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The Determinants of House Prices and Construction: An Empirical Investigation of the Swiss Housing Economy [1]

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This paper studies the Swiss housing price determinants. The Swiss housing economy is reproduced by employing a macro-series from the last seventeen years and constructing a vector-autoregressive model. Conditional on a comparatively broad set of fundamental determinants considered, i.e. wealth, banking, demographic and real estate specific variables, the following findings are made: 1) real house price growth and construction activity dynamics are most sensitive to changes in population and construction prices, whereas real GDP, in contrary to common empirical findings in other countries, turns out to have only a minor impact in the short-term, 2) exogenous house price shocks have no long-term impacts on housing supply and vice versa, and 3) despite the recent substantial price increases, worries of overvaluation are unfounded. Furthermore, based on a self-constructed quality index, evidence is provided for a positive impact of quality improvements in supplied dwellings on house prices.

Keywords

Housing Demand; Housing Supply and Markets

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1. Introduction

Consequences of the United States subprime crisis include 1.4 trillion USD losses on American based loans and related securities, highly volatile and dried up stock markets, founded fear of recession, and distressed households with burst dreams of home ownership. As well, the "annus horribilis" is not over yet. Other equity and housing markets are being "infected" and further losses are expected. The very recent economic crisis of an unexpected global dimension is probably the greatest in our history that had its source in a national real estate market. However, this is not the first property crisis in the United States, and it is not the only country where such a crisis has occurred. In fact, real estate crises are notoriously regular incidents.

Switzerland has also experienced in the early 90s, a notable real estate economy crisis that led to historically high losses in the banking sector and leveraged an economic downturn. Presently, after a decade, there is still comparatively little known about the price dynamics of the Swiss housing asset. Despite the immense value of Swiss properties which, based on authorised mortgages, is estimated to amount from 2231bn to 2717bn USD,[2] empirical studies of the real estate market are very limited. Properties are traditionally regarded as a matter of course or production factor. The overall importance and associated risks are usually neglected.[3]

The case of the Swiss real estate economy is particularly interesting because of its heavily constrained supply. Findings from a stand-alone study of a country with excessively constrained supply may differ significantly from panel studies with pooled regressions. There are three main reasons for the constrained supply. First, the topography of the country consists in over 70 percent of mountainous regions. Hence, development becomes very difficult. Secondly, there are heavy regulations imposed on new constructions, resulting in time consuming zoning regulations or restricted building authorisations. Thirdly, the construction sector is heavily protected by regulators. Employment of foreign labour in this sector is generally not possible and contracting to foreign developers is very restricted.

1.1 The Swiss Housing Market

The Swiss housing market exhibits several remarkable characteristics. Switzerland's home ownership rate of only 34.6 percent is the lowest among developed countries by a significant margin. It is mainly attributed to the fact

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[2] Based on Credit Suisse estimation for the year 2000 (Credit Suisse 2000), the value for the year 2007 was estimated with *SWX IAZI Investment and Private Real Estate Price Indices* and the relative shares (fixed from year 2000) of each real estate class.

[3] For an extensive study of risks associated with real estate investments refer to Borowiecki (2006).

that house prices are very high relative to rentals, household incomes and wealth (Bourassa and Hoesli 2006). However, regulations in favour of tenants and discriminatory taxation of home owners shape further considerable disincentives for house buyers.

A further characteristic of the Swiss real estate market is the very high degree of protectionism. The so-called Lex Koller legislation from 1985 has a major restrictive impact on acquisitions of properties by persons residing abroad. Despite the recent loosening of Lex Koller (e.g. approval for purchases of holiday flats), there are still significant barriers for foreigners who want to invest in the Swiss housing market. A major future impact on house prices can be the abolishment of Lex Koller which was recently decided by the Swiss Federal Council. Nevertheless, the relevant law is not expected to be abolished completely until 2010.

Despite Switzerland’s relative small land area, there is a remarkably high level of diversity. The Swiss four regions (i.e. German, French, Italian and Rhaeto-Romanic) have huge differences in local economies, distinct cultures, and diverse climates and topographies. The substantial differences lead to heterogeneous demand and supply in the regional housing markets. Thus, the question is whether an analysis of Swiss housing economy with a national approach is reasonable. A justification can be made by the existence of presumably coherent housing price responses to shocks. Moreover, some recent research suggests that long-term diversification potential of housing property investments in smaller countries do not exist (e.g. Oikarinen (2007) for Finnish housing market).

1.2 Historical Housing Price Development

An historical analysis of Swiss house prices, based on the *SWX IAZI Private Real Estate Price Index*, provides some indication for a 25-year housing price cycle with a clear upward trend (Figure 1).

The Swiss construction boom of the early 80s was fuelled in 1987 by a substantial money supply extension (i.e. introduction of the Swiss Interbank Clearing System). Nevertheless, the bubble burst when the speculative belief of the market was confronted with an unexpected economic slowdown in the early 90s. Moreover, in order to reduce speculation in the real estate economy, the federal authorities introduced urgent sanctions[4], adding fuel to the flames and causing huge price drops in commercial property. The measures resulted in housing price stagnation, until the federal authorities decided to subsidise the housing market in order to counteract the construction sector crisis and

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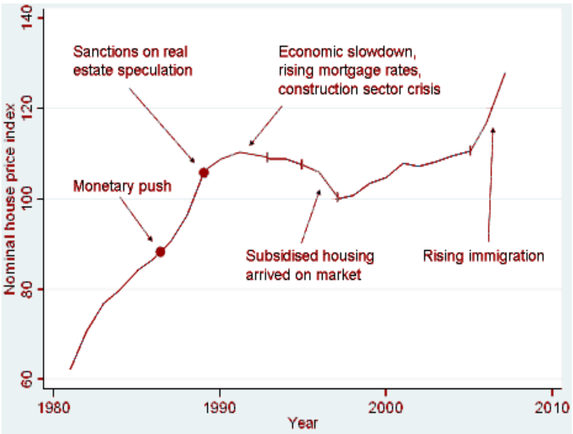
[4] Federal authorities introduced a 5-year blocking period for selling of non-agricultural land and buildings, more stringent mortgage underwriting criteria and stricter regulations for pension fund investors.

stimulate the national economy. The subsidies in the extent of over 6bn USD resulted in a housing construction boom and led to a massive oversupply. The vacancy rate more than quadrupled during the seven years and housing prices deflated to over five percent per annum. Consequently, the sluggish responding supply began to gradually decline until around 2002. During the last three years, aside from a comparatively low supply, there was a substantial rise in immigration with a total population growth rate of over one percent and an increase in household disposable incomes. Therefore, house prices have reverted to significantly positive growth rates.

