidence levels. This is presumably caused by the fact that labor cost constitutes a relatively large share of the construction cost index .

An arising question is whether and to what extent crises influence the Swiss housing economy. Ideally we would perform an out of sample analysis and provide a separate investigation for the years of crisis. Alternatively, one could also obtain interaction terms between all included independent variables and the periods of a crisis. Both methods are however unattainable in this study, due to the very short data series of only 20 annual observations. Therefore, we refrain to a third approach and measure the difficult years of a crisis with a dummy variable. In the third specification we include an indicator function (*Crisis*) that takes the value one for the years when a crisis occurred in Switzerland and zero otherwise.[11] It is interesting to observe in columns 5 and 6 that the estimated coefficient on the crisis variable is negligible in size and clearly insignificant. Furthermore, it can be observed that the point estimates on all remaining variables remain basically unchanged in sign, size and significance. Based on these results, one can draw the tentative conclusion that the studied crises do not affect the Swiss housing market through any channels other than GDP, construction prices and unemployment.

The estimated coefficients between the dependent and the independent variables are straightforward to interpret and broadly in line with what one would expect. The explanatory power of the models, as suggested by the R^2 statistic, is very high. The information criteria (i.e. AIC, SBIC and HQIC) suggest that the first specification, in which we exclude

[11] We set the indicator function equal to one for the duration of the crisis of the early 1990s (i.e. 1990-1994) and the recent global financial crisis (i.e. 2006-2009). The results are robust to numerous alterations of those particular years.

unemployment and the crisis dummy, is the preferred model. Based on the baseline specification we depict in Figures 6 and 7 the estimated and actual house price and construction activity developments, respectively. It is reassuring to observe that the model tracks the actual changes in house prices and construction activity very closely.

Next, we turn to an analysis of the dynamics of the endogenous variables and calculate their responses to shocks in either of the dependent variables. We plot the impulse response functions (IRF) and cumulative impulse response functions (CIRF) in Figures 3 and 4, respectively. A shock to house prices results in a temporary decrease in the construction activity, before it reverts to a positive growth rate around three years later. There is no reaction found in house prices to a shock in construction activity growth, which indicates a rather unidirectional relationship between housing prices and construction activities. A construction activity shock increases its growth for up to three years. A shock to the house price growth leads to higher prices during the first year before the price changes start to decrease again in the second year. It is interesting to observe that in the long-run an exogenous house price shock is not very persistent.

Finally, we estimate Cholesky forecast-error variance decomposition. The forecast error variance decomposition measures the contribution of each type of shock to the forecast error variance. In Figure 5 these decompositions are visualized. The contribution of a house price shock to the forecast error variance of house prices is nearly 100 per cent. Its role however gradually decreases over time. The same shock contributes also to the forecast error variance of construction activity, albeit only up to 15 per cent. The contribution of a construction activity shock to the forecast error variance of construction activities is similarly low on impact but increases slightly over time. A shock in the construction activity explains almost the entire forecast error variance of construction activity the next year and marginally decreases over time.

6. Conclusion

This study investigates the house price and construction activity determinants and dynamics for the relatively protected and isolated Swiss housing market. We cover a very interesting time period, that is 1990 to 2009, in which two substantial economic crises occurred. Focusing on such period allows the unique investigation whether and how a protected market becomes affected by economic turbulences. We employ vector autoregressive techniques in order to model house prices and construction activity. The employed methodology allows to illuminate the relationship between the two endogenous variables and to establish how a set of potential determinants influence the Swiss housing economy.

We find that house prices are positively associated with construction prices, working

age population as well as GDP and a negatively with interest rates. Construction activity is positively related to working age population and GDP and discloses a negative relationship with construction price and interest rates. Our estimates are broadly in line with theoretical predictions and previous empirical findings. Those results and a separate specification controlling for the years when an economic crisis occurred, support the view that the Swiss housing market is barely affected by economic turbulences. The predictions based on our model correspond well with actual data and indicate that the model is well specified. The findings are consistent with the dominant view in the literature that the housing market is not very efficient. Lagged house price changes are able to predict future house price growth. Similarly, past changes in construction activities contain information for current construction activities.

