Does strong Regulation help the Swiss Real Estate Market?

Thomas ANKENBRAND
ta@avaco.ch
Faten BEN BOUHENI
faten.ben_bouheni@telecom-em.eu

Abstract

The real estate market in Switzerland is attracting much attention at the moment as fears about the formation of a bubble and a subsequent crash are increasing. We analysis the Swiss real estate market using Agent-based modeling (ABM) from December 1986 to September 2014. Thus our model combines explicit knowledge of behavioral patterns of the agents with implicit knowledge in the form of time series analysis. Our findings show a high degree of reliability and indicate that the Swiss real estate market is in a rather weak condition. In the absence of positive market forces, the market has a tendency towards a negative correction. In addition, the past cycles in the real estate markets of different countries show that, first, as real estate markets tend to be subject to cyclical behavior, an up or down movement of prices is much more likely to occur than a sideways movement. The upward and downward price phase of real estate cycles tend to be symmetric concerning their duration and slope. From these insights we conclude that if the past long-term trend of increasing prices in the Swiss real estate market stops, a hard landing must be expected. Second, a long-term decline of real estate prices is the most probable scenario once the tipping point has been reached. Finally, we discuss the possible influence of the new regulation on Swiss real estate market and compare the situation with the crisis in the 90nties.

Keywords: Agent-based modeling, Swiss real estate market, Regulation
JEL classification: C63, G170, R20

1. Introduction

The issue of real estate market and the behavior of its actors become a fertile field of research since the recent subprime crisis of 2007/2008. The influence of the last real estate crisis in Switzerland were severe in 90nties. This paper aims to analysis the Swiss real estate market which may help regulators to take the right decision, using an Agent-based modeling (ABM) of the Swiss real estate market and the analysis of the past real estate crisis in Switzerland.

Whereas the majority of agent-based models focus on financial markets, we have adjusted the ABM to the Swiss real estate market. Due to technological, economic, social, cultural, and political development, individuals, organizations, and institutions are inevitably facing constant change in their everyday actions (Toivonen and Viitanen, 2015; McBlain and Vrkic, 2006).

Real estates and the actions related to them affect the surrounding environment remarkably. Indeed, the environmental impact caused by real estates is significant. The building and real estate sector is the biggest individual user of fossil fuels (Elfving, 2009). According to calculations, approximately 40% of the world's primary energy-use is from buildings (UNEP, 2007). The Swiss real estate market is very important. A significant amount of private and public wealth is bound in real estates. The value of the Swiss building stock is around CHF 2.54 Trillion (Staub, 2014).

We emphasize on the Swiss real estate market because risks to this market increased "marginally" in the second quarter of 2014 as growth in home prices and mortgages outpaced that of income (Bosley, 2014)[1]. The Swiss National Bank's (SNB) expansive monetary policy has kept down the cost of taking out a mortgage, leading to a strong rise in residential property prices. Over the past year, mortgage growth exceeded that of the economy. At its policy review in June, the SNB urged banks to allot credit prudently (Bosley, 2014). Two decades ago, an overheating of the real estate market led to bank failures. To prevent Switzerland from suffering a real estate market crisis similar to that of the 1990s, the government has required banks to build up capital in the form of a buffer to make them more resilient to write-downs. The countercyclical buffer was doubled to 2 percent of mortgage-related assets in January 2014, with banks given until the end of June to comply. The buffer, which the government implemented at the behest of the SNB, can be raised as high as 2.5 percent (Bosley, 2014).

Despite growing interest toward research in the real estate market since the subprime crisis of 2007/2008, there is still a lack of an interdisciplinary and multidimensional analysis concerning the future real estate market in each country because each real estate market has its specific features.

Our approach is quite different and leads to new insights and applications. We use market data to verify the assumptions and the design of the ABM. The similarities of the Agent-based model and the real estate market are measured by comparing the price time series of the artificial and the real market. Introducing a number of ad hoc parameters one could get a more realistic and reliable model. The parameters are obtained from past time series observation in the Swiss real estate market which the agents can use for their trading decisions. This allows to integrate different partial theories especially coming from the micro or agent level or the macro level of the markets and to test this hypothesis about the structure and the development of the real estate market. (Ferber, 1994).

1.1. The Swiss real estate market

The real estate market in Switzerland is attracting much attention at the moment. Whereas over the past few years rising prices have led to high returns for investors and very little defaults for creditors, more recently concerns about the formation of a speculative bubble followed by a corresponding correction have increased. The real estate market in Switzerland is characterized by illiquidity and high transaction costs. The consequences of a real estate crash are dramatic for everyone involved, and it takes years to recover. The established risk management practice is to focus on the acquisition phase of new real estate objects. Effective adjustments to an

[1] "Swiss Real Estate Market Inches Closer to Bubble, UBS Says », Aug 5, 2014. Bloomberg.
http://www.bloomberg.com/news/2014-08-05/switzerland-s-property-market-inches-closer-to-bubble-ubs-says.html

already existing portfolio are only possible in a relatively stable market environment. Otherwise they can come at a very high price with the added risk of unwanted counter effects, for instance lowering market prices by selling high volumes of real estate objects. For this reason, strategic planning over a time horizon of five to ten years is essential. Doing so again requires adequate forecasting and analysis tools that offer more than simple single measure forecasts, and instead can capture the complex, dynamic dependencies between the various constituent market factors. This is where simulation models can help. ABM generates virtual worlds for what-if scenario analysis and stress testing.

1.2. Past Real estate crisis in Switzerland

The Swiss National Bank decreases the interest rates 1987. The goal was to weaken the Swiss Franc and to stimulate the economic grow after the stock market crash. In addition the money aggregate was technically expanded with the Swiss Interbank Clearing. The retail banks try to increase their volumes with low prices and expand their risk parameters. Real estate was in the general opinion a safe investment with no risk. Also the pension funds have increased their real estate investments (Pfiffner, 2011).

The inflation rate and the interest rates were beginning to rise since 1988. Three new laws should reduce the speculation. The subject was an introduction of a blocking period for trading of properties and a limit of loan to value of properties. The third law sets a limit for pension funds for investing in real estate. The result was a sharp correction of the real estate markets and increasing write-downs in the balance sheets of the banks (Pfiffner, 2011).

