Universität Zürich[UZH]

Thesis

To obtain the degree of

Master of Advanced Studies in Real Estate

Relationship between Monetary Variables, House Prices and the Macro Economy in Residential Property in Switzerland

Sample period 2000 until Present, and the Following Years

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Glossary

CCB	Countercyclical Capital Buffer
CPI	Consumer Price Index
DCF	Discounted Cash Flow
ECB	European Central Bank
FINMA	Swiss Financial Market Supervisory
FSR	Financial Stability Report
GDP	Gross Domestic Product
IMF	International Monetary Fund
LTI	Loan-to-Income
LTV	Loan-to-Value
MaPs	Macro Prudential Policies
RPPI	Residential Property Price Index
SECO	State Secretariat for Economic Affairs
SFSO	Swiss Federal Statistical Office
SNB	Swiss National Bank
SoFiE	Society for Financial Econometrics
VAR	Vector Auto Regression

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Abstract

This thesis studies the relationship between residential real estate prices and short-term interest rates in Switzerland. Adopting a vector autoregressive analysis (VAR) methodology the study focuses on the period between 2000 and 2017. No significant two-way relationship is found to exist between residential real estate prices and short-term interest rates during this period.

In a further investigation, it is argued that the exchange rate peg adopted by the Swiss National Bank in 2011, together with the distinct evolution of different segments of the real estate market drive this result. Adjusting the baseline model, it becomes clear that a two-way relationship *does* exist between real estate prices and short-term interest rates in Switzerland.

1. Introduction

Monetary policy works in tandem with macro prudential policy (Cizel, Frost, Houben & Wierts, 2016, p.6-8). In the period after 2000 macro prudential policy was activated worldwide in order to reduce systemic risk within the banking sector. With the aim of addressing exuberant credit growth, various restrictions applying to both borrowers and lenders were introduced.

In Switzerland, the national bank conducts its monetary policy by steering interest rates to ensure price stability and to combat an overheating of the economy. If interest rates increase, financing becomes more expensive and investments decrease as a result, affecting real estate prices.

The relationship between monetary policy and real estate prices is a complex relationship that is affected by many factors. This holds true also in Switzerland. Since the global financial crisis of 2007, the Swiss economy has been operating in a low interest rate environment. This has had a considerable, and well documented impact on the evolution of risks in the domestic real estate market which can also be observed through real estate prices (see for example Basten & Koch, (2014), Stadler, (2015), Hildebrand (2010), Abbassi, Nautz & Offermanns (2010), Chaney § Hoesly (2010). In addition, the Swiss National Bank (SNB) set a minimum exchange rate of CHF 1.20 per euro. By doing so, the SNB instated an exceptional monetary policy situation in which it no longer could adjust interest rates in reaction to observable risks.

1.1 Research Objectives

The aim of this research is to identify the investor i.e. real estate developer, as the principal agent. By shedding some light on the relationship that exists between real estate prices and interest rates, this thesis endeavours to provide a useful tool for developers to predict the varying developments that are relevant for the conduct of their business. More concretely, this research aims to clarify the important role that interest rates play in residential property prices, and vice versa.

Uncertainty within the real estate market can be perceived as the possibility of an occurrence of unexpected upswings and downswings in building values. Therefore, assessing the interplay between interest rates and real estate would provide a means to better equip developers in anticipating important changes to variables relevant for their business.

1.2 Importance

The VAR approach adopted in this thesis has uncovered several interesting and important findings:

- First, it confirms the existence of a two-way relationship between short-term interest rates and real estate.
- Second, it confirms the fact that the relationship has changed since 2011. The model shows that before 2011 prices and interest rates had an important impact on one another. It is however, not possible to say much about how relationship looks now as not enough data exists following the exit of the peg (future research).
- Third, it confirms the fact that adopting a high-level perspective for real estate, for assessing the relationship is not sufficient. It is important to acknowledge the differences that exist between segment developments as well as regional developments (though this is out of the scope of this thesis).
- Therefore, for developers an in-depth approach provides the clearest representation of the true nature of relationships between property prices and other economic factors and can hence provide significant insight into how to achieve goals, depending on objectives such as, for example, economic risks, mortgage risks and future investments.

1.3 Research Design

The thesis is structured as follows:

(1) Section 1 - introduction, as above.

(2) Section 2 – focuses on the existing literature, outlining the research objective before explaining the design of the research approach adopted in this thesis.

(3) Section 3 - details, from a theoretical point of view, the data used and its use for the purpose of answering the question defined in Chapter 1 providing a brief summary of different empirical research approaches using VARs models.

(4) Section 4 - outlines the model to be estimated.

(5) Section 5 – presents the results.

(6) Section 6 – surveys with experts.

(7) Section 7 – conclusion and future prospects.

2. Background

2.1 Monetary Policy in Switzerland and the Role of the Interest Rate

According to Jordan (2016, 24 October): "When the central banks want to stimulate the economy as well as to increase the inflation, they lower the monetary policy rate. Because inflation does not respond immediately, real interest rates temporarily fall below the equilibrium interest rate. This situation leads, again temporarily, to higher growth and more inflation. On the other hand, if the central banks want to lower the inflation, they raise the interest rate".

In the wake of the financial crisis, long-term and short-term interest rates have already had historically low levels for several years. This holds for advanced economies, in general, and for Switzerland, in particular. Switzerland is a small economy that is interconnected with the rest of the world and heavily depends on economic developments abroad. The nominal interest rates in Switzerland have tended to co-move with those in other countries however at lowers level. This historical low interest rate in Switzerland can be explained in other terms, for example as the result of a low and stable inflation. (Jordan, 2016, 24 October).

In the aftermath of the youngest global financial crisis (2007), central banks have been widely criticized for having kept interest rates too low for too long (see for example Hott and Jokipii, 2012). Since 2008, interest rates have declined steadily in Switzerland. In September 2011, and bearing in mind the massive overvaluation of the Swiss Franc, the Swiss National Bank (SNB) took the decision to introduce the peg (implementation of the CHF 1.20 exchange rate against the euro). (Swiss National Bank, 2001).

Since removing the peg in January 2015, the SNB took the decision to drop reference interest rates from the banks' sight deposit at the national bank to -0,75% and the target range for the three-month Libor unchanged at between -1.25% and -0.25%. In other words, currently the short-term interest rate as well as the yields on bond with terms of up to ten years are negative. (Jordan, 2016, 24. October).

The above graph represents the interest rates relationship between EZB i.e. ECB (European Central Bank) and SNB (Swiss National Bank)

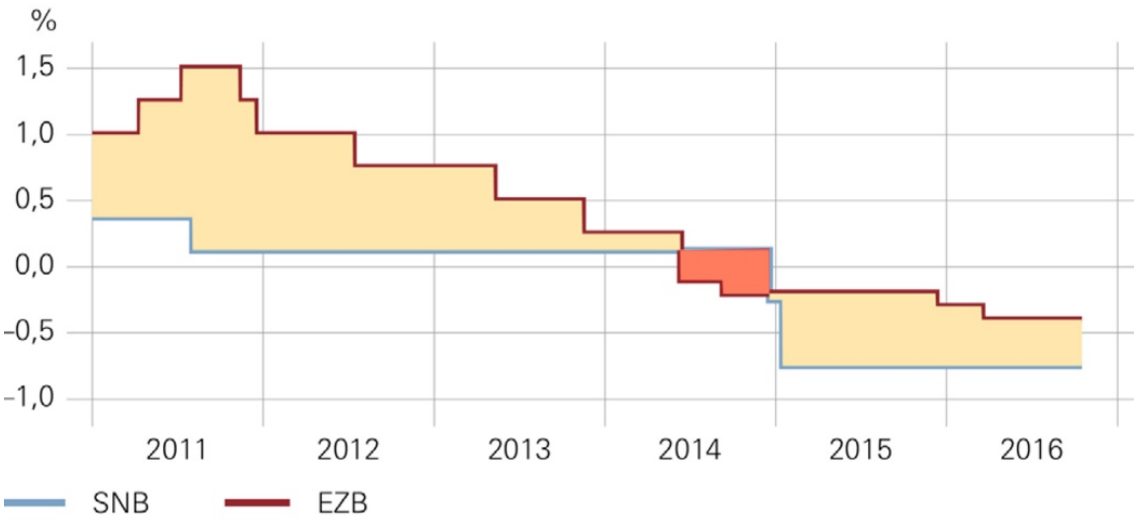

Figure 1: Interest rates relationship between European Central Bank and the Swiss National Bank. Source: Jordan (2016, 24. October, p.12).

An extended period of very accommodative monetary policy, even when fully justified as a reaction to prevailing economic circumstances, is not without risks and side-effects. Long periods of low rates represent a risk to financial stability. By lowering the cost of credit and increasing the value of assets, low interest rates could provide the breeding ground for asset price and credit booms. This phenomenon can be observed by the current developments in Swiss mortgage and real estate markets: real estate prices and mortgage credit have been growing with considerable momentum for several years and have long since reached levels that can no longer be fully justified by fundamental factors. (Swiss National Bank, FSR 2017, p.4-26)

Housing bubbles are notably important compared to other asset bubbles, according to Hott et al. (2012) Firstly, "housing is a large fraction of national wealth, and residential investment is a significant and volatile part of GDP. Secondly, leveraged financial institutions hold a significant fraction of their portfolio in assets, such as mortgages or mortgage-backed securities, whose values depend greatly on movements in house prices" (p.2). Based on a sample of 14 OECD countries (including Switzerland) within a theoretical house price model with calibrated fundamental house prices, the authors Hott et al. (2012) examined the impact, of interest rates that are "too low" for "too long" on housing bubbles, reaching the conclusion and providing evidence that interest rates that are set "too low" for "too long" have a significant impact on the creation of housing bubbles (p.1-20).

2.2 Macro Prudential Policies and Mortgage Regulation in Switzerland

In reaction to the lower monetary policy rates, central bankers and policy makers have been vocal about the need to supplement monetary policy with additional tools that target the source of growing risk. It was acknowledged that existing prudential regulation focussed too much on individual institutions and too little on the system as a whole. (Borio and Shim, 2007, p.1-19). Therefore, the years after 2000 have been characterized by the implementation of increasing macro prudential policies worldwide. Such macro prudential policies have as their aim to boost the resilience of the financial system and to mitigate banking sector risk. On a large scale, the intention of macro prudential policies is to reduce systemic risk (risk of collapse of an entire financial system or entire market) (Cizel et al., 2016, p.6-9).

Mortgage lending constitutes an important component of Swiss domestically oriented banks' balance sheets. Forthwith in Switzerland, 85% of private domestic loans fall under the mortgage segment. Furthermore, the lending volumes of banks and insurance companies as well as prices of residential real estate have continued to increase on a regular basis. The analogy between increased mortgages relative to GDP makes clear that mortgages have increased as rapidly as GDP. Thus, the level of mortgage debt in Switzerland is approaching one of the highest in the world (FINMA, 2016). The graph below depicts the mortgage volume of domestic oriented Swiss banks as a percentage of GDP in Switzerland:

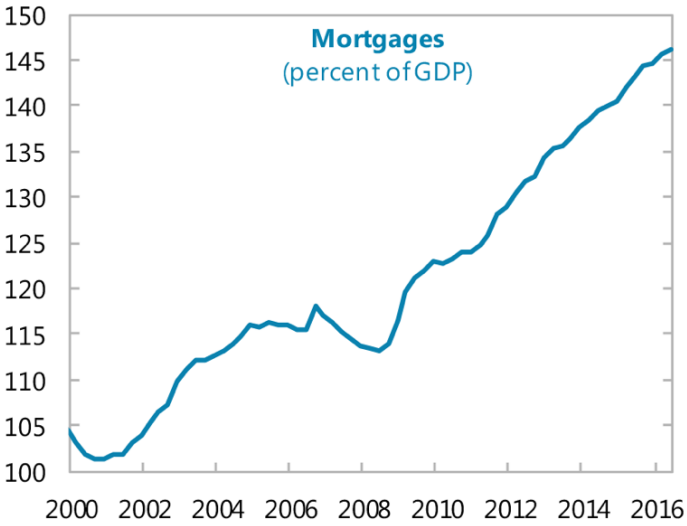

Figure 2: Mortgage volume of domestic oriented Swiss banks as a percent of GDP in Switzerland. Source: International Monetary Fund, 2016, p.27.

Developments in the domestic mortgage and real estate market, together with the constrained monetary policy, prompted Switzerland to react in 2012. The Federal Council announced a package of macro prudential measures aimed at targeting the source of risks. (Schweizerische Eidgenossenshaft, 2012).

These measures can be explained as follows: (i) increase from 75% to 100% in risk weight for high loan-to-value mortgage loans, (ii) revision of the self-regulation rules for mortgage lending which restricts the use of pension saving as collateral for borrowers and (iii) the legal basis for the activation of a countercyclical capital buffer (CCB). (Danthine, 2013, 11 October).

The sectoral CCyB was activated in February 2013, requiring the banks to hold 1% of risk-weighted mortgage position financing residential real estate located in Switzerland and successively increased to 2% in January 2014. Finally, in June 2014 the amortization period was shortened from 20 to 15 years. (Swiss National Bank, 2016).

Before these measures were announced, many banks were expanding their own lending criteria to the limit with the results that it affected both financial sustainability for the borrower and the loan-to-value-ratio applied to the property. Thus, increasing the risk that increases of the interest rates of mortgages rendering borrowers unable to pay back their loans (a real estate bubble bust).

2.2.1 A Revision of the Self-Regulation Rules

Briefly, the revision of the self-regulation rules were implemented as a means to require banks to hold more capital for underpinning residential mortgage lending if the borrower does not contribute a minimum down payment from a source other than occupational benefits (second pillar) and does not repay the mortgage principal in an appropriate manner. Banks define the minimum requirements for mortgage lending in their self-regulation provisions, which are to be recognized by FINMA as a minimum standard. Accordingly, the minimum down payments required of borrowers from their own funds should amount to at least 10 per cent of the lending value of the property – this should not be obtained by pledging or early withdrawal of Pillar 2 assets. Similarly, the mortgage debt on residential properties is to be repaid so that it amounts to no more than two-thirds of the collateral value after 20 years. (FINMA, 2012).

In September 2014, as a result of mortgage volume lending having grown faster than income, CPI and GDP, the self-regulation guidelines were further revised.

The following adjustments were made:

- The amortisation period was shortened from 20 to 15 years, with the requirement that the loan is repaid in regular tranches of equal amounts from the start.
- The eligibility of second incomes when assessing financial sustainability was changed
- The "lower of cost or market" principle was introduced. The lending value of real estate is now based on the market value or the purchase price, whichever is lower" (FINMA, 2014).

2.2.2 The Countercyclical Capital Buffer (CCB)

In February 2013, Switzerland was the first country to activate countercyclical capital buffers (CCB) with the aim to protect the banking sector from prejudicial effects of the financial cycle. Given the nature of risks observed, the Swiss authorities chose to activate the buffer on a sectoral basis.

The CCB is a key macro prudential tool of the Basel III banking regulation. It is a temporary measure that increases the capital requirements imposed in banks i.e. requiring that banks increase their risk-weighted capital ratios whilst holding a fraction of each loan in the form of equity capital. This fraction, expressed in terms of a minimum capital requirement relative to risk-weighted assets, depends on the presumed riskiness of loans and banks are urged to have sufficient "skin in the game" in order to prevent excessive risk-taking. (Basten and Koch, 2015, p.7).

Given the targeted nature of risks observed in the domestic mortgage and real estate market, the Swiss authorities announced an activation of a sectoral CCB, which targeted mortgage credit. The targeted nature of the measure means that the additional, temporary, requirements imposed on banks depended on the size of the banks' exposure to the risk. (Swiss National Bank, 2012).

In response to measures taken (a revision of the self-regulation rules and the CCB), the dynamics of the Swiss mortgage and real estate markets have slowed down. One can observe a downward trend in real estate price momentum, while mortgage volumes have also recorded slower growth. Taken together, these observations suggest that the measures have had an impact on mortgage lending and real estate prices. (International Monetary, 2015, p.24-27).

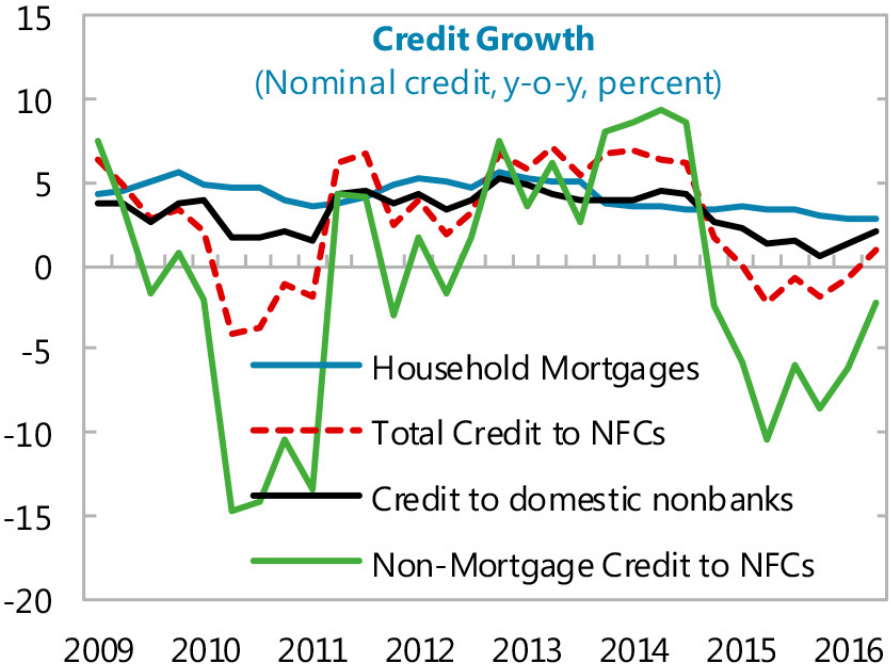

Figure 3: Credit growth over the sample period 2009-2016.
Source: International Monetary Fund, 2016, p.24.