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Tables

Table 1. Descriptive Statistics.

	Obs	Mean	Std. Dev.	Min	Max
Δhp_c	20	-0.35%	3.34%	-6.33%	8.29%
Δconstr	20	1.19%	10.39%	-15.74%	21.04%
Δcp_c	20	-0.47%	2.73%	-7.73%	3.47%
rir	20	3.12%	1.39%	1.01%	5.72%
Δpop	20	0.77%	0.43%	0.04%	1.67%
Δgdp/w	20	-2.14%	1.84%	-8.86%	0.58%

Note: Mean, Std. Dev., Min and Max values are in percentages.

Table 2. Stationarity Tests.

	1 lag		**2 lags**		**3 lags**	
	ADF	PP	ADF	PP	ADF	PP
Δhp_c	-2.961*	-13.146**	-2.302	-12.891**	-2.055	-12.403*
Δconstr	-3.794***	-22.882***	-3.152**	-21.738***	-2.317	-19.851***
Δcp_c	-3.627**	-14.622**	-1.867	-12.282*	-2.929*	-11.197*
Rir	-0.749	-3.279	-0.343	-3.627	-0.911	-3.177
Δpop	-2.124	-8.563	-2.039	-8.570	-1.948	-8.681
Δgdp/w	-4.084 ***	-21.981***	-2.992 **	-19.903***	-2.396	-18.095***
Δunemp.	-3.973***	-16.330**	-2.581	-14.968**	-2.833*	-13.426**

Note: 'ADF' denotes the Augmented Dickey-Fuller test. 'PP' denotes the Phillips-Perron test. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. House Prices and Construction Activity.

	(1) Δhp_c_t	(2) $\Delta constr_t$	(3) Δhp_c_t	(4) $\Delta constr_t$	(5) Δhp_c_t	(6) $\Delta constr_t$
Δhp_c_{t-1}	0.0591	-1.781***	0.0352	-1.737***	0.0402	-1.729***
	(0.122)	(0.408)	(0.115)	(0.403)	(0.113)	(0.402)
Δhp_c_{t-2}	-1.024***	-0.389	-0.907***	-0.604	-0.891***	-0.578
	(0.167)	(0.556)	(0.170)	(0.595)	(0.168)	(0.597)
$\Delta constr_{t-1}$	-0.129***	0.532***	-0.111**	0.498***	-0.108**	0.502***
	(0.0446)	(0.149)	(0.0430)	(0.151)	(0.0424)	(0.151)
$\Delta constr_{t-2}$	0.128***	-0.158	0.127***	-0.157	0.121***	-0.166
	(0.0384)	(0.128)	(0.0359)	(0.126)	(0.0361)	(0.128)
Δcp_c_t	0.338***	-1.906***	0.108	-1.480**	0.144	-1.424**
	(0.131)	(0.438)	(0.183)	(0.640)	(0.185)	(0.655)
rir_{t-1}	-0.019***	-0.064***	-0.019***	-0.064***	-0.019***	-0.064***
	(0.00258)	(0.00862)	(0.00242)	(0.00846)	(0.00238)	(0.00846)
Δpop_t	7.343***	17.66***	7.530***	17.31***	6.954***	16.43***
	(1.291)	(4.309)	(1.212)	(4.242)	(1.370)	(4.866)
$\Delta gdp_{W,t}$	0.613***	2.618***	0.474**	2.874***	0.468**	2.863***
	(0.191)	(0.639)	(0.196)	(0.688)	(0.193)	(0.686)
$\Delta unemp_t$			-0.010*	0.020	-0.010*	0.020
			(0.00630)	(0.0220)	(0.00620)	(0.0220)
crisis					0.006	0.009
					(0.00707)	(0.0251)
constant	0.0140	0.125***	0.00993	0.133***	0.0113	0.135***
	(0.00988)	(0.0330)	(0.00955)	(0.0334)	(0.00952)	(0.0338)
R2	0.85	0.82	0.87	0.83	0.87	0.83
AIC	-7.576	-7.576	-7.572	-7.572	-7.410	-7.410
HQIC	-7.401	-7.401	-7.378	-7.378	-7.197	-7.197
SBIC	-6.680	-6.680	-6.577	-6.577	-6.315	-6.315
Observation	20	20	20	20	20	20

Note: Standard errors in parentheses. The Crisis dummy takes the value one for the years 1990 to 1994 and 2006 to 2009, and zero otherwise. Description of remaining variables is presented in Table A1 in the Appendix. *** p<0.01, ** p<0.05, * p<0.1.