1.3. Agent-based real estate market models

Several studies describe agent-based models of housing markets (Geanakoplos et al. 2012; Jordan et al. 2012; Gilbert et al. 2009). Most of these models were built with the intention to help explain observable patterns such as spatial and social segregation, or spatial and temporal distributions of housing prices. These models typically combine demographic factors such as age distribution or family size with economic factors such as wealth distribution, income or level of debt. Sometimes, also psychological factors are included, for example value structures or changing fashions. From all these factors, agent behavior rules are deduced. Most of these models rely on a grid-like or map-based settlement representation with individual parcels and houses. Hedonic modelling, which also focuses on single real estate objects, is yet another, more traditional approach on which many real estate market studies rely. These studies typically try to derive information from aggregated data on real estate objects in a certain region or during a certain time period.

From the study of the Swiss real estate market, using both of the model of quality measures and the scenario analysis based on the rise of interest rates, we have been able to make a few conclusions that seem worthy of discussion. Among these are the following: (1) the presented Agent-based model has a high degree of reliability. (2) The scenario analyses indicate that the Swiss real estate market is in a rather weak condition. In the absence of positive market forces, the market has a tendency towards a negative correction, which becomes more poignant in the presence of negative market forces such as rising interest rates. In the simulated scenarios, increasing interest rates can lead to a strong negative correction of the real estate markets.

The paper proceeds as follows. Section 2 presents the literature review, section 3 exposes the methodology and data of the Agent-based model, section 4 analysis of the cycles and regulation, section 5: the main findings and in section 6, we conclude.

2. Literature review

2.1. Real estate market

Toivonen and Viitanen (2015) present the different forces of change affecting the commercial real estate market in the Helsinki Metropolitan Area in Finland using the environmental scanning method. They find that different actors working with real estate and land use issues can benefit from this knowledge in far reaching planning over these issues. Actors are able to make better decisions and prepare themselves for the future. The authors conclude that because of the constant changes happening in the action environment, the need to foresee and evaluate future requirements and demand set to real estates will only increase in the future. Moreover, Hatemi et al. (2014) investigate the extent by which real estate markets are integrated with the world market. They apply a case-wise bootstrap analysis on a sample of the real estate markets of the US, UK, Japan, Australia and the UAE especially during periods of distress. Their findings show that all five markets are integrated with the world market — with the US and UK markets being the most internationally integrated real estate markets and UAE being the least. Their results also demonstrate that the US subprime crisis has a different effect on the real estate markets. They find that the US real estate market crisis made the US and UAE real estate markets to be more integrated internationally but resulted in the Japanese market becoming less globally integrated. On the other hand, the crisis did not affect the extent of integration of the Australian and UK markets with the world market, whether it is with the world stock market or the world real estate market. They conclude that global market risk should be priced in real estate investments, and that international shocks such as the US sub-prime crisis have a differential impact on different real estate markets.

Geipele and Kauskale (2012) provide empirical evidence using daily data for stock prices for 17 real estate companies traded in the Sao Paulo, Brazil stock exchange, from August 26, 2006 to March 31, 2010. They use the U.S. house price bubble, financial crisis and risk measures to instrument for momentums and reversals in the domestic real estate sector. They find evidence of conditional premium persistence and conditional volatility persistence in the market. They find also that the conditional risk-return relationship in the sector is consistent with the prospect theory of risk attitudes in this period. They conclude that certain companies seem to be operating on a perceived potential industry return above the target, while most others are below the target, and the whole sector is below target on average.

Zhou and Sornette (2008) analyze 27 house price indices from June 1983 to March 2005. Their analyses confirm the existence of a real estate bubble. This bubble is found, however, to be confined to a rather limited time interval in the recent past from approximately 2003 to mid-2004 and has progressively transformed into a more normal growth rate in 2005. Their data up to mid-2005 suggest that the current growth rate has now come back to pre-bubble levels. The authors conclude that there has been no bubble from 1990 to 2002 except for a medium-sized surge in 1995, then a short-lived but very strong bubble until mid-2004 which has been followed by a smoothed transition back to what appears to be normal. In addition, they have identified a strong yearly periodicity which provides a potential for fine-tuned prediction from month to month. As the intra-year structure is likely a genuine non-artificial phenomenon, it offers a remarkable opportunity for monitoring in real time the normal versus abnormal evolution of the market and also for developing forecasts on a monthly time horizon. In particular, a monthly monitoring using a model that we have developed here could confirm, by testing the intra-year structure, if indeed the market has returned to ‘‘normal’’ or if more turbulence is expected ahead. In addition, it would provide a real time observatory of upsurges and other anomalous behavior at the monthly scale (Zhou and Sornette, 2008).

2.2. Agent - based modelling (ABM)

The majority of agent-based models focus on financial markets and price dynamics, which emerge through the interaction of heterogeneous agents. Such models have been quite successful in replicating and explaining some intriguing features of the financial market, such as endogenous bubbles and crashes as well as stylized facts of return time series including volatility (LeBaron, 2006, Hommes, 2006, Chiarella et al., 2009, Hommes and Wagener, 2009, Lux, 2009, Fischer and Riedler, 2014). The model introduced in Raberto et al. (2012) takes a macroeconomic perspective and mainly focuses on the lending channel of banks. However, the model presented in Thurner et al. (2012) focus on the effects of leverage on returns, which they find to produce fat tails and clustered volatility.

Recently, Fischer and Riedler (2014) develop an ABM of the financial market across countries where agents are endowed with balance sheets that contain equity capital as well as debt. The authors find that the empirically observable log-normal distribution of bank balance sheet size naturally emerges and that higher levels of leverage lead to a greater inequality among agents. Furthermore, greater leverage increases the frequency of bankruptcies and systemic events. Credit frictions, which are define as the stickiness of debt adjustments, are able to explain a key difference in the relation between leverage and assets observed for different bank types. Lowering credit frictions leads to an increasingly procyclical behavior of leverage, which is typical for investment banks. Nevertheless, the impact of credit frictions on the fragility of the model financial system is complex. Lower frictions do increase the stability of the system most of the time, while systemic events become more probable. Moreover, Was and Lubas (2014**)** propose a method for creating realistic and effective models of crowd dynamics, which takes into account the Agent-based modelling combined with non-homogeneous and asynchronous Cellular Automata, dedicated for specialized engineering aims. On the basis of bibliographical research and their previous experiences. They conclude that the use of the Agent-based approach makes it possible to apply different scenarios and situational contexts, namely competitive and non-competitive evacuation or free movement of pedestrians.

Arfaoui et al. (2014) proposes an agent-based model to study the impact of the European regulation the REACH (Registration, Evaluation and Authorization of Chemicals) on industrial. They note that (1) stringency is the most determining feature of policy design (timing is also decisive but it appears to be of secondary importance); (2) technology substitution that brings radical technological change and significant pollution reduction is possible only if regulation is stringent enough but after many sacrifices, especially in terms of market concentration and number of failures; and (3) soft regulation does not lead to technology transition because of weak incentive and selection effects.

