

Assessment of Fixed Rate Mortgage Implied Insurance Cost: Method and ex-post Swiss Market Analysis

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Abstract

A huge part of housing finance is related to mortgage. In Europe, loan-to-value range between 50% and 85% for mortgage while the mortgage market/GDP ratio increased by 20% between 1998 and 2010. In most developed countries housing is the most important household's investment or expenditure. This investment is generally leveraged by mortgage borrowing. The mortgage can bear fixed or variable interest rate; both with their pros and cons. Fixed rate allows easier budgeting over years since the bank bear the interest rate risk. This property of fixed rate mortgage is often assimilated to insurance that hedge against monthly payment fluctuation. Usually, initial variable rate is cheaper since the interest rate risk is assumed by the borrower.

Yet, there has been surprisingly little work on mortgage decisions from the perspective of the household. Instead, most research on mortgages has been conducted by real estate or fixed-income securities specialists who are interested in pricing mortgage-backed derivatives.

This paper proposes a method to assess the relative cost of fixed rate mortgage implied insurance for the borrower. Thus, we link the insurance cost with insurance premium concept and the related hedged risk. The proposed method is applied to Swiss data. This method offers a sound's basis for comparison of the cost of fixed mortgage rate in time and among countries. It also allows the exploration of the relationship between fixed rates implied insurance cost and people's preference for the financial product.

We use the method to analyse mortgage rate between 2002 and 2012. We compare variables rates (Libor and bank's variable rate) with five and three years fixed rate. We find that most of the time fixed implied insurance is costly for the borrower. This cost represents a value between 0.5% and 7% of the total initial mortgage when compared with Libor.

Keywords: ARM, FRM, Mortgage type

Introduction

A huge part of housing finance is related to mortgage. In Europe, loan-to-value range between 50% and 85%¹ for mortgage while the mortgage market/GDP ratio increased by 20%, from 32% to 52%, between 1998 and 2010². In most developed countries housing is the most important household's investment or expenditure. This investment is generally leveraged by mortgage borrowing. The most important decisions of the mortgage borrower are to choose the amortization maturity of their mortgage and the type of rates to use. The mortgage can bear fixed or variable (Adjustable mortgage rate or float rate) interest rate, both with their pros and cons. Fixed rate allows easier budgeting over years since the interest rate risk is borne by the bank, similar to an implied insurance. Variable rate is initially cheaper since the interest rate risk is assumed by the borrower. Among other reasons that make those choices important, the high cost of strategy change probably comes first.

Financial advisors generally advise their clients toward a fixed rate mortgage (FRM) for less wealthy and risk-averse people since that rate will remain the same for a long time, keeping the payment amount constant. For more wealthy people that can face some payment variation, financial advisors generally advise an adjustable rate mortgage (ARM) because it is usually less expensive over the long run. This said, they're still a huge difference in the use of both types of rates throughout different countries.

Cost of strategy change

We previously mentioned that the choice between rate types is important because strategy change can be costly. This cost comes from mortgage contract and varies among countries. In some countries, whatever the type of mortgage, the contract is valid for a given number of years. In order to leave the contract and reimburse the mortgage earlier than agreed borrower will need to pay penalty fees. These penalties and administrative rules are components of the standard mortgage contract available in a given country. In Switzerland, the borrower that contracts an ARM can usually change its mortgage into FRM at any moment. In Canada for instance, the contract is usually valid for five years, so if the borrower wants to change his mortgage contract he will have to pay the penalty. Penalties vary from the total revenue lost incurred by the bank to a fix amount of money given in the initial contract.

Type preference reasons

Many reasons explain why people choose a type of rate instead of the other. One reason could be to minimize the cost of strategy change. Previous research demonstrates that the choice between mortgage types is driven by economic anticipation, age, income, wealth, tilt problem³, etc. For example, we observe that people that are mobile tend to choose ARM over an FRM in the US. There are no such studies that have been conducted in Switzerland, but since the huge difference in Swiss market relative to US, the result would have probably been different. A reason that drives the choice of type that has been found to be significant is the risk aversion. Since FRM include a risk management component, it is not surprising that risk-averse people tend to choose this mortgage type. Risk aversion is probably a function of other characteristics that have been found to be significant. Mobile, wealthy and younger people tend to be less risk averse and are also found to choose ARM more often.

¹ European Mortgage Federation, Eurostat

² 1998-2010 growth in mortgage debt to GDP, Eurostat

³ Tilt problem exist when borrower choose ARM, which implies lower payment, to increase his purchase power, compare to FRM. This problem exists in countries where the credit norms are based on actual mortgage payments, which is not the case in Switzerland and many European countries.

Everyone is risk averse on different level. We should expect people to choose the FRM on the basis of the risk protection cost. A borrower that is more risk averse would choose an FRM even if the risk hedging cost is high, while someone that is less risk averse will choose FRM only if the risk hedging is cheap. We should observe a link between risk hedging and ARM popularity. Risk aversion is one of many reasons that define the preference for a type of mortgage. From our knowledge, there is no academic paper that links the cost of the hedging with the relative popularity of FRM and ARM. In this paper, we develop a model, a slight improvement of previous similar ones (Tucker, 1991, Milevsky, 2001, Templeton et al., 2002) that values the risk hedging property of FRM. From this model we develop risk characteristics. Hedging cost itself should not be enough to link with ARM relative popularity. Risk-averse people will assess the cost relative to the hedged risk properties. If the risk is high, people will be willing to pay more for the risk protection. For the same cost, higher risk means cheaper hedging cost. We then apply cost model and compute risk characteristics for a limited Swiss mortgage market data.

Mortgage market in Switzerland

Historically, the Swiss mortgage market was mainly an ARM market. In the last ten years, the fixed rate has gained in popularity. While it was only 24% of the mortgages in 1994, it has increased to 74% in 2004⁴. In 2010 and 2011, the variable rate mortgage represented 58% of the number of new mortgages underwritten⁵. Since 2008, the Swiss national bank keeps track of the number of mortgages per type. They also keep statistics about posted rates by bank as well as effective rates on new deals. This relatively new data gathering by the Swiss national bank underlines the relevance of investigating the questions related to variable versus fixed mortgage.

Another particularity of the Swiss mortgage market is the link between the mortgage rate and the price of the rent that may be requested for residential and commercial buildings. The tenant of a building can increase the rent if the mortgage rate increase and renter can request a reduction when mortgage rates go down. The fact that a large percentage of owners now use fixed mortgages to manage the interest rate risk raises questions about the usefulness of this law. By the actual law, the interest rate risk is borne by the tenant. Knowing that only 40% of the housing is owner-occupied, the actual popularity of the fixed interest rate is interesting.

Yet, there has been surprisingly little work on mortgage decisions from the perspective of the household. Instead, most research on mortgages has been conducted by real estate or fixed-income securities specialists who are concerned in pricing mortgage-backed derivatives. This fact is mentioned by Campbell in the Journal of finance in 2006 (Campbell, 2006). So this research project is also interesting from the point of view that it chooses to look at the mortgage choice from the eye of the borrower.

The contribution of this paper is to propose an innovative approach to compare ARM and FRM. It applies the approach to Swiss data sample which, from our knowledge, have not been studied in a comparative way between ARM and FRM cost for the borrower. The goal of this paper is not to develop a method to predict future event or best choice for the borrower even though future work can use the proposed method to develop a forecast method. The reader needs to understand that even if FRM may be more expensive than ARM that does not mean that ARM was the best choice. FRM offer an additional hedging property which bears some value that can explain cost difference. This paper only looks to value this hedging cost and the properties of the related risk.

⁴ Swiss National Bank, computed by Martin Brown, University of St-Gallen

⁵ Swiss National Bank data, number of mortgage agreement

The following of the paper will be divided as follow. Section 2 discusses the relevant previous research that has looked at mortgage dynamic between fixed and variable. Section 3 presents the methodology proposed to analyse implied insurance cost and risk measures. Section 4 uses proposed models to explore Swiss data.

Section 2: Discussion

The literature about mortgages is vast. The numbers of angles to look at a mortgage and the decisions involved are numerous. We list and describe here the most relevant and most recent ones for the different aspects of academia research in the field.

In a presidential address published in the Journal of Finance, Campbell (2006) highlights the importance of personal finance issues. He does recognize that we lack definition and status for this field. Since household behaviours are difficult to measure, and a household faces constraints that are not captured in actual models, household finance is challenging. The author identifies the mortgage as the most important issue of household finance and underlines evidence which suggests that many households invest efficiently. He also comments on the fixed mortgage as a hedging strategy to avoid risk. We take this idea of a hedging purpose of fixed mortgage in our modeling for this paper. Campbell says that there is evidence that homeowners respond to the spread between ARM and FRM, but this does not seem to explain all the movements in the FRM share. He also points out that, despite the tilt problem, there is no evidence that less sophisticated households use ARM. He finally makes the point, perhaps obvious, that unsophisticated households tend to have a herding behaviour, using the standard contract in the country they reside. The method proposed in this paper looks at the fixed rate mortgage implied insurance in the perspective of the borrower.