Figures

Figure 1. Swiss house price 1982 to 2010.

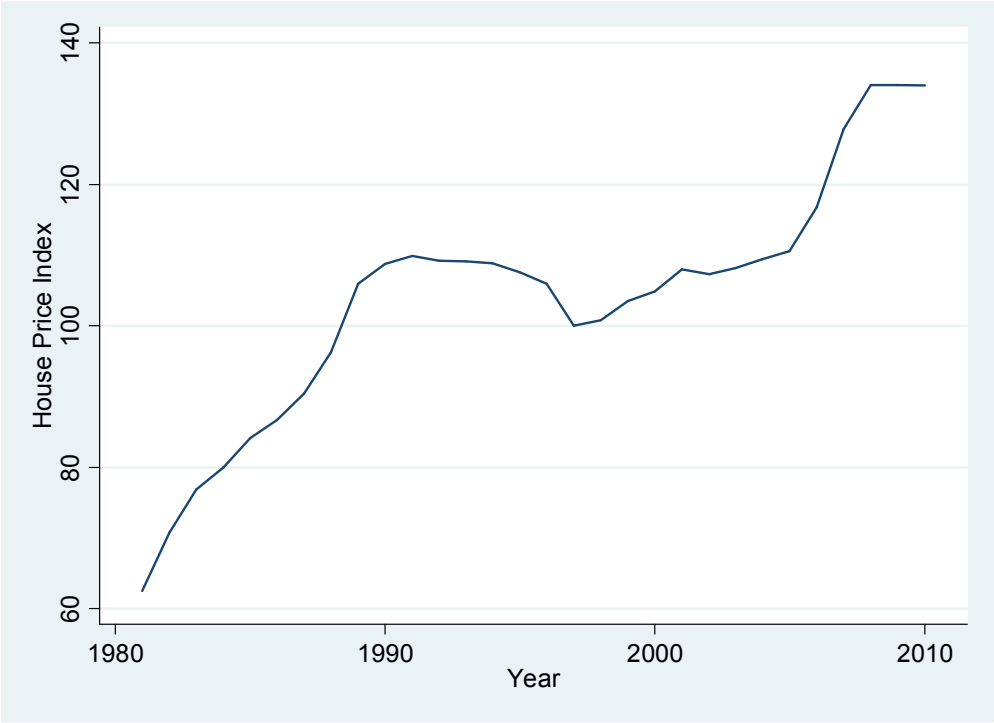


Figure 2. Risk-return profiles of international housing economies.



Source: Borowiecki (2009). Note: Switzerland (CH) is based on the inflation adjusted SWX IAZI Private Real Estate Price Index. BIS calculation based on national data is employed for all remaining countries, that is Australia (AU), Belgium (BE), Canada (CA), Denmark (DK), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Japan (JP), Netherlands (NL), New Zealand (NZ), Norway (NO), Spain (ES), Sweden (SE), Switzerland (CH), United Kingdom (GB) and United States (US)). The covered time period is 1981 to 2006.

Figure 3. Impulse Response Functions.