3. Methodology and data

3.1. Agent-based model

In this paper, we use AVACO Model. The model intends to create a real estate market of Switzerland. This type is often referred to as artificial market. It analyze a small number of agents with their strategies. It is more analytic than computational (LeBaron, 2006). In AVACO's agent-based real estate market model traded goods are real estate market indices (Kostadinov 2013). Based on a set of fundamental and technical input parameters, agents take a decision to either buy or sell such an index. From the combination of all agents' buy and sell decisions, a market forecast is deduced, which can effectively be used for trading and/or risk management.

Market participants are limited in their knowledge about their environment and their computing power. The agents are bounded rational because of this limitations. They are using simple reasonable rules of thumb for the decision under uncertainty instead of rational optimal decision rules (Simon, 1957). Hommes (2006) gives an overview of the discussion.

In the model, agents are grouped in three different classes representing real-world investors: Institutional investors, private residents or self-users and trend followers or speculators. Depending on their class, agents invest in either the SWX IAZI Investment Real Estate Price Index (SI Investment PR; IAZI, 2013a), and/or SWX IAZI Private Real Estate Price Index (SI Private PR; IAZI, 2013b). To make trading decisions, they rely on a set of both technical and fundamental factors based on the movements of different time series[2]. Their decision includes whether to buy or sell the index or alternatively to take no action. Table 1 gives an overview on all agent classes, the index they trade and the time series they use as input decision factors.

[2] Data sources: Swiss rental price index provided by Bundesamt für Statistik (2013), Swiss Bond Index published by Neue Zürcher Zeitung, MSCI World Index by MSCI (2013).

Table 1: Agent classes, traded indices and input decision factors

Agent class	**Institutional Investors**	**Private residents/ self-users**	**Trend followers/ speculators**
Characteristics	• Insurance companies, pension and real estate funds • A mid- to long-term investment perspective • Low leverage • Investment in property as an alternative to bonds or stocks • Perform technical and fundamental analysis	• Potential land- and house owners who buy real estate for their own, private use • A long-term perspective	• Trade real estate for speculative reasons • Always follow the markets' trends • Short-term investment perspective • Rely on technical analysis
Market/ traded index	• SI Investment PR	• SI Private PR	• SI Investment PR • SI Private PR
Decision inputs	• SI Investment PR • Swiss rental price index • Swiss Bond Index • MSCI World Index • Swiss population	• SI Private PR • Swiss rental price index • Swiss Bond Index	• SI Investment PR only or SI Private PR only

Source: Kostadinov and Ankenbrand (2013a)

The simulation is 'round-based' with a round equaling a quarter. Each round/quarter, agents re-evaluate the current situation based on their sources of information and make a decision whether to buy or sell an asset. They then register their trade orders with a virtual market maker agent. Once all agents have placed their orders, the market maker clears the market. From all buy and sell orders of an index, a forecast is computed. This forecast constitutes the model's collective guess. A wealth effect is also in place. Agents trading successfully for some time accumulate more wealth than others. As time goes by, they start trading higher volumes. As a consequence, their influence on the virtual market or forecast increases. This allows modeling the drift component (changes) of the market resulting from innovation, regulation, etc. (Kostadinov and Ankenbrand, 2013a)

Agent-based modeling generates virtual worlds for what-if scenario analyses and stress testing. Agent-based modeling and simulation reproduces the complex patterns found in real-world markets. To do so, the relatively simple behavioral structures of individual market participants – the agents – are simulated and combined to a more complex international market setting. In this framework, agents decided to either buy or sell a certain financial product based on a set of fundamental and technical input parameters. Combining all agents' decisions, a market forecast is deduced, which can effectively be used for trading and/or risk management. This approach allows us to develop a dynamic, non-linear model, comprising multiple input factors. It combines explicit knowledge of the agents' behavioral patterns with implicit knowledge in the form of time series analysis.

The trading process is iterated, and consists of the following steps:

- Decision and order placement of the agents
- Calculation of the price
- Accounting of the orders in the book of the agents

First, every agent places his buy or sell orders in the order book of the desired market. The order book contains all orders of specific asset. The agents can only use market orders. Actually no limit or conditional orders are supported by the model environment. Our simulation is 'round-based'. All agents constantly re-evaluate the current (market) situation based on their sources of information and hence decide whether to buy or sell an asset every single month. Next, they register their trade orders with a virtual market maker agent. Once all agents have placed their orders, the market maker clears the market. A price forecast is then computed from the total of all buy and sell orders. (Kostadinov and Ankenbrand, 2013a)

In the model, price calculations are based on demand and supply of each particular asset under consideration. They evolve according to Equation 1:

$$\boldsymbol{y_{t+1} = p_t + \alpha \frac{D(t) - S(t)}{D(t) + S(t)}}$$

Where *p* is the respective time series and *y* is the predicted or artificial time series. *D* is the demand and *S* is the supply of each asset provided to the market by the agents. The market is never in equilibrium. The adaptation of the market is depending on $\boldsymbol{\alpha}$. The market can be a long time far away from an equilibrium price. This leads to the question and third step how to handle the excess demand or supply (LeBaron, 2006).

The third and last step of the trading cycle is the clearing and the accounting of the executed orders: The assets and the cash are added or removed to or from the account of the agents based on the realized price. Moreover, the new value of the cash and asset portfolio is calculated for every agent. Next, a new cycle begins with the placement of the orders of the agents based on their trading rules. All orders that are placed are also executed once every trading cycle because there exists a market maker for every market, who has the obligation to execute the difference of buy and sell orders for his own account (LeBaron, 2006). The buy and sell orders of the investors and technical traders do not match normally. The excess demand or supply is managed over the inventory of the market maker, who adapts the price based on the net excess. This leads to another foundation of the pricing Equation 1 (Hommes, 2006). To make trading decisions, the agents in our model rely on a set of both technical and fundamental factors based on past movements of different time series. They decide to either buy or sell an asset, or to take no action at all. We model two types of agents: Fundamentalist and technical traders (Hommes, 2006).

There are different agents for every market with different trading profiles and trading rules. The agents are simple reactive agents in the present model who use past prices as input to their trading decision before executing their output, which is an order they place in the order book in every trading cycle. They do not have any information about the behavior of the other agents in the model except for the (past) price movements of different assets. Besides, our model incorporates a wealth effect: Agents that trade successfully over time accumulate more wealth than others. This increases their trading volume and therefore their influence on the virtual market and forecast. Unsuccessful investors disappear from the markets, while the group of well-performing investors grows through the accumulation of money. This implicit selection drives the agent population towards a dynamic fitness maximization (LeBaron, 2006). The resulting adaptation allows us to model the drift component of the market structure emerging from innovation, regulation, etc.