Figure 1 Historical House Prices



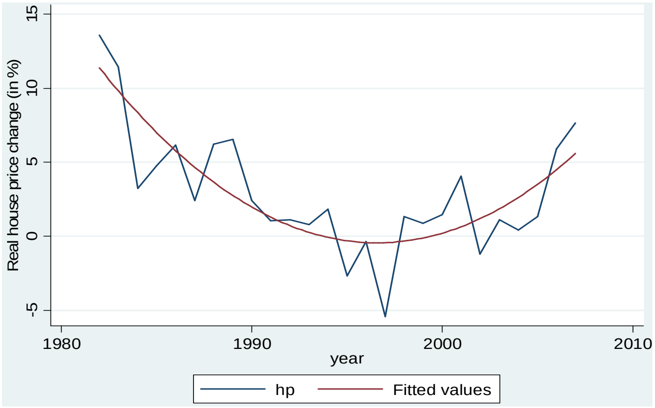
Source: SWX IAZI Private Real Estate Price Index

The appreciation of house prices may remain high in the future through tentative suggestions via a computed quadratic trend in Figure 2. On the other hand, the present global economic downturn and gradual increase in housing supply will possibly have a negative impact on Swiss house prices.

How does the performance of Swiss residential properties compare internationally? Two broad groups of countries are distinguished while analysing risk-return profiles of seventeen developed housing economies (comparisons in Figure 3). The first group (i.e. Belgium, Ireland, Netherlands, Spain and the United Kingdom) has significantly higher variations in price which is recompensed by capital growth rates of up to 5 percent per annum. The second group is associated with lower variations and returns, consisting of almost all the remaining countries, including Switzerland. Japan and Germany are outliers and have negative growth rates in real house prices.

Interestingly, the Swiss housing market with regard to risk profiles dominates all remaining housing economies. This is presumably attributed to the numerous legislations that restrict speculation and foreign capital inflow. At first glance, the lowest volatility and fairly high capital return of 2.56 percent per annum (geometric growth rate) suggest a relatively good performance of the Swiss residential property market. However, the gain from house price inflation is counterbalanced by heavy fiscal burdens. Furthermore, there is the possibility of the existence of international differences in income returns, which are not incorporated in the depicted indices.

Figure 2 Real House Price Dynamics and Fitted Trend



Source: Inflation adjusted SWX IAZI Private Real Estate Price Index

Figure 3 Real House Price Growth and Volatility By Country, 1981-2006[5]

Source: Inflation adjusted SWX IAZI Private Real Estate Price Index (for Switzerland). BIS calculation based on national data (for all other countries)

[5] An international comparison is conducted for the following countries: 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).

2. Literature Overview

2.1 Countries Analysed

Research in the early 90s focused on particular features of the US housing market.[6] However, in very recent years, extensive studies of several other housing markets were conducted. Housing market determinants were analysed; among others, for the Danish (Wagner 2005), Finnish (Oikarinen 2005), French (Bessone et al. 2005), Irish (McQuinn 2004, Rae and van den Noord 2006), Japanese (Nagahata et al. 2004), Dutch (OECD 2004a, Hofman 2005, Verbruggen et al. 2005), Spanish (OECD 2004b), British (Meen 2002) and American (Meen 2002, McCarthy and Peach 2004) economies. The analysis of these countries was complemented by panel studies of groups in advanced economies (e.g. Iacoviello 2000, Sutton 2002, Tsatsaronis and Zhu 2004).

Econometric studies are very limited for the Swiss housing economy. Presumably, the largest contributors to Swiss housing market transparency are Credit Suisse that publishes the "Swiss Issue Real Estate" annually and Wuest & Partner, publisher of "Immo-Monitoring". Both publications provide an overview of the most important property markets that are affecting developments. Further non-technical and descriptive analyses are provided by Savioz and Bengui (2006) who examine the formations of bubbles on the Swiss housing market. An econometric study is conducted by Bourassa and Hoesli (2006) who analyse the drivers for the unusually low rates of Swiss home ownership.

2.2 Study of Determinants

There is broad coherence among researchers when it comes to distinguishing the direction of impact of each house price determinant and the signs corresponding to economic theory. However, when it comes to distinguishing the explanatory power or size of parameters, there seems to be little agreement. Elasticities of real house prices with respect to economic fundamentals differ widely depending on the sample of countries, period examined and methodology used.

The majority of empirical studies analyse the impact of changes in real disposable income on house prices.[7] Some researchers provide evidence for the substantial explanatory power of income (e.g. Holly and Jones 1997), whereas other studies claim that the importance of income as a real house

[6] E.g.Poterba(1991)examines the changes in the construction costs,demographic factors and real after-tax costs of homeownership as possible determinants of shifts of demand and supply in the housing market;Case and Shiller(1989,1990)study auto-correlation properties;Cho(1996)analyses the speculative bubbles as property price drivers.

[7] Frequently, the real disposable income was substituted by gross domestic product or gross national product.

price driver is minor (Tsatsaronis and Zhu 2004). According to Tsatsaronis and Zhu (2004), it is the change in inflation rate that has a major impact and accounts for 50 percent of the total variation in house prices, whereas real disposable incomes and interest rates account for around 10 percent each. These results correspond fairly with Sutton (2002) who finds in a panel study that gross national product dynamics explain on average, around 10 percent of house price movements and interest rate changes explain less than 5 percent. Moreover, Sutton (2002) claims that equity price dynamics account for around 10 percent of house price changes.

Several other variables were proven to be significant. However, variance decompositions are not included in every study, thus the relative explanatory importance remains unidentified in some cases. In particular, there are analyses of labour market data (Schnure 2005), demographic dynamics (e.g. OECD 2004b), changes in housing stock supply (e.g. Rae and van den Noord 2006), and construction cost dynamics (e.g. Oikarinen 2005). Moreover, Egert and Mihaljek (2007) introduce determinants that are specific to housing markets in Central and Eastern Europe(CEE):indicators of security and reforms in non-bank financial institutions, and indicators of banking reforms and interest rate liberalisation.Furthermore,Egert and Mihaljek study the impact of changes in housing quality, as it is plausible that the recent significant improvement in housing quality in the CEE could have been a significant driver for house price appreciation.Nevertheless,because of non-availability of data series,the authors decide to use real wages as a broad proxy for changes in housing quality. Iacoviello(2000) thoroughly studies the impacts of monetary shocks on house prices and provides evidence of the existence of a significant negative impact on real house prices to an adverse monetary shock.Furthermore, Iacoviello claims that monetary and income related demand shocks are a significant driver for short-run price fluctuations in the housing market.

2.3 Econometric Models and Time Periods

Single country research are based primarily on error correction models, while research on a group of countries mainly adopt vector autoregressive (VAR) systems and dynamic OLS panel regressions. Frequently, panel studies are preferred because it is possible to employ more observations, thus enabling more robust results. However, country specific conclusions based on panel parameter estimates may raise the problem of homogeneity assumptions and are quite risky.

The application of annual datasets allows studies of a longer time series, for example, Holly and Jones (1997) examine a period that is 56 years in time. However, shorter annual datasets are also employed, e.g. Jud and Winkler (2002) cover only 15 years. Recent research usually build on data that are 20 to 30 years in time and employ quarterly data series. Drawing on monthly data (e.g. Meese and Wallace 2003) is rather an exception.