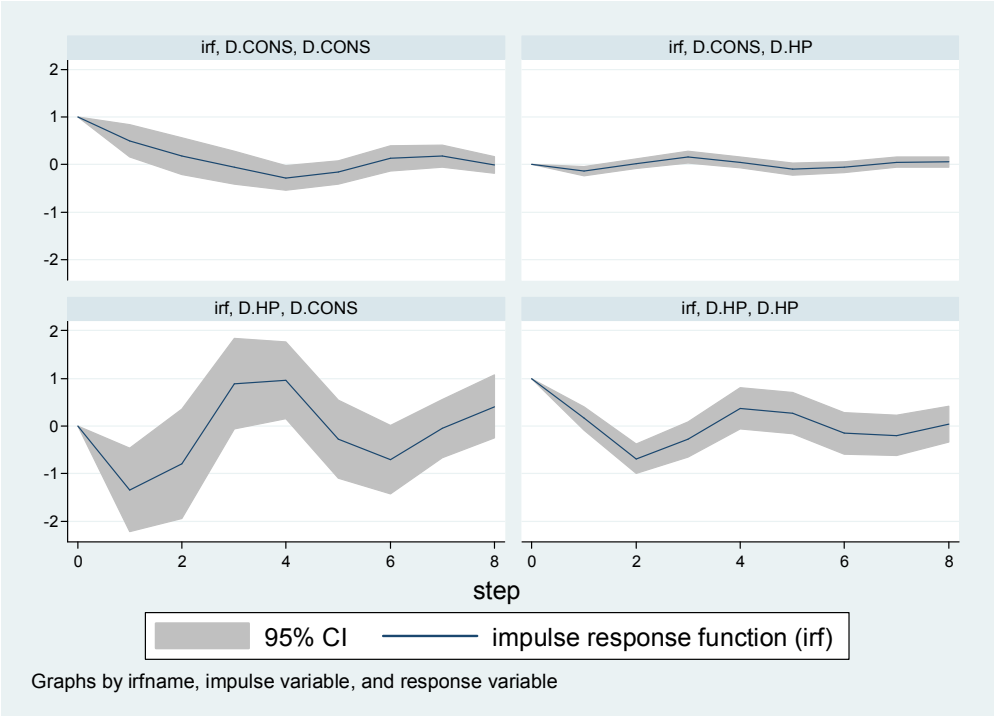


Figure 4. Cumulative Impulse Response Function.

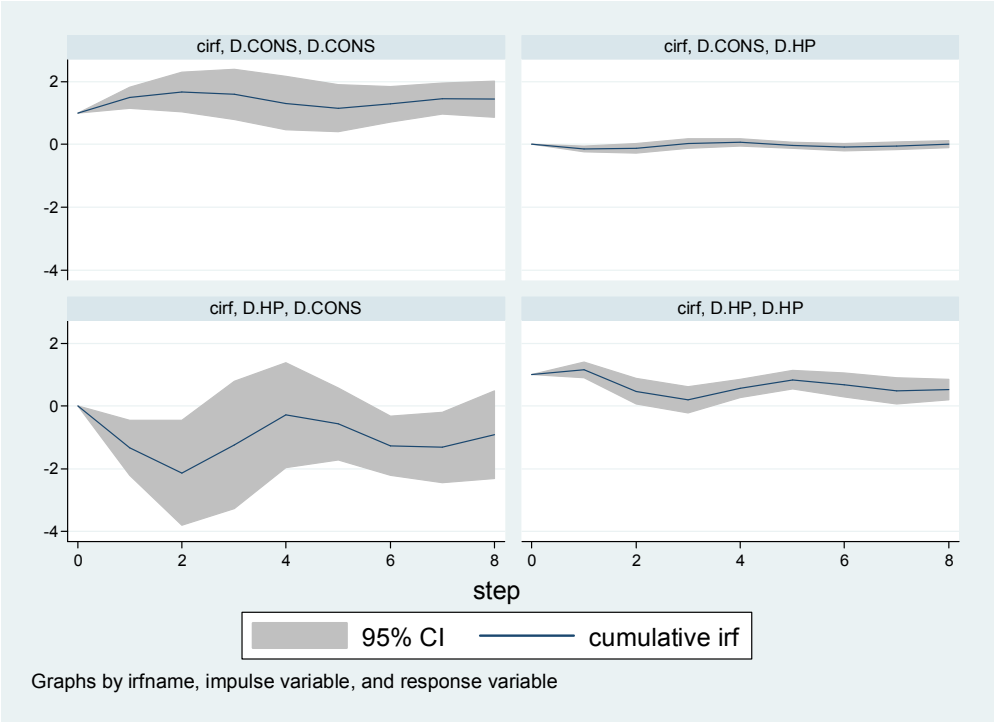


Figure 5. Forecast Error Decomposition.