Technical traders study market data in an attempt to gain insight into price movements of an asset. To do so, they search for recurring patterns of price movements. In our artificial population, technical trading agents are univariate traders. Many technical analysts believe in a trend behavior of financial markets and use moving averages or momentum analyses to detect such trends. Hence, they tend to buy assets when they are expensive and sell them when they are cheap. The contrarian traders do the opposite: They buy assets which are out of favor and therefore run against the crowd.

We include a trend followers who buy (sell) an asset if its price in the last trading cycle exceeds (falls below) the price in the previous period.

$$o_{t+1} = \begin{cases} m_t * r & if \quad (p_t - p_{t-1}) > 0 \\ -n_t * r & if \quad (p_t - p_{t-1}) < 0 \end{cases}$$

Where *p* is the time series, *m* the cash account, *n* the deposit, *r* the trading ratio and o the order.

Another type of agents are the fundamentalists, who act value oriented based on different input indicators. Lastly, market makers have the obligation to execute the difference of buy and sell orders of the other agents for their own account. They always clear the market and therefore guarantee its liquidity.

The benchmark for measuring the degree of replication is depending of the purpose of the model. There exist different kind of models which covers different empirical results of financial market time series. LeBaron (2006) gives a good overview. We employ two different quality measures to assess our model's forecasting quality: The hit rate and the model efficiency. The hit rate indicates how many times an up or down price movement has been correctly predicted by the model. It takes on values between 1 (100% hits and 0% misses) and 0 (0% hits and 100% misses).

$$d = \frac{1}{n}\sum_{i=1}^{n} a(i)$$
$$with$$
$$a_i = \begin{cases} 1 & if \quad \big(p(t+1) - p(t)\big)\big(y(t+1) - x(t)\big) > 0 \\ 0 & otherwise \end{cases}$$

Where *p* is the time series, *y* is the predicted time series and *n* is the number of test data sets.

While the hit rate accounts for the number of correctly predicted price movements, it does not contain any information about the relative size of these movements and the resulting potential gains and losses. It is widely known that one single big drawdown can nullify a whole series of precedent gains. Therefore, we also consider the model efficiency r or the distance from the ideal net profit (Refenes 1995, 71):

$$r = \frac{\sum_{i=0}^{n} s_t(p_{t+1} - p_t)}{\sum_{i=0}^{n} |p_{t+1} - p_t|}$$

$$s_t = \begin{cases} 1 \; if \; (y_{t+1} - p_t) > 0 \\ -1 \; if \; (y_{t+1} - p_t) < 0 \\ 0 \; if \; (y_{t+1} - p_t) = 0 \end{cases}$$

Where *p* is the time series and *y* is the predicted time series.

Besides producing trend predictions for the next quarter, the model can be used for long term scenario analysis and stress testing. The values of the input indicators depends on scenarios. The price calculation of the multistep forecast is following calculated:

$$\boldsymbol{y_{t+1} = y_t + \alpha \frac{D(t) - S(t)}{D(t) + S(t)}}$$

Where *y* is the predicted or artificial time series. *D* is the demand and *S* is the supply of each asset provided to the market by the agents.

4. Preliminary analysis: Real estate market across the world

4.1. Real Estate Cycles

Figure 1 shows the historical house price developments of multiple countries in the years 1971-2007. The figure was originally published in a study authored by Agnello and Schuknecht (2009) and shows preprocessed[3] house price data the authors had obtained from the Bank for

[3] The exact details of the pre-processing steps and the identification algorithm for booms and busts can be found in their study. The pre-processing involved amongst others the application of a Hodrick-Prescott-filter on the

International Settlements (BIS). The authors were interested in the identification of boom and bust periods, and they applied an algorithm to identify such periods.

The approach of Kostadinov and Ankenbrand (2013b) is somewhat different. There are three main defining characteristics of cycles: duration, amplitude and slope (Claessens et al., 2011). They want to investigate visually into these characteristics, i.e. they want to know how the upward phase correlates with the downward phase of real estate cycles. For this purpose the original figures as published by Agnello and Schuknecht (2009) are modified, omitting certain graphical elements depicting boom and bust periods originally included. At the same time red bars are inserted to highlight the duration and amplitude of cycles and also blue dashed lines to highlight cycles that were still ongoing at the end of the charts. The absence of a blue dashed line at the right side of a chart indicates that as yet no cycle peak has been observed (Switzerland, Germany).

What is striking is the cyclical nature of real estate markets depicted in figure 1. As one can see, nearly all of these markets have a tendency to either long-term upward or downward price movements. Prolonged side movements are clearly in the minority. Furthermore, there obviously is a strong correlation between the upward and the downward phase of a cycle. The vertical (red) bar in most cases cuts the horizontal (red) bar at its mid-point, i.e. in most cases the detrended prices fall back to the level they were at the beginning of the cycle. This is the same as stating that the downward slope is roughly the mirrored version of the upward slope. These or similar findings are also supported by other studies (Bracke, 2011; André, 2010; Roehner, 2006).

As the charts end in 2007, it is interesting to take a look into the further development for the years from 2007 to 2013. Kostadinov and Ankenbrand (2013b) wanted to know whether in any of the charts in figure 1, where prices had increased prior to the year 2007, a soft landing could be observed in the following years. For this purpose they applied the same procedure as Agnello and Schuknecht, i.e. they took the available but augmented BIS dataset (BIS 2013) and followed their data detrending procedure steps. Figure 2 shows the results[4]. Germany and Japan did not show any significant price increases prior to 2007; hence these countries are omitted.

logarithmized data for detrending. They then identified peaks as housing price growth patterns of $\{\Delta x_t > 0, \Delta x_{t+1} < 0\}$ and troughs as patterns of $\{\Delta x_t < 0, \Delta x_{t+1} > 0\}$. Some of the data the authors used can be obtained from the BIS website: http://www.bis.org/statistics/pp.htm.

[4] Caused by the deferred time frame in combination with the mathematical details of the detrending procedure the charts in figure 2 might not perfectly fit the continued curves in figure 1.