2.4 Problems and Criticism

As for any econometric study, a number of valid criticisms can be applied. The estimated models can disclose a lack of stability. House price elasticities of supply and demand can vary over time due to structural breaks caused, for example, by changes in regulatory conditions, demographic dynamics or taxes that cannot be controlled. In particular, studies that cover long periods of time may be prone to bias caused by incorporation of one or more structural breaks. On the other hand, papers analysing particularly short time periods may not cover a full house price cycle and therefore, are also biased.

Next, in house price studies, the relatively low availability and high limitation of data are notorious issues. In part, the lack of datasets does not allow building of econometric models in accordance to the theory and problems with non-linearity and multicollinearity. This inability to build econometric models results repeatedly in implausible signs and sizes of the estimated parameters.

The heterogeneous nature of housing provides another significant problem to the measurements of house price dynamics. Studies that do not employ quality adjusted time series can be strongly biased as over time, important changes in the average quality standards may exist.

3. The Data

3.1 Data Sources

The selection of the dataset was aimed at providing representatives for various housing demand drivers and housing supply determinants. The house price series is reflected by the annual CPI adjusted IAZI SWX Private Real Estate Price Index. Equity price, reflected by the SPI total return index, was used to approximate the wealth effect. The banking sector is reflected by CPI adjusted interest rates. Demographic changes were represented by population growth at household formation age, i.e. 20 to 64 age cohort. For modelling of the supply side and real estate specific determinants, the number of completed dwellings during a year and the CPI adjusted construction price index were incorporated. Finally, this work pioneers the incorporation of a quality index which is computed and discussed in Appendix 1. Sources and shortcuts of all employed variables are provided in Table 1.

Extensive trials to incorporate total gross domestic product (GDP) or GDP per capita could not deliver significant or plausible results, therefore GDP macro-series are not incorporated in the main model. However, the base model will be extended by the GDP series in order to control for consistency.

Table 1 Data Sources

	Variable Name	Source
hp	SWX IAZI Private Real Estate Price Index	SWX, IAZI: 1981 to 1995
cpi	Consumer Price Index	SNB: 1921 to 2008
gdp	Gross domestic product	SNB:1981 to 2007
ir	Interest rates	SNB: 1989 to 2008
equity	SPI total return	SWX: 1984 to 2007
pop	Population	BFS: 1980 to 2006 (For 2007 Encarta Estimation)
constr	Housing construction	SNB: 1980 to 2007
cp	Construction price	SNB: 1989 to 2007
q	Swiss Quality Index	Own computation based on Wuest & Partner Real Estate Price Indices (s. Appendix 1)

***Source*:** Compiled by the author

The selected datasets cover the time period from 1991 to 2007 on an annual basis. Hence, the number of observations is comparable with Jud and Winkler (2002).

3.2 Unit Root Testing

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 (e.g. Oikarinen 2007, Sutton 2002). According to the ADF test, the real interest rates seem to be stationary while all remaining variables are integrated of order one. The results from the PP test are slightly different. The PP approach suggests that real interest rates are integrated of order one and the population seems to be integrated of an order greater than one. This may be caused by the relatively low number of observations. For instance, when applying the PP test for a longer data series of population, the results correspond to the ADF test.

In summary, taking into consideration the results from unit root testing, graphical analysis and recent empirical research (e.g. Sutton 2002, Oikarinen 2007), real interest rates are assumed to be integrated of order 0, i.e. stationary at level, and all remaining variables to be integrated of order 1, i.e. stationary at their first differences.

4. Methodology

4.1 Structuring the VAR Model

Joint endogenous dynamics among the selected variables may exist. Hence, the choice of a VAR model seems appropriate. In Table 3, the structure of the restricted VAR model is summarised and in the following section, a discussion is provided.

Table 2 Augmented Dickey-Fuller and Phillips-Perron Unit Root Tests

Variable Name		ADF		Phillips-Perron	
		Level	Difference	Level	Difference
hp_c	Housing price (CPI adjusted)	1.592 (1)	-2.783* (0)	-0.407 (2)	-2.949* (2)
constr	Housing construction	-1.946 (2)	-3.147** (0)	-1.755 (2)	-3.136** (2)
cp_c	Construction price index (CPI adjusted)	0.055 (3)	-4.105*** (1)	-0.541 (2)	-2.583* (2)
rir_c	Real interest rate (CPI adjusted)	-2.954** (2)	-3.409** (2)	-1.453 (2)	-6.858*** (2)
equity_c	Equity prices (CPI adjusted)	-0.824 (1)	-3.956*** (1)	-0.911 (2)	-29.14*** (2)
pop	Population (20 to 64 age cohort)	-0.679 (2)	-2.991** (3)	-1.472 (2)	-2.130 (2)
q	Swiss Quality Index	-0.904 (2)	-2.825* (0)	-0.892 (2)	-2.806* (2)

Note: The number of lags is denoted in parentheses. *, **, *** indicate the rejection of a unit root at the 90%, 95% or 99% confidence level (based on MacKinnon approximate p-values). All tests are conducted with a constant. The number of lags for the ADF test is computed as proposed by Ng and Perron (1995) and for the PP test as proposed by Newey-West: number of lags = int{4(T/100)^(2/9)}, where T is the number of observations.
Source: Own computation

Table 3 Endogenous and Exogenous Variables

	Variables
Endogenous	Δhp_c, Δconstr
Exogenous	Δcp_c, rir_c, Δequity_c, Δpop, Δq,

Note: Δ implies the first difference of a variable.
***Source*:** Compiled by the author

Deciding upon Akaike's information criterion (AIC), Hannan-Quinn information criterion (HQIC) and Schwarz Bayesian information criterion (SBIC), the real interest rates are excluded from the group of endogenous variables, i.e. only an exogenous effect is allowed, despite the rather high degree of autocorrelation. An assumption from Sutton (2002) is adopted with respect to equity prices, i.e. the growth rate of equity prices is not predictable on the basis of other variables from the system, therefore, stock prices are analysed as exogenous. Moreover, the quality of residential properties is assumed to be exogenous, even though there may exist a positive influence of stock price inflation on the quality of dwellings. It is reasonable to believe that household demand for quality housing would be higher when their wealth level rises. However, as the overall effect of quality on housing market turned out to be minor, therefore, an assumption that equity prices and quality of dwellings do not interact should not contribute to any significant biases.

Population dynamics and construction price changes are allowed similarly, to impact only exogenously the system. Does population growth and construction price inflation shift in conjunction? A rise in population size results in labour supply increase; hence, ceteris paribus, the wages and therefore, the construction costs would be expected to fall. On the other hand, a rise in population size results in higher population density and may shift constructions to farther locations or sites with poor access. Hence, a positive impact on construction prices can result. In summary, the long-term correlation between population growth and construction price changes is presumably close to zero and neglected in this study.

Finally, a higher quality of supplied dwellings should be expected to impact construction prices. However, as previously argued, the overall influence of quality is minor. Therefore, allowing for no interaction between the two variables should not lead to any substantial biases.