There have been a number of studies of the profile of the borrowers in the 80s and 90s. The first of them (Dhillon et al., 1987) threw the basis of what had been confirmed after them. According to their study, the choice between ARM and FRM is not influenced by characteristics of the borrower. Nevertheless, they underline that short expected housing tenure (aka mobility in research that followed); married couples and co-borrowers are more likely to choose ARM. The married couple and co-borrower could be assimilated to risk aversion that was included in the research that followed. Some studies (Brueckner and Follain, 1988, Sa-Aadu and Sirmans, 1995, Templeton, 1996) found that the main determinants of the choice of ARM vs. FRM were the level of income, the mobility of the borrower, and the likelihood of a rise in the ARM. Brueckner and Follain (1988) also underline that the most important determinants of the choice are not related to borrower characteristics, but to external factors such as the likelihood of the ARM to rise. They also mention that the popularity of the ARM during the 80s in the US was mainly due to an unusual interest rate configuration.

Smith (1987) looked at the correlation between the real interest rate and real income, and then the real interest rate and real asset values. The study found that a positive covariance between those terms is linked with a higher popularity of adjustable loan contracts (ARM among others).

Other studies look at the characteristics of borrowers that used insured mortgage (FHA) based on the borrowing constraints (Hendershott et al., 1997). They find that the choice of insurance is driven by the first down payment, monthly payment and to lower insurance costs.

Since most of the research on the subject is from a previous century, one may think that there is nothing more to be learned about the choice between ARM and FRM. Even though the knowledge of the profile of ARM and FRM borrowers is well established, there are research to deeper understand the situation. More recent research looks at risk aversion relation to the choice. Campbell and Cocco (2003) look at the ideal mortgage contract and introduce risk aversion as a parameter in their model. They find that

borrowing constraints and risk aversion has a huge impact on the attractiveness of the ARM. Nevertheless the ARM is generally attractive even for risk-averse borrower.

VanderHoff (1996) gives some insight to the importance of the prepayment in FRM versus ARM. He found that option is used when it is not in-the-money, but that the use of the option is linked to the personal life cycle imperative. Surprisingly, he found that ARM holders are less mobile because they terminate their mortgages less, which is in contradiction with previous research. This contradiction may be due to the fact that the study uses data from 1985-1989, a period of highly increasing interest rates. He links the use of the ARM with the tilt problem. Using ARM allows the owner to move on to a bigger house sooner, avoiding future transaction cost. Fixed rate borrowers tend to terminate in order to move or to refinance at a lower rate. He also found that the default rate is higher for ARM and that it is related to an anticipation of rate increase instead of a real increase in payment. Even though we are aware that VanderHoff results are specific to the period of time their results underline the relevance of relatively small period analysis in a methodological point of view.

Loan terms are very different among countries. In Switzerland and US, primary mortgage can be interest only. In other countries, such as Canada, the maximum loan term is regulated. Nevertheless every mortgage borrower faces the choice of loan term or, in other words, amortization. The relevance of term choice studies is methodological. The usual methods used in term choice researches consider the financial effort as a primary parameter in the analysis. These studies are not looking at what people do, but at what people *should* do. This kind of research has a financial advice and portfolio approach (Delbert and Don, 1998, Aulerich, 2004, Basciano, 2006). This paper applies that concept to ARM vs FRM comparison. Very few academic studies look at the economic choice between ARM and FRM in the point of view of the borrower. Instead, most of the researches focus on the borrower profile and behaviours. None of them, from our knowledge, links the cost related to FRM and the insurance against payment fluctuation implicitly included.

Research by Lino (1992) explored what people believe to be the cheaper mortgage rate according to their expectations compared to the actual cheaper mortgage. They conclude that consumer education is needed. The study gave insight on the importance of education and definition of a cheaper mortgage. In that study all mortgages are assumed to have the same value for the lender - which is a good assumption, but they do not take into account that the FRM includes some kind of insurance against future interest rate fluctuation. Such insurance may be very valuable to borrowers that face financial constraints.

Other research has looked to link ARM and FRM choice and price with macroeconomics (Henry and Tyler, 2000, Koijen et al., 2009). Henry and Tyler investigated the link between choices, while Koijen et al. focused on building a timing strategy. Even though it would be great to build a strategy that allows moving from ARM to FRM in order to reduce the overall cost of the mortgage, those kinds of strategy implies advanced knowledge of the economics. As previous research showed, borrowers lack education, making it hard to conceive the average borrower would calculate market timing in relation to their mortgage. Even more, the transaction fees are not negligible in a mortgage contract.

In 2001, a chair of financial planning in Canada did a study that compared the ARM and FRM for Canadians (Milevsky, 2001). The strategy was not to assume that the borrower can assess the economic environment, but to assess what kind of rate is better most of the time. Milevsky used a methodology that takes its inspiration from previous research, tuning it to make it even more consistent. He used a strategy similar to Delbert and Don (1998) where they used the same financial effort for both types of mortgages. He demonstrated with historical data that ARM has been better for borrowers most of the time. Milevsky's paper is the basis of the methodology that is proposed here. We develop it further, addressing alternative investment issues, and include a concern for the risk that the borrower takes when choosing an ARM, exploring risk characteristics.

Recent research focuses on ARM and FRM pricing under the actual governmental intervention (Krainer, 2010). It concludes that high buying activity of the government for fixed mortgage backed securities (MBS) decreased the price for them, reducing the attraction of ARM. In such a context, we should observe that the relative cost of the FRM is low regarding the ARM. The methodology that we propose enables us to observe such pricing fluctuations and to have a better basis for country comparison of the impact of mortgage legislation, *ides* cost of implied insurance and risk characteristics instead of nominal or direct rate comparison.

There are very few academic journal articles with a main focus on the Swiss mortgage market itself, even less about Switzerland in comparison with other countries. Nevertheless, the last few years gave us a number of papers that allow us to perceive the Helvetic difference and its sources (Bourassa and Hoesli, 2010, Bourassa et al., 2010). Despite their focus on Switzerland they do not investigate the ARM and FRM dynamic. This paper uses Swiss data sample to demonstrate the use and result obtained with the method proposed. It will investigate specific risk hedging characteristics of FRM.

Section 3: Method

The method proposed here is inspired by previous research that studied term choices (Delbert and Don, 1998, Aulerich, 2004, Basciano, 2006) and ARM versus FRM choice (Tucker, 1991, Milevsky, 2001, Templeton et al., 2002). We adapt the methodology to find the equivalent cost of insurance premium included in the FRM. A household has the choice to borrow an FRM or an ARM. If they can borrow FRM, they have to be able to afford FRM periodic payment. If they borrow ARM, they will have a lower initial required periodic payment, but they can choose to increase the payment at the same level as the initial payment required on FRM. For convenience amortisation period will be referred as the term of the mortgage while the maturity of the mortgage will refer to the mortgage contract duration which could differ from the term. So it is possible for an ARM borrower to set up exactly the same cash flow scheme than FRM borrower with two exceptions. The borrower will have the same initial mortgage and same periodic payment, but not the same final debt at the maturity of the mortgage contract. In addition, ARM borrower faces the risk to have its minimum payment increase in the future. As long as the minimum payment is under the FRM periodic payment there are no consequences for the ARM borrower that pays a payment equal to the FRM one. There still risks that at some point the ARM minimum payment will be higher than periodic FRM payments. So basically the FRM is offering a hedge against this possibility. This hedge is referred to as the insurance property of the FRM. The cost of this hedging strategy is represented in the difference of the remaining mortgage debt at maturity. In order to obtain the present value of this cost of hedging we define the additional amount that an ARM borrower needs to borrow such that the mortgage debt at maturity is the same as an FRM borrower. This amount could be negative.

The FRM implied insurance cost is similar to a life insurance premium. Individual pays an amount each period and his succession receives indemnity when he dies. The real cost of the insurance on a yearly basis (the mortality rate among insurer's customer) is only known ex-post. It is the same for the real FRM alternative mortgage rate (ARM) that is only known ex-post. The idea to use ex-post data to value the cost of FRM implied insurance is similar then looking at the cost of a life insurance ex-post.

Section 3.1: Cost, premium and indemnities assessment

The financial effort of the borrower is composed of the periodic payment and the final reimbursement at maturity. In reality, most of the debt left at maturity will be financed by a new mortgage contract, but still the final reimbursement comes from new debt or from personal capital, the effort is the same. In the specific case of ARM and FRM we need to keep the same payment. If we keep the same initial mortgage with both types of rate, with the same payment, the final debt of ARM and FRM will be different (Figure

1). The cost at maturity of the FRM is represented by the difference between debts (X'). Since we want to compare the differential cost between both types of mortgage at the moment of the initial mortgage, we need to apply a strategy which results in the same set of cash flows. To obtain the same payments and same final debt with different interest rates we need to have initial debts that are different. In other words, for this specific case the borrower would have been indifferent between borrowings with a FRM and borrowing a different amount (superior or inferior) with an ARM on which he would be sure to make the same payments and will have the same remaining debt. The difference between both initial debts will be equivalent to the risk hedging cost (or benefit) for this specific situation. This cost is implicitly included in the rate on FRM. This risk hedging cost is noted X in figure 2.