2.3 Review of Related Literature

2.3.1 The Matter of Property Prices

This thesis aims to better understand the drivers of house prices, with a particular focus on understanding the role of short-term interest rates in this regard. This chapter provides a review of the relevant literature as a basis from which VAR model can be developed to provide some clarity.

As Hofmann (2001) pointed out in his study, credit demand and credit supply are affected by property prices, and taking into consideration that real estate collateral is often used to loans security, property price has an important effect on the borrowing capacity of the private sector. The positive correlation between credit conditions and property prices, can be explained by the credit demand and supply, which means that property prices may be affected by credit conditions.

As is known, real estate pricing depends on the discounted future stream of dividend payments (DCF). Hofmann (2001) points out that "Higher liquidity may have an indirect effect on assets valuation…but it may also be that additionally available liquidity simple increases the demand for a (temporary) fixed supply of property, driving up real estate property prices" (p.1-9).

With the use of various co-integration tests Hofmann (2001) concludes, that the long-run development of credit to the private non-bank sector in 16 industrialized countries (sample period 1980-1998), cannot be explained just by the GDP and the interest rate, but when the property price is added to the system, the author could identify long-run relationships linking credit positively to GDP and property prices negatively to the interest rate (p.26).

As Goodhart and Hofmann (2008) maintain, a permanent increase in house prices is not just having an isolated positive effect on landlords and owner-occupiers. Alternatively, it is important to bear in mind that the effect for tenants and first-time buyers is negative in that they are paying higher rents and saving more to purchase a house. It is this asymmetry, which plays an important role in a positive wealth or collateral effect of house prices on consumption. When house prices rise above construction cost, new house construction becomes profitable, as a result residential investments are a positive function of house prices.

The authors mentioned above conclude that monetary variables have a significant effect on house prices, and house prices have a significant effect on future money and credit growth. In addition, shocks to house prices, and to money and credit lead to repercussions in economic activity and aggregate price inflation (p.180-203).

Hott (2009) developed a model to apply to Switzerland, Ireland, Japan, the Netherlands, the UK and the US (countries that experienced at least one house price cycle within the past 40 years.) The model is used to calculate the fundamental value of houses, assuming that the imputed rents are equal to the fundamental value of rents. Using three different criteria the author establishes that house prices fluctuate more that fundamentally justified and that the behaviour of investors can help to explain the fluctuations i.e. over and under evaluation of house prices (p.1-36).

Hofmann (2001) argues that “Innovations to the real interest rate have significantly negative effects on real lending, real GDP and real property prices…, this finding could be interpreted as supporting the view that monetary authorities may, via their leverage over short-term interest rates, be able to smooth or even limit the occurrence of financial cycles…Whether and how centrals banks should respond to changes in credit conditions and property prices therefore remains an important open issue for future research” (p.26).

2.3.2 Macro Prudential Policies

Cizel et al. (2016): "Macro prudential policies include measures that apply directly to lender, such as countercyclical capital buffers and restrictions that apply to borrowers such as LTV and LTI ratio caps." (p.6). With a focus on studying the effects of macro prudential policies within advanced and emerging market economies, Cizel et al. (2016) show that macro prudential policies tend to slow the credit bank growth (p.21-22).

Despite these observations, the literature about the effectiveness of macro prudential policies remains relatively rare. One important reason is that in many countries, including Switzerland, several measures are adopted simultaneously addressing the same source of risk. It therefore becomes difficult to disentangle the impacts of individual measures. (Akinci & Olmstead-Rumsey ,2015, p.3-5, 27).

As explained in Chapter 2.2.2 Switzerland was the first country to implement and activate the Countercyclical Capital Buffer (CCB) with the aim of protecting the banking sector from prejudicial effects of the financial cycle. Basten et al. (2015) explain that "The revised Basel framework sets significantly higher requirements for loss absorption, puts greater emphasis on a higher quality of capital and better captures the full scope of bank risk. In terms on the resilience objective of macro prudential policy, the CCB, requires banks to increase their risk-weighted capital ratios during boom periods, thus rendering them more resilient to potential loan losses when risks materialize during downturns" (p.8).

Despite the difficulties associated with conducting research on macro-prudential policies, as explained above, Basten et al. (2015) examined the mortgage pricing of Swiss banks directly before and after activating the CCB. They draw the conclusion that activating the CCB contributed to the resilience of banks i.e., it pushed up mortgage rates for more exposed banks, and it shifted mortgage lending to more resilient banks. Another important conclusion is that prices, i.e. mortgage interest rates, capture decisive information on the willingness to lend and are closely associated with quantities of lending (p.8-32).

2.3.3 Consumption

As mentioned above (Chapter 2.3.1), housing is a major component of wealth, and house prices fluctuate considerably over time.

According to Campbell and Cocco (2004) "It is tempting to attribute the correlation between house prices and consumption to a direct housing wealth effect: Increasing house prices increase housing wealth, which in turn increases consumption…", but as the authors Campbell et al. (2004) point out, the definition of financial wealth could be understood as the sum of financial assets and the value of real estate minus debt outstanding. This definition makes clear that an increase in house prices leads to an increase in homeowners' financial wealth, which in actual fact does not mean that their real wealth is larger too. However, the correlation between house prices and consumption can be explained by the relaxing or tightening of borrowing constraints e.g. an increase in house prices relaxes borrowing constraints, even if there is no wealth effect associated (p.1-2).

Aoki, Proudman and Vlieghe (2004) agree with the argument explained above, they developed a model that focused on the macroeconomic effects of imperfections in credit markets in the UK. They examined the sample period1970-1970 identified as before deregulation; sample period 1890-1989 the period of gradual deregulation and sample period 1990 -2001 after deregulation. They argue that the relationship between house prices and consumption is changing over time and explained this phenomenon by pointing out that the response of consumption to an unanticipated change in interest rates will therefore be larger, and the response of house prices and housing investment will be smaller.

They also argue that the degree of deregulation plays an important role in house prices and consumption, this means that in a highly deregulated mortgage market the effect on house prices will be muted but on the other hand the effect on consumption will be amplified. Another suggestion is that a certain change in house prices could presumably be associated with a larger change in consumption in the post-deregulation period. (p. 415-434).

2.4 Historical Evolution

Using a simple heuristic model to incorporate the qualitative historical data, this chapter aims to explain how the different variables: residential property prices, the interest rates real GDP, consumer price index, total loans and mortgage loans have performed in the last 17 years.

All the historical data is publically available from the Swiss National Bank and the OECD dataset.

2.4.1 RPPI (Residential Property Price Index)

The residential property price index, also known as a House Price Indices (HPI), measures the price of residential properties over time with a geographical covering over the whole country. In Switzerland, the index is provided by Wüest Partner, Fahrländer Partner and IAZI and it is divided in three segments: privately owned apartments (asking and transaction price), single-family houses (asking and transaction price), and rental housing unit (asking price). It is important to note, that IAZI has a private real estate index based on single-family houses and the privately-owned apartments.

Owned Properties

Measured as an asking and transaction price in quarterly average and with the unit criteria (Q1 2000 =100) the following graphs represent the RPPI's performance for the last 17 years for privately owned apartments and single-family houses as well as the rental housing units in Switzerland.

The blue line represents the privately-owned apartments. The orange line represents the single-family houses (owned segment). The grey line represents the rental housing units. The graph makes clear the huge importance represented by the privately-owned apartments segment for the entire real estate market. It suggest that when analyzing the real estate market as a whole, a composite index constructed as the weighted average of single-family houses and apartments, could mask some important results.

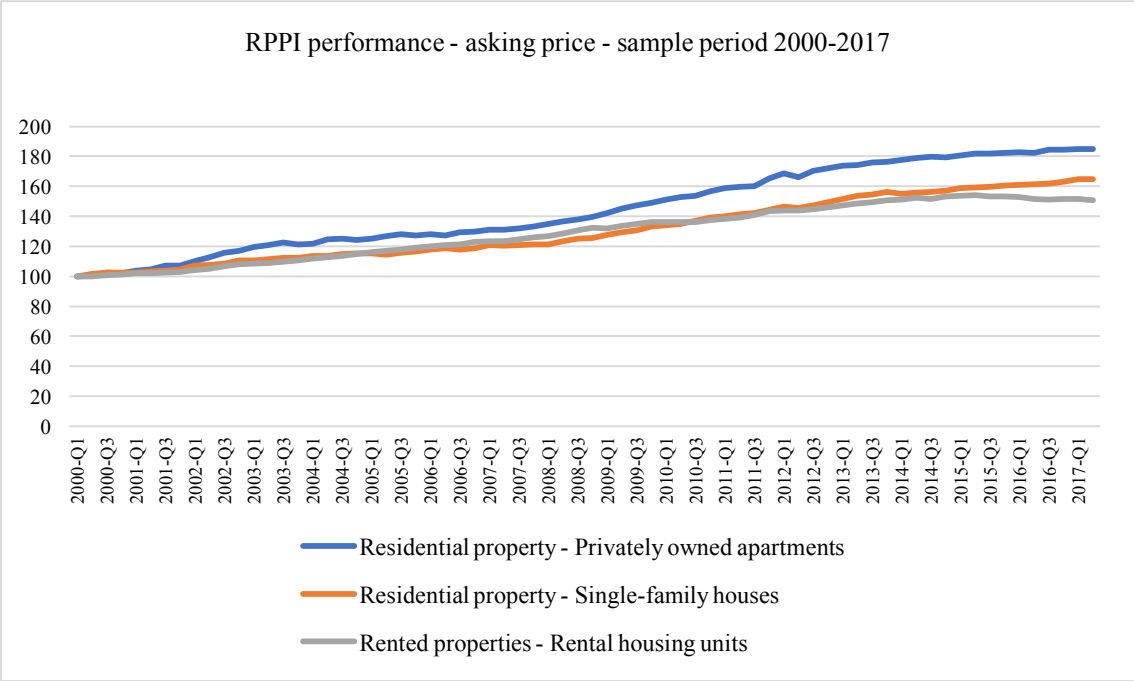

Figure 4: Residential property price performance over the sample period 2000-2017.
Source: Wüest Partner data and own calculations.

As reported by Credit Suisse (2017), after 14 years of an extreme increase in the residential property sector, the price growth appears to be stagnating. The high property prices, as well as the tightened regulatory requirements, (explained in Chapters 2.1 and 2.2) makes the acquisition of new property unaffordable for the average owner. On the other hand, and as a reward for the extremely low level of mortgage interest rates, those who own their homes are benefiting from very low living costs.

Measured on a national Swiss average, almost 39% of gross income is needed to afford a new property, which is above the "golden rule of financing", which (as well know fact) is set by a maximum of one third.

Households are currently restricted from buying outside the surrounding regions, resulting in an accelerated price growth in these regions. New properties are too expensive for most households in some instances making existing properties a more affordable alternative. (p.7-15).

The graph below represents the imputed affordability of new condominiums and single-family houses for average household as % of income under the following parameters: 5% interest rate, 1% maintenance, 80% loan-to-value and repayment on two third thirds within 15 years.

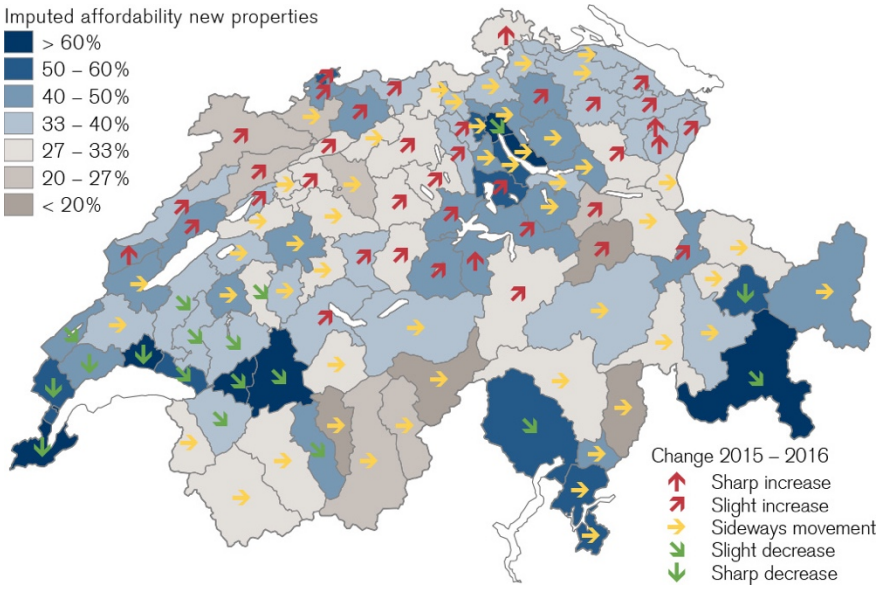

Figure 5: Affordability of new condominiums and single-family houses for average household.
Source: Credit Suisse, 2017, Figure 3, p.8.

The graph below represents the imputed affordability of existing condominiums for an average household as % of income under the following parameters: 5% interest rate, 1% maintenance, 80% loan-to-value and repayment on two third thirds within 15 years.

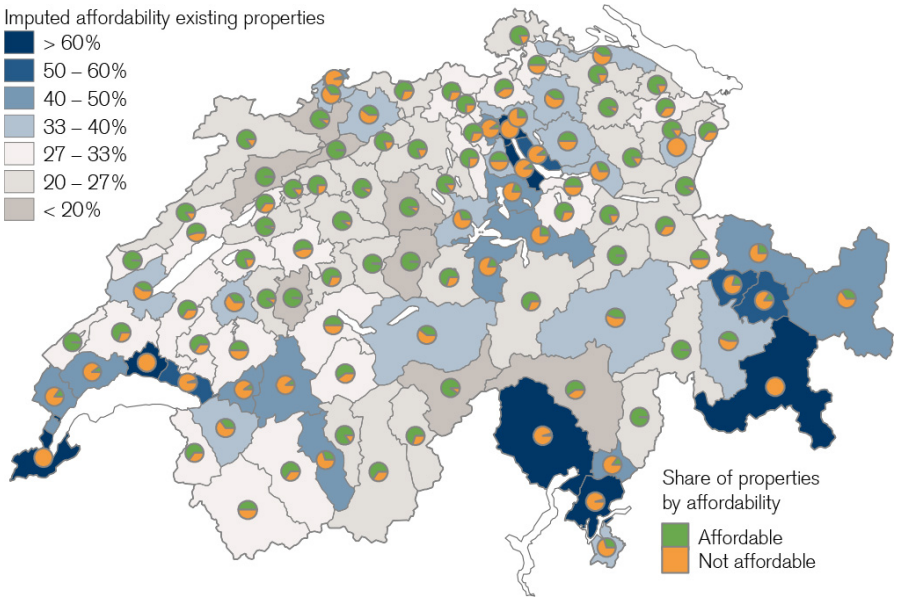

Figure 6: Affordability of existing condominiums for average household.
Source: Credit Suisse, 2017, Figure 4, p.8.

Rented Properties

According to Credit Suisse (2017): in contrast to the owner-occupied property market, which is (more or less) in balance, the rental accommodation market remains another situation. The negative interest rate situation and the discrepancy involving other investment alternatives has driven institutional investors to invest in this asset sector.

The years after the Franc-shock have been characterized by a construction boom, which has resulted in an excessive production of rental apartments. Importantly, the oversupply is mostly applicable to the locations outside the cities and larger towns, this phenomenon cannot currently be observed in the major centers.

On the other hand, aspects such as a decline in immigration of migrants with high purchasing power and extremely low interest rates on mortgages have motivated high-income tenants to become home owners. Whilst recent immigration from countries with a low purchasing power has also influenced the demand for rented residential properties, Thus, it is important to understand, that demands have changed to being progressively represented by lower income groups.

As pointed out by the Credit Suisse Study, the vacancy rates increased from 1.77% to 1.99% in mid 2016, thus representing the sharpest increase of the past 15 years. Tenants outside the major cities are benefiting from this situation and are finding a suitable property without spending too much.

Another important issue, is the fact that prices decrease sharply in the high-price segment and partially in the medium price segment. The economic imbalance between demand and supply on the rental market is reflected by a stagnation and decrease of the rents, particularly in the high-price segment. However contrary to this, a significant price increase of 7% to 10% has been observed in the low-price segment during the last year. (p.7-29).

2.4.2 Macro Variables Impacting Real Estate Prices

Short-term Interest Rates

According to OECD (2017), short-term interest rates can be defined as follows: “Short-term interest rates are the rates at which short-term borrowings are affected between financial institutions or the rate at which short-term government paper is issued or traded in the market. Short-term interest rates are generally averages of daily rates,

measured as a percentage. Short-term interest rates are based on three-month money market rates where available."

It is well known that short-term interest rates are closely linked to monetary policy. In fact, before the global financial crisis of 2008, the primary tool of the central banks to stabilize the macro economy was indeed the short-term interest rate. (Sononda and Sudo, 2016, p.1-6).

The short-term interest rate has a significant impact on the mortgage and real estate market. In fact, the most frequent way to negotiate the interest rate on mortgages in Switzerland is the 3-months Libor linked rate with a maturity of either 3 or 5 years. The abolition of the Libor, is to be expected at the end of 2021. Currently, there is some speculation about this issue and how the banks are going to solve the problem. The use of a Saron reference or different reference interest rates appear as a plausible solution. However, so far no bank has provided a statement about this matter, leaving the door open for future discussion. (Schäfer, 2017, 14 September).

Furthermore, one-third of the mortgage volume has a repricing which is shorter than one year, and in fact 85% of credit from the domestic banks is within the mortgage segment. Thus, one can expect that an increase in the short-term interest rates would have a significant impact on property prices. (Swiss National Bank, FSR 2017, p.20-22).