4.2 Cointegration Testing

Since there is a unit root in either of the endogenous variables and they have the same order of integration, *I (1)*, cointegration tests may be conducted. The results from Johansen's cointegration tests are summarised in Table 4.

Table 4 Cointegration Testing

H_0	$H_{alternative}$	Trace Statistic	Critical Values 5%	Critical Values 1%
$r = 0$	$r \geq 1$	9.3138	15.41	20.04
$r \leq 1$	$r \geq 2$	1.7975	3.76	6.65

H_0	$H_{alternative}$	Max.eigenvalue Statistic	Critical Values 5%	Critical Values 1%
$r = 0$	$r = 1$	0.3413	14.07	18.63
$r \leq 1$	$r = 2$	0.0950	3.76	6.65

Note: Reported results for tests with no deterministic trend and intercept. Similar results were found when linear or restricted trends are included and/or intercepts are allowed. All tests investigated non-stationary data series (i.e. real house prices and construction activity at level).
***Source*:** Own computation

The likelihood ratio trace test fails to reject the null hypothesis of no cointegration, i.e. $r=0$. Similarly, the maximum eigenvalue statistic cannot reject the null hypothesis of no cointegration. For the underlying sample that covers 1991 to 2007, both results are plausible. In summary, the employed limited data series of the endogenous variables show no signs of a cointegrating relationship. Therefore, construction of a vector error correction model is abandoned and only a VAR model is estimated.

4.3 Lag-Order Selection

The estimation of the lag order, *k*, in a VAR (*k*) system, is based on lag order selection statistics. As it is improbable that impulses of any of the variables included in the VAR will significantly impact the system after more than three years, the maximum lag-order is restricted to three. Table 5 reports the three information criteria, i.e. AIC, HQIC and SBIC, and a sequence of likelihood-ratio (LR) test statistics for all of the full VARs of order less than or equal to three. In conclusion, the AIC, HQIC and LR statistics suggest incorporating two lagged changes, and therefore, the estimated model will be a VAR (2).

Table 5 Lag-order Selection for VAR

Lag	LR	AIC	HQIC	SBIC
0	-	-5.979	-5.930	-5.489
1	14.659	-6.371	-6.303	-5.685*
2	9.515*	-6.460*	-6.372*	-5.578
3	4.7119	-6.267	-6.159	-5.188

Note: * Indicates the suggested lag-order.
***Source*:** Own computation

4.4 The Model

Finally, all the collected information can be gathered together to construct the following VAR (2) system:

$$\Delta hp\_c_t = \beta_1 \Delta hp\_c_{t-1} + \beta_2 \Delta hp\_c_{t-2} + \beta_3 \Delta constr_{t-1} + \beta_4 \Delta constr_{t-2} + \beta_5 \Delta cp\_c_{t-1} + \\ + \beta_7\, rir\_c_{t-1} + \beta_6 \Delta equity\_c_{t-1} + \beta_8 \Delta pop_{t-1} + \beta_9 \Delta q_{t-1} + u_t \qquad (1a)$$

$$\Delta constr_t = \gamma_1 \Delta hp\_c_{t-1} + \gamma_2 \Delta hp\_c_{t-2} + \gamma_3 \Delta constr_{t-1} + \gamma_4 \Delta constr_{t-2} + \gamma_5 \Delta cp\_c_{t-1} + \\ + \gamma_7\, rir\_c_{t-1} + \gamma_6 \Delta equity\_c_{t-1} + \gamma_8 \Delta pop_{t-1} + \gamma_9 \Delta q_{t-1} + e_t \qquad (1b)$$

4.5 Post Testing

Table 6 summarizes the results from two tests for autocorrelation of the disturbance terms. The Lagrange-multiplier test fails to reject the null hypothesis of no autocorrelation of residuals. Similarly, the Durbin-Watson test does not provide any indication for positive or negative autocorrelation of error terms at the 5 percent significance level.

Table7 reports the Jarque-Bera,skewness and kurtosis statistics. At the 5 percent significance level, all tests fail to reject the null hypothesis of normally distributed disturbances. Therefore, white noise of residuals can be concluded.

Table 6 Lagrange-multiplier and Durbin-Watson Tests

Lagrange-multiplier Test			Durbin-Watson Test	
Lag	**Chi^2**	**df**	**Equation**	**d-statistic**
1	5.122	4	1a	2.141
2	2.799	4	1b	2.577

***Source*: Own computation**

Table 7 Tests for Normally Distributed Residuals

	Jarque-Bera Test		Skewness Test			Kurtosis Test		
Equation	**Chi^2**	**df**	**Skewness**	**Chi^2**	**df**	**Kurtosis**	**Chi^2**	**df**
1a	0.875	2	.04946	0.007	1	1.8932	0.868	1
1b	4.039	2	1.0098	2.889	1	4.2743	1.150	1
Both	4.914	4		2.896	2		2.018	2

***Source*: Own computation**

Results from Granger causality tests and the goodness-of-fit parameters are reported in Table 8. The null hypothesis of no Granger causality is rejected at the 1 percent significance level in both cases.

According to the adjusted coefficient of determination (Table 8), as much as 58 percent of the house price variation is explained by the model. The explanatory power of Equation (1b) is lower (*adjusted* $R^2 = 0.36$), but still satisfactory. In comparison with recent house price studies, the estimated model does a good job. House price models typically disclose *adjusted* R^2 values approximately between 35 and 70 percent (e.g. Capozza et al. 2002, Messe and Wallace 2003, Riddel 2004, Harter-Dreiman 2004). Changes in construction are usually explained less adequately with *adjusted* R^2 values of around 50 percent (e.g. Kenny 2003).

Table 8 Granger Causality Test and Goodness-of-fit

	Granger Causality Test			Goodness-of-fit	
Equation	**Excluded**	**Chi^2**	**df**	**R^2**	**Adjusted R^2**
1a	Δconstr	10.177	2	0.815	0.578
1b	Δhp_c	10.272	2	0.720	0.361

***Source*: Own computation**

4.6 Some Warnings

The VAR systems, as in almost every econometric methodology, have their weak points. First, as stated by Cochrane (1994), the propagation mechanism is a crucial issue. In order to understand a shock, it is indispensable to determine its influences on the system. Unfortunately, in many cases, there is more than one propagation mechanism that results in the same response and controlling for some impulses is virtually impossible, because of the complexity of real world. Secondly, economic agents and policy makers who possess substantial information advantages are able to base their predictions on more variables than those included in a VAR system. On this account, one must be aware that shock identification and evaluation based on simplified stylized features have only limited explanatory and predictive power. In addition, there is the problem of linearity: shocks equal in magnitude, but of opposite signs may impact the endogenous variables in an asymmetrical way. Kenny (2003), for instance, presents evidence for asymmetrical properties of housing supply responses. Finally, the existence of truly exogenous shocks is disputable. As pointed out by Cochrane (1994): "(…) the imperialistic march of economics makes events truly outside the economic system rarer every day". Traditionally believed to be true exogenous shocks, even the actions of policy-makers are in fact, as described by the Federal Reserve System, only responses to events and not randomised experiments.