Figure 1. FRM 5 years and ARM model cash flows (yearly payment), Cost at maturity

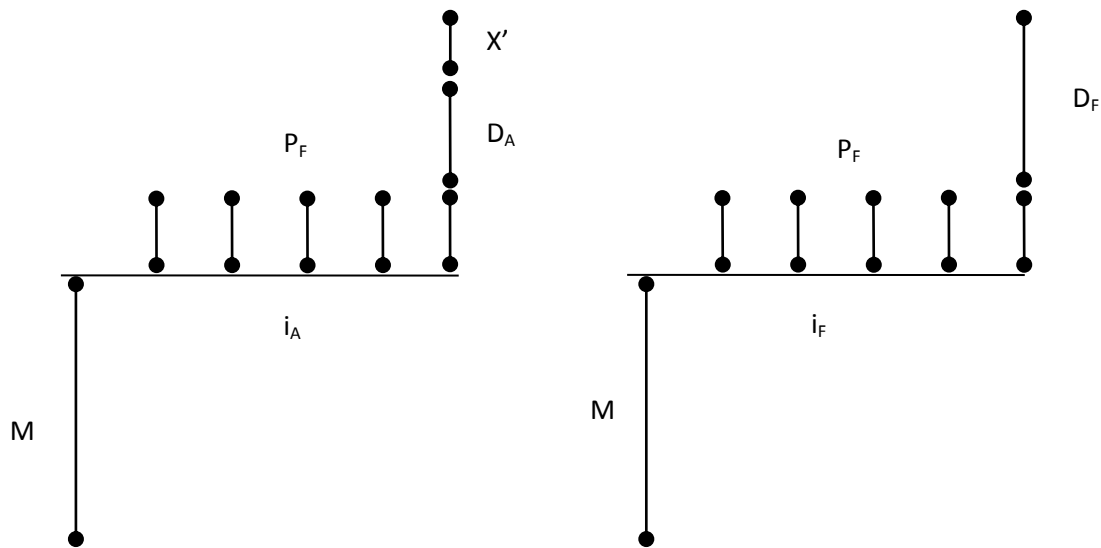
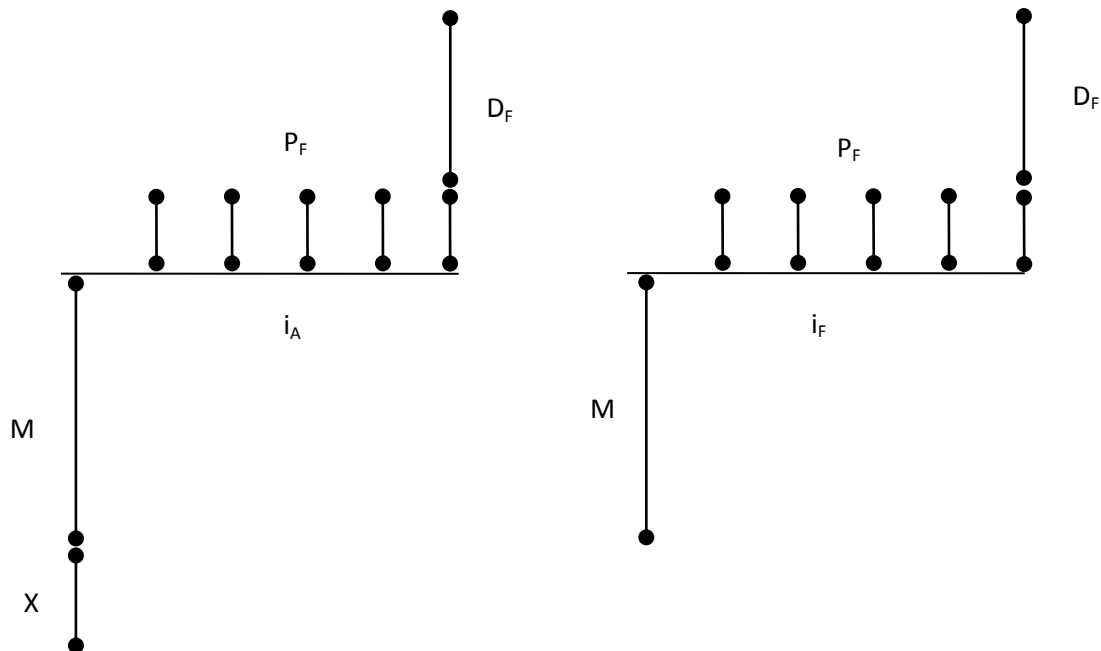


Figure 2. FRM 5 years and ARM model cash flows (yearly payment), Cost at time 0



In the model, the borrower receives a house of value M, receives an insurance of value X, makes a series of payments, equivalent to those requested on FRM (P_F), and pays the remaining debt at the end of the term, equivalent to the debt he would have had with a FRM (D_F). We create two situations with exactly the same cash flows for the borrower: FRM versus ARM with insurance (X). Since the cash flows are exactly the same, the borrower is indifferent between both strategies.

In the valuation method for the cost of the insurance we implicitly take into account that the mortgage allow ARM borrower to pay only the FRM payment if ever the minimum payment on ARM become higher. In a real case this is not possible, so X is the cost of the insurance net of possible indemnities that would have protected the borrower from higher payment. In the current model, payments that have not been done are reported on the total debt. Further development of the method will account for indemnities that would pay the difference. This will value the equivalent insurance premium.

Following lines translate the method into formulas. We are looking to find X added to initial mortgage such that: $D_{ARM} = D_{FRM}$. Equation (1) presents the value of FRM final debt after S years, the maturity of the initial mortgage contract. Equation (2) presents the value of ARM at contract maturity S when the payment is the same as required by FRM for an initial mortgage (M+X).

$$D_F = M \left[(1 + i_F)^S - P_F \sum_{t=1}^S (1 + i_F)^{S-t} \right] \quad (1)$$

$$D_A = (M + X) \left[(1 + i_{At})^S - P_F \sum_{t=1}^S (1 + i_{At})^{S-t} \right] \quad (2)$$

$$(1 + i_{At}) = \left(\prod_{p=t}^S 1 + i_{Ap} \right)^{1/(S-t+1)} \quad (3)$$

Where:

D_F is the amount of debt left to pay on a FRM after S periods.

M is the initial mortgage in CHF

i_F is the interest rate required on an FRM

S is the maturity of the mortgage for the need of the comparison, $S \leq T$

P_F is the payment required for a FRM of term T period and initial mortgage 1

D_A is the amount of money left to pay on an ARM after S periods of ARM when the payment is P_F

$(1+i_{At})$ is the geometric average of the accumulation factor on an ARM for period's t to S, equation (3)

i_{Ap} is the variable rate required on the mortgage for period p.

For $D_A = D_F$ we find equation 4, where X represents the cost of FRM implicit insurance.

$$X = M \left(\frac{(1 + i_F)^S - P_F \sum_{t=1}^S (1 + i_F)^{S-t}}{(1 + i_{A0})^S - P_F \sum_{t=1}^S (1 + i_{At})^{S-t}} - 1 \right) \quad (4)$$

We can observe (equation 4) that the cost of the insurance is a percentage of M, so if we choose M equal to one we obtain the cost as a percentage of the initial mortgage. In the application of the model to Swiss data we will use a reference mortgage equal to 1.

The only difference between FRM and ARM, if the payment on an ARM is the same as the one required by FRM, is the insurance that the borrower will never have payment fluctuation. Then, X is the actual cost of this specific FRM for the borrower for that specific date.

The innovation of this method is to look at the problem in the framework of an insurance cost at time 0, to propose a generic format inspired from previous methodology and to consider payment differences as mortgage reimbursement. Accessorily we prefer a mortgage of amount one and look for the decision for each mortgage maturity.

In opposite to previous studies in the domain we consider that best alternative investment for the extra money saved by the ARM lower minimum payment is to reimburse an additional portion of the mortgage. Previous studies implicitly, or explicitly, invest payment difference in an alternative security (Milevsky, 2001, Tucker, 1991, Templeton et al., 2002).

Since FRM borrower uses the total amount P_F for mortgage payment, it makes sense to apply the same to ARM. It could be demonstrated that investors cannot, most of the time, find a better risk free investment than mortgage debt reimbursement. Any other use of the ARM/FRM payment difference, from real option to T-Bill, need to bear higher return than ARM in order to be a rational choice. So the minimum opportunity cost need to be the ARM debt payback. Using mortgage payback can be considered a conservative valuation of the FRM. If alternative investment expected returns are higher than ARM, the implicit cost of FRM would be higher.

We have to acknowledge here that ARM bears some option. A borrower can decide to keep ARM in expectation that FRM will go down and benefit from better financing opportunity. While the option value is included in variable rate and that we do not include timing in the model, the insurance cost does not include the value lost with the impossibility to use the option. Therefore, the insurance cost result can be considered conservative. To our knowledge there is no model that allows forecasting future mortgage rate.

Many studies in finance have shown that it is not possible to make abnormal return from this kind of strategy. Those studies did not stop financial researchers to build optimal strategies that maximize the benefit. Few of those researches are looking explicitly at mortgage rates. When they are researched, the result is consistent with other finance areas, even if a strategy is possible; the operational cost offsets the profit. The most recent research in this area is forecasting short term rate with simple model and conclude exactly the same as other previous studies (Arsham et al., 2008). This forecasting area falls beyond the scope of this paper. The aim of this paper is to quantify the cost and benefit of ARM versus FRM, not to forecast which one is the best financial choice for a specific economic environment.

Previous studies of the subject look at the financial effort at the end of the period (X'). While it makes sense for term comparison strategies, in mortgage type we may miss a part of the information when we compare cost over several years. We need to compare value at time of the initial mortgage. Milevsky (2001) proposes an alternative method that translates the cost of FRM in months. To do so they need to look at the whole mortgage term, which makes differences very important when comparing results over years since they are dependent on the inflation. In this paper, we consider the decision to be taken for each maturity, propose a method that assesses the FRM cost at time 0 and express the result as a percentage of the mortgage (M).