On the other hand, and as explained in Chapter 2.1, the authors Hott et al. (2011) provide evidence that long periods with low interest rates have a significant effect in the creation of housing bubbles. In this regard, it is important to note that in Switzerland mortgages have increased as rapidly as GDP and that interest rates remain at a historically very low level.

Long-term Interest Rates

According to the OECD (2017), long-term interest rates can be defined as follows: "long-term interest rates refer to government bonds maturing in ten years. Rates are mainly determined by the price charged by the lender, the risk from the borrower and the fall in the capital value…In all cases they refer to bonds whose capital repayment is guaranteed by governments…Long-term interest rate is one of the determinates of business investment…".

The graph above represents the interest rate performance in Switzerland for the last 17 years. It is obvious, that since the Franc-shock of 2015 (explained in Chapter 2.1) interest rates persist to be negative.

The graph bellow represents the short-term and long-term interest rate performance. The grey line represents the long-term interest rate. The blue line represents the short-term interest rate. The graph is based on OECD dataset.

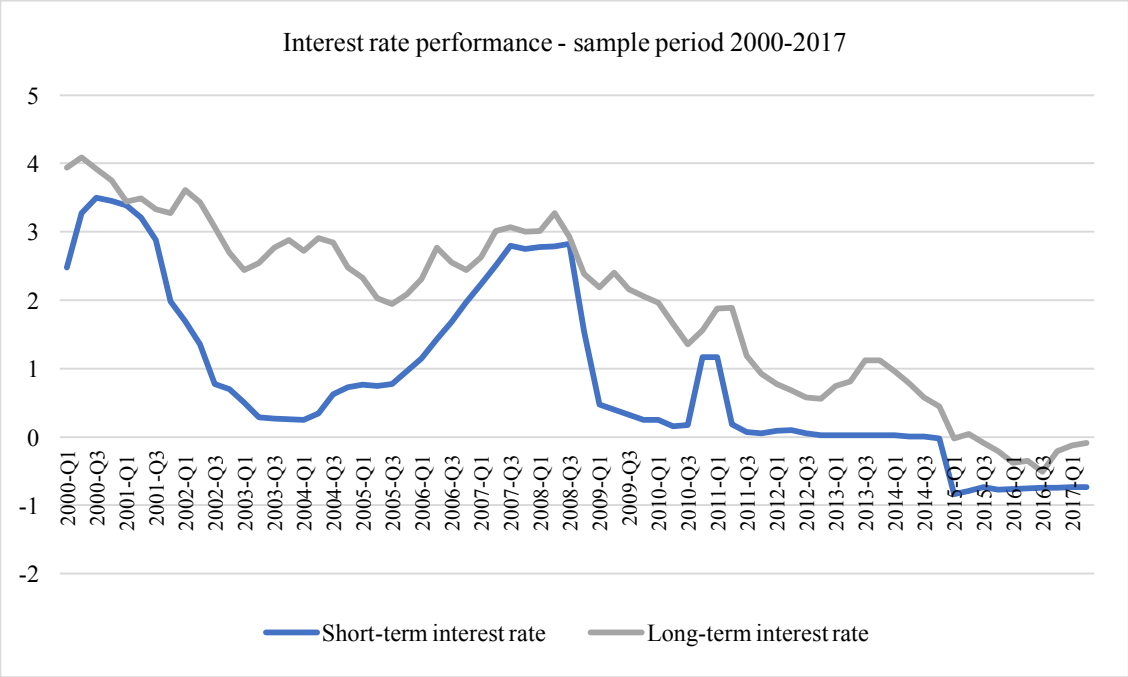

Figure 7: Interest rates performance over the sample period 2000-2017.
Source: Organisation for Economic Co-operation and Development (OECD) data and own calculations.

The Real GDP (Gross Domestic Product)

As we know, the real GDP is a primary index to measure the health of an economy, and in contrast to the nominal GDP, it is considered independent of price fluctuations (inflation and deflation). EOCD (2017), Real GDP.

Swiss real GDP depicted in Figure 8 is measured in percent and growth rates. The graph below shows the quarterly GDP performance for the last 17 years. With the exception of 2001, 2002 (the years after the Dot-com bubble) and 2009 the year after the real estate bubble in the US, the GDP has had a positive performance in the last decades. According to OECD data, the annual growth rate of real GDP for 2018 is expected to be 1.93%. The current year is expected to close with a growth rate of 1.47%. The grey line represents the quarterly change from the previous quarter and it is seasonally adjusted.

The blue line represents the GDP quarterly change from the same quarter of the previous year and it is non-adjusted.

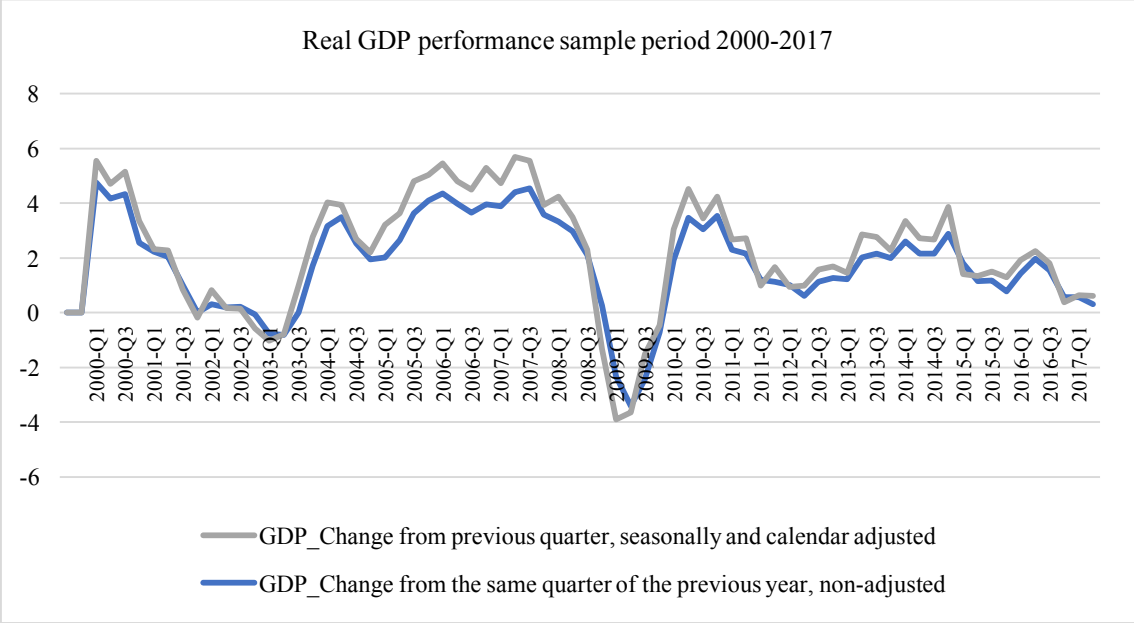

Figure 8: Real GDP performance over the sample period 2000-2017.
Source: Organisation for Economic Co-operation and Development (OECD) data and own calculations.

"The price to-rent-ratio is given by the ratio of nominal house prices to rental prices. This is a measure of the probability of owning a house. The price-to-income ratio is given by the ratio of nominal house prices to nominal household disposable income per capita. This is a measure of the affordability of purchasing a house" OECD (2017), Analytical house prices indicators.

Significantly, if the price to-rent-ratio as well as the price-to-income ratio are over their long-term averages, house prices are said to be over-evaluated.

The graph below represents the price-to-rent ratio and price-to-income ratio in Switzerland over the sample period 1985-2015, as we can see since 2011 the apartments segment has been clearly over the average (measured as 100%), in this regard it is clear that the relationship between property prices and GDP, i.e. sharp moves in property prices, will indeed affect the real GDP growth. Another important aspect, which is explained in Chapter 2.2, is that mortgage grows as rapidly as GDP, in other words the relation between GDP and apartments segment present an upsetting imbalance.

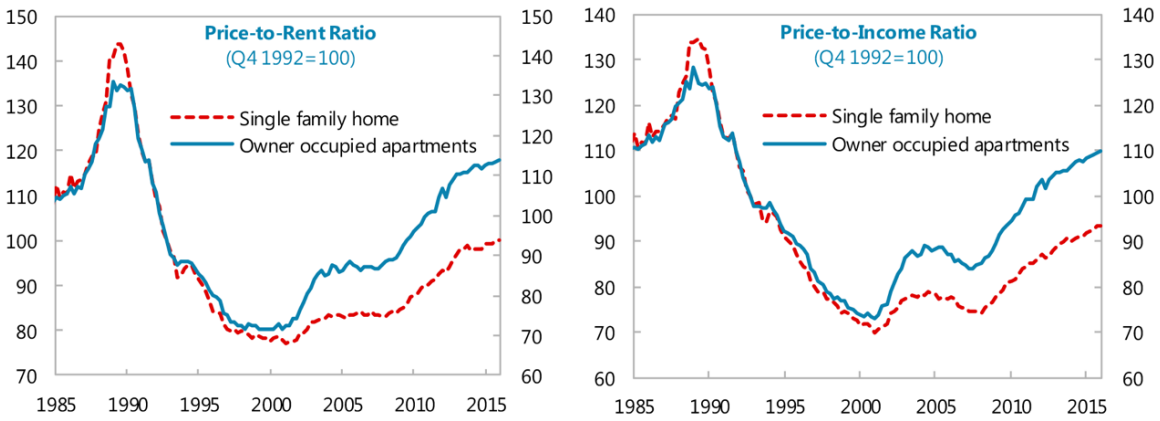

Figure 9: Price-to-Rent Ratio and Price-to-Income Ratio, comparison between single-family houses and owner occupied apartments over the sample period 1985-2017.
Source: International Monetary Fund, 2016, p.24.

CPI (Consumer Price Index)

According to OECD (2017), CPI is explained as follows: "Inflation, measured by CPI is defined as the change in the prices of a basket of goods and services that are typically purchased by specific groups of households… is measured in terms of the annual growth rate and in index… inflation measures the erosion of living standards". The annual growth rate of CPI for 2018 is predicted by 0.36%. The current year is expected to close with a growth rate of 0.49%.

Bearing in mind that development on the real estate market are considered to forecast inflation, financial stability and economic growth, a strong momentum in the real estate market i.e. high prices and a faster increase in mortgage as GDP remains an important risk for financial stability. (Jordan, 2009, p.2-7 and Jordan, 2012, p.1-3).

The graph bellow represents the CPI performance for the last 17 years in Switzerland. The grey line represents the change from the corresponding month of the previous year in percent. The blue line represents the national index.

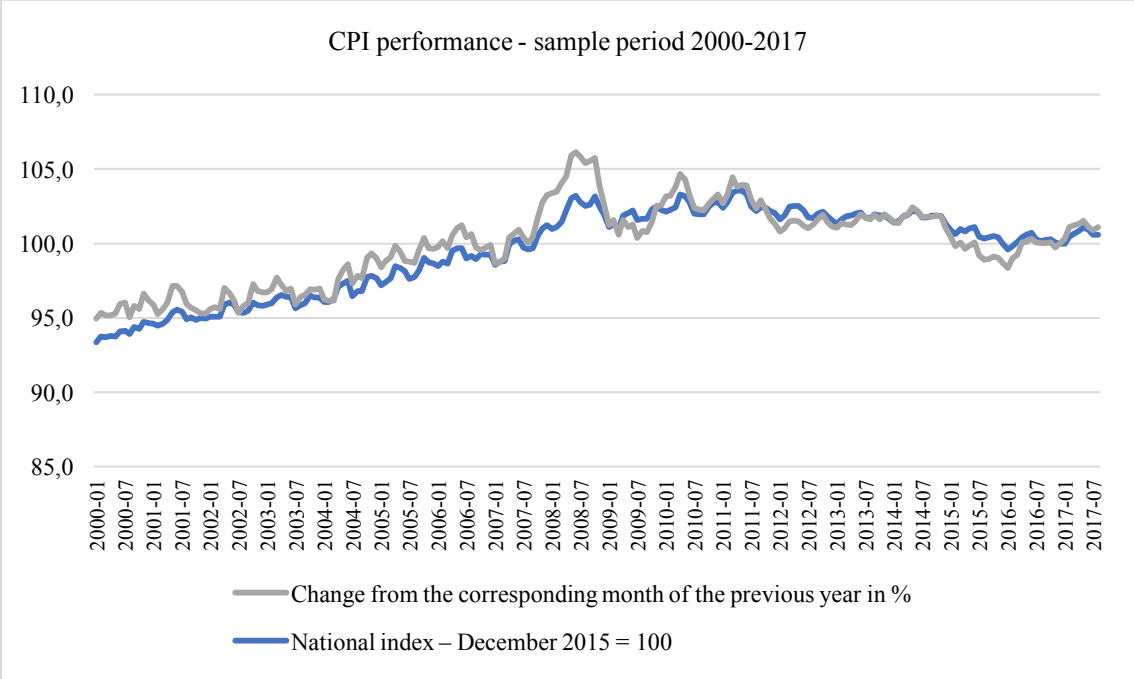

Figure 10 CPI performance over the sample period 2000-2017.
Source: Swiss federal Statistical Office (SFSO) data and own calculations.

2.4.3 Other Real Estate Related Variables

Total Loans and Mortgages Loans

As described in Chapter 2.2, mortgage loans are especially important in Switzerland, when compared to other credit (see figure 11 below). This is particularly true for the domestically oriented banks, which are comprised of the following: Raiffeisen Banks, Cantonal Banks, Big Banks and Regional and Saving Banks. In fact, mortgage loans constitute a considerable portion of these banks' balance sheet (around 85%).

The close relationship between mortgage volumes and real estate prices has been well documented by both FINMA and the Swiss National Bank. As reported in the latest financial stability report from the Swiss national bank (FSR 17, p.5), the mortgage growth of domestically focused banks continued increasing in 2016 and the share of new loans with high loan-to-income has risen further. This corresponds with a high interest rate risk from maturity transformation. It is important to note that the imbalances in the mortgage and real estate markets have slightly declined but remain at levels similar to those in 2014 when the Federal Council took the decision to adjust the level of the sectoral CCyB to 2%.

The graph below depicts the evolution of total loans and mortgage loans for the last 17 years in Switzerland. The blue line denotes total loans; the grey line denotes mortgage

loans. The graphs emphasize the important role that mortgages play in Switzerland. The values are measured at the end of the month, in CHF millions.

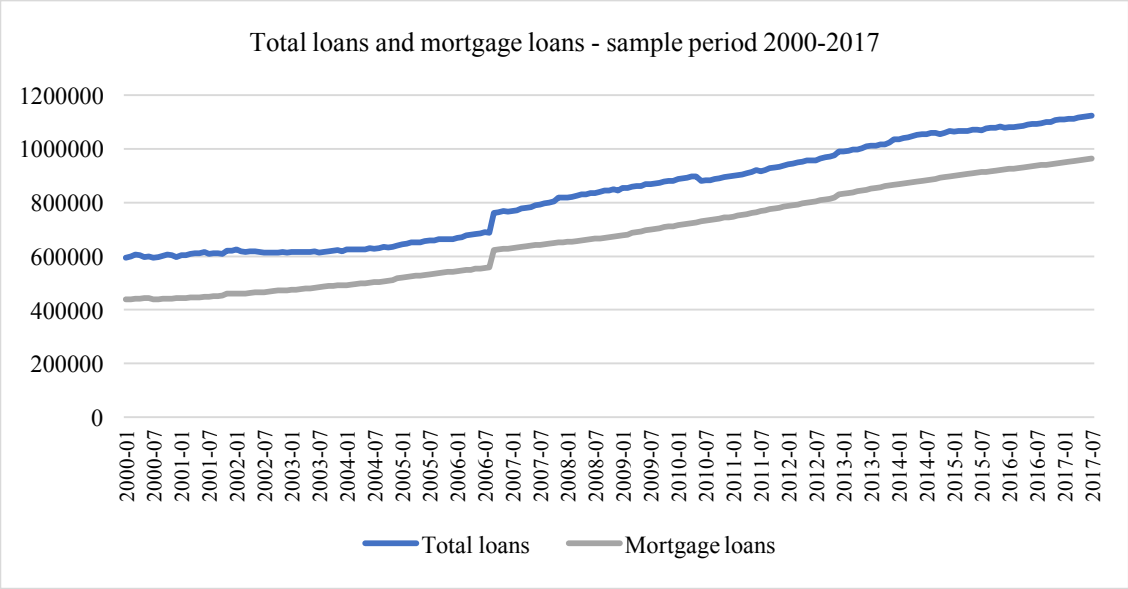

Figure 11: Monthly relationship between total loans and mortgage loans over the sample period 2000-2017.
Source: Swiss National Bank (SNB) data and own calculations.

Interest Rate on New Loan Agreements (Mortgage)

According to the SNB definition "… a mortgage is a claim secured by real estate, In the case of a variable mortgage not linked to a base rate of interest rate, the bank can alter the rate of interest rate…the term of the loan is considered to be unlimited. In the case of a variable-rate mortgage linked to a base rate of interest rate, the bank is contractually required to make periodic adjustments to a base rate of interest. The term of the loan is considered limited. In the case of a fixed-rate mortgage, the rate of interest is fixed when the loan agreement is concluded and remains unchanged throughout the maturity of the loan." (Swiss National Bank, undated).

The following graph represents the interest rate on new loan agreements' performance over the sample period 2008-2017 for three different types on mortgage in Switzerland: variable mortgage, mortgage with fixed interest rates and mortgage with Libor-linked rates.

The values are monthly median values. The blue line represents the interest rate median of variable mortgages. The orange line represents the interest rate median value of mortgages with fixed interest rate and a 5 years' maturity. The grey line represents the interest rate median value of mortgage linked with 3 months-Libor maturity rates, and 5 years' mortgage maturity. The data for the time-period before 2008 is not available.