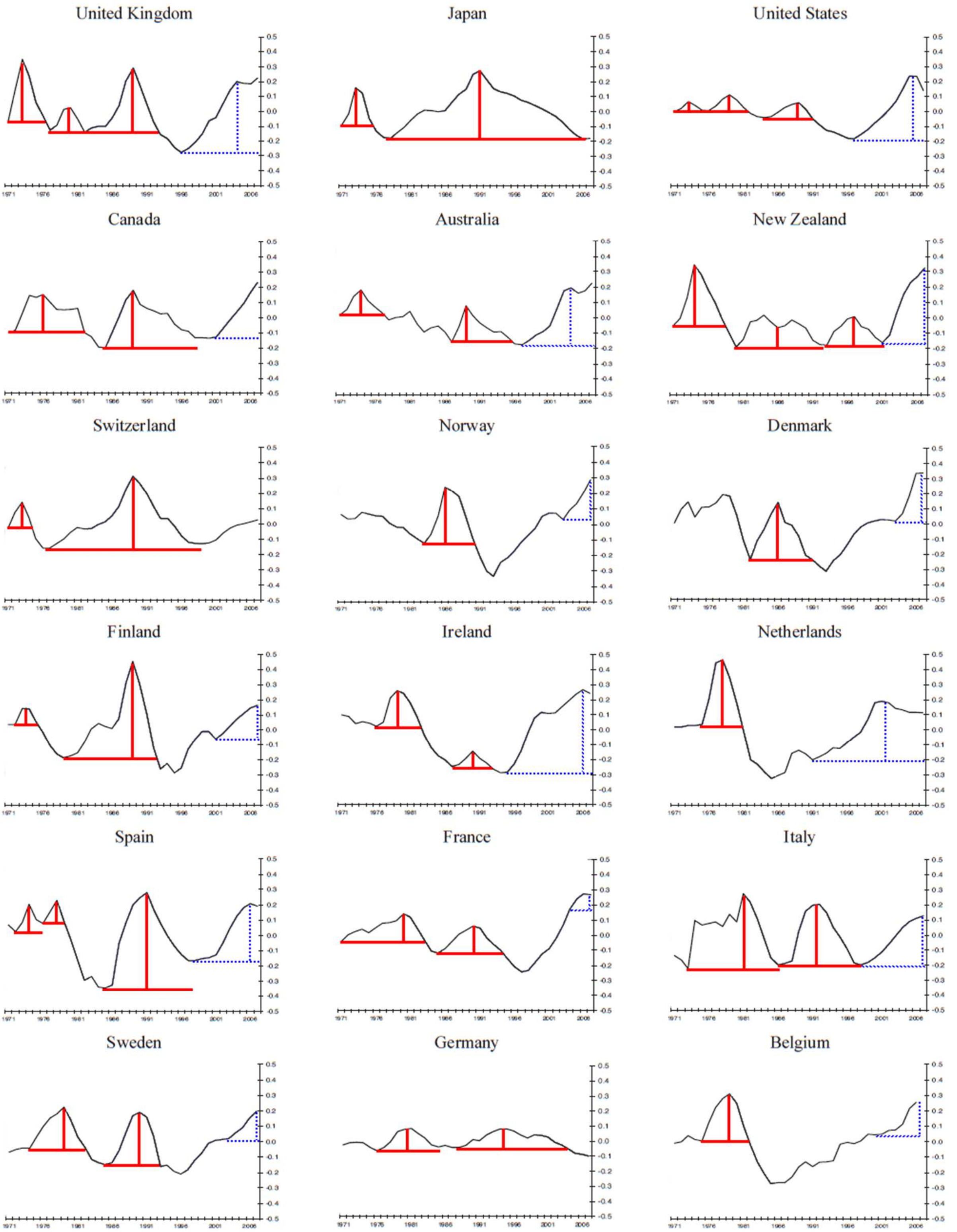


Figure 1 Detrended housing prices calculated by Agnello and Schuknecht (2009) for various countries in 1971-2007. The original figure additionally contains periods identified by them as booms and busts, which we omitted for clarity. Red and blue lines have been added by us. In red: Characteristics of past real estate cycles. In blue: Characteristics of real estate cycles that have not ended in 2007. Source: Agnello and Schuknecht (2009), original figure title: ***Housing prices gaps and Boom and Bust Phases. Period: 1971-2007.***

In figure 2 all of the observed countries – with the notable exception of Switzerland, which will be discussed in detail – experienced decreasing real estate prices in the years after 2007. In Australia, the prices zigzagged a little longer until in 2010 they plunged till 2013. In Canada the price decreases do not appear as pointed as for the other countries, and the future will show whether prices fall back to an even lower level or not. For Finland, Ireland and France there was not enough data from BIS in order to produce a chart. However, according to different sources (Delmendo 2013; IPD 2012) these three countries also experienced price drops in those years. In cases like Norway and Sweden, one or two shorter cycles seem to overlap a longer one (ca. 1996 to 2009).