We expect X to be positive most of the time due to the risk hedging component of FRM. When X is negative, it means that FRM would have resulted in a higher wealth for the borrower, for that specific date. Then, the hedging component brings value to the borrower. If X is always positive that would mean that the borrower is always better with ARM, thus FRM insurance never pays more than its cost.

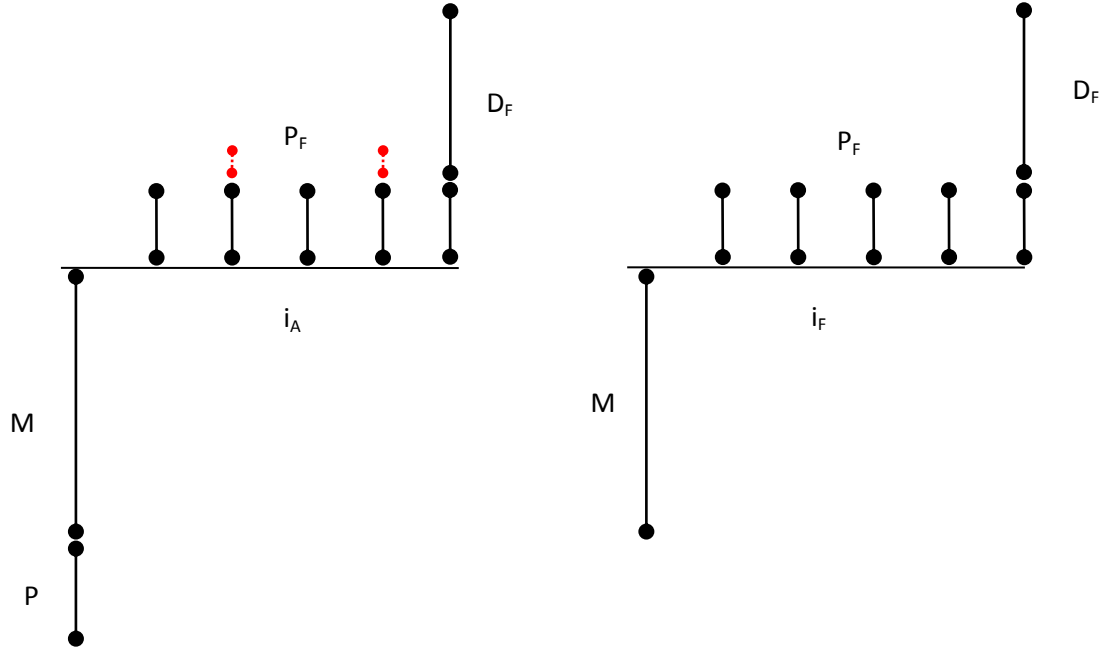
The method presented here allows computation of premium based on ex-post available data and it is not useful as it is to define premium cost ex-ante. Nevertheless, the method exposed here give a basis for future work aiming at determining which information is useful to value ex-ante FRM premium cost and to better understand the FRM versus ARM market dynamic. Even though past does not warrant the future, it is good insight to know if usual premium are higher or lower in a given country and to observe the historical trend.

Some could say that to compare ARM with FRM is not a good strategy because once the choice is made the alternative cannot enter into consideration anymore. Despite this argument, this kind of comparison is vastly used in finance, economics and management. For example, most measures used on a daily basis in funds' performance assessment are based on alternative choice comparison, usually market index. In our case the comparison basis is the ARM.

The previous method compares the cost of the insurance included in the FRM with a comparable ARM. To use an insurance language, this gives information in regard to the cost net from the insurance benefit of fixed payment. We could look at the ARM as an insurance that would pay the amount in extra to the P_F each time it is needed. If the insurance does that payment instead of just allowing the payment to go higher without having to pay it, negative amortization, it is more valuable. Figure 3 shows the related cash flow involved. P is the equivalent that would have been paid to get an insurance that would reimburse any amount over P_F (equation 5).

Usually in insurance we define the pure premium as the cost of the risk. In addition to the pure premium the insurance premium include some contingency reserves, administration fees and profit. While X is the cost for the borrower without indemnities, it is not the cost of the risk hedged. If we look at this as fire insurance we have P , which is the insurance premium. We have some risk event (rare in the case of the fire insurance) which in the mortgage would be the need for the insurance to pay the amount higher than P_F . X is the premium without indemnities related risk event ($P_F < P_A$) value, thus $(P-X)$ is the value of the risk hedged. X should then represent all reserve and fees (loadings) from the insurer, in this case the bank.

Figure 3. FRM equivalent "Indemnities"



$$P = M \left(\frac{(1 + i_F)^S - P_F \sum_{t=1}^S (1 + i_F)^{S-t}}{(1 + i_{A0})^S - \text{Max}[P_F; P_{At}] \sum_{t=1}^S (1 + i_{At})^{S-t}} - 1 \right) \quad (5)$$

Where:

P_{At} is the minimum payment required for an ARM of term T-t periods on mortgage debt at time t

We now have the tool to look at the FRM implicit insurance cost for the borrower. We may find out high or low implicit insurance premium. We have a definition of the value of the risk hedged which we can compare with the premium. In classic insurance (life and casualty) operations value of the risk represent an important part of the premium. In some other commercial insurance it is possible to observe low risk value to premium, for example in some extended warranty offered by retailers. What is the case for the FRM implicit insurance? A low risk value to premium ratio does not mean that the insurance is expensive. If there is a customer base for such insurance that means the price is considered fair for those customers. Risk hedged by FRM may have a very low frequency, but a potential severity that worth the cost. It is then important to look at the properties of risk hedged when we analyse those result. In our knowledge we are the first to look at FRM cost relative to hedged risk properties.

Section 3.2: Risk

There is different approaches and definition of risk. In the case of insurance the importance is the downside risk. In our specific, the risk hedged by FRM is the possibility that the minimum payment under ARM could be higher than the FRM payment. This risk could be seen as the number of time where the payment under ARM is higher than under FRM (frequency). It could also be seen as the amount by which it is higher (Severity).

The severity can be seen on different angles. Usual approach in finance for downside risk is to compute the average squared negative return as proposed by Sortino (Sortino and Van der Meer, 1991, Sortino, 1994, Sortino and Forsey, 1996). One could argue that severity in 4.5 years' worth less than same event in six months. This reality is taken into account in premium computation. The risk that matter for household is the average value of the event and the amount of that event. Large discrepancies are more important for household then small one. It's Sortino argument to use the average squared negative return.

The essential argument about using negative return in investment performance measure is that investors prefer investment that makes the higher result while presenting the minimum downside risk. It is similar with FRM mortgage, the higher the difference between ARM minimum and FRM payment, the worst is the situation. We could assess the risk as the average amount by which it is different. We could also believe that what is of importance for mortgage borrower is the total amount by which it is different, which would result in the same ranking. Another risk that could be of importance is the maximum risk insured, the maximum payment difference.

Possible risk measures parameters:

- Frequency: Number of events
- Severity 1: Average difference between ARM and FRM
- Severity 1': Total difference between ARM and FRM
- Severity 2: Max difference between ARM and FRM
- Severity 3: Average squared difference between ARM and FRM (Sortino like)

While it is possible to compute the risk measure parameter in absolute it seems better to consider the risk as a percentage of the total number of payment periods or as a percentage of the FRM payment. While the use of the absolute number will not change the ranking for measure based on frequencies it will be more intuitive to interpret. In the case of severity absolute number will potentially impact the result since a period with higher mortgage rate will result in higher payments, so it would be possible for a result that is proportionally marginal to significantly impact the overall result. For that reason severity parameter will be expressed as a proportion of the FRM periodic payment.

A premium that hedge a lot of risk is better than the same premium that covers no risk. In other words, one could be more willing to buy insurance if the risk is real than if the risk is almost nonexistent. Risk management theory often states that high severity and low frequency risk worth insurance while auto financing is better for high frequency risk (Trieschmann et al., 2005).

Section 4: Application to Swiss data

Data

The valuation method and hedged risk characteristics have been computed from Swiss historical mortgage data. Our database is built from Zurich Kantonal bank and completed with National Swiss Bank public data. The section will present descriptive statistics of the database. Then, we will show the evolution of the insurance premium and risk parameters over time.

The database cover mortgage rate between 2002 and 2011. Switzerland borrowers that want a variable rate have choice between monetary market mortgage, which rates are linked to London Inter-Bank Offering rates (Libor), and a variable rate based on the bank's variable. Libor mortgage rates for different adjustment periods (three month and six months) and different contracts maturity (three and five years) are available. Fixed mortgage for two to ten years are also available. This paper shows the cost of FRM for five and three years fixed rate in comparison with variable and Libor rates for mortgage contracted

between November 2002 and November 2006, November 2008 for three years FRM. The period coverage is limited by data availability. It is also limited by the need to have variable rates for the whole period in order to price the FRM since the method is ex-post.

Descriptive statistics

Table 1 shows descriptive statistics for each mortgage contract under analysis.

Table 1. Mortgage rates descriptive statistics

| Rates | Min | Max | Average | Volatility |
|---------------|------|------|---------|------------|
| Variable | 3.03 | 3.78 | 3.17 | 0.15 |
| Libor 3m* | 1.33 | 3.05 | 1.85 | 0.47 |
| Libor 6m* | 1.38 | 3.16 | 1.95 | 0.50 |
| Libor 3m** | 1.30 | 3.02 | 1.83 | 0.47 |
| Libor 6m** | 1.40 | 3.18 | 1.97 | 0.50 |
| 3 years Fixed | 2.57 | 3.87 | 3.06 | 0.15 |
| 5 years Fixed | 2.96 | 4.11 | 3.40 | 0.31 |

*3 years contract; **5 years contract

Table 2 gives the spread range and average between ARM and five years FRM. The spread is the difference between ARM and FRM rates at a given date. It is understood that ARM rate will be applied for a shorter time, and then an adjusted rate will be applied to the debt. The FRM will be applied for the whole five years.