5. Empirical Results

5.1 House Price and Construction Activity Drivers

The estimated parameters of the proposed modelling approach are reported in the second and third columns of Table 9. Despite the employment of rather short datasets, plausible and significant results are attained.

House price changes are most sensitive to population. A 1 percent increase in population growth at a specific household formation age, i.e. 20 to 64 age cohort, results in 2 percent higher house price growth. This is presumed to be mainly caused by the heavily constrained housing supply; the market can adjust in the short run only by increasing house prices. The second most important house price driver is the change in construction costs. An appreciation of construction costs leads roughly to equal increases in prices of dwellings. This may suggest the very high market power of Swiss property developers; an increase in construction prices is fully transferred to the buyers. This finding may be caused by relatively low competition in the Swiss real estate economy, which is dominated by a few large developers. Moreover, contracting foreign developers is heavily restricted, especially with regard to foreign labour employment in the construction sector. Next, a 10 percent rise in equity prices is followed by a 1.4 percent house price appreciation. Rising supply, e.g. a 10 percent increase in the number of completed dwellings during one year, results in house price deflation equal to 1.2 percent during the following year and 0.6 percent two years thereafter. Subject to the sluggish supply responses to overall changes in the housing economy, this negative impact is notoriously important for the cyclical shaping of house prices. Interestingly, house prices drop only by 0.7 percent after real interest rates increase by one percentage point. Possibly, the explanatory power of the relatively stable and low Swiss interest rates is limited. Finally, improvements in quality of new constructed or modified dwellings have a highly significant positive impact on residential property prices. However, the influence is only marginal. The quality index is possibly biased downwards because it does not incorporate quality improvements of surroundings (e.g. improvements in infrastructure).

Table 9 Model Estimation

	Base Model (Equations (1a and 1b))		Base Model Without Quality Index		Base Model Extended by GDP Growth and Restricted to First Lags
	Δhp_c_t	**$\Delta constr_t$**	**Δhp_c_t**	**$\Delta constr_t$**	**Δhp_c_t**
Δhp_c_{t-1}	0.504** (0.234)	2.664*** (0.959)	0.520* (0.274)	2.634*** (0.993)	0.319 (0.229)
Δhp_c_{t-2}	0.456** (0.196)	1.956** (0.804)	0.462** (0.229)	1.945** (0.833)	-
$\Delta constr_{t-1}$	-0.116*** (0.042)	0.401** (0.173)	-0.087* (0.047)	0.349** (0.173)	-0.126*** (0.047)
$\Delta constr_{t-2}$	-0.065 (0.042)	-0.236 (0.173)	-0.077* (0.049)	-0.212 (0.178)	-
Δcp_c_{t-1}	1.039*** (0.312)	-3.540*** (1.279)	0.702** (0.329)	-2.918** (1.196)	1.025*** (0.312)
rir_c_{t-1}	-0.00745*** (0.001)	-0.01829*** (0.006)	-0.00759*** (0.002)	-0.01829*** (0.006)	-0.00802*** (0.002)
$\Delta equity\_c_{t-1}$	0.145*** (0.023)	0.268*** (0.094)	0.123*** (0.025)	0.310*** (0.090)	0.102*** (0.024)
Δpop_{t-1}	2.055** (1.014)	11.366*** (4.160)	3.137*** (1.075)	9.369** (3.904)	2.225** (1.086)
Δq_{t-1}	0.00037** (0.00015)	-0.00068 (0.00060)	-	-	0.00037** (0.00016)
Δgdp_c_{t-1}	-	-	-	-	0.466 (0.321)

Note: Standard errors in parentheses. *, **, *** indicate 10%, 5% or respectively 1% significance levels.
***Source*:** Own computation

The construction activity is mainly driven by population growth, construction price changes and house price dynamics. Increased population growth rate by 1 percent is followed by a remarkable 11.4 percent increase in construction activity. This sharp rise can be seen as a counterforce to the price increases after a higher population growth rate is observed. A 1 percent decrease in construction costs results in a 3.5 percent rise in construction activity whereas increasing house price by 1 percent stimulates the residential construction activity and leads to a 2.7 percent increase in completed residential development after one year and 1.9 percent after two years. Worsening conditions on capital markets, for instance, a one percentage point increase in real interest rates lowers the construction activity by 1.8 percent. Rise in equity prices by 10 percent leverages housing development by 1.2 percent. The positive impact of equity price changes on residential development can be presumably explained by a higher capital transfer to the housing development sector, followed after capital gains on the stock markets have been realised. Lastly, the results suggest a marginal negative impact of quality improvements on residential development. Presumably, the necessity of supplying housing space of better quality is a disincentive for construction activity. However, the effect is statistically not significant.

In order to test for robustness of the results, the self-constructed quality index has been excluded from the base model. The results of the restricted model are depicted in the fourth and fifth columns of Table 9. The estimated parameters of the amended model do not diverge significantly from the base model parameter estimates. Hence, the quality variable has not substantially biased the results.

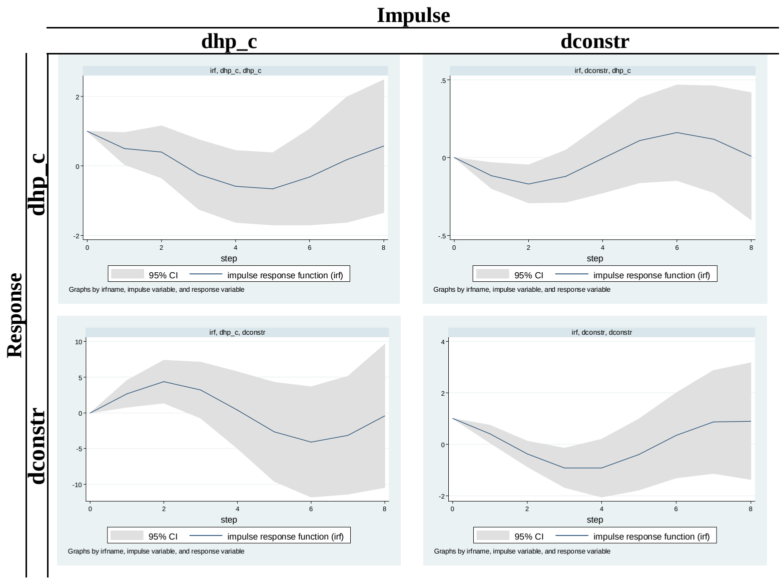
According to recent empirical studies, real GDP growth is an important house price driver. Therefore, a further amendment to the base model was made and a CPI adjusted GDP growth series was included.[8] The last column of Table 9 presents the estimated elasticities. In order to leverage the significance, only the first lag of the endogenous variables is included in the model. However, the significance of real GDP growth is still quite low. The estimated house price elasticity relative to real GDP growth is statistically significant only at the 15 percent significance level and suggests a 0.47 percent increase in real house price after a 1 percent rise in real GDP growth. A possible explanation for the low size and significance may be the comparatively very low Swiss home owner occupancy rate which implies that rising incomes lead mainly to increases in the rents and the impact on house prices is lagged and indirect.