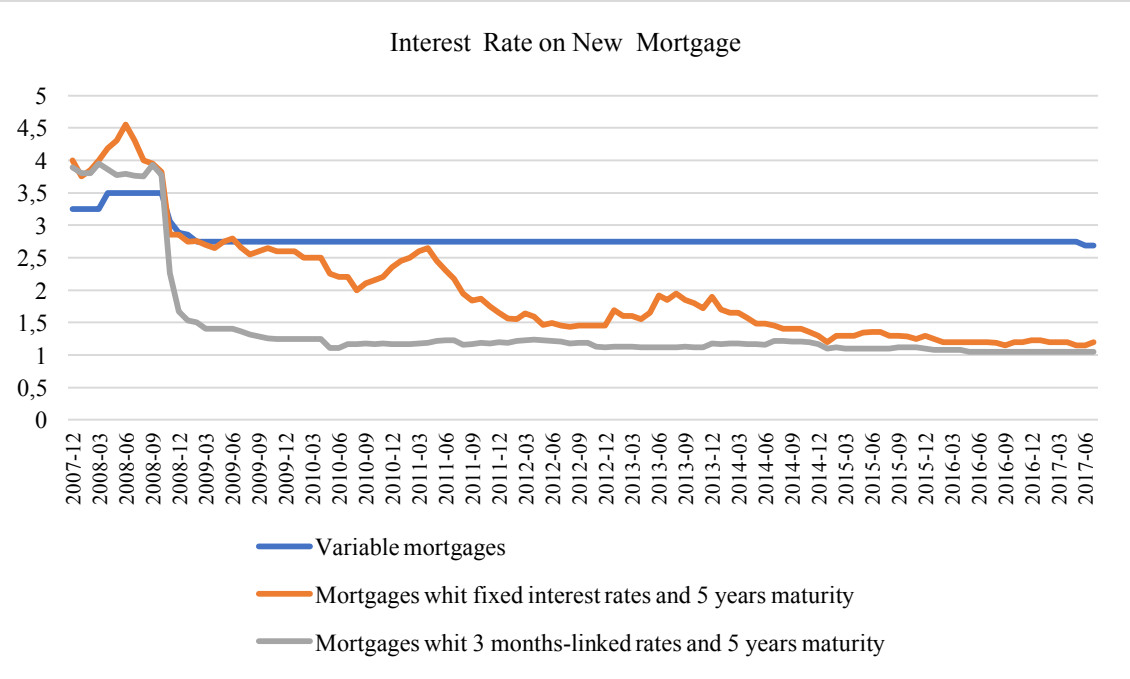

Figure 12: Interest rate performance on mortgage rates over the sample period 2000-2017.
Source: Swiss National Bank (SNB) data and own calculations.

As pointed out (see p.16) one of the most frequent forms to negotiate the interest rate mortgages in Switzerland is the 3-months Libor linked rate with a maturity of 3 or 5 years. Schäfer (2017, 14 September).

Mortgage interest rates are relevant because a change in the interest rate level would lead to an interest rate adjustment in the short or medium term, for a significant proportion of the outstanding mortgage. One-quarter of the outstanding mortgages have a repricing maturity of more than five years. Consequently, the other three-quarters would be affected by an interest rate increase over a five-year horizon. As mentioned (p.16) one-third of the outstanding mortgage has a repricing maturity which is shorter than one year and this makes this segment very vulnerable to increase in the interest rates. (Swiss National Bank, FSR 2017, p.20-22).

3. Empirical Research

3.1 Methodology

To analyse more correctly the interplay between short-term interest rates and residential property prices in Switzerland a formal model incorporating other relevant variables, such as real GDP and CPI is needed.

In what follows, Chapter 3.1 initially presents a literature overview of vector autoregressive (VAR) models used in practice before describing the empirical VAR model adopted to answer the research question. Finally, the results are presented.

VAR Model – The Beginning

According to Del Negro and Schorfheide (2010): "At first glance, VARs appear to be straightforward multivariate generalizations of univariate autoregressive models. At second sight, they turn out to be one of the key empirical tools in modern macroeconomics" (p.7).

Vector auto regression (VAR) is a stochastic process model, which is used to detect the linear interdependencies between multiple time series. They are multivariate simple linear time-series models where the endogenous variables in the system are functions of lagged values of all endogenous variables.

Christopher Sims (1980), Nobel Memorial Prize in Economic Sciences in 2011, introduced the VAR Model in his paper "Macroeconomics and Reality" published in the Journal of the Econometric Society in 1980. Sims' (1980) main critique focused on the fact that identification was based on existing large-scale models of those days. He argued that the restrictions imposed in the identification style were not credible and that rational expectations were more subversive of identification than was recognized. Sims pointed out that models based on expectations imply that behaviour depends on the expected values of the variables. For this reason, it is extremely important to ensure that expected future values have rich patterns of variation in order to identify the parameters of the structure.

He presented a new way of estimating large-scale macro models, reinterpreted the old models as unrestricted, reducing forms and treating all variables as endogenous. Sims developed a multivariate time series models within a six-variable system using quarterly post-war data series for the U.S and West Germany. In other words, using a vector auto regression.

VARs models provide a useful tool for forecasting monetary policy i.e. they make possible an empirical analysis of the effects of monetary policy instruments on macroeconomic variables (p.1-33).

Sim's work focused on the study of monetary policy. In the above-mentioned paper Sims (1980), Macroeconomics and Reality his research concerning the relationship between money, real GNP, unemployment, wages, price level and import prices, showed that it was feasible to obtain macroeconomic models which provide useful descriptive characteristics without impacting on the hypotheses commonly accepted at the time.

According to Jordan and Savioz (2003) "VARs exploit the information in a macroeconomic time series without imposing strong restrictions relating to the structure of the economy…they do not need any assumptions about the course of exogenous variables for the period of the forecasting horizon. All variables… are endogenous...VARs are an ideal method of producing unconditional benchmark forecast because they rely on only a minimum amount of structural information, i.e. on the choice of the variables and on the lag length" (p.81-82).

3.2 VAR Model – Literature Review

This chapter provided a brief summary of six different empirical research approaches using VARs models. The focus of the section being on real estate studies as well as other macroeconomics factors in order to identify the variables employed and how the identification is carried out as well as how certain authors employ the VAR model.

(i) Assenmacher-Wesche and Gerlach (SNB 2008) - "Financial Structure and the Impact of Monetary Policy on Asset Prices" (p.1-37).

Drawing on quarterly data for the sample period 1986-2006 within a single-country VARs as well as panel VARs, the authors analysed the response of residential property and equity prices, inflation and economic activity to monetary shocks in 17 countries. The variables employed were: equity prices, residential property prices, consumer prices indices, real gross domestic product and interest rate.

The above approach follows the research strategy of Goodhart and Hofmann (2008). The authors focused the empirical research on countries which have experienced movements of variable severity at different points in time.

The method can be explained as follows: in a first step, they studied the impact of monetary policy on the economy using a single VAR model for each individual country. The models were developed using the following five variables: CPI (p), real GDP (y), the three-month interest rate (i), real residential property prices (rpp) and real stock prices (rsp).

With the exception of the interest rate, all variables are in logarithms. Employing a unit root test, they concluded that the variables were nonstationary in levels, but stationary in first differences. In a second step, they performed a co-integration test between the variables using a common lag length of four.

The mathematical form using for the individuals' countries can be written as:

$$Y_{n,t} = \mu_n + A_n(L)Y_{n,t} + \varepsilon_{n,t},$$

Where: $y_{n,t} = (p_{n,t}, y_{n,t}, i_{n,t}, rpp_{n,t}, rsp_{n,t})$, μ_n is a constant , $A_n(L)$ is a matrix polynominal in the lag operator , $\varepsilon_{n,t}$ is a vector of normally, identically distributed disturbances" (p.8)

Choleski decomposition was used to investigate the responses of the different variables to monetary policy shocks. Importantly, the main question is how asset prices react to a change in the interest rate, keeping the other variables constant.

The identification structure "allows output and the price level to react only with a lag to monetary policy shocks, whereas property and equity prices may respond immediately. We thus assume that central banks react to current output growth and inflation when setting interest rates, but not to current property and equity prices" (Assenmacher-Wechse et al., 2008, p.8-9).

Bearing in mind how sensitive the results were to this assumption, they concluded that the ordering matter to equity prices, rather than to residential property.

In a second step, they follow Goodhart and Hofmann (2008) and drew on a panel VAR (PVAR) where real residential-property and real equity prices were incorporated.

In line with the recommendation of Persana and Smith they estimated the PVAR by the mean group estimator instead of using an estimation based on conventional fixed effects. "This estimator assumes that the parameters vary cross-sectionally and provide

a consistent estimate of the mean effects by averaging the coefficients across countries" (Assenmacher-Wechse et al., 2008, p.11).

The panel VAR can be written as:

$$Y_{n,t} = \mu_n + A_n(L)Y_{n,t-1} + \varepsilon_{n,t}$$

"Where $Y_{n,t}$ is a Nx1 vector containing the observations for N countries, n=1, …N

μ_n is a country-specific intercept and $A_n(L)$ is a lag polynomial with the VAR coefficients. The disturbances, $\varepsilon_{n,t}$ have zero means and a country-specific variance, σ_n^2 We assume that the coefficients in $A_n(L)$ vary randomly across countries and that the typical element $a_{n,i,j}^p$ in $A_n(L)$ can be written as $a_{n,i,j}^p = a_{i,j}^p + \eta_{n,i,j}^p$ where n is the country index, p=1, …, P, the lag order of the VAR and I, j=1, …K the number of variables in the Var. Our interest is in the mean parameter value, $a_{i,j}^p$" (p.12)

They found that after a monetary policy shock it takes six quarters before the price level starts to fall, this falling became significant after two years. Property prices and equity prices reacted in a different way: property prices reacted earlier but take longer to recover, by contrast equity prices fall immediately after an increase in interest rate.

Thus, the transmission mechanism of monetary policy depends on the characteristics of the institutional financial system. The authors split the countries into two groups depending on their financial structure. They consequently estimated a PVAR for each group and explored how the results differ between the two groups.

The following criteria were employed in order to analyse the VARs:

- the importance of floating rate financing,
- the importance of housing equity withdrawal,
- the LTV ratio,
- the mortgage-debt to GDP ratio,
- the valuation method that is used in different countries,
- whether mortgage loans are securitised and the aspect of owner-occupied housing.

The authors concluded that responses of residential property prices to monetary shocks did not seem to depend significantly on the investigated criteria, the reaction of equity

prices and GDP was larger and more persistent in the expected countries with a stronger monetary transmission mechanism.

Important conclusions drawn from the above-mentioned work can be summarized as follows: monetary policy has large and predictable effects on residential property prices, monetary policy shocks depress equity prices by about as much as they reduce residential property prices. Moreover, the authors emphasized, that it is important to understand that it is not possible to use monetary policy to simultaneously stabilise equity and residential property prices. Another important conclusion drawn in respect of the performance of the individual-country VAR, is the uncertainty of the impact of monetary policy on asset prices. (p.1-37).

(ii) Goodhart and Hofmann (2008) – "House prices, money, credit and the macroeconomy" (p.181-202).

Using a VAR model on a panel of 17 industrialized countries, over the sample period 1970Q1-2006Q4 and with a lag order of four (based on Akaike information criterion), Goodhart and Hofmann investigated the multidirectional link between money, credit house prices, and the wider economy. They also re-estimated the model for the sample period 1985-2006 and compared the results with those obtained for the full sample period. Based on a dummy variable augmented panel VAR, the authors mainly tested the hypothesis that monetary shocks have stronger effects on house prices in time of house price booms by comparing the impulse response under the boom scenario with those under the no-boom scenario.

The variables adopted were GDP, CPI, a short-term interest rate, nominal house prices, nominal broad money, and nominal bank credit on the private sector. Except for the short-term interest rate all variables are seasonally adjusted.

The panel VAR can be written as:

$$Y_{i,t} = A_i + A(L)Y_{i,t} + \varepsilon_{i,t}$$

"Where $Y_{i,t}$ is a vector of endogenous variables $\varepsilon_{i,t}$ is a vector of errors. A_i is a matrix of country-specific fixed effects. $A(L)$is a matrix polynomial in the lag operator whose order is determined by the Akaike information criterion considering orders up to four. The vector of endogenous variables comprises the log differences of real GDP (Δy) the log difference of the consumer price index(Δcpi), the level of the short-term nominal

interest rate (ir), the log difference of nominal residential house prices (Δhp), the log difference of nominal broad money (Δm), and the log difference of nominal private credit (Δc). The vector $Y_{i,t}$ is therefore given by $y = [\Delta y, \Delta cpi, ir, \Delta hp, \Delta m, \Delta c]'$" (p.188).

The dummy variable panel can be written as:

$$y_{i,t} = A_i + A_{NB}(L)y_{i,t} * D_{i,t}^{NB} + A_B(L)y_{i,t} * D_{i,t}^{B} + \varepsilon_{i,t}$$

"Where $D_{i,t}^{B}$ is dummy variable that is set equal to one when there is a house-price boom in period t in country i, and equal to zero otherwise $D_{i,t}^{NB}$ is, in turn, a dummy variabale that is set equal to one when there is no house-price boom in period t in country I, and equal to zero otherwise." (p.197).

The model was estimated by FE OLS (fixed-effects ordinary least squares), the authors decided to use this estimation due to the large size of the time-series dimension of the panel. Based on Granger causality test, the authors assess the significance of the direct lead-lag relationship between the endogenous variables. Changing the order of the variables (based on a simple Cholesky decomposition) the authors performed the robustness test, with the conclusion that changes in the ordering of the variables had no substantial effect on the results.

Importantly, the authors argue that it was not possible to attach a clear structural meaning to the shocks, which actually means a highly significant multidirectional relationship between the variables.

In order to test the hypothesis that the link between monetary variables and house prices became stronger after financial deregulation the authors replicated the empirical exercises for the sample period 1985Q1-2006Q4 and compared the results with the ones obtained by the full sample period. The lag of estimation over the short sample period was three. The difference between the full-and the sub sample impulse responses was generally not statistically significant.

The empirical analyses of Goodhart and Hofmann (2008) reveal that the effects on house prices of shocks to money and credit are stronger when house prices are booming than otherwise. To reach their conclusions, they ran a dummy variable augmented panel VAR setting one variable to one in a house price boom or zero otherwise.

(iii) Hofmann (BIS 2001) - "The determinants of private sector credit in industrialised countries: do property prices matter?" (p.1-26).

Making use of a co-integrating VAR model, Hofmann investigated the determinants of credit to the private non-bank sector in 16 industrialized countries, focusing on quarterly data for the sample period 1980Q1-1998Q4.

In the co-integration analysis, the author shows that the long-run development of credit cannot be explained by standard credit demand factors (GDP and the real interest rate). However, when the property prices are added to the system they identified long-run relationships linking real credit positively to real GDP and real property prices and negatively to the interest rate. According to Hoffman (2001): "Credit is found to adjust significantly to the co-integrating relationship, implying that there is a long-run relationship linking credit to GDP, property prices and interest rate." (p.1).

Estimate error-correction models were used to analyse dynamic interactions by computing orthogonalised impulse responses. Importantly, impulse responses are in line with prior expectations i.e. standard Cholesky decomposition.

The variables employed were the following: property price indices (measured as a weighted average of residential and commercial property prices), nominal interest rate, nominal credit aggregated (transformed into terms by using the CPI) and real GDP. As a proxy for aggregating real financing costs, the author used an ex post short-term real interest rate, measured as the three-month interbank money market rate, less annual CPI inflation.

All data, except for nominal interest rates were seasonally adjusted and transformed into natural logs. Hofmann used different lags orders for each country (between 2 and 8 for the minimal system and 2 and 5 for the extended system).

Based on a co-integration analysis (Johansen approach), Hofmann analysed the relationship between real lending, real GDP, the real interest rate and the property prices

The VAR model can be written as:

$$X_t = B_1 x_{t-1} + B_k x_{t-1} + \mu + \varepsilon_t,$$

"Where x is a vector of endogenous variables, μ is a vector of constants, and Ɛ is a vector of errors terms, which is assumed to be white noise. In order to assess whether property prices play a role in explaining the development of credit we estimate two

econometric models, a minimal system comprising only the log of real credit, the log of real GDP and the interest rate, and an extended system also comprising the log of real property prices." (p.10).

Two econometric models were estimated, a minimal system, including only the log of real credit, the log of real GDP and the interest rate as well as one extended system including the log of real property prices to the minimal system.

According to Hofmann, "the Johansen methodology is based on maximum like hood estimation, so that Gaussian error terms are required. The lag-order of the VARs was therefore chosen in order to obtain well behaved VAR residuals…The VAR model was reformulated in vector-correction form as:" (p.12).

$$\Delta x_t = C_1 \Delta x_{t-1} + \cdots + C_{k-1} \Delta x_{t-k+1} + C_0 x_{t-1} + \mu + \varepsilon_t$$

For some countries, it was necessary to add some centred impulse dummies in order to eliminate some outliers in the real interest rate equation.

As explained above the Cholesky decomposition involves a recursive ordering of the variables. The author used a standard Cholesky decomposition to recover the structural shocks from the reduced system. The order adopted was as follows: real GDP, real credit, real property prices and the real interest rate.

It is a significant assumption that real GDP does not respond simultaneously to innovations of the other variables, but may affect the other variables within the quarter. The author also assumed that interest rate reacts simultaneously to all alterations but has no simultaneous effect on the other variables i.e. that interest rate moves are transmitted with a lag. Another important assumption was that credit had a simultaneous effect on property prices but not on the other way.

In short, the author concluded that the impulse responses i.e. shocks using the standard Cholesky decomposition were in line with his expectations and he found strong evidence of a two-way relationship between credit and property prices.