Table 2. Interest rate spread descriptive statistics

| Spread (5 years vs) | Min | Max | Average | Volatility |
|---------------------|-------|------|---------|------------|
| Variable | -0.43 | 1.08 | 0.23 | 0.39 |
| Libor 3m* | 0.73 | 2.22 | 1.55 | 0.36 |
| Libor 6m* | 0.61 | 2.12 | 1.45 | 0.36 |
| Libor 3m** | 0.75 | 2.25 | 1.57 | 0.36 |
| Libor 6m** | 0.60 | 2.10 | 1.43 | 0.36 |
| Spread (3 years vs) | | | | |
| Variable | -0.71 | 0.84 | -0.11 | 0.21 |
| Libor 3m* | 0.70 | 1.84 | 1.21 | 0.09 |
| Libor 6m* | 0.58 | 1.73 | 1.11 | 0.08 |
| Libor 3m** | 0.72 | 1.86 | 1.23 | 0.09 |
| Libor 6m** | 0.57 | 1.71 | 1.10 | 0.08 |

*3 years contract; **5 years contract

Cost of risk, Insurance premium and Indemnity value

The method proposed offer a valuation for the cost of risk, the insurance premium and indemnity value. Following figure 4 to 6 show the results for the period under study for an interest only mortgage. It is expected to observe a lower premium for 3 years FRM since the insurance runs for a smaller amount of time. If the market is efficient and competitive we should observe a similar indemnity to premium ratio.

Table 3 shows that in average it is the case. While a 10 to 15% indemnity ratio may look small, the stability of it among different rate type suggest that it is a market consensus.

Table 3. Cost, Premium and Indemnities value of the FRM implied insurance

| 5 years | Cost | | | Premium | | | Indemnity Value | | | <u>Indemnity Premium</u> |
|----------------|--------|-------|---------|---------|-------|---------|-----------------|-------|---------|------------------------------|
| | Min | Max | Average | Min | Max | Average | Min | Max | Average | Average |
| Infinite | | | | | | | | | | |
| Variable | -0.89% | 5.20% | 1.44% | 0.00% | 5.20% | 1.61% | 0.00% | 0.89% | 0.16% | 9.94% |
| Libor 3m* | 1.48% | 7.58% | 4.18% | 2.80% | 7.58% | 4.64% | 0.00% | 1.36% | 0.46% | 9.91% |
| Libor 6m* | 0.58% | 7.07% | 3.67% | 2.27% | 7.07% | 4.27% | 0.00% | 1.69% | 0.60% | 14.05% |
| Libor 3m** | 1.60% | 7.67% | 4.31% | 2.86% | 7.67% | 4.73% | 0.00% | 1.31% | 0.42% | 8.88% |
| Libor 6m** | 0.53% | 6.96% | 3.61% | 2.21% | 6.96% | 4.20% | 0.00% | 1.68% | 0.59% | 14.05% |
| 3 years | | | | | | | | | | |
| Infinite | | | | | | | | | | |
| Variable | -1.65% | 4.36% | 0.76% | 0.00% | 4.36% | 1.16% | 0.00% | 1.65% | 0.40% | 34.48% |
| Libor 3m* | -1.43% | 7.48% | 2.68% | 0.35% | 7.48% | 2.95% | 0.00% | 1.78% | 0.27% | 9.15% |
| Libor 6m* | -1.48% | 7.04% | 2.33% | 0.38% | 7.04% | 2.66% | 0.00% | 1.86% | 0.32% | 12.03% |
| Libor 3m** | -1.35% | 7.53% | 2.76% | 0.37% | 7.53% | 3.01% | 0.00% | 1.72% | 0.25% | 8.31% |
| Libor 6m** | -1.50% | 6.96% | 2.29% | 0.36% | 6.96% | 2.62% | 0.00% | 1.87% | 0.32% | 12.21% |

Figure 4. Cost of 5 years FRM implied insurance for mortgage contracted between 11/2002 and 11/2006

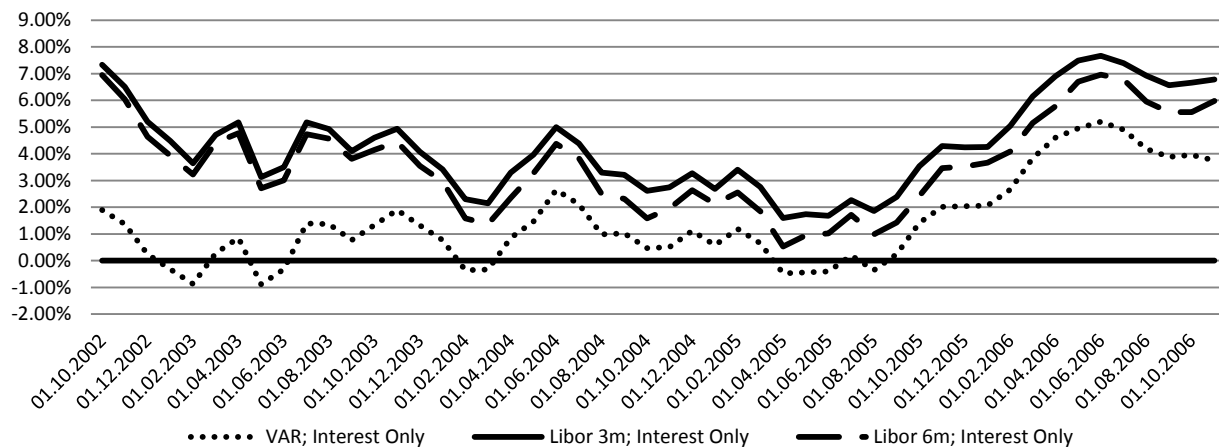


Figure 5. Premium of 5 years FRM implied insurance for mortgage contracted between 11/2002 and 11/2006

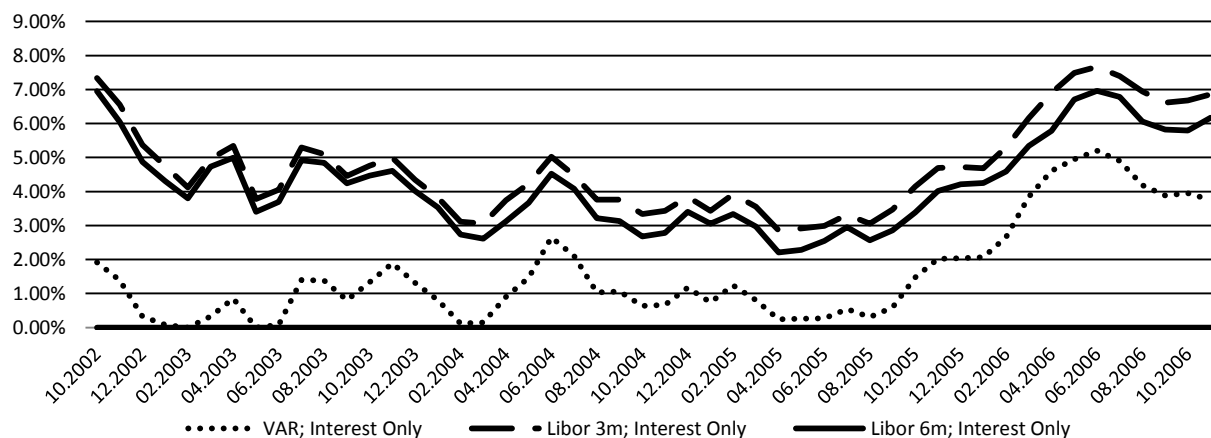
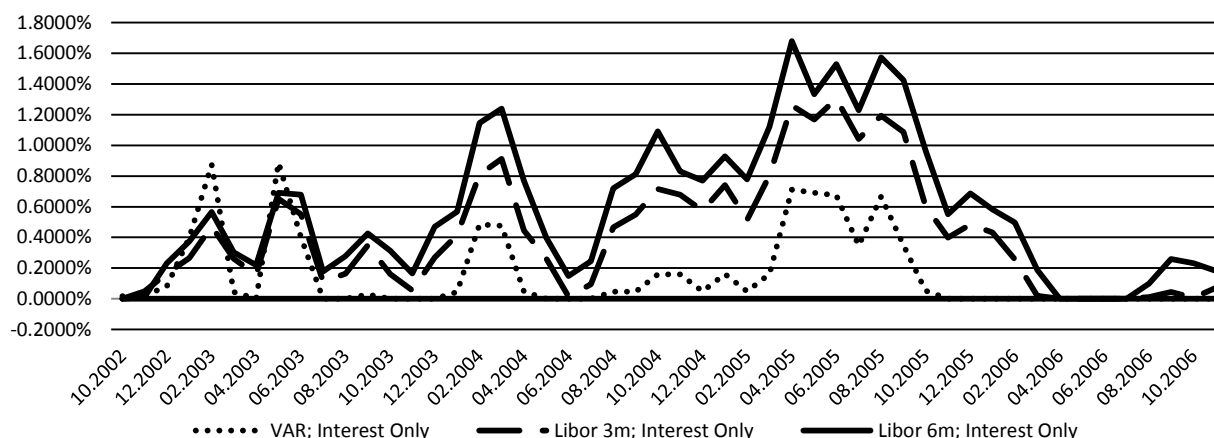
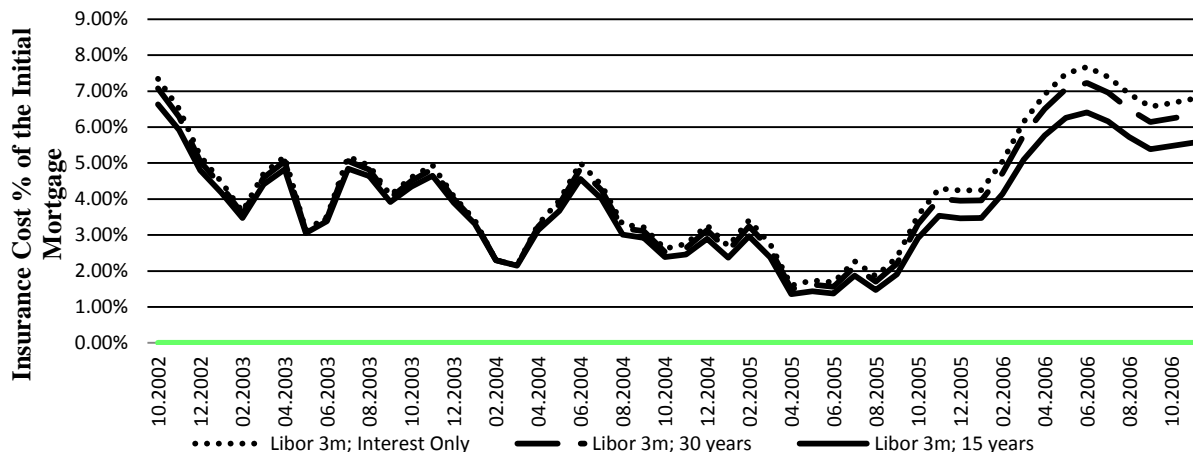