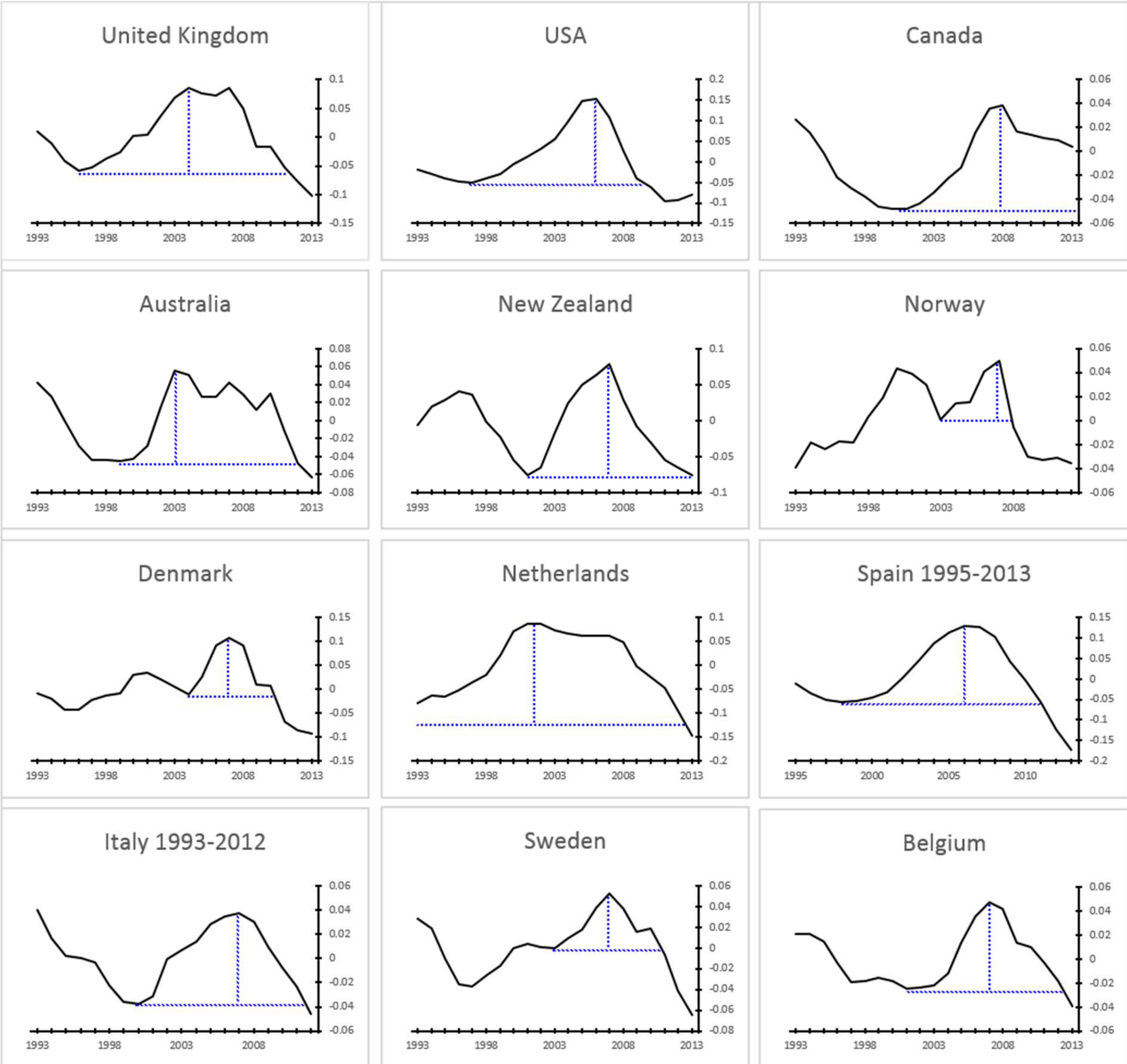


Figure 2 Detrended housing prices for various countries in the years 1993-2013 (unless stated otherwise)

The conclusions from above still hold true. First, prolonged side movements are clearly in the minority, real estate prices tend to either move upwards or downwards. Second, there is a strong correlation between the upward and the downward phase of a cycle.

Agnello and Schuknecht (2009) also investigate quantitatively into the characteristics of cycles they explicitly identify as bubbles. Table 2 is an excerpt of a more complete table found in their study[5]. It gives an overview of ten different bubbles concerning on the one hand the durations of the upward and downward phases (column "Persistence") and on the other hand their magnitudes, measured as a relation between house prices at their peak and their trough[6]. For instance, the Swiss real estate boom in the years 1983-1989 persisted seven years and had a magnitude measure of 34.70. The boom phase was followed by a bust phase in the years 1990-1999 lasting for 10 years and having a (negative) magnitude of -44.17.

Country[7]		*Years*	*Persistence*	*Magnitude*
United Kingdom	Boom	1983-1989	7	43.31
	Bust	1990-1996	7	-56.58
Japan I	Boom	1986-1991	6	27.42
	Bust	1992-2006	15	-45.47
Japan II	Boom	1979-1991	13	45.19
	Bust	1992-2006	15	-45.47
Switzerland	Boom	1983-1989	7	34.70
	Bust	1990-1999	10	-44.17
Denmark	Boom	1983-1986	4	37.58
	Bust	1987-1993	7	-45.42
Finland	Boom	1987-1989	3	44.41
	Bust	1990-1993	4	-71.45
Netherlands	Boom	1971-1978	8	47.10
	Bust	1979-1985	7	-78.95
Italy	Boom	1987-1992	6	40.12
	Bust	1993-1998	6	-40.36
Spain	Boom	1986-1991	6	62.55
	Bust	1992-1998	7	-44.64
Sweden	Boom	1986-1990	5	29.87
	Bust	1991-1993	3	-35.61
Averages	Boom		5.8	40.79
	Bust		7.3	-51.55
	Difference		1.5	-10.65

Table 2 Boom-bust phases in industrialized countries over the period 1970-2007 according to Agnello and Schuknecht (2009)

The table illustrates that there exists a strong positive correlation between both the persistence of the upward and downward phase of a bubble as well as a strong negative correlation between their magnitudes. It is important to note that the durations can be as short as three years for the boom and four years for the bust phase in the case of Finland, or as long as thirteen years for the boom and fifteen years for the bust phase in the case of Japan (ibid; table 2). Kostadinov and Ankenbrand (2013b) suggest to call Switzerland a "long cycler" together with some other countries due to their relatively long duration of real estate cycles.

[5] See Agnello and Schuknecht (2009): *Table 2: Boom-bust phases in industrialized countries over the period 1970-2007* in section 3.3. For brevity some additional data have been omitted. The full table further contains measures for short-term interest rates and real credit growth over the boom and bust phases.

[6] The given value of the magnitude is not a percentage value, however the measure can be compared among countries and between booms and busts. See Agnello and Schuknecht (2009) for a more precise definition.

[7] For Japan two different possible ways of identifying a real estate bubble are given by the authors denoted as Japan I and II.

Of interest is also another study authored by Roehner (2006). The author takes a look at several historical real estate cycles in different places in the USA and also in other countries. Compared to the last authors, he does not explicitly refer to bubbles but more generally talks of real estate price peaks. He comes to similar conclusions that price peaks are almost symmetrical with respect to their maximum, which means that the rising and falling phases have approximately the same duration. A soft landing is seldom.

4.2. Regulation of the Swiss Real Estate Market

In the early 1990s high interest rates and poor loan performance lead to problems in the banking sector. The regional and cantonal banks with poorly diversified activities were in a difficult situation. But the banking crisis and the recession were comparatively mild. Most of the failing banks are taken over by stronger banks, especially by the big banks (SNB, 2007; 767).

To prevent Switzerland from suffering a real estate market crisis similar to that of the 1990s, different steps are taken from the different regulatory bodies in Switzerland. Elements are the tightening of micro prudential supervision, a revision of capital requirements, a revisions of the self-regulation guidelines and the countercyclical capital buffer (CCB). All activities aim to protect the banking sector from the consequences of a real estate price corrections by increasing its loss-absorbing capacity. In addition, it should lead to reducing the attractiveness of credit provision (SNB, 2014).