5.2 Dynamics of the Housing Market

Cyclical dynamics of growth rates in house prices and construction activity changes after unanticipated shocks are presented by means of impulse-response functions (IRF) and cumulative impulse-response functions (CIRF) in Figures 4 and 5 respectively. After an internal shock to either of the variables, the autocorrelation is positive during approximately first two years. Afterwards, a negative effect can be observed for about four years before a reversion to positive growth rates takes place.

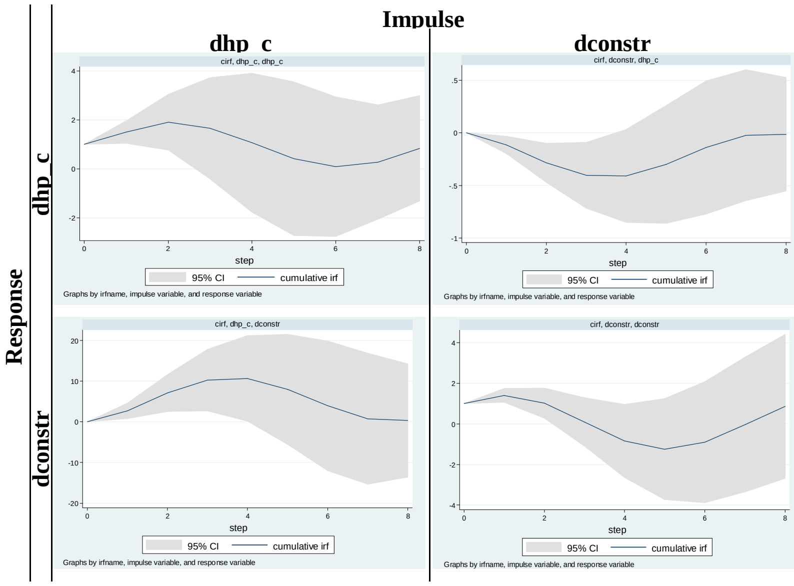
[8] Unit root tests (ADF and PP) suggest that real GDP is integrated of order one, i.e. *I(1)*.

Figure 4 Impulse-response Functions of Endogenous Variables



***Source*:** Compiled by the author

Figure 5 Cumulative Impulse-response Functions of Endogenous Variables



***Source*:** Compiled by the author

The explanation for this varying impact may be the contrarian interaction between both variables. The CIRF illustrates the remarkable sinusoid relationship and the long-term effect, i.e. eight years after the shock, of an approximate 0.9 percent increase in either variable.

An interesting result is the lack of a long-term impact on housing stock output after a house price shock and vice versa. During the first four years, a positive shock on house prices leads to growing construction activity by up to 10 percent, until the effect reverts and a contraction in residential property development takes place. Presumably, the increased residential construction growth leads to oversaturation on the market, and downsizing of development activity follows. The response of house price changes to a shock on construction activity is similar, although less distinct and with opposite sign. The positive impact after four years can be presumably explained by the intertemporal reversion to negative growth of construction activity that causes house price appreciation.

5.3 Relative Importance of Housing Market Drivers

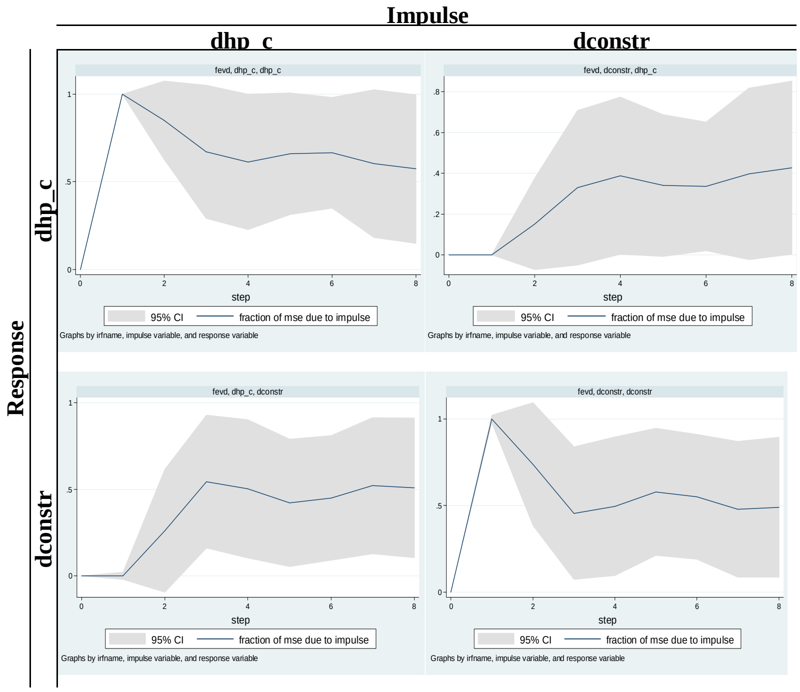
The effects of a house price growth shock on construction activity dynamics and vice versa are lagged by one year (Figure 6). After around three years, the intervariable relationship explains up to half of the dynamics of the other variable. The other approximate halves of the movements are explained by autocorrelation of either endogenous variable.

5.4 Investigation of Overvaluation

Figures 7 and 8 depict the predicted and actual development of house prices and construction activities, respectively. Apparently, the fitted values are a good prediction of the housing market, which suggests appropriate model specification. The only exception is the divergence that takes place in the time period of 1992 to 1994 when the prediction of the construction activity is biased upwards. This is presumably caused by failing to incorporate in the model, the introduction of sanctions that negatively impacted the housing economy in the early 90s.

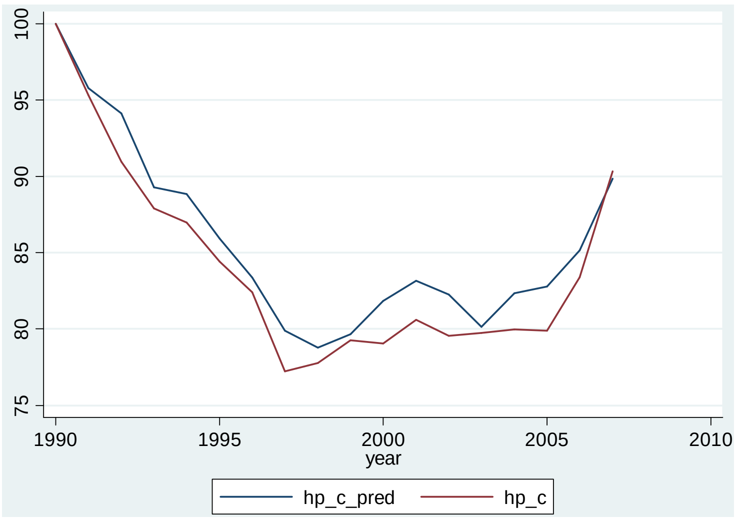
The estimated prediction does not suggest any overvaluation of house prices. However, in the most recent two years, house prices have appreciated much stronger than warranted by the fundamentals. In addition, the construction activity is slightly under supply. Do these findings warrant reasons for worry about future overvaluation?