Figure 6. "Indemnities" equivalent of 5 years FRM implied insurance for mortgage contracted between 11/2002 and 11/2006



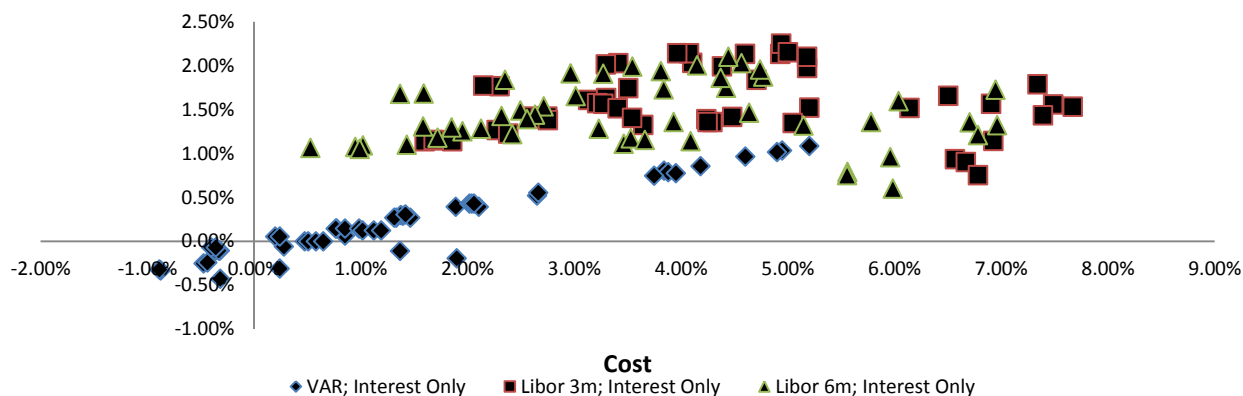
Since the term of the mortgage can have an impact on the cost of the FRM implied insurance we compute the cost parameters for 15, 30 and infinite (interest only) mortgage (Figure 7). Those terms are critical for the following reasons. In Switzerland second rank mortgage has to be repaid within 15 years. Thirty years is a usual international amortization period. And finally, Swiss borrower can use indirect amortization. This allows borrower to avoid paying back the mortgage, but use retirement plan to guarantee future mortgage reimbursement. This indirect amortization result in fact to an interest only mortgage. Cost difference between interest only and 30 years averaged between 0.07% to 0.14% with minimum -0.07% and maximum 0.44%. The difference between interest only and 15 years averaged between 0.21% to 0.50% with minimum -0.18% and maximum 1.26%. The shorter the amortization the cheaper the insurance should be and it is what we observe in the data. This is expected because shorter amortization results in a capital reimbursement, then into lower interest paid on the long run. Since risk event are more likely to happen in a more or less far future the "indemnity" expectation is lower with faster amortization.

Figure 7. Cost of 5 years FRM implied insurance when compare with Libor 3m for different amortization period



Since the spread is often used as a valuation parameter to choose between ARM and FRM we show in the same graph both premium and spread (Figure 8). If premium move in the same direction as spread or better, anticipate the premium move, the intuitive method to use the spread as the proxy for FRM value may be a good method. While the spread seems a good proxy for FRM implied cost when compared with VAR, the relationship does not seem strong for Libor.

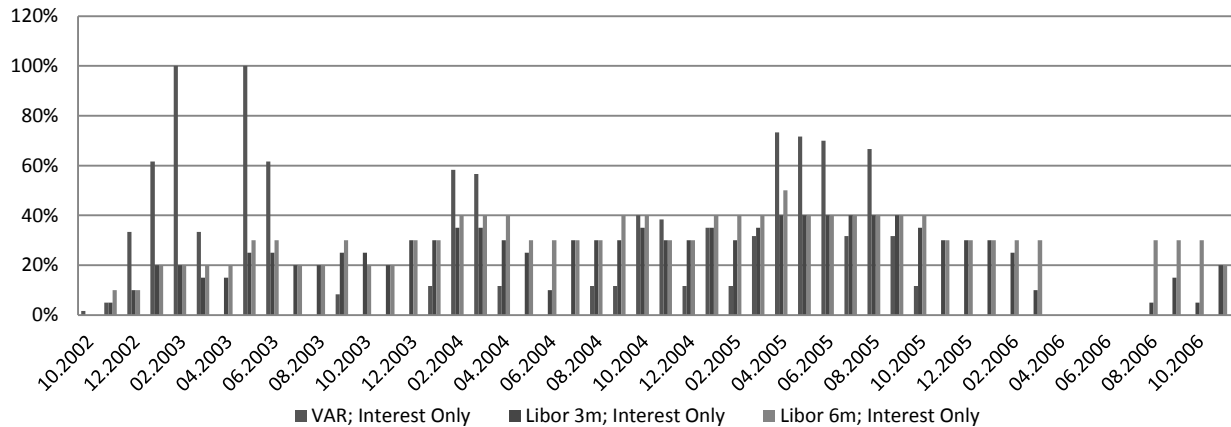
Figure 8. Relationship between Cost of FRM and mortgage rate spread



Risk characteristics

As mentioned in section three the value is not enough to judge if the FRM implied insurance is expensive or not. Figure 9 shows the frequency when comparing FRM 5 years and alternative ARM. We can observe that most of the time a borrower that would have chosen ARM would have face some monthly payment higher than the payment under FRM. This would happen between 20% and 30% of the periods for interest only mortgage. The frequency averaged between 10% and 20% for shorter amortization period. With such a frequency of risk event we can easily understand why borrower would like to get an insurance against this risk.

Figure 9. Frequency of risk event when comparing FRM 5 years and alternative ARM, from 11/2002 to 11/2006



Even though frequency would explain the need of insurance, the severity of the risk event needs to be high enough to justify paying for risk hedging. The average severity has been around 0.25% to 4% of the monthly payment with a maximum between 2% and 13% (Figure 10). The average severity is a lot lower when considering short amortization. Even with an average severity of 4% of the monthly payment (total 2.4 monthly payments), the cost of the FRM implied insurance averaged 3.7% of the total mortgage. For 800'000CHF mortgage, the average total severity would represent 5'440CHF and the average implicit insurance cost represents 29'600CHF. The cost of the insurance is roughly 5.5 times the value of the total severity hedged. The fact that FRM is quite popular underlines the will of the borrower to pay such cost for the underling insurance. We have to underline that the borrower that makes the choice to use FRM does not know ex-ante the risk realisation. The borrower uses some risk expectation in order to make his choice. If the borrower chooses FRM it is because he expects the risk to be real and costly. Borrowers buy insurance that cost much more than the underlying expected risk event severity. Historical data show that on a strict cost and risk basis they tend to overestimate the risk. This trend could be explained by additional external cost related to risk event realisation. Table 4 gives an overview of the risk characteristics for an interest only mortgage.