(iv) Berlemann, Freese 2012 - "Monetary policy and real estate prices: a disaggregated analysis for Switzerland" (p.469-486).

Berlemann and Freese, employed a new quarterly dataset for the sample period 1987Q4-2008Q2 for Switzerland. This was in order to estimate a VAR model and to examine the following: impulse responses of house and condominium prices, the

residential rental market and various sub-segments of the market for commercial real estate to interest rate shocks.

As know, the sub-segments of the real estate market are defined as follows: residential property, commercial property and public property.

The following variables were employed: CPI, GDP, the three-month target libor, money aggregate M3 and Swiss (Stock) performance Index (real estate). The data was seasonally adjusted and all the data was in logs, except for the inflation rate and the interest rate.

The authors estimated a reduced form of VAR, which can be written as: (p.477-478).

$$x_t = C + \sum_{i=1}^{P} A_i * X_{t-i} + u_t$$

"Where x_t is the vector of the n endogenous variables at time t, A_i are the nxn matrices of parameters… u_t denotes a nx1 vector of unobservable error terms where" (p.477)

$$Eu_t = 0$$

$$En_t u'_t = V$$

In order to observe the orthogonal shocks (interest rate shocks) they reformulated the VAR in a structural form.

$$A * X_t = C + \sum_{i=1}^{P} A_i^* * x_{t-i} + B * \varepsilon_t$$

Where "ε_t denotes the nx1 vector of disturbances which are now uncorrelated and can be interpreted as structural shocks where" (p.477)

$$E\varepsilon_t = 0$$

$$E\varepsilon_t \varepsilon'_t = D$$

"The relationship between the VAR residuals and these structural shocks can be written as:" (p.478).

$$\varepsilon_t = B^{-1} \cdot u_t.$$

The Cholesky-decomposition was used to identify the system. All estimated VARs were specified in levels. Thus, they generated impulse responses to a one-time interest rate shock, bearing in mind, that impulse responses in VARs models became imprecise when using various parameters, the authors have generated confidence bands using Monte Carlo simulations to obtain one standard error confidence bands.

The empirical analysis was conducted in two steps, first they estimated benchmark model which include aggregate measures for the stock and the real estate market, secondly they exchanged the aggregate real estate performance index against the measures of the sub-segments of the real estate market and estimated a joint model within these sub-segments of the real estate market into the same VAR model.

The benchmark model had a lag length of 1 quarter for all VARs, in correspondence with most of the empirical research the authors found that the monetary policy remains without any effect on the stock market but had a significant effect on the aggregate real estate market.

Using the disaggregate model, they studied the reaction of the real estate market in a uniform manner with interest rate shocks and estimated a VAR with 10 endogenous variables. "… we find quite heterogeneous reactions of the real estate variables on interest rate shocks which indicate that the effects of monetary policy are quite different for the various sub-segments of the real estate market… higher interest rates lead to an increase of credits costs making acquisitions of one's property less attractive… an increase in the Swiss libor rate is quickly followed by increasing rental prices" (p.481-482).

The authors argued that the effects of monetary policy on privately used real estate is the opposite: a contractive monetary policy leads to decreasing prices for houses and flats. But on the other hand, they found a reverse effect in respect of rental prices of apartments. It is important to note that commercial property prices do not react significantly to interest rate shocks.

Several specification tests were carried out in order to observe the robustness of the empirical results: firstly they changed the variables in the Cholesky ordering, secondly they used the GDP deflator instead of the CPI as a measure of the aggregate prices, thirdly they repeated all estimations with unadjusted data and finally they omitted the monetary aggregate M3 completely from the VAR model. In all the latter tests the

results were similar - by exchanging M3 with M1, as well as substituting the monetary aggregate for the volume of mortgage loans, the results remained similar.

According to Berlemann and Fresse, "while in the light of the presented empirical evidence monetary policy seems to be inadequate to decrease or eliminate an already existing, huge house price bubble, it might be useful in successfully leaning against the wind when house prices start diverging from their fundamental values…Finally, it should be underlined…that using monetary policy to keep house prices on the fundamental level is not without an adverse effect on the rental market" (p.486).

(v) Lack (SNB 2006) – "Forecasting Swiss inflation using VAR models" (p.3-23).

Lack illustrates how the SNB uses VAR models to forecast price inflation, bearing in mind that since late 1999 inflation forecasts have been regularly calculated and published by the SNB and are the main guide for policy decisions.

It is significant that inflation is forecast as conditional (with the assumption that the reference interest rate will remain unchanged over the forecast sample period) as well as unconditional i.e. if the reference interest rate evolves in an endogenous manner.

The SNB does not comply with one particular VAR model and different VAR´s forecast models were combined, giving those forecasts equal weight, to produce one final forecast and reduce the RMSE (root mean squared error).

The variables are used from a pool of 10 variables within:

- CPI,
- the trade-weighted nominal and real exchange rate index of the Swiss franc,
- real GDP,
- the money aggregates M1, M2 and M3,
- outstanding domestic bank loans,
- the three-month LIBOR
- the ten-year government bond yield.

The interest rate is the only variable which is not transformed with the natural logarithm and the series is not seasonally adjusted. The estimation of the VAR models is either in first differences (stationary) or in levels (co-integrating relationship among the variables) and contains a constant term but no time trend.

For models in differences the variables M1, bank loan and exchange rates seem to be the most informative ones. On the other hand, for models in levels M3 and outstanding performed well.

According to Lack, five variables are employed to describe the most important dynamics in an economic system. CPI is clearly included in all models and the other variables are determined in an evaluation process. Other variables outside the pool, which could explain inflation, such as mortgage loan and index of PPI are also aggregated in the process. All models are estimated in rolling regression and ranking, the best models are then re-estimated and the final inflation forecast is calculated as the combination of those models.

The lag length is 4 lags and the estimation period is 15 years. As mentioned above, the evaluation criteria are the RMSE (root mean squared error). Significantly, an increase in the number of models reduces the U-statistic i.e. the RMSE of the forecast. Bearing in mind longer forecast horizons, models estimated in levels of variables are superior to models estimated in first differences.

(vi) Stulz (SNB 2007) "Exchange rate pass-through in Switzerland: Evidence from vector autoregressions" (p.2-24).

Using recursively identified VAR models, Stulz investigated the pass-through of exchange rate and import price shocks to a different aggregated price in Switzerland.

In a first step, the author examined within a full-sample analysis (1976.01–2004.12) the transmission of exchange rate and aggregated import price shocks to aggregated import and consumer prices. In a second step, he investigated the changes in pass-through over time using a sub-sample analysis.

The identification of the structural shocks is done using a recursive scheme i.e. of Choleski decomposition.

The aim of the study is to shed light on the transmission of fluctuations in the exchange rate to import prices and consumer prices and those three variables above mentioned variables constitute the centre of the analyses. Other variables such as output gap, broad measure of money and foreign consumer prices were also included in the model.

The data is based on monthly observations and all series, except for the nominal exchange rate, were seasonally adjusted. The only exogenous variable in the model was

the foreign consumer prices, it is significant that the model is based on first differences. All series except for the output gap, were treated as log differences.

The reduced form of the model was estimated with six lags for the endogenous and exogenous variables. The identification was achieved in two steps, firstly the reduced form of the model was estimated by OLS and secondly the reduced form residual transformed.

The authors used a recursive identification scheme (Choleski decomposition) which means that the decomposition is only unique up to the ordering of the variables.

The robustness was tested with alternative recursive as well as non-recursive identification schemes. In order to observe the sensitivity of the results, the author ran a level VAR and a VECM. The result evidence is very dependent on the specification of the empirical model, the author included several robustness tests such as different identification schemes and data transformation.

The table below provides a summary of the variables employed as well as the identification process described in the studies presented above.

Authors	**Variables**												**Tests**			**Identification**
	Equity Prices	Residential Property Prices	Property Prices as the weighted avarage of residential and comercial property prices	CPI	GDP	Interest Rate	M3	Real Estate Performance Index	Nominal House Prices	Nominal Broad Money	Nominal Bank Credit	Nominal Credit Aggregate	Cointegration	Unit Root	Granger Causality	Choleski Decomposition
(i)	x	x		x	x	x							x	x		x
(ii)				x	x	x			x	x	x				x	x
(iii)			x		x	x						x	x	x		x
(iv)				x	x	x	x	x								x
(v)	10 pooled variables															
(vi)	3 endogenous varibles and 1 exogenous variable															x

Table 1: Summary of employed variables.
Source: own table.

4. Empirical Model Development

4.1 Mathematical Notation

A VAR model describes the evolution of a set of k variables over the sample period (t=1, 2…T) as a linear function of only past values. According to Enders (2012), p. 286, the standard form of the VAR, where all variables are I(0) STATIONARY, can be written as:

$$x_t = A_0 + A_1 x_{t-1} + e_t$$

Where: A_0 is a vector of constants, A_j is a time invariant *k x k* matrix, and e_t is a vector of error term, *i* denotes the element (e.g. RPPI) observed at time *t*. For illustration, a_{i0} can therefore be defined as an element *i* of the vector A_0, a_{ij} as the element in row *i* and column *j* of the matrix A_1 , and e_{it} as the element *i* of the vector e_t.

The standard form of VAR can be rewritten as:

$$x_t = \alpha_{10} + \alpha_{11} y_{t-1} + \alpha_{12} z_{t-1} + e_{1t}$$

$$z_t = \alpha_{20} + \alpha_{21} y_{t-1} + \alpha_{22} z_{t-1} + e_{2t}$$

Errors terms e_{1t} and e_{2t} satisfy the following; every error term has mean zero, the variance of e_{1t} is time independent and the autocorrelation of e_{1t} and e_{1t-i} is zero for $i \neq 0$. According to the above-mentioned literature, the variance-covariance matrix of the error terms is defined as:

$$\sum = \begin{bmatrix} var\ (e_{1t}) & cov\ (e_{1t,} e_{2t}) \\ cov\ (e_{1t,} e_{2t}) & var\ (e_{2t}) \end{bmatrix}$$

Taken into consideration that all elements are time independent, the compact notation can be written as:

$$\sum = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{21} & \sigma_2^2 \end{bmatrix}$$

Where $var\ (e_{it}) = \sigma_i^2$ and $cov\ (e_{1t,} e_{2t}) = \sigma_{12} = \sigma_{21}$

4.2 Data

The dataset consists of quarterly data for the sample period 2000Q1-2017Q2. Except for the interest rate which was taken from the OECD Library, all data is taken from the publically available Swiss National Bank dataset.

Initially, the empirical model is estimated using the following four variables: CPI, real GDP, interest rate and residential real estate index (RPPI). These variables were chosen based on their macroeconomic significance in elucidating the relationship between property prices and interest rate.

Except for the interest rates all the variables were incorporated in first differences. The inflation (CPI) and the residential property prices index (RPPI) were incorporated as "dlog" i.e. logarithms and first differences. A detailed description of the data is provided in the appendix.

CPI (Consumer Price Index)

Monthly CPI data is transformed into quarterly series by considering the weighted average over three months. The national index was measured as 100 in December 2015. The data is obtained from the SNB data portal.

Real GDP (Gross Domestic Product)

Real GDP is measured as the change from the same quarter of the previous year and it is non-adjusted. The data is obtained from the SNB data portal.

Short-Term Interest Rate

The short-term interest rate is the 3 month-Libor. Data is provided by the OECD data set, and as explained above, the value is used in levels.

RPPI (Residential Property Price Index)

Since the asking price is the main criterion to be investigated, this study focuses on the asking price for residential property. The apartment price index obtained from the SNB data portal, is considered.

Model Evaluation and Stationarity

As a starting point, a unit root test was employed to assess the stationarity of the model. The result showed that all roots are outside the imaginary circle and the absolute value i.e. modulus values are below one. Since, as described in the data section, all variables are considered in first differences with the exception of interest rates, the model is indeed stationary in first differences.

Bearing in mind that the model is estimated using quarterly data, and in line with the above presented literature, a lag order of four was chosen. The lag order was tested and corroborated employing the Hannan-Quin information criterion (HQ).

Once stationarity has been established, as a second, step, a Breusch-Godfrey LM test is employed to assess the autocorrelation of the residuals. The results of this test conclude that the model is sufficient to capture all dynamics.

Impulse response, Identification and Choleski Decomposition

As is well known, the impulse response function is a shock to the VAR system and identifies the responsiveness of the endogenous variables.

According to Enders (2012), the Choleski decomposition i.e. recursive ordering, was used to impose identification restrictions. It is important to note that when using this kind of restriction, it is necessary to return to the primitive system or structural VAR presented below:

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt}$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt}$$

In short, the Cholesky decomposition can be understood as the imposition of a recursive ordering in y_t which does not have a contemporaneous effect on y_t. This restriction is formally represented by setting $b_{21} = 0$ in the primitive system, where the error terms can be decomposed as: $e_{1t} = \varepsilon_{yt} - b_{12}\varepsilon_{zt}$ and $e_{2t} = \varepsilon_{zt}$ (p.285& 296).

Considering the significance of the ordering, a reversed ordering of the variables was tested to check the reaction of the model to the impulse response function. (these results are explained in Chapter 5).

5. Results

5.1 The Model – Cholesky and Impulse Response Function

To assess the manner in which the variables react to each other, and in line with the Cholesky decomposition, in a first step, the response of the variables was tested with the variables ordered as follows: inflation, GDP, the short-term interest rate and the property prices. The sample period is set as 2000q1-2017q2 with a lag order of three.

The relation between the variables was observed during eight lags and all the results of this simulation are within the confidence bands.

Significantly, the impulse response in the above-mentioned order (CPI, GDP, Interest rate and residential property prices) implies that changes in inflation would be

contemporaneously affected by shocks to all the other variables, this is due to the fact that the system in this ordering is ruled to start at zero.

The following analysis concentrates on explaining the fluctuations in property prices avoiding focus on the relationship between the other variables. Consequently, this does not pose a major problem, since the declared intention of this study is to investigate closely the relationship between property prices and interest rates.

5.2 Sample period 2000q1-2017q2 - Residential Property Prices Response

Interest rate shocks: Property prices react with a lag of two quarters to interest rates shocks, this response has a bigger impact for the first six periods, diminishing after 7 periods. Moreover, contrary to expectations, it is surprising to observe that there is not much impact from property price shocks on interest rates. In correspondence whit the findings of, Hofmann (2001) and Goodhart and Hofmann (2008) it is possible to expect a two-way relationship to exist between these variables.

CPI shocks: By analysing the responses of property prices to CPI shocks, it is possible to conclude that after two quarters inflation shocks immediately cause a negative response in the fluctuations of property prices. This response appears to be more significant in the short run than in the long run.

GDP shocks: Property prices fall immediately after a GDP shock. This response fluctuates along the entire analysed period and it appears to not have the same impact as the response to interest rate shocks.

Given the time-period that is considered for this study, several issues could be driving the somewhat surprising results reported above. Primarily, the special monetary policy situation on Switzerland between 2011 and 2013, whereby the Swiss National Bank opted to peg the Swiss Franc to the Euro could have an important impact on the observed relationship between prices and interest rates. Through its decision, the SNB´s tool for addressing risk on the real estate market was removed. (Jordan, 2012, 7 February), in other words, the SNB was no longer able to react to real estate relates risks through adjustments to interest rates.

In addition, and as explained in Chapter 2.1, in 2012 the Swiss Federal Council announced a package of measures aimed at reducing risks emanating from the real estate market on Swiss Financial Stability such as CCB and LTV. Consequently, the

relationship between residential real estate prices and interest rates that had existed until 2011, has suddenly become more complex.

It has been comprehensively documented by the Swiss national bank (FSR 2017) that risks from residential real estate market have emanated predominantly from the apartment segment, in this regard it is important to remember, that loans with a repricing maturity of more than five years remain one quarter of the outstanding mortgage volume, which means that a rise in the interest rate would have a considerable impact in the short and medium term on 75% of the mortgage volume. Importantly, one-third of the mortgage volume have a repricing maturity shorter than 12 months. It follows that with an increase in the interest rate there is in fact a considerable risk of a significant price correction in the apartment segment.

In the chart below one can observe the speed at which risks in the apartment segment have built up since 2008, particularly when compared to the evolution of the single-family house segment. Taking a weighted average of these distinct indices can mask some important details.

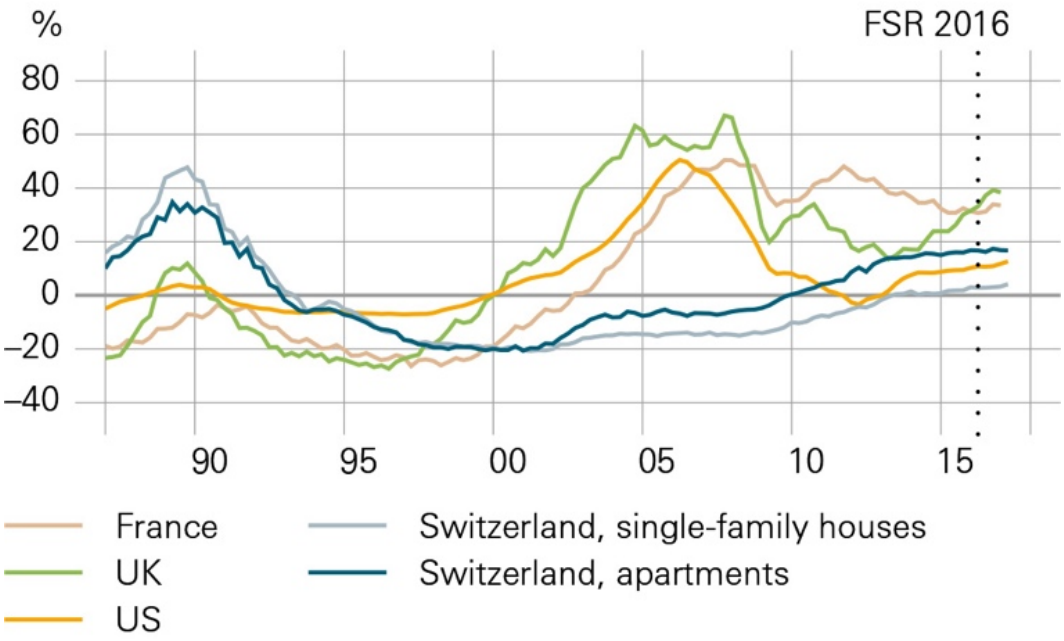

Figure 13 : Residential real estate: price-to-rent-ratios, deviation from long-term average calculated over the sample period 1970-2017, asking price is used for Switzerland.
Source: Financial Stability Report 2017, Chart 9, p.9.