Figure 6 Variance Decomposition of Endogenous Variables



***Source*:** Compiled by the author

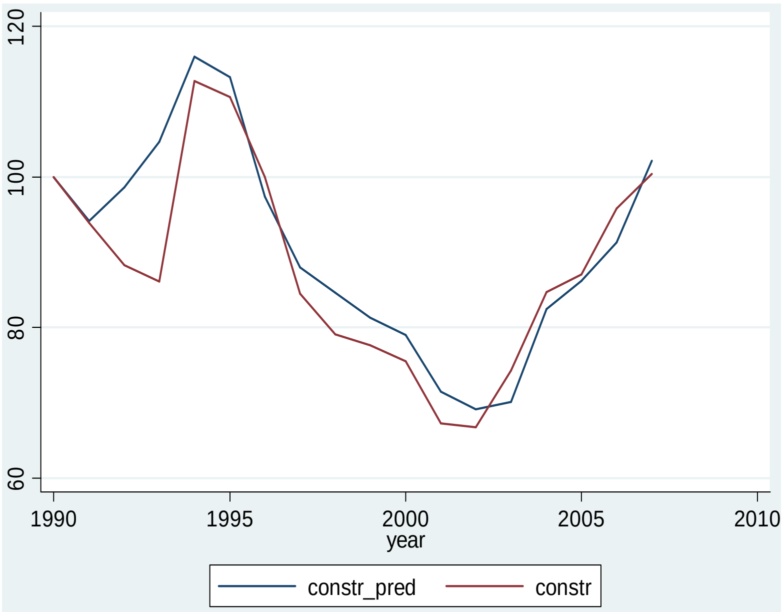
Figure 7 Predicted and Actual House Price Dynamics



***Source*:** Compiled by the author

Determined by the conservative fiscal and regulatory approach of Swiss authorities towards the housing market, the risk of house price bubbles is presumably a minor problem. Furthermore, during the last three years, the number of authorised residential developments is growing faster than the number of completed housing construction. Therefore, the construction projects that are presently in the pipelines will soon arrive on the market and possibly meet the suggested supply levels. Moreover, the present global economic downturn is also impacting the Swiss economy and may foreshadow some downward pressure on house prices.

Figure 8 Predicted and Actual Construction Activity Dynamics



***Source*:** Compiled by the author

6. Conclusion

This paper mainly contributes as an econometric study of the Swiss housing economy. Based on observations from seventeen years, i.e. during 1991 to 2007, a VAR model is created in order to reproduce the housing economy. The selected data series explain the ways that house prices are affected through wealth and the banking channel and by demographic and real estate changes. Conditional on a comparatively broad set of considered fundamental determinants, real house prices and construction activity are shown to be most sensitive to changes in population and construction prices. In contrary to recent empirical findings from other countries, real GDP turns out to have only limited explanatory power. In addition, based on a self-constructed quality index, evidence for a positive impact of quality improvements in supplied dwellings on house prices is provided albeit the effect is only marginal. Furthermore, impulse-response functions suggest that exogenous shocks on house prices have no long-term effects on construction activity. Analogously, exogenous supply shocks do not impact, in the long-run, house prices. Hence, authorities that stimulate the national economy by, for instance, subsidising housing construction, should not worry about long-term house price increases. Lastly, the results do not provide signs of any overvaluation on the housing market.

It must be highlighted that the real estate economy is a very local issue and each empirical study with a national approach may be biased because of the remarkably heterogeneous nature of real estate. Even in a comparatively small country, such as Switzerland, substantial differences may exist between various regions. Moreover, the estimated house price elasticities, especially with respect to demographic changes, may be prone to substantial differences caused by a varying demand of various age cohorts for different kinds of residential property (e.g. family house, urban-flat, holiday home). Furthermore, the results may be affected by future expectations of housing market participants or psychological biases. If households expect price increases in the housing market, they may not be willing to sell at present, thus only “lemons” would remain on the market. This would lead to price drops, despite an actual rise in value caused by expectations of future price appreciation. In a different situation, when housing prices are in a downturn, households may not be willing to sell under the nominal price at which their dwelling was purchased in the past. Consequently, the actual market price would again be biased. Clearly, further research is necessary for a better understanding of the variations in demand for different kinds of properties and of the differences between regional housing economies. Also, further academic investigation of psychological biases of households with regard to real estate transactions is needed.

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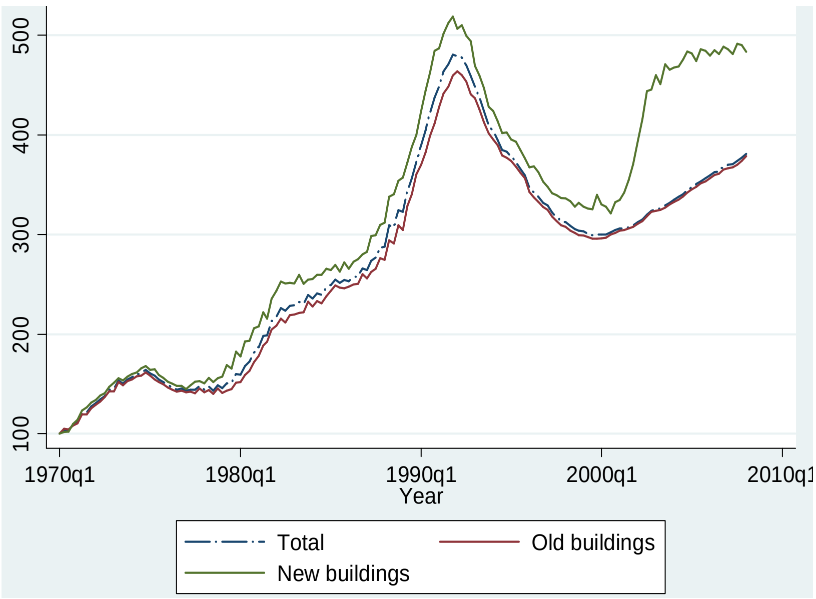
Appendix 1 Computation and Discussion of Swiss Quality Index

Computation of a quality index based on fundamentals is an extremely complex and ambiguous process, as it depends on a subjective selection of a broad set of fundamentals. Therefore, instead of a structural derivation, the quality index is computed in an indirect way based on New, Old and Total Real Estate Price Indices from Wuest & Partner.

The hedonic Wuest & Partner price indices are based on several observed characteristics, such as area and number of rooms of a dwelling or on a set of dummy variables for the presence, for example, of a garden, a swimming pool or air conditioning. Therefore, it does not incorporate numerous unobserved criteria, such as design of the garden, dispatch of the swimming pool or quality of the air conditioning. Such characteristics are presumably of higher quality in new or modified dwellings and solely controlling for the year of construction is not sufficient as the difference in quality between new or modified and old dwellings may not be constant over time. Figure A.1 seems to provide support for the made assumptions and exhibits evidence for a rising difference over time between prices of new and old dwellings.