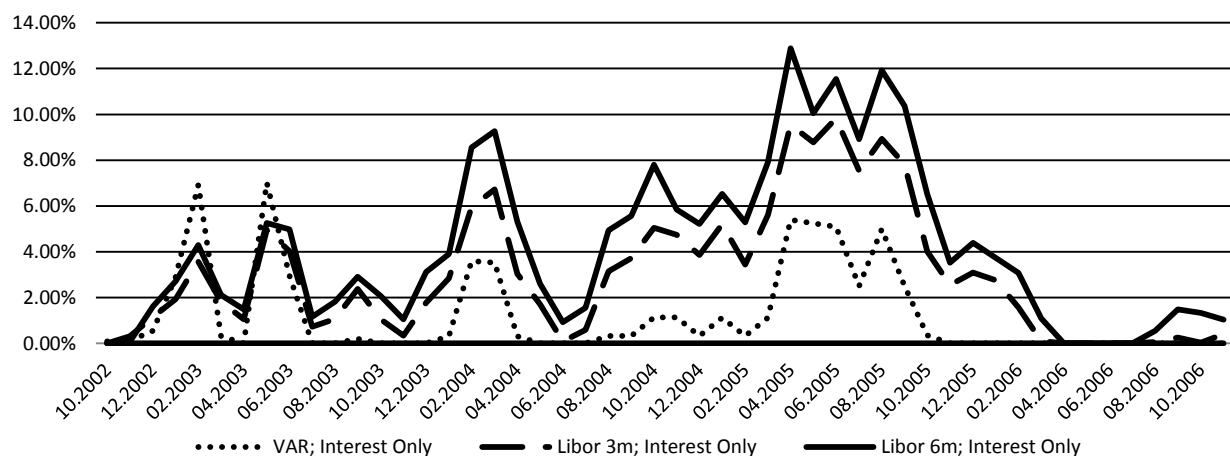
Table 4. Risk characteristics descriptive statistics

| 5 years | Frequency | | | Severity (Average % PMT) | | | Max Severity | | |
|----------------|-----------|--------|---------|--------------------------|--------|---------|--------------|--------|---------|
| Infinite | Min | Max | Average | Min | Max | Average | Min | Max | Average |
| Variable | 0.0% | 100.0% | 21.8% | 0.00% | 7.02% | 1.21% | 0.00% | 18.17% | 5.18% |
| Libor 3m* | 0.0% | 40.0% | 24.7% | 0.00% | 10.26% | 3.25% | 0.00% | 34.18% | 14.07% |
| Libor 6m* | 0.0% | 50.0% | 27.6% | 0.00% | 12.98% | 4.20% | 0.00% | 39.41% | 17.08% |
| Libor 3m** | 0.0% | 40.0% | 23.4% | 0.00% | 9.83% | 2.98% | 0.00% | 33.25% | 13.30% |
| Libor 6m** | 0.0% | 50.0% | 27.6% | 0.00% | 12.89% | 4.17% | 0.00% | 38.45% | 16.65% |
| 3 years | | | | | | | | | |
| Infinite | Min | Max | Average | Min | Max | Average | Min | Max | Average |
| Variable | 0.0% | 100.0% | 45.2% | 0.00% | 23.51% | 5.40% | 0.00% | 37.29% | 8.97% |
| Libor 3m* | 0.0% | 66.7% | 21.4% | 0.00% | 25.28% | 3.41% | 0.00% | 55.72% | 11.06% |
| Libor 6m* | 0.0% | 66.7% | 25.9% | 0.00% | 26.41% | 3.95% | 0.00% | 58.58% | 11.84% |
| Libor 3m** | 0.0% | 66.7% | 20.2% | 0.00% | 24.44% | 3.19% | 0.00% | 54.79% | 10.55% |
| Libor 6m** | 0.0% | 66.7% | 25.0% | 0.00% | 26.56% | 3.94% | 0.00% | 59.27% | 11.67% |

Household that buy a home usually don't want to move often. They will buy a house in a long term minding. It may be interesting to acquire a bigger house with current financial resources, knowing that those resources will increase overtime. The household may tend to get the larger mortgage their financial mean can support in order to buy the house that they will own for a long period of time. Switzerland

household does not face tilt problem since ARM maximum borrowing is based on a fictive mortgage rate similar to FRM ones. This large mortgage may put monthly budget at risk. If a monthly payment cannot be made default may arise with its related cost. Households have in fact two alternatives when they decide the size of the mortgage they get. First, they can buy a smaller house that allows budget flexibility then auto-insure, aka use ARM instead of paying for FRM implied insurance. In this eventuality, the household will have to move, with transaction fees related to the bigger house, when their financial situation improves. Second they can buy a more expensive house within the limit of their budget, but get the insurance of the FRM that they will not face a default risk. Roundtrip transaction costs for a real estate transaction in Switzerland is between 3.48% and 8.93% (Source: Global Property Guide website). To those cost we need to add related moving fees. For a household that face budget constraints with high potential default cost, FRM implied insurance cost are expected to be within the range of the transaction cost related with the first strategy. With FRM the household can avoid default risk, perceived and real, benefit of a bigger house right now and avoid transaction cost related to moving in the future. For the constrained household the average severity is an important risk characteristic, but not as much as the maximum severity of an event.

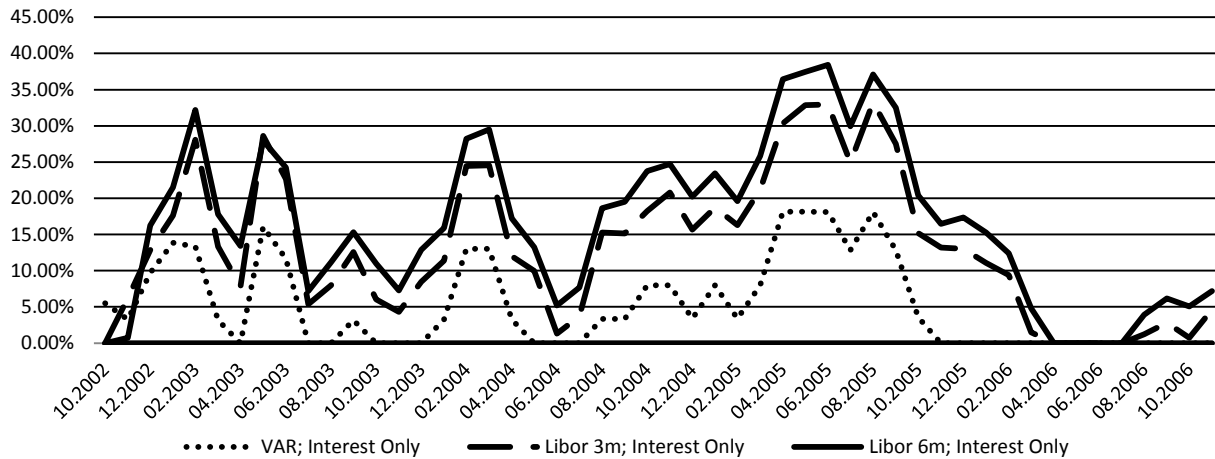
Figure 10. Average severity of risk event when comparing FRM 5 years and alternative ARM, from 11/2002 to 11/2006



Since constrained household may be more preoccupied with maximum severity of a risk event because it only needs one event to trigger a default, we look at the maximum severity. Maximum severity averaged between 1% and 17% over the period under study with a higher maximum severity at 39% (Figure 11). We can understand that a constrained household may be unable to face a monthly payment increase of this order. If a constrained household consider the probability of this event high enough, it may be cheap to choose FRM. We observe that for 15 years amortization period higher maximum severity were 6% of monthly payments. It suggests that 2nd order mortgage that needs to be paid back after fifteen years hardly present a risk that justifies using FRM since the average cost is over 3% of initial mortgage in average.

A household that does not face that kind of budget constraint and don't bear those possible default cost and potential transaction fee of moving should consider the cost of the insurance. We should meet more FRM among the young and high loan-to-asset ratio borrower. US studies suggest the opposite, but there is the presence of tilt problem that does not exist in Switzerland. This question is beyond the scope of this paper and we do not have access to that data, but future investigation could look at this question.

Figure 11. Maximum severity of risk event when comparing FRM 5 years and alternative ARM, from 11/2002 to 11/2006



Higher the risk, higher should be the premium. We observe that there is a negative relationship between risk characteristics and implied insurance premium (Figures 12 to 14). That would mean that higher risk is not included in the premium of FRM. The correlation between premium and risk characteristics are around -0.9 for Pearson's and Spearman's coefficient. Future work can be made to define a future risk assessment method, but even if a strong relation between risk and premium exist at the end of the contract the insurance still bear a positive cost. Predict future ARM level in regard to actual FRM is not an easy task. The average borrower surely does not have the skill and knowledge to make such prediction. The best strategy for the borrower would be to look at the historical cost, to look at the historical severity and to build his strategy over his capacity to face the risk event. Knowing that risk is frequent and average severity low in regard to the insurance cost, household without budget constraint should prefer auto-insurance (ARM). For the household that face moderate budget constraint the choice between insurance, or not, is relative to their risk aversion.