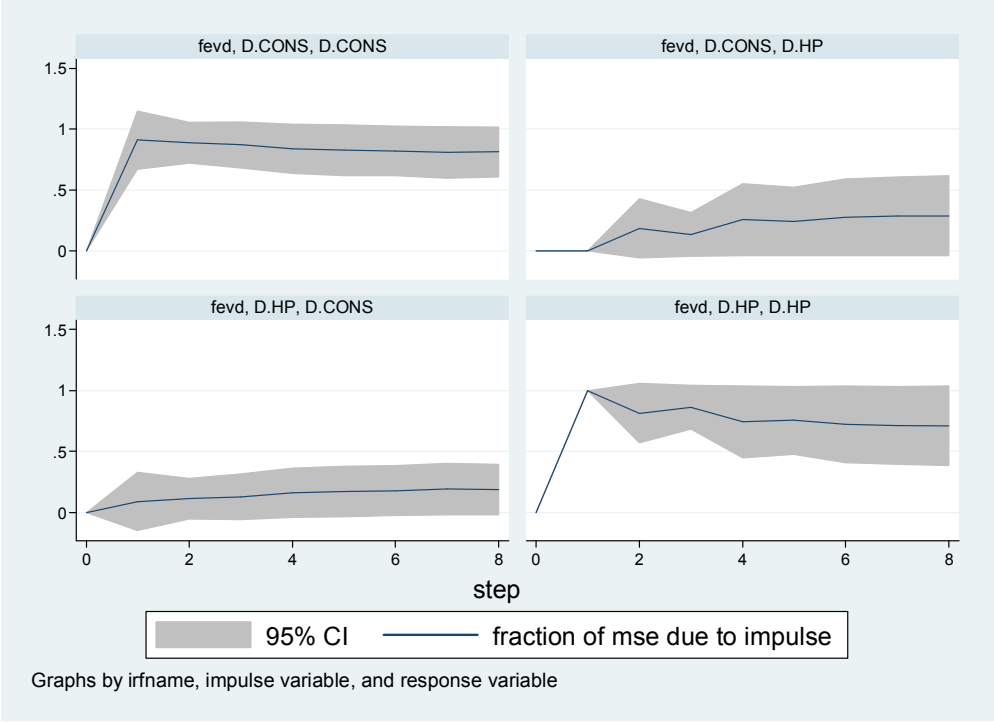


Figure 6. Predicted vs. Actual Construction Activity Growth.