Figure A.1 New, Old and Total Housing Price Developments



***Source*:** Wuest & Partner

In the following, it is assumed that the rising difference is due to a relative rise in the quality of newly constructed or modified residential properties. In other words, the rising difference between both indices is a measure of the "amount of new housing quality" that arrives on the market during a time period.[9] Based on that assumption, a proposition is made with the following computation of the quality index:

$$q_t = (new\_dwellings_t \ / \ total\_dwellings_t) * (hp_{N,t} - hp_{O,t}), \qquad \text{(A.1)}$$

where quality at time period t, q, equals the weighted difference between new housing price hp_N and old housing price hp_O.The weighting(i.e.$new\_dwellings_t$ $/total\_dwellings_t$)is needed for considering the relative share of completed dwellings that accounts for the importance of price differences in a time period.

First, the weighting, i.e. the relative share of new dwellings in a time period, will be estimated by using the following Wuest & Partner formula for total real estate prices:

$$hp_T = (new\_dw / total\_dw) * hp_N + (old\_dw / total\_dw) * hp_O, \qquad \text{(A.2)}$$

It is possible to depict the share of new dwellings in the housing market as follows:

$$new\_dw / total\_dw = (hp_T - hp_O * (old\_dw / total\_dw))/ hp_N, \qquad \text{(A.3)}$$

where hp_T is the total housing price.[10] Inputting Equation(A.3)into(A.1)we get:

$$q = [(hp_T - hp_O * (old\_dw / total\_dw)) / hp_N] * (hp_N - hp_O). \qquad \text{(A.4)}$$

In the next step, $old\_dw / total\_dw$ needs to be computed. Obviously, old and new dwellings sum up to total dwellings, i.e. $new\_dw / total\_dw = 1 - old\_dw / total\_dw$. Hence, the following equation holds

$$a * hp_O + (1 - a) * hp_N = hp_T, \qquad \text{(A.5)}$$

where a is the relative share of old dwellings and can be noted as follows:

$$a = old\_dw / total\_dw = (hp_T - hp_N) / (hp_O - hp_N). \qquad \text{(A.6)}$$

Finally, the quality index can be attained after Equations (A.4) and (A.6) are linked, i.e.:

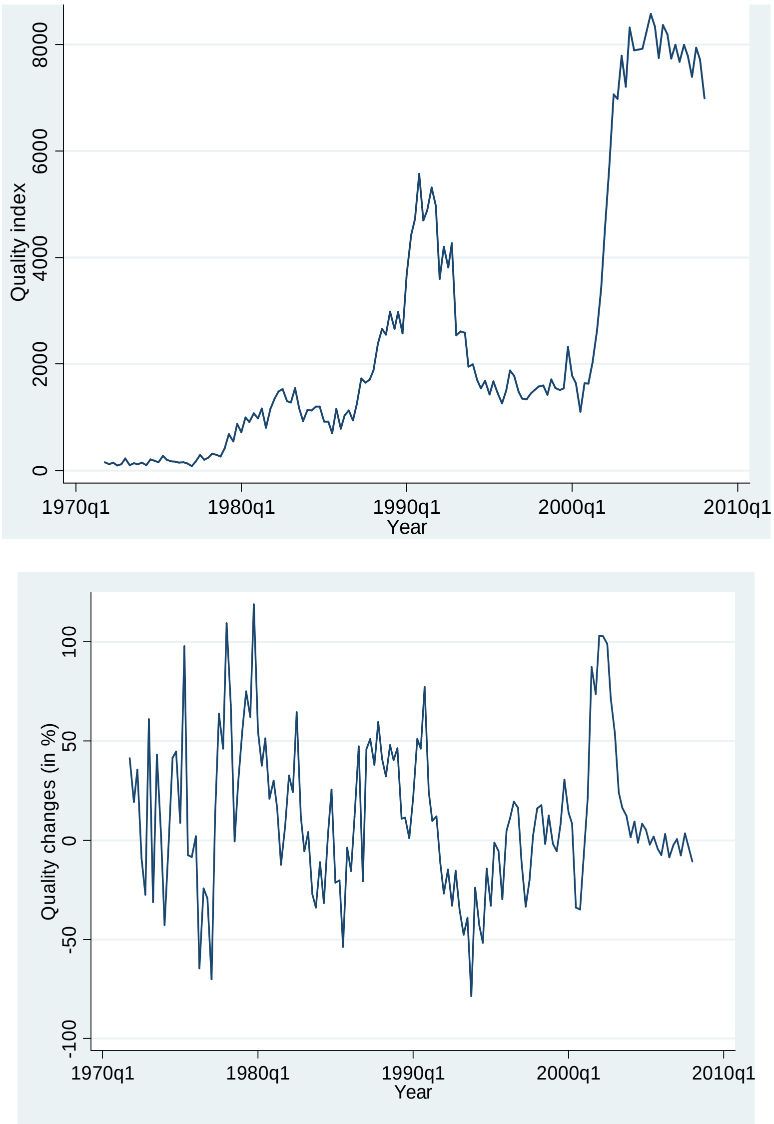
$$q = [(hp_T - hp_O * (hp_T - hp_N) / (hp_O - hp_N)) / hp_N] * (hp_N - hp_O). \qquad \text{(A.7)}$$

Figure A.2 displays the development of the quality index and its dynamics since 1971. A long-term upward trend and a rather high variation in the supplied housing quality can be observed.

[9] Note that qualitative improvements of the surroundings of dwellings, e.g. better public transport system or less air pollution, which presumably affect old and new dwellings in the same way, are not taken into consideration.

[10] For simplicity, time indices are abandoned.

Figure A.2 Swiss Quality Index and Quality Dynamics



***Source*:** Own computation based on Wuest & Partner Real Estate Price Indices

The depicted quality index suggests a clear increase in the quality of supplied dwellings until the early 90s, presumably caused by improvements and innovations in the building sector. In the remainder of the 90s, the quality of constructed or modified dwellings decreased. It is possible that during the difficult period of property price deflation, the building companies needed to economise on construction costs and cut back on quality standards of the supplied dwellings. In the years 2001 to 2004, i.e. after the real estate crisis, the building industry became more attractive and property developers might have experienced harsher competition. Presumably, in order to outcompete competitors, construction firms supplied dwellings of significantly higher quality. Hence, a substantial rise in the quality index can be noticed. Since around 2005, the newly constructed or modified dwellings are characterised by high quality standards.

Can the difference between new and old house prices (see comparison in Equation A.1) be attributed to differences in the relative demands? New and old dwellings are both normal goods. Therefore, their relative demand curves should devise similar elasticities with respect to all house price determinants. Rae and van den Noord (2006), however, argue that there exist some minor differences between new and old house price elasticity relative to real disposable income. On the other hand, Rae and van den Noord (2006) do not control for quality dynamics. Hence, the real cause of the different elasticities remains a mystery.