Figure 12. Premium vs frequency from 11/2002 to 11/2006

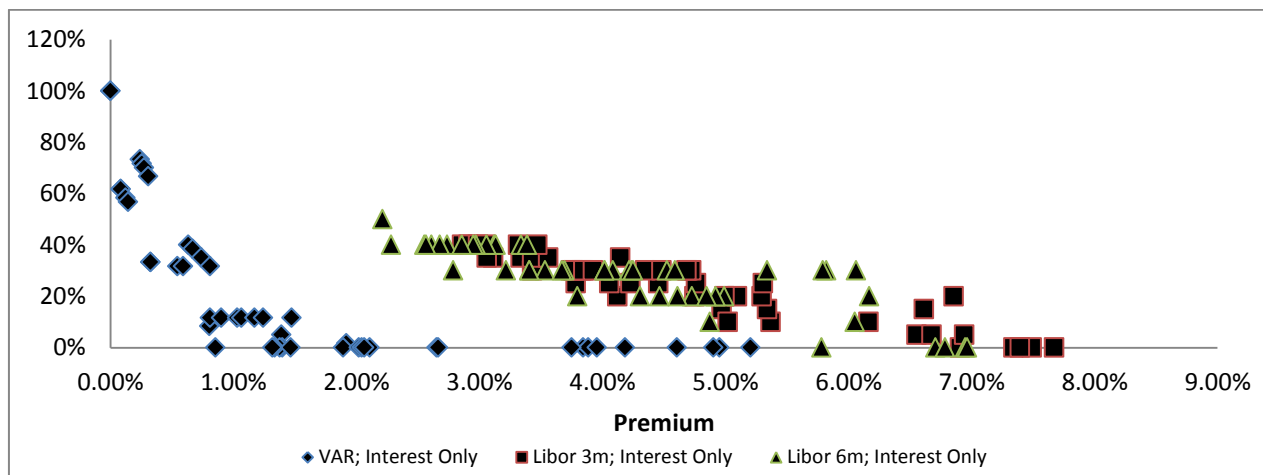


Figure 13. Premium vs average severity from 11/2002 to 11/2006

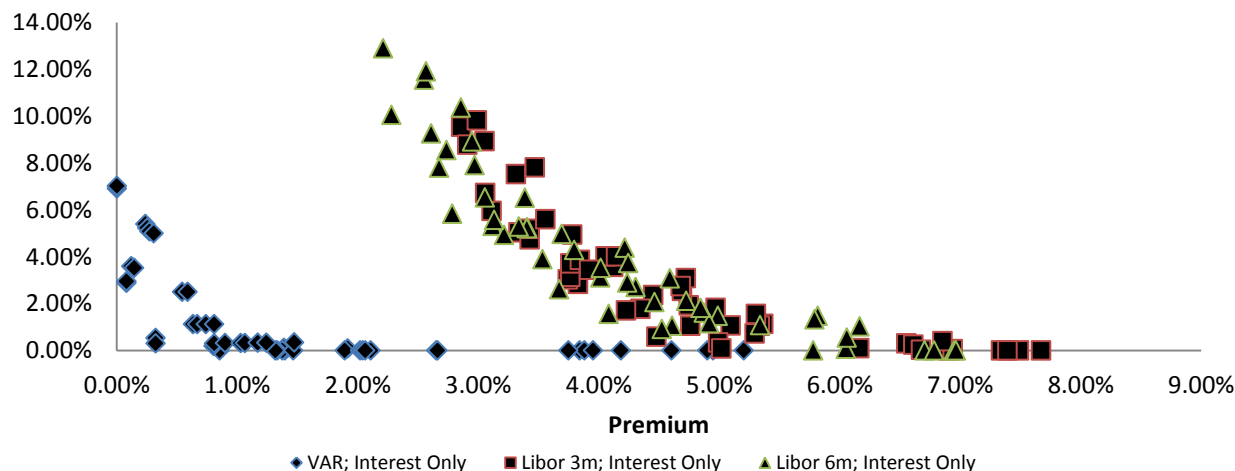
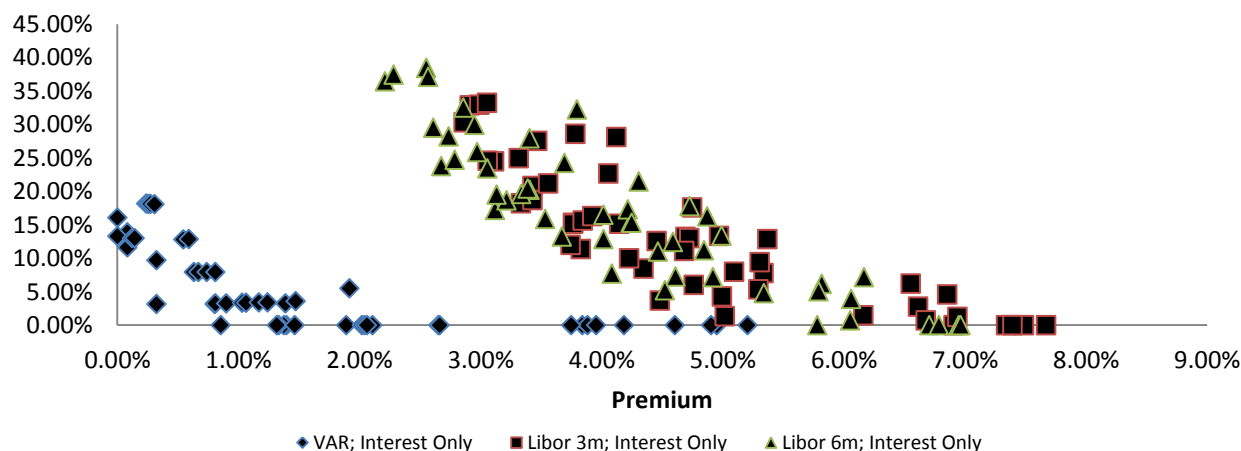


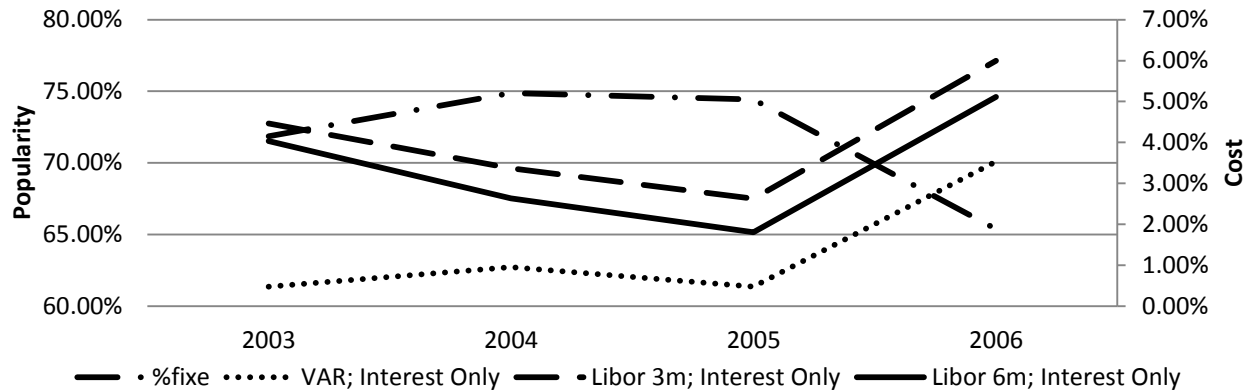
Figure 14: Premium vs Maximum severity from 11/2002 to 11/2006



Popularity

In the previous part about premium and risk we discuss the existence of a market for both mortgage types. There are extremes cases and there are numbers of in-between possible situations. For them, the choice to get the insurance or not will depend on the price of the insurance and on their risk aversion. If the market is efficient, customer should react in function of the price of the implicit insurance premium. Even when the insurance price is higher, there still have customers that want the hedging property whatever the cost. Those borrower are simply more risk averse or more constrained. Figure 15 shows, for the few years the data cover, the relationship between implied insurance cost and FRM market share. The limited data that we actually have, suggest that when FRM cost increase the relative popularity of the product declines. We can observe that FRM popularity is inversely proportional with implied insurance cost when compared with Libor. While the interest rate spread seems to be a good proxy for FRM cost when compared with banker's VAR, the popularity seems more linked with FRM cost compared to Libor. From 11/2002 to 11/2006 FRM popularity only fluctuates between 66% and 74%. It would be interesting to investigate this relationship further. Since from 1996 to 2010 the FRM popularity did fluctuate between 42% and 80% there may be much to learn from this larger period of time.

Figure 15. FRM cost and Popularity



Conclusion

This paper proposed a method to price the FRM implied insurance against the future monthly payment fluctuation. The method is a natural development of the previous research with few slight innovations that allow a more consistent value with borrower reality. First innovation is to link the price as a percentage of the initial mortgage. Second innovation is to apply ARM and FRM payment to mortgage debt reimbursement. Third innovation is to compute a value at time zero of an ARM that would command an equivalent financial effort for exactly the same cash flow than a FRM. Those innovations are minor, but allow for further investigation of the dynamic of the FRM implied insurance.

The main contribution of this paper is to look at the insurance property of the FRM. Most academic paper that discussed the FRM underlined the insurance against future payment fluctuation properties. This paper is the first one to define and investigate risk characteristics. We define concepts of frequency and severity to be applied in the specific situation of FRM/ARM comparison.

This paper is also the first to look at the FRM versus ARM cost for Switzerland. While this type of research has been investigated in other market the cost of FRM on the Swiss market has never been studied before. We use the risk characteristics investigation and cost to analyse the market. Despite the fact that data series were limited the analysis shows the informational potential of risk characteristics analysis.

We found that the cost of 5 years FRM when compared with ARM is always positive when the alternative ARM considered is linked to a Libor rate. The cost for 5 years FRM has been up to 7% of the initial mortgage. The value of the indemnities of an insurance, which would have paid each time the ARM payment would have been higher than the FRM one, has been less than 2% and averaged 0.5%. For the period considered the value that the borrower get seems disproportional with the cost beard. Our analysis of the situation and underlying market propose that this cost level reflect external transaction cost. The FRM insurance allows constrained household to avoid those future transaction cost. The level of insurance cost is consistent with the observed transaction cost avoided. While the cost of insurance makes senses for constrained household it would be interesting, in a future study, to investigate if the popularity of FRM reflect the number of constrained household. We also find that mortgage interest rate spread, which is the intuitive comparison to assess the cost of an FRM is representative