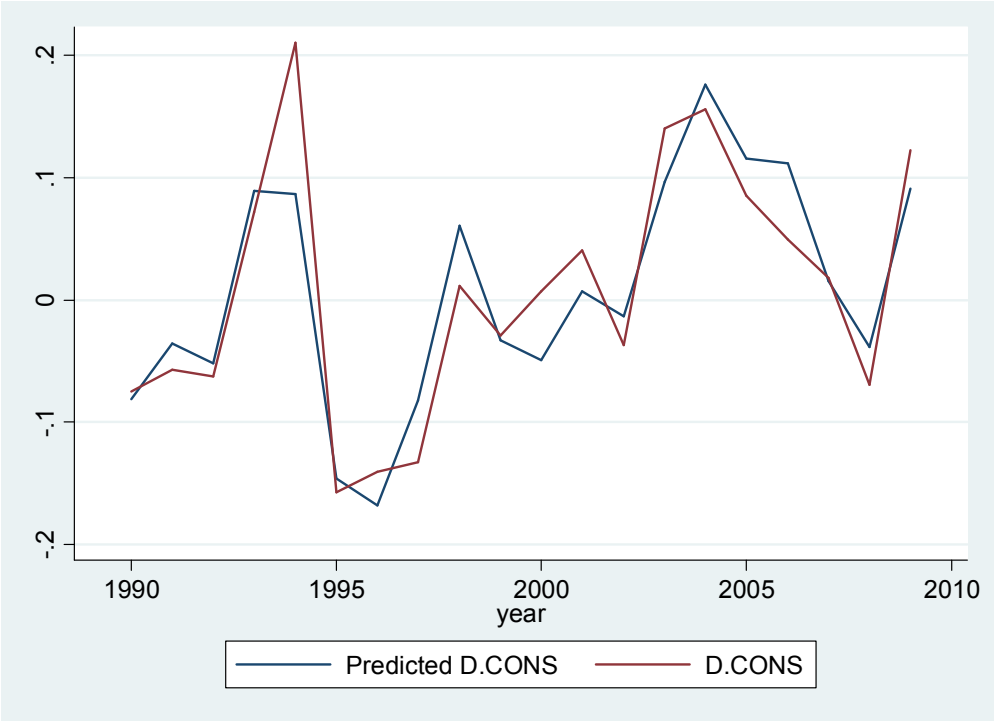
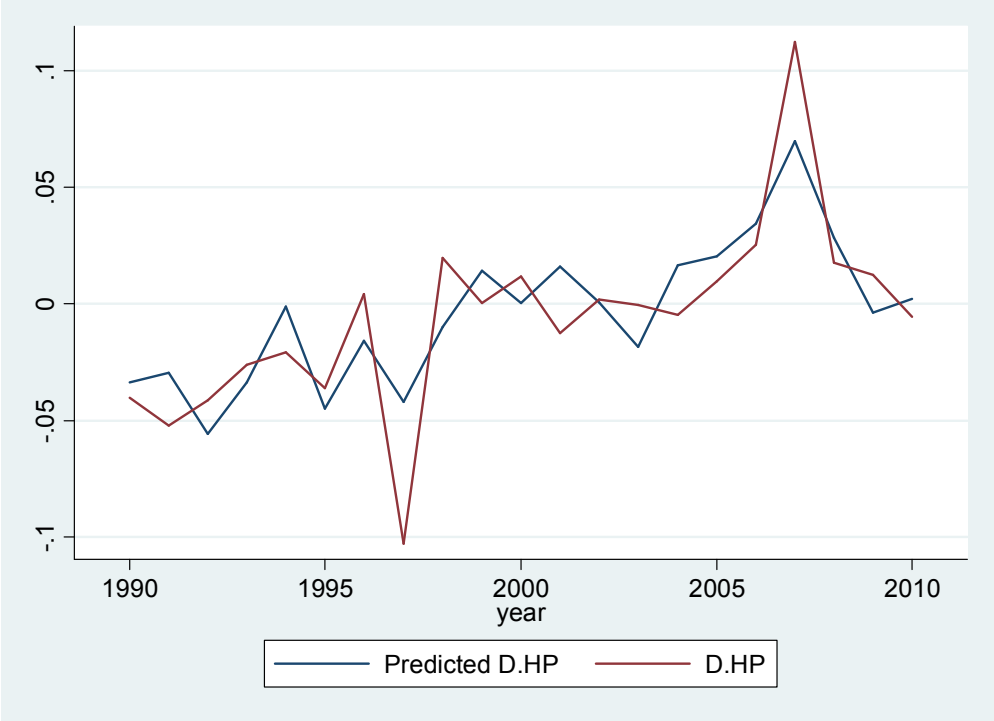


Figure 7. Predicted vs. Actual House Price Growth.



Appendix

A.1. Data Sources and Variable Description

	Variable name	Source	Variable description
Δhp_c	SWX IAZI Private Real Estate Price Index 1982-2010	SWISS EXCHANGE	This index is a weighted aggregate of the SWX IAZI Private House Price Index and SWX IAZI Condominium Price Index. It is calculated based on anonymous transaction data provided by banks, insurers and pension funds. CPI adjusted, log change from previous year.
Δconstr	Housing construction 1981-2009	SNB	Number of apartments under construction, log change from previous year.
Δcp_c	Construction Price Index 1989-2009	SNB	This construction cost index covers residential properties (houses and condominiums). CPI adjusted, log change from previous year.
rir	Real interest rate 1989-2009	SNB	Discount rate ('Special rate bottleneck financing facility'). Adjusted by the consumer price inflation rate.
Δpop	Population 1980-2009	SNB	Working age population (aged 20 to 64). Log change from previous year.
$\Delta gdp_{/w}$	GDP 1980-2009	IMF	Change in Swiss GDP relative to world GDP. CPI adjusted.
Δunemp	Unemployment 1980-2009	IMF	Change in Swiss Unemployment
CPI	Consumer Price Index 1980-2010	IMF	Swiss consumer price index.