In this regard, it is important to note that in a first step the model was estimated using the weighted average of the apartment and the single-family house segment. By running this estimation, house prices displayed no impact to the interest rate. This response is contrary to the expectations and shows no correlation with macro prudential policies. In

agreement whit the findings of Hofmann (2001) and Goodhart and Hofmann (2008), the objective of this study is to test the two-way relationship between property prices and interest rates.

The following, in a second step, will decompose the sample period into two distinct periods: one containing information before the peg and another after its removal.

According to the variance decomposition test, the GDP is the variable with the smaller contribution to the whole system. For this reason and as a robustness check, a new VAR model with three variables is estimated.

The variables are ordered as follows: inflation, interest rate and property prices. In line to the Schwarz information criterion, this VAR proceeds with three lags and the Cholesky decomposition is examined during eight periods.

5.3 Sample Period 2000q1-2011q4 - Residential Property Prices Response

The output generated from the re-estimated model can be observed in the graphs below. The graphs present the response of the model to shocks in the different variables. The blue line represents the property price response; the red dot-line represents the confidence bands. The Y-axis is the magnitude and the X-axis is the duration of the impact, measured in quarters. In other words, these graphs represent the unanticipated one-unit change in the impulse variable on the output variables.

Interest rate shocks: The initial impact that one-unit shock in interest rates cause to property prices is slight and negative. After two periods property prices decrease further to 0.04 % before it starts normalizing again. The great impact is observed after 2 quarters and the impact lasts around 7 quarters after which time the property price index returns to its initial level.

CPI shocks: The response of apartment prices to inflation shocks is very similar to that of interest rate shocks. This is due to the fact, that interest rates and inflation are closely related (i.e. CPI is one of the significant factors to set the interest rate). Thus, it is possible to observe an impact at three quarters with the path returning to “normal” four quarters later.

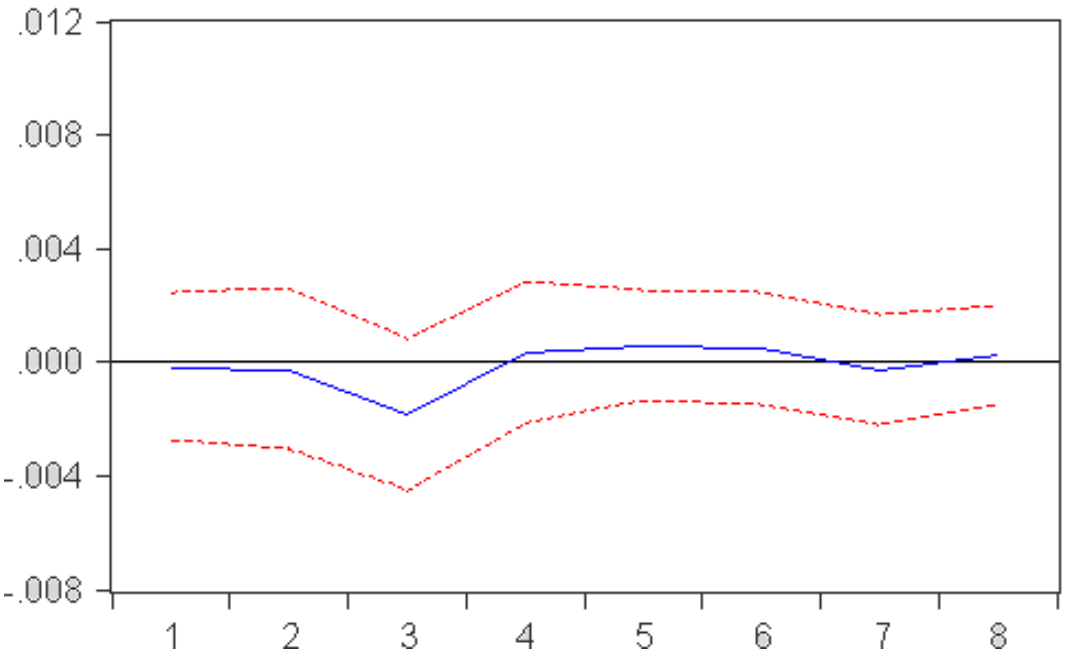

Figure 14: The graph represents the property prices reaction to CPI shocks over the sample period 2000-2011.
Source: SNB and OECD data and own calculations.

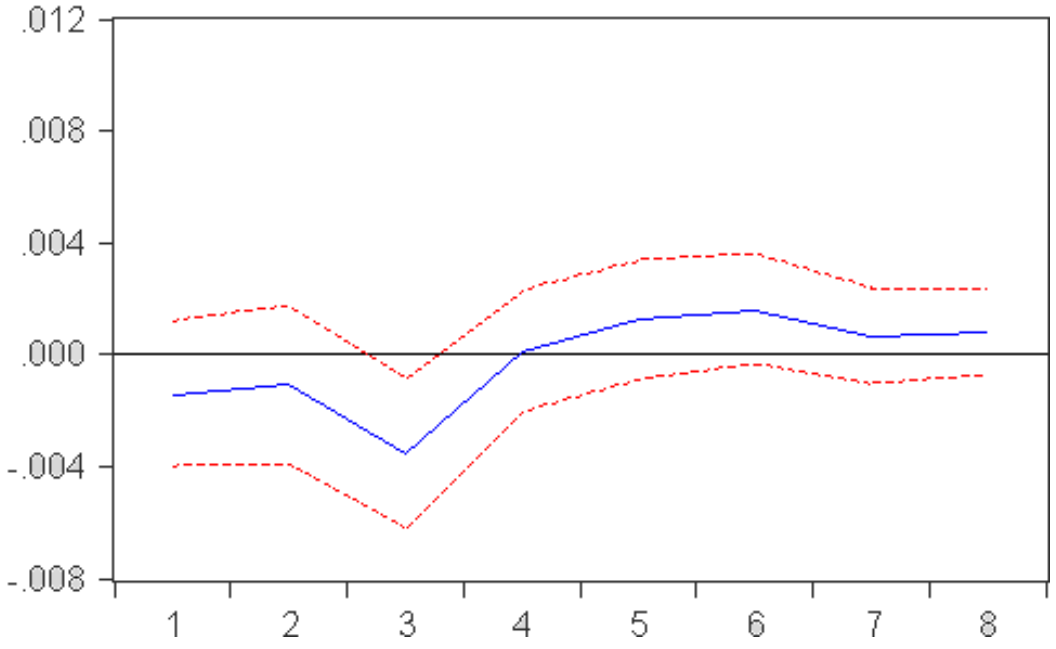

Figure 15: The graph represents the property prices reaction to interest rates shocks over the sample period 2000-2011.
Source: SNB and OECD data and own calculations.

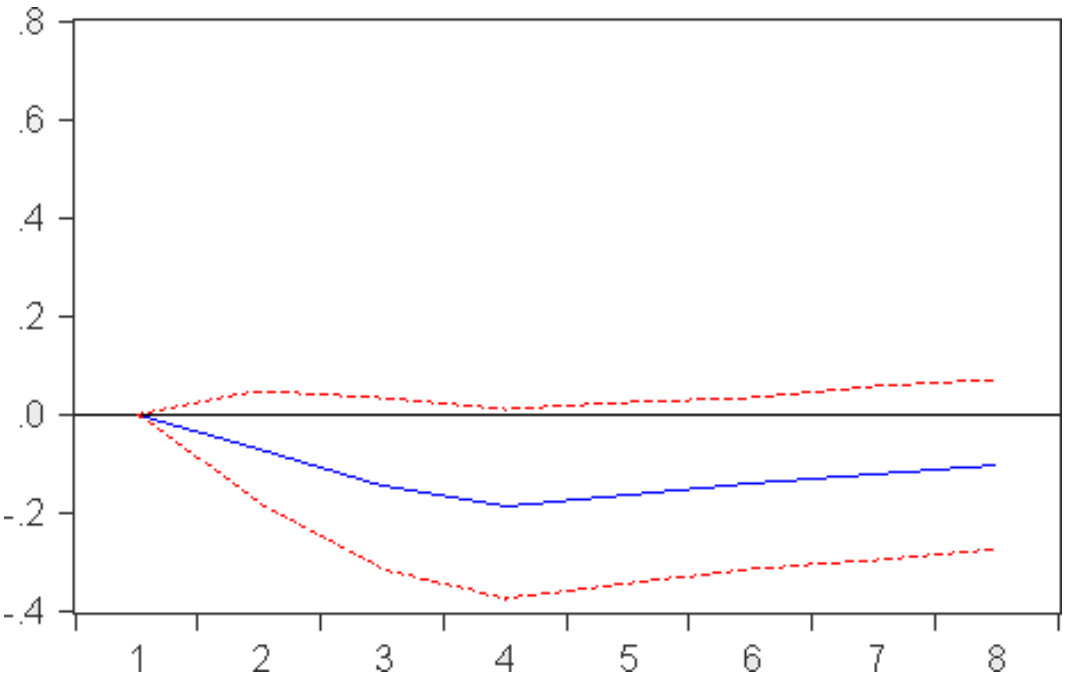

Figure 16: The graph represents the interest rate reaction to property prices shocks over the sample period 2000-2011.
Source: SNB and OECD data and own calculations.

As Figure 15 indicates, property prices fall almost immediately after an increase in the interest rate with a return to equilibrium around for quarters later.

Figure 16, which represents the interest rate reaction to property prices over the sample period 2000-2011 can be explained as follow: according to the Cholesky decomposition, the ordering of the variables elucidates the independence (exogeneity) of the variables relative to one another, it is important to note, that this exogeneity is relative and not absolute. Importantly, and bearing in mind the macro prudential policies which have been implemented in Switzerland since 2012 as well as the special monetary policy which was in function between 2011 and 2013, and in line with the literature explained above, one could expect a two-way relationship between property prices and interest rate, which is confirmed by the model and it is interpreted as a multi-causal i.e. indirect response. (see conclusions).

As mentioned previously, the model was initially tested by employing the weighted average between apartments and single-family houses over the sample period 2000-2017. It showed that interest rate did not react to fluctuation in property prices. By running the model over the same sample period but employing apartment prices instead of a weighted average between apartments and single-family houses, not much interest rate reaction to property price fluctuations was shown. However, there is a difference

when taking into consideration the period of time before the Swiss National Bank opted to peg the Swiss Franc to the Euro and as Figure 16 make clear, it is possible to confirm the hypothesis that a two-way relationship between property prices and interest rates exists.

Goodhart and Hofmann (2008) found a two-way relationship between house prices and monetary variables, "… monetary variables are found to have a significant effect on future house prices and, at the same time, house prices are found to have a highly significant effect on future money and credit growth…" (p.192).

Hofmann (2001) found a two-way relationship between credit and property prices i.e. of "increases in boost lending and vice versa.". Subsequently innovation to the interest rate have a significant negative effect on real lending and property prices. (p.2).

These findings clarify the two-way relationship between property prices and interest rate and strengthens the results and conclusions drawn in this study i.e. fluctuations in interest rate have a direct impact on property prices and property prices have an indirect effect on interest rate.

By extending the model over the sample period 2012q1-2017q2 it is possible to confirm the hypothesis about the two-way relationship between house prices and interest rates. It is important to note, that in January 2015 the SNB unpegged the Swiss Franc from the Euro. However, there is not enough data available to be able to analyse the last two years, and future research would be necessary.

In conclusion, the relationship between property prices and interest rates will become increasingly complex over the following years and as explained above, an increase in the interest rate displays a considerable risk in the apartment segment.

On the other hand, the fact that the Swiss residential real estate market is divided in three different segments: owned apartment, single-family houses and rented apartment play an important role in the two-way relationship between property prices and interest rates. In fact, there is not much impact on single-family houses to interest rate fluctuations, but when the apartment segment is analysed, the situation appears significantly different.

The Swiss real estate market displays important differences regarding location, i.e. regional and cantonal differences. More in depth research, which is out of the scope of

this thesis, could be done to identify and quantify the risk of future developments and inversions.

6. Survey with Current Experts

This research highlights how an econometric model can help us to understand the true nature of the relationship between property prices and interest rates. The findings confirm the hypothesis that a two-way relationship between property prices and interest rates exists.

Importantly, the findings in this thesis highlight the complex nature of the interplay between prices and interest rates. Important segmental differences are shown to have a considerable impact, and it is anticipated that regional differences would reveal the same finding. Therefore, the research conducted in this study emphasises the need to acknowledge important differences within the Swiss real estate market be it at segment or regional level. More in depth research in this area would be fruitful for mitigating risk and uncertainty.

To gain an understanding of how important such an analysis is for developer and investors, a sample of three real estate experts from larger real estate companies were interviewed. The idea behind the interviews was to test whether the model developed in the context of the thesis could be used to develop a real estate business plan and risk strategies.

6.1 Questions

Following an explanation of the model and a presentation of the results, the following questions were posed to them:

- What is your opinion about property prices and interest rate in Switzerland?
- Did the presented results change or confirm your opinion about the relationship between property prices and interest rates in Switzerland?
- Do you believe that an in-depth analysis, for example: retail segment Winterthur or owned apartments Zürich, would help you to highlight important risks and vulnerabilities relevant for your business?
- Do you believe that econometric analysis of future developments and investments could help to mitigate the risks and improve your business?
- As a second step, based on the output of this model, it could be possible to extend the assessment to include forecast of property prices to more aggressive

interest rates shocks. Given the associated uncertainty, how do you feel about using forecast for the conduct of business? What criteria would need to be met for you to consider such an exercise useful for the development of risk strategies.

6.2 Expert Opinions

The following is a summary of certain anonymous expert opinions, single interviews which are allowed to be published in this study are cited in the appendix.

The interest rate can be seen as a multifaceted aspect which is of considerable importance for investors and developers. Moreover, various other factors such as the abolition of the Libor in 2012, a rise in the interest rate which consequently involves a higher cost of financing, the demand and supply of money as well as "behavioural finance" make the situation even more complex and place uncertainty on future investments.

A increase in the interest rate is not an imminent probability, but an important issue to consider is how rapidly and how high the interest rate would increase and whether the Swiss national bank would increase the interest rate before the European central bank does.

The model presented in this study regarding property prices and interest rates, reveals how rapidly property prices react to interest rate shocks and it highlights the important effects of varying time-periods and regimes on property prices in Switzerland.

The conclusion that the single-family house does not have much significance for the whole system is a somewhat surprising aspect. However, this is clarified when one considers the increasing risks accumulated in the apartment segment since 2008 and how this segment is currently developing in comparison to the apartments segment. In this regard, a more in depth analysis of the different real estate segments, as well as geographical regions, would be fruitful for investigating the speed at which interest rates can have an impact on property prices.

At a first sight, another surprising issue is the impact of property prices on interest rates. This should be regarded as having a multi causal impact or indirect impact in which property prices are seen as an investment product which influences the Swiss financial market. In other words, investors have a notion of the yields and these yields have

interest rates upon which calculations are based and these have impact on property prices, which subsequently affect the financial market.

Econometrics models could be fruitful to facilitate better understanding of the impact and inter dependence of property prices and other important variables. These could also facilitate an investigation of the speed at which interest rates have an impact on property prices.

A forecast model could be of benefit to future research and make possible an investigation of the risks involving an increase in interest rates as these meet property prices. Such models could be useful to mitigate risks.

However, the question is how user friendly such models are and how much a priori knowledge one needs in order to develop these models. For future use the focus should be on combining academic research, practical experience and education involving real estate.

7. Conclusion

7.1 Summary of Results

The empirical analysis of this work offers the following interesting insights:

- It clarifies the relationship between macro-prudential policies and property prices in Switzerland. Over the last years, several macro prudential policies have been implemented: loan-to-value (LTV) applied to the property, restricting the use of pension saving as collateral for borrowers, the activation of the countercyclical capital buffer (CCB), the shortened of the amortisation period as well as the self-regulation rules for the banks. All of these measures together have worked to stabilize the houses prices.
- On the other hand, it is important to consider that mortgage debt remains very high and it is indeed rising. The loan-to-income ratio on new mortgage loans have not declined, which emphasises the ongoing risks in the mortgage and real estate market.
- Interest rates and house prices do have a two-way relationship, house prices react almost immediately to interest rate shocks and this response is very significant for a considerable period. Bearing in mind the development, the construction and or the real estate investment, the results can give important

insights to mitigate the risk. The reaction of interest rates to house prices is found not to be direct and can be understood as a multi causal effect. The interest rate affects the mortgage and the yield of future investment (DCF) which consequently has an impact on the property price and vice versa.

- Over the last years the evolution of apartment prices and single-family house prices have followed very different paths. Imbalances on the Swiss real estate market have been confined to the apartment segment, while the single-family houses have remained relatively unaffected. Given the importance of these sub-segments, as stand-alone segments, from a financial stability perspective, it is important that they are considered individually. In the current environment, adopting a weighted measure of these segments would result in a considerable loss of important and relevant information.
- A combination of the abolishment of the Swiss Franc peg in 2015, the various macro prudential policies that have been implemented since 2012 and the yet unknown impact that future measures- including abolition of the Libor by 2021- could have, the relationship between property prices and interest rates will become increasingly complex over the following years.
- The Swiss real estate market is very important and intricate market. An in-depth analysis of the different real estate segments, as well as geographical regions provides the most accurate information for developing risk based tools.