Following the crisis in the 90nties, the Swiss Bankers Association has implemented guidelines for the processing of mortgages. This self-regulation is revised in July 2014 (SBA, 2014a). In addition, the Swiss Bankers Association put in place minimal conditions for mortgages which defines some risk parameters. The first version is from 2012. 2014 the guidelines are tighten. The minimum requirement for mortgage financing are (SBA, 2014b):

- A minimum of 10% equity capital, not originating from second pillar assets
- Amortization within 15 years to 2/3 of the loan value

The countercyclical capital buffer (CCB) is a component of the Basel III framework. The activation of the CCB is possible from July 2012 in accordance with Art. 44 of the Capital Ordinance. The maximum level is set at 2.5% of total domestic risk weighted assets of a bank. It is supplement other capital requirements (SNB, 2014).

The decision of the implementation level of the CCB is taken by the Swiss Federal Council based on an official proposal of the SNB. The proposal depends on an assessment of the mortgage and real estate markets of the SNB. Two main categories of indicators will feed into the systematic analysis: domestic mortgage volume indicators and domestic residential real estate price indicators. In addition the SNB will consult the Swiss Financial Market Authority (FINMA) regarding its view of the situation (SNB, 2014).

5. Main findings: Swiss Real Estate Market

Our approach is related to three strands of studies. The first strand focuses on a fundamental ABM. The second strand of studies is a chart or technical model of the real estate markets. The third strand is a qualitative beside the two other quantitative. It compares the regulation of today and in the 90nties.

5.1. Agent-based model

We ran the ABM model over a time period from Dec. 1986 to September 2014, resulting in 110 trading rounds. Table 3 gives an overview of the achieved results[8]:

Table 3: Simulation results: Model quality measures

	SI Investment PR	**SI Private PR**
Observed upward price changes	59	66
Observed downward price changes	51	44
Generated BUY signals	63	74
Generated SELL signals	47	36
Hits	84	85
Misses	26	26
Hit rate	0.75 (75%)	0.75 (75%)
Model efficiency	0.54 (54%)	0.54 (54%)

Investment Real Estate Price Index (SI Investment PR), and Private Real Estate Price Index (SI Private PR)

For both observed indices, the SI Investment PR and the SI Private PR, the hit rate has a value of 0.75 (75%). This means in 3 of 4 quarters the trend prediction of the Swiss real estate market was correct. Although the hit rate gives an overall impression of the number of correctly predicted price movements, it does not say anything about the relative size of these movements and the resulting potential gains and losses. As is well known, a single big drawdown can nullify a whole series of precedent gains. The current model efficiency is 0.54 (54%) for the SI Investment PR and 0.54 (54%) for the SI Private PR. The economic meaning is the relation between the realized and the possible profit and is 54%.

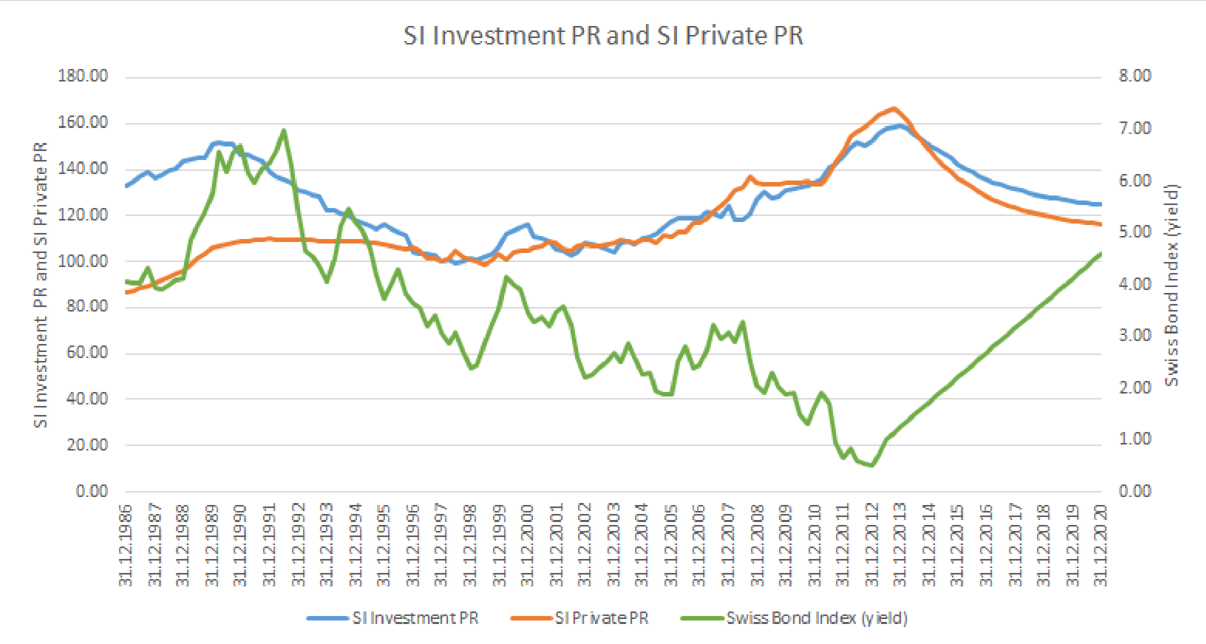
A criticism of agent-based models is that there are too many degrees of freedom (LeBaron, 2006). The parameter space can be reduced through a stringent economic foundation and an evolutionary control of the development of the parameters.

Besides producing trend predictions for the next quarter, the model can be used for long term scenario analysis and stress testing. In the following example, the effects of a long-term rise in interest rates on the SI Investment PR and SI Private PR are analyzed. The simulation is run up to the last quarter end (Q3 2014) relying on historical data, then the interest rates are continuously increased. From this point on, the output time series (SI Investment PR and SI

[8] By coincidence both the hit rate and the model efficiency happen to have the same values for both indices. This can of course not be generalized.

Private PR) is generated by the model. Figure 3 shows the outcome of the simulation runs for both target indices and also the yield of the Swiss Bond Index as the varied input measure.

Figure 3: Scenario analysis results



Source: Authors' models

For both indices, a long-term increase of the interest rates leads to a clearly observable and significant decrease of both indices.

In a situation lacking both positive as well as negative market forces, the simulated market is nevertheless inclined towards a negative correction. The reason is that the majority of agents/market participants have already invested in real estate, and their potential to adding further assets to their existing investment portfolio is limited due to monetary limitations. If however negative market impulses prevail, a significant negative correction is to be expected according to our simulation results. Therefore, according to the model a further long-term rise in the Swiss real estate markets is to be expected only in a regime of prolonged, strong and positive market forces. Our conclusion goes in the same line with Toivonen and Viitanen (2015), which consider that when market actors are aware of the forces appearing in their action environment, they are able to notice any new phenomena emerging and quickly adapt their actions and even steer the development to the desired direction.

5.2. The Swiss cycle

Unlike the other countries shown in figure 2, in Switzerland real estate prices continued to rise also in the years 2007 to 2013. Figure 3 depicts the SWX IAZI Investment Real Estate Price Index (IAZI 2013a; SI Investment PR; blue line) and the SWX IAZI Private Real Estate Price

Index (IAZI 2013b; SI Private PR; orange line) in the years 1987 to 2014 Q3. Given the finding that in real estate cycles the downturn phase mirrors the preceding upturn phase, and assuming that the cycle's tipping point was reached today, then both indices can be projected into the future. This is indicated by the dashed lines in figure 4.

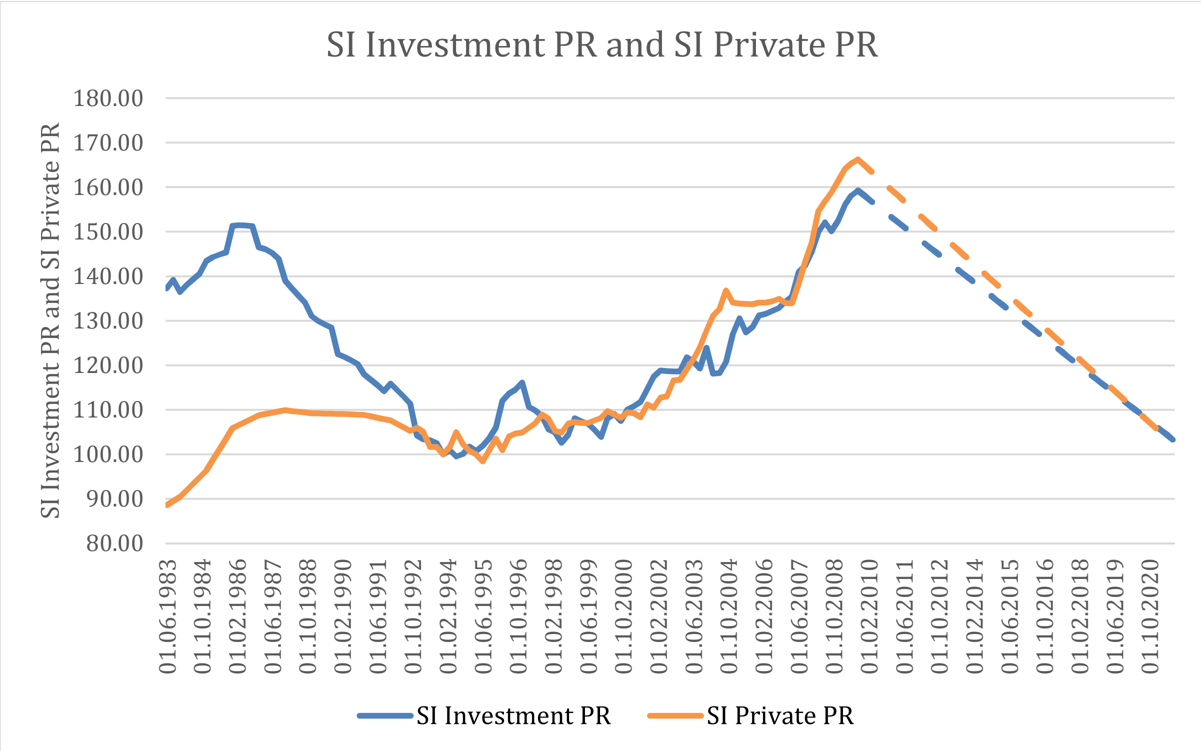


Figure 4 SI Investment PR index (blue) and SI Private PR Index (orange). The dashed lines projects the indices onto the future, given that the cycle's tipping point was reached today.

These projections actually correspond well with the simulation results provided by our agent-based model of the Swiss real estate market in figure 3. As we have argued above, prices will either continue to rise or otherwise they will fall, but a prolonged sideways movement is not very probable.

5.3. Regulation

An assessment of the implications of the regulation is for several reasons difficult. First, most of the regulations aren't in place during the previous crisis period (SNB, 2014). Second, a direct international comparison isn't possible because the situation in Switzerland is different in some aspects. Third, markets are a complex system without simple in- and output relations (Ankenbrand, 1998). However, having a CCB in place during the previous crisis period would have increased the resilience of the banking system based on the banks' capital situation at that time. A large portion of the losses would have absorbed. The countercyclical character can help reduce the amplitude and the consequences of a crisis. It should have a positive effect on the dynamics of mortgage lending and property prices through the relative chance in capital requirements (SNB, 2014).

6. Conclusion

Does strong regulation help the Swiss real estate market? The AVACO model of the Swiss real estate market offers a response through the following findings: the hit rate represents -75% for the SI Investment PR and 75% for the SI Private PR; and the model efficiency shows -54% for the SI Investment PR and 54% for the SI Private PR, which implies a high degree of reliability. The high degree of reliability and the economic soundness give confidence to use the model for forecasting and long term simulation of the Swiss real estate market.

The long term simulation and scenario analyses indicate that the Swiss real estate market is in a rather weak condition. In the absence of positive market forces like decreasing interest rates or decreasing stock market, the Swiss real estate market has a tendency towards a negative correction, which becomes more poignant in the presence of negative market forces such as rising interest rates. In the simulated scenarios, increasing interest rates can lead to a strong negative correction of the real estate markets. The probability of decreasing prices in the Swiss real estate market is higher than the probability of a further increase.

We found also that the real estate markets tend to move in cycles. That is, they tend to be in an upward or a downward phase. Prolonged sideways movements of real estate prices are a rather uncommon phenomenon and in fact occur rarely. Moreover, looking back at Switzerland's real estate price development of the last decade, it can be seen that prices were in a long-term upward trend ever since 2000. As was shown, real estate cycles tend to be highly symmetric concerning the characteristics – duration, amplitude, slope – of both the upward and downward phase. Therefore, once the tipping point has been reached a corresponding negative correction (hard landing) must be expected, which would mean a long-term decline of real estate prices mirroring more or less the preceding upward phase.

A soft landing of the market will be uncommon. If the regulation stops the increasing of the real estate prices, the danger of a long term decrease of the prices is given. This danger is significant because the real estate market is in a weak condition.

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