7.2 Discussion

The interest rate has been at historically low levels for several years. In Switzerland, interest rates tended to co-move with those in the other countries however, at lower levels. As the literature has shown long periods with low interest rates can have a significant impact on the creation of housing bubbles (see Hott et al. 2012). Low interest rates could provide the background for asset prices and credit booms. Currently in Switzerland this phenomenon can be observed through the increasing growth of mortgage and real estate prices, which have reached levels that are no longer justified by fundamental factors.

In 2011 and due to the massive overvaluation of the Swiss franc, the Swiss national bank took the decision to introduce an exchange rate peg. In January 2015, the peg was removed and as this study shows, this important monetary policy has had significant impact on the real estate market.

On the other hand, the years after 2000 have been characterized by the implementation of increasing macro prudential policies worldwide. In 2012 as a reaction to developments in the mortgage and the real estate market, with the constrained monetary policy, the Federal Council announced a package of macro prudential measures aimed to targeting the source of risks. These measures have subsequently had impact on mortgage lending and the real estate market, which has decreased slightly. However, the imbalances in the mortgage and real estate market remains at a considerable risk level.

In Switzerland, currently 85% of the loans are mortgage related loans. The importance of mortgage related credit is increasing rapidly when considered as a % of GDP. As argued in this study, an increase in the interest rate could constitute a considerable risk for Swiss short- or medium-term of 75% of the mortgage volume. Moreover, the apartments segment constitutes a considerable imbalance to the real estate market and when measured on a national Swiss average, 39% of gross income is required to afford a new property, which is above the "golden rule".

The Swiss real estate market is very complex and has been influenced by macro prudential as well as monetary policies. This study focuses on how these policies have had impact on the Swiss real estate market and it addresses the issue involving the relationship between house prices and interest rates.

With the use of an empirical VAR model the relationship between property prices and interest rates is clarified. My study highlights how house prices react immediately to interest rate shocks and house prices also have an impact on the interest rate. Initially, this result seems somewhat surprising, but when one considers the multi causal or indirect effect that real estate has as an investment product, which can also affect the whole financial market, this matter is clarified.

7.3 Future Prospects

Since 2008, imbalances have been building on the Swiss real estate market. Risks in the apartment segment have increased steadily. An increase in the interest rate would affect a considerable part of the outstanding mortgage volume. Therefore, a more in-depth analysis, bearing in mind the segmental and regional differences (which is out of the scope of this thesis), would clarify the true nature between property prices and interest rates.

Bearing in mind the uncertainty of an increase in the interest rate i.e. the speed and magnitude of this increase, a forecast model could be useful to analyse impacts of this kind.

Using the presented model as a basis, one could create different interest rate scenarios. It would then be possible to analyse the manner in which property prices react to various different shocks and within the context of macro prudential and monetary policies one could then investigate the probability of such increases meeting property prices.

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9. Appendix

9.1 Data - Background

	GDP_2	GDP_1	CPI_1	CPI_2
	Change from the same quarter of the previous	Change from previous quarter, seasonally and	Change from the correspon ding month of the	National index – Decembe r 2015 = 100
2000Q1	4,76	0,8	1,6	93,6
2000Q2	4,17	0,5	1,6	93,9
2000Q3	4,33	0,8	1,5	94,1
2000Q4	2,55	0,8	1,6	94,5
2001Q1	2,24	0,1	1	94,5
2001Q2	2,05	0,2	1,5	95,3
2001Q3	1,01	-0,2	1	95,1
2001Q4	0,00	-0,2	0,4	94,9
2002Q1	0,30	0,5	0,6	95,1
2002Q2	0,19	0,0	0,7	95,9
2002Q3	0,21	-0,1	0,3	95,4
2002Q4	-0,06	-0,5	1	95,9
2003Q1	-0,76	-0,3	1	96,1
2003Q2	-0,81	0,0	0,5	96,4
2003Q3	0,01	1,0	0,4	95,8
2003Q4	1,71	1,0	0,5	96,4
2004Q1	3,17	0,9	0,1	96,1
2004Q2	3,50	0,4	0,9	97,3
2004Q3	2,53	0,2	0,9	96,7
2004Q4	1,94	0,3	1,4	97,7
2005Q1	2,03	1,2	1,4	97,4
2005Q2	2,66	1,0	1,1	98,3
2005Q3	3,64	1,2	1,2	97,8
2005Q4	4,11	0,9	1,1	98,8
2006Q1	4,37	1,1	1,2	98,6
2006Q2	3,99	0,8	1,3	99,6
2006Q3	3,65	0,9	1,2	99,0
2006Q4	3,95	1,3	0,5	99,3
2007Q1	3,90	0,8	0,1	98,7
2007Q2	4,41	1,3	0,5	100,1
2007Q3	4,55	1,0	0,6	99,7
2007Q4	3,60	0,3	1,7	100,9
2008Q1	3,32	0,9	2,5	101,2
2008Q2	2,97	0,5	2,7	102,8
2008Q3	2,11	0,2	3	102,6
2008Q4	0,27	-1,6	1,6	102,5
2009Q1	-2,34	-1,6	0	101,1
2009Q2	-3,41	-0,2	-0,7	102,1
2009Q3	-2,42	0,9	-1	101,6
2009Q4	-0,71	0,2	-0,2	102,3
2010Q1	1,94	1,1	1,1	102,3
2010Q2	3,48	1,0	1	103,1
2010Q3	3,05	0,4	0,3	102,0
2010Q4	3,53	0,7	0,3	102,7
2011Q1	2,31	0,4	0,6	102,9
2011Q2	2,16	0,6	0,4	103,5
2011Q3	1,20	-0,2	0,4	102,4
2011Q4	1,13	0,5	-0,5	102,2
2012Q1	1,01	-0,1	-0,9	102,0
2012Q2	0,61	0,4	-1	102,4
2012Q3	1,13	0,4	-0,5	101,8
2012Q4	1,28	0,4	-0,3	101,8
2013Q1	1,22	0,2	-0,4	101,6
2013Q2	2,03	0,8	-0,4	102,0
2013Q3	2,16	0,6	0	101,8
2013Q4	1,99	0,3	0	101,8
2014Q1	2,59	0,8	0	101,6
2014Q2	2,16	0,6	0,1	102,1
2014Q3	2,16	0,5	0	101,8
2014Q4	2,88	1,0	-0,1	101,7
2015Q1	1,81	-0,4	-0,7	100,8
2015Q2	1,15	0,2	-1,1	101,0
2015Q3	1,19	0,3	-1,4	100,4
2015Q4	0,77	0,5	-1,4	100,3
2016Q1	1,43	0,5	-1	99,8
2016Q2	1,98	0,3	-0,4	100,6
2016Q3	1,55	0,3	-0,2	100,2
2016Q4	0,56	-0,2	-0,2	100,1
2017Q1	0,58	0,1	0,5	100,4
2017Q2	0,32	0,3	0,4	100,9

Table 2: CPI and GDP Data, sample period 2000q1-2017q2
Source: Swiss National Bank

	RPPI	RPPI	RPPI	short-term, interest rate	long-term, interest rate	Loan	Mortgage
	Privately owned apatments, asking	Single-family houses, asking prices	Rented properties, Rental housing units,	short-term interst rate, 3 month-Libor	long-term interst rate	Total loan	Mortgage loan
2000Q1	100	100,00	100,00	2,48	3,9	599.886	440.443
2000Q2	100,42	101,64	99,95	3,27	4,1	599.673	443.048
2000Q3	102,57	102,37	100,72	3,5	3,9	597.284	440.454
2000Q4	102,07	102,32	101,36	3,45	3,8	601.843	442.061
2001Q1	103,83	102,44	101,94	3,45	3,4	604.753	444.266
2001Q2	104,49	103,47	102,01	3,21	3,5	612.015	447.233
2001Q3	107,01	103,63	102,45	2,88	3,3	610.124	450.694
2001Q4	107,20	104,63	103,07	1,98	3,3	616.869	457.837
2002Q1	110,22	107,08	104,12	1,69	3,6	619.870	460.977
2002Q2	112,55	107,36	105,14	1,35	3,4	617.024	464.576
2002Q3	115,51	108,48	106,75	0,77	3,1	612.958	467.943
2002Q4	116,97	110,39	107,95	0,7	2,7	613.219	472.465
2003Q1	119,58	110,62	108,50	0,5	2,4	615.063	476.225
2003Q2	120,85	111,25	108,73	0,29	2,5	616.587	481.062
2003Q3	122,41	112,17	109,79	0,27	2,8	615.922	486.141
2003Q4	121,10	112,19	110,55	0,26	2,9	620.167	490.721
2004Q1	121,74	113,42	111,66	0,25	2,7	625.098	494.644
2004Q2	124,75	113,46	112,51	0,34	2,9	627.248	499.711
2004Q3	125,26	114,75	113,48	0,62	2,8	630.771	504.707
2004Q4	124,37	115,12	114,87	0,73	2,5	635.212	511.799
2005Q1	125,00	115,04	115,95	0,76	2,3	647.956	522.841
2005Q2	126,64	114,35	116,92	0,75	2,0	652.866	528.418
2005Q3	128,11	115,67	117,89	0,77	1,9	660.551	534.861
2005Q4	127,36	116,61	118,91	0,96	2,1	664.039	540.791
2006Q1	127,93	117,81	119,86	1,15	2,3	672.547	546.728
2006Q2	127,27	118,65	120,87	1,43	2,8	682.098	552.354
2006Q3	129,25	117,99	121,31	1,68	2,6	713.379	579.504
2006Q4	129,74	118,71	122,88	1,97	2,4	765.443	627.035
2007Q1	130,88	120,80	123,33	2,23	2,6	773.122	632.290
2007Q2	131,08	120,33	123,58	2,51	3,0	784.853	639.241
2007Q3	131,75	120,75	124,69	2,8	3,1	796.399	644.561
2007Q4	133,32	121,06	125,79	2,75	3,0	813.570	650.846
2008Q1	134,74	121,34	127,00	2,78	3,0	821.686	654.886
2008Q2	136,78	123,53	128,50	2,79	3,3	831.963	660.207
2008Q3	137,70	125,27	130,46	2,82	2,9	839.825	666.781
2008Q4	139,39	125,59	132,37	1,54	2,4	846.131	672.541
2009Q1	142,26	127,76	132,04	0,47	2,2	855.625	681.392
2009Q2	145,18	129,16	133,63	0,4	2,4	863.732	692.195
2009Q3	147,39	130,44	134,74	0,32	2,2	871.480	701.816
2009Q4	149,00	133,40	136,32	0,25	2,1	879.214	710.123
2010Q1	151,09	133,99	136,37	0,25	2,0	890.429	718.191
2010Q2	152,83	135,02	135,99	0,16	1,7	891.532	726.469
2010Q3	153,71	137,02	136,09	0,17	1,4	883.870	735.509
2010Q4	156,77	139,04	137,63	1,17	1,6	894.271	743.306
2011Q1	158,75	139,85	138,34	1,17	1,9	902.551	750.883
2011Q2	159,68	141,28	139,12	0,18	1,9	913.955	760.475
2011Q3	160,20	142,11	140,70	0,07	1,2	922.274	771.020
2011Q4	165,40	144,26	143,37	0,05	0,9	932.861	781.126
2012Q1	168,82	146,32	144,07	0,09	0,8	945.928	790.744
2012Q2	166,12	145,69	144,02	0,1	0,7	955.390	799.389
2012Q3	170,27	147,20	144,66	0,05	0,6	962.588	807.834
2012Q4	171,89	149,50	146,05	0,02	0,6	979.140	820.735
2013Q1	173,66	151,60	147,07	0,02	0,8	993.500	835.025
2013Q2	174,24	153,63	148,48	0,02	0,8	#######	845.350
2013Q3	175,69	154,58	149,36	0,02	1,1	#######	853.981
2013Q4	176,20	156,38	150,66	0,02	1,1	#######	862.920
2014Q1	177,56	154,84	151,20	0,02	1,0	#######	870.242
2014Q2	178,91	155,86	152,41	0,01	0,8	#######	877.670
2014Q3	179,68	156,40	151,71	0,01	0,6	#######	886.052
2014Q4	179,33	157,03	153,33	-0,02	0,5	#######	894.180
2015Q1	180,75	158,73	153,86	-0,84	0,0	#######	901.923
2015Q2	181,72	159,36	154,12	-0,79	0,0	#######	908.736
2015Q3	181,75	159,54	153,20	-0,73	-0,1	#######	914.808
2015Q4	182,25	160,63	153,39	-0,77	-0,2	#######	921.253
2016Q1	182,61	160,74	152,64	-0,76	-0,4	#######	926.633
2016Q2	182,24	161,22	151,58	-0,75	-0,4	#######	933.601
2016Q3	184,26	161,71	151,25	-0,74	-0,5	#######	939.561
2016Q4	184,43	162,96	151,39	-0,74	-0,2	#######	945.535
2017Q1	184,65	164,62	151,53	-0,73	-0,1	#######	952.347
2017Q2	184,90	164,80	150,76	-0,73	-0,1	744.687	638.912

Table 3: RPPI, Interest rates, total loan and mortgage loans Data, sample period 2000q1-2017q2
Source: Swiss National Bank and OECD

Reference Products	Median Variable mortgages	Median Mortgages whit fixed interest rates and 5 years maturity	Median Mortgages whit 3 months-linked rates and 5 years maturity
2007-12	3,25	4	3,89
2008-01	3,25	3,75	3,8
2008-02	3,25	3,85	3,8
2008-03	3,25	4	3,95
2008-04	3,5	4,19	3,86
2008-05	3,5	4,3	3,77
2008-06	3,5	4,55	3,79
2008-07	3,5	4,3	3,76
2008-08	3,5	4	3,75
2008-09	3,5	3,95	3,93
2008-10	3,5	3,82	3,77
2008-11	3,06	2,85	2,26
2008-12	2,88	2,85	1,67
2009-01	2,85	2,75	1,53
2009-02	2,75	2,76	1,5
2009-03	2,75	2,7	1,4
2009-04	2,75	2,65	1,4
2009-05	2,75	2,75	1,4
2009-06	2,75	2,8	1,4
2009-07	2,75	2,66	1,36
2009-08	2,75	2,55	1,32
2009-09	2,75	2,6	1,29
2009-10	2,75	2,65	1,26
2009-11	2,75	2,6	1,25
2009-12	2,75	2,6	1,25
2010-01	2,75	2,6	1,25
2010-02	2,75	2,5	1,25
2010-03	2,75	2,5	1,25
2010-04	2,75	2,5	1,25
2010-05	2,75	2,25	1,11
2010-06	2,75	2,2	1,11
2010-07	2,75	2,2	1,17
2010-08	2,75	2	1,17
2010-09	2,75	2,1	1,18
2010-10	2,75	2,15	1,17
2010-11	2,75	2,2	1,18
2010-12	2,75	2,35	1,17
2011-01	2,75	2,45	1,17
2011-02	2,75	2,5	1,17
2011-03	2,75	2,6	1,18
2011-04	2,75	2,65	1,19
2011-05	2,75	2,45	1,22
2011-06	2,75	2,3	1,23
2011-07	2,75	2,17	1,23
2011-08	2,75	1,95	1,16
2011-09	2,75	1,84	1,17
2011-10	2,75	1,87	1,19
2011-11	2,75	1,75	1,18
2011-12	2,75	1,65	1,2

Table 4: Interest rate on new mortgage, sample period 2000-2011 (monthly data)
Source: Swiss National Bank

Reference values	Median	Median	Median
Products	Variable mortgages	Mortgages whit fixed interest rates and 5 years maturity	Mortgages whit 3 months-linked rates and 5 years maturity
2012-01	2,75	1,56	1,19
2012-02	2,75	1,55	1,22
2012-03	2,75	1,64	1,23
2012-04	2,75	1,59	1,24
2012-05	2,75	1,46	1,23
2012-06	2,75	1,49	1,22
2012-07	2,75	1,45	1,21
2012-08	2,75	1,43	1,18
2012-09	2,75	1,45	1,19
2012-10	2,75	1,45	1,19
2012-11	2,75	1,45	1,13
2012-12	2,75	1,45	1,12
2013-01	2,75	1,69	1,13
2013-02	2,75	1,6	1,13
2013-03	2,75	1,6	1,13
2013-04	2,75	1,55	1,12
2013-05	2,75	1,65	1,12
2013-06	2,75	1,92	1,12
2013-07	2,75	1,85	1,12
2013-08	2,75	1,95	1,12
2013-09	2,75	1,85	1,13
2013-10	2,75	1,8	1,12
2013-11	2,75	1,72	1,12
2013-12	2,75	1,9	1,18
2014-01	2,75	1,7	1,17
2014-02	2,75	1,65	1,18
2014-03	2,75	1,65	1,18
2014-04	2,75	1,57	1,17
2014-05	2,75	1,48	1,17
2014-06	2,75	1,48	1,16
2014-07	2,75	1,45	1,22
2014-08	2,75	1,4	1,22
2014-09	2,75	1,4	1,21
2014-10	2,75	1,4	1,21
2014-11	2,75	1,35	1,2
2014-12	2,75	1,3	1,17
2015-01	2,75	1,2	1,1
2015-02	2,75	1,3	1,12
2015-03	2,75	1,3	1,1
2015-04	2,75	1,3	1,1
2015-05	2,75	1,34	1,1
2015-06	2,75	1,35	1,1
2015-07	2,75	1,35	1,1
2015-08	2,75	1,3	1,1
2015-09	2,75	1,3	1,12
2015-10	2,75	1,29	1,12
2015-11	2,75	1,25	1,12
2015-12	2,75	1,3	1,1
2016-01	2,75	1,25	1,08
2016-02	2,75	1,2	1,08
2016-03	2,75	1,2	1,08
2016-04	2,75	1,2	1,08
2016-05	2,75	1,2	1,05
2016-06	2,75	1,2	1,05
2016-07	2,75	1,2	1,05
2016-08	2,75	1,19	1,05
2016-09	2,75	1,15	1,05
2016-10	2,75	1,2	1,05
2016-11	2,75	1,2	1,05
2016-12	2,75	1,23	1,05
2017-01	2,75	1,23	1,05
2017-02	2,75	1,2	1,05
2017-03	2,75	1,2	1,05
2017-04	2,75	1,2	1,05
2017-05	2,75	1,15	1,05
2017-06	2,6875	1,15	1,05
2017-07	2,6875	1,2	1,05

Table 5: Interest rate on new mortgage, sample period 2012-2017 (monthly data)
Source: Swiss National Bank

9.2 Data - Model

	GDP 2	CPI 2	RPPI	short-term, interest rate
	Change from the same quarter of	National index – Decembe r 2015 =	Privatel y owned apatme	short-term interst rate, 3 month-Libor
2000Q1	4,76	93,6	100	2,48
2000Q2	4,17	93,9	100,42	3,27
2000Q3	4,33	94,1	102,57	3,5
2000Q4	2,55	94,5	102,07	3,45
2001Q1	2,24	94,5	103,83	3,45
2001Q2	2,05	95,3	104,49	3,21
2001Q3	1,01	95,1	107,01	2,88
2001Q4	0,00	94,9	107,20	1,98
2002Q1	0,30	95,1	110,22	1,69
2002Q2	0,19	95,9	112,55	1,35
2002Q3	0,21	95,4	115,51	0,77
2002Q4	-0,06	95,9	116,97	0,7
2003Q1	-0,76	96,1	119,58	0,5
2003Q2	-0,81	96,4	120,85	0,29
2003Q3	0,01	95,8	122,41	0,27
2003Q4	1,71	96,4	121,10	0,26
2004Q1	3,17	96,1	121,74	0,25
2004Q2	3,50	97,3	124,75	0,34
2004Q3	2,53	96,7	125,26	0,62
2004Q4	1,94	97,7	124,37	0,73
2005Q1	2,03	97,4	125,00	0,76
2005Q2	2,66	98,3	126,64	0,75
2005Q3	3,64	97,8	128,11	0,77
2005Q4	4,11	98,8	127,36	0,96
2006Q1	4,37	98,6	127,93	1,15
2006Q2	3,99	99,6	127,27	1,43
2006Q3	3,65	99,0	129,25	1,68
2006Q4	3,95	99,3	129,74	1,97
2007Q1	3,90	98,7	130,88	2,23
2007Q2	4,41	100,1	131,08	2,51
2007Q3	4,55	99,7	131,75	2,8
2007Q4	3,60	100,9	133,32	2,75
2008Q1	3,32	101,2	134,74	2,78
2008Q2	2,97	102,8	136,78	2,79
2008Q3	2,11	102,6	137,70	2,82
2008Q4	0,27	102,5	139,39	1,54
2009Q1	-2,34	101,1	142,26	0,47
2009Q2	-3,41	102,1	145,18	0,4
2009Q3	-2,42	101,6	147,39	0,32
2009Q4	-0,71	102,3	149,00	0,25
2010Q1	1,94	102,3	151,09	0,25
2010Q2	3,48	103,1	152,83	0,16
2010Q3	3,05	102,0	153,71	0,17
2010Q4	3,53	102,7	156,77	1,17
2011Q1	2,31	102,9	158,75	1,17
2011Q2	2,16	103,5	159,68	0,18
2011Q3	1,20	102,4	160,20	0,07
2011Q4	1,13	102,2	165,40	0,05
2012Q1	1,01	102,0	168,82	0,09
2012Q2	0,61	102,4	166,12	0,1
2012Q3	1,13	101,8	170,27	0,05
2012Q4	1,28	101,8	171,89	0,02
2013Q1	1,22	101,6	173,66	0,02
2013Q2	2,03	102,0	174,24	0,02
2013Q3	2,16	101,8	175,69	0,02
2013Q4	1,99	101,8	176,20	0,02
2014Q1	2,59	101,6	177,56	0,02
2014Q2	2,16	102,1	178,91	0,01
2014Q3	2,16	101,8	179,68	0,01
2014Q4	2,88	101,7	179,33	-0,02
2015Q1	1,81	100,8	180,75	-0,84
2015Q2	1,15	101,0	181,72	-0,79
2015Q3	1,19	100,4	181,75	-0,73
2015Q4	0,77	100,3	182,25	-0,77
2016Q1	1,43	99,8	182,61	-0,76
2016Q2	1,98	100,6	182,24	-0,75
2016Q3	1,55	100,2	184,26	-0,74
2016Q4	0,56	100,1	184,43	-0,74
2017Q1	0,58	100,4	184,65	-0,73
2017Q2	0,32	100,9	184,90	-0,73

Table 6: Model data, sample period 2000q1-2017q2
Source: Swiss National Bank and OECD

9.3 Graphs – Model

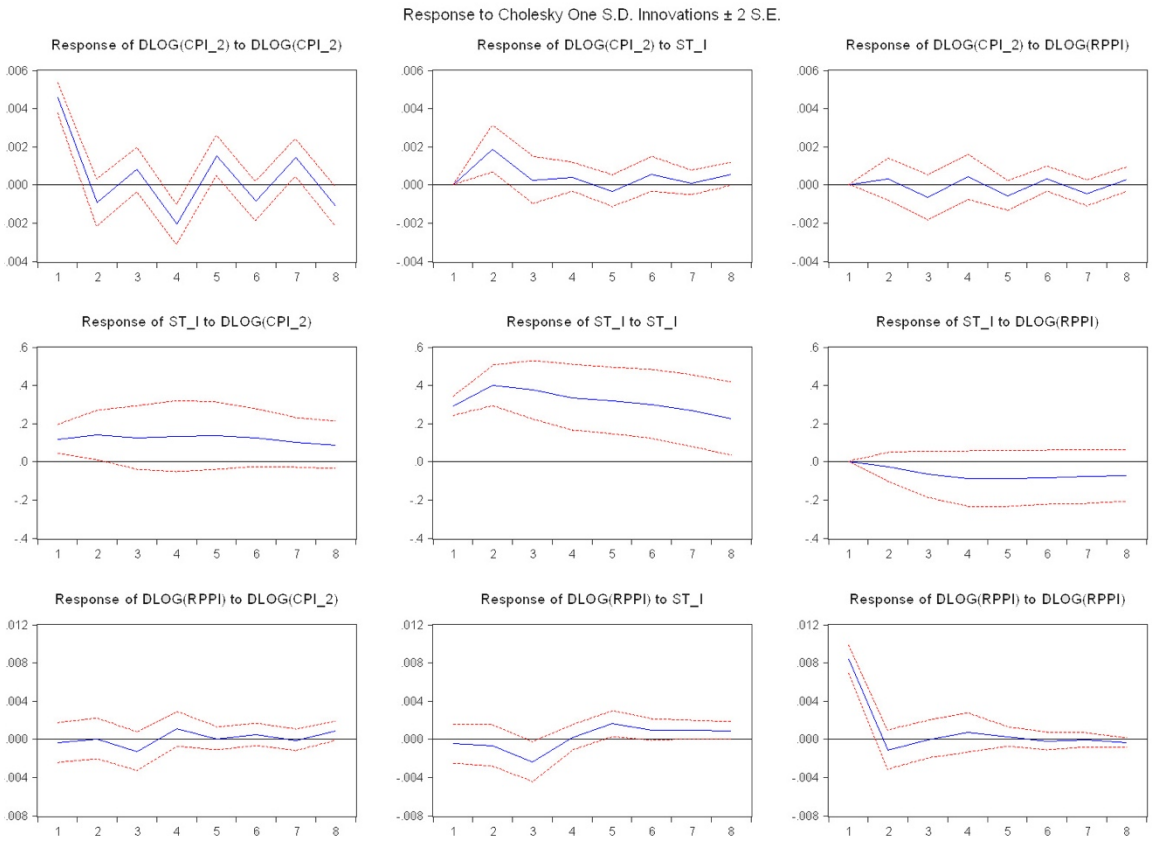

Figure 17: Impulse response – Cholesky decomposition, sample period 2000q1-2017q2
Abbreviation: CPI_2 = CPI, ST_I = short-term interest rate, RPPI = residential property price index

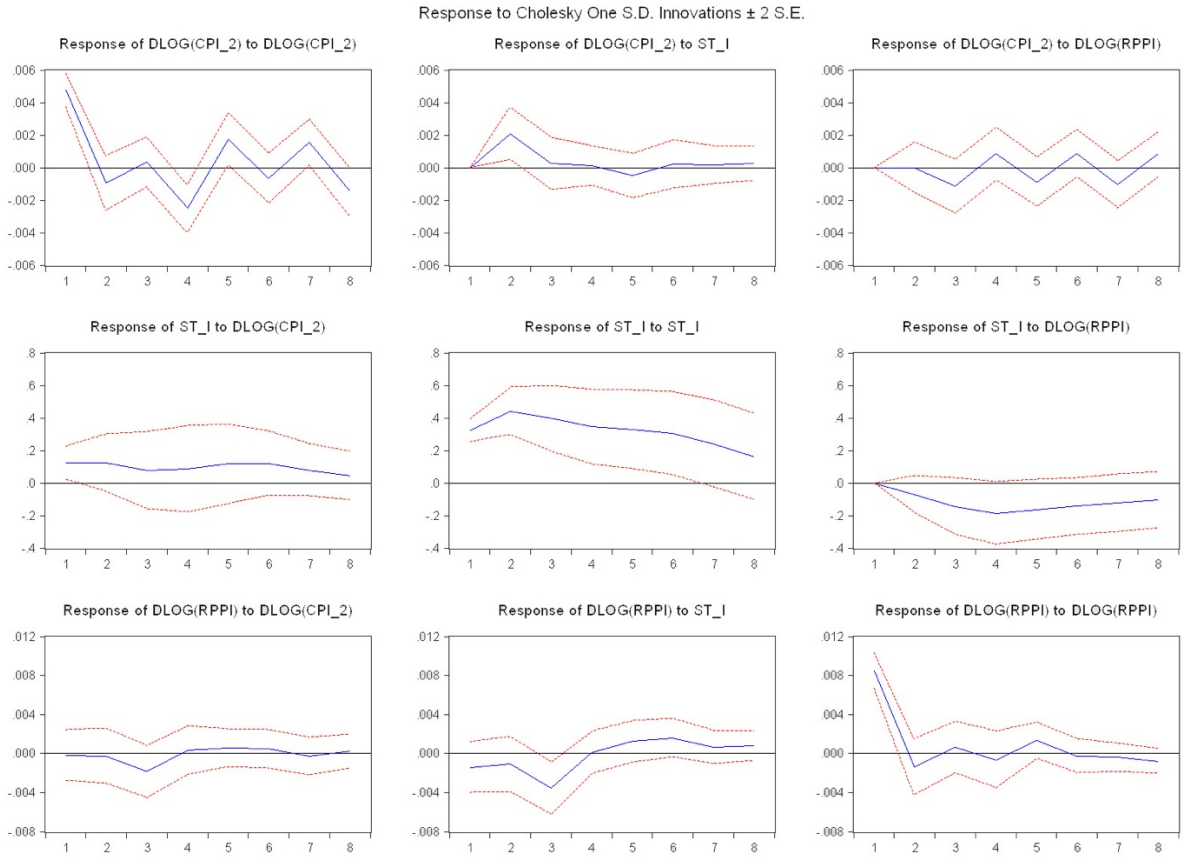

Figure 18: Impulse response – Cholesky decomposition, sample period 2000q1-2011q4
Abbreviation: CPI_2 = CPI, ST_I = short-term interest rate, RPPI = residential property price index

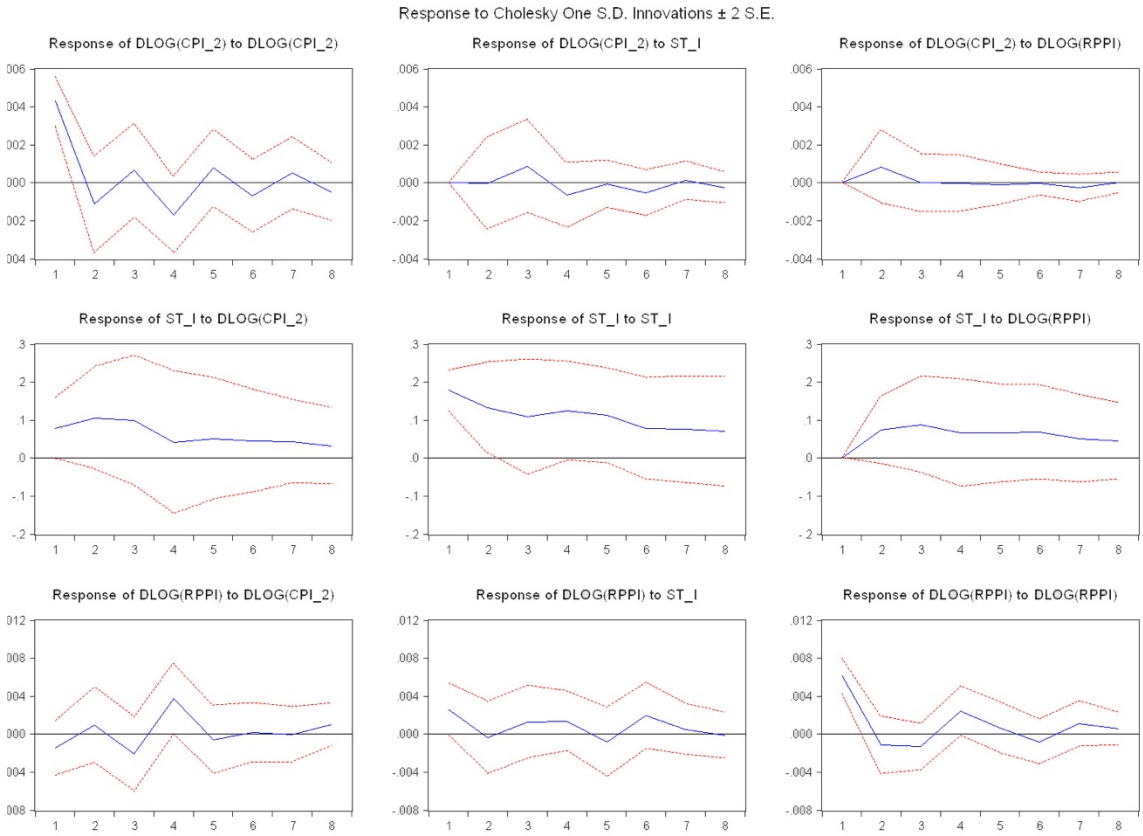

Figure 19: Impulse response – Cholesky decomposition, sample period 2000q1-2011q4
Abbreviation: CPI_2 = CPI, ST_I = short-term interest rate, RPPI = residential property price index

9.4 Survey whit Current Experts – Single Interviews

Whit many thanks to the participating experts:

Patricia Reichelt, Head Research and Market Analysis, CSL Immobilien

"The interest rate is an issue which is of major importance for the investors, and hugely influences portfolio performance. However, it is necessary to take into consideration the importance of "behavioural finance" for the whole system i.e. the manner in which interest rates have a significant psychological effect on the investor side.

The influence of property prices on interest rates is not a regular impact. This phenomenon can be explained as having a multi causal impact i.e. during the last years real estate played an important role as an investment product, which subsequently influenced the Swiss financial market. The longer this situation prevails, the larger the impact will be from property prices to interest rates.

Consequently, the model partly confirms the argument regarding the impact of interest rates on property prices and reveals the speed at which property prices react to interest rate shocks.

Initially, the observation that single-family houses do not appear to play a significant role in respect of the system seems surprising, but if we consider the increasing risks accumulated in the apartment segment since 2008 (see figure 13) this is clarified.

An in-depth analysis would be fruitful and econometric models could facilitate better understanding of the effects of property prices and other variables. Future research could benefit from a focus on producing a forecast. However, the question to pose is whether such models would be user friendly and how much a priori knowledge one needs in order to develop these kinds of models. Here the combination and exchange between academic research and practice as well as real estate education has to be strengthened".

Michael Schiltknecht Head Real Estate Development, Steiner AG

"Interest rate risks play a n important role for inversions and developments. Importantly, the Libor will be, as we have heard, abolished by 2021. This low interest rate period will probably continue for some years, however it is interesting to follow the different speculations about which condition could be the trigger for raising interest rates in Switzerland. Just recently we heard, that a positive decision of the Swiss

National Bank to raise the interest rate could even come before the European Central Bank does.

The model confirms the results of this study regarding property prices and interest rates, and the rather surprising aspect which reveals that single-family houses do not have significant impact on the whole system. Furthermore, the latter is clarified by observing the development between both segments as shown in figure 4.

In-depth research employing econometric models could facilitate an investigation of the speed at which interest rates have an impact on property prices. It would be of considerable use to be able to make a forecast when investigating the probability of the risk involving how an increase in interest rate would meet property prices".

Declaration of Authorship

I hereby assure that I have written the presented Thesis on the topic *"Relationship between Monetary Variables, House Prices and the Macro Economy in Residential Property in Switzerland, Sample Period 2000 until Present, and the Following Years"* without any further auxiliary means that the ones cited in this Thesis. Every part of this Thesis has been cited literally or analogously has been clearly indicated in every single case through the indication of its source (including secondary literature).
This Thesis has not been presented in this or any similar form to any other examination committee and has not been published so far.

Küsnacht, 05. December 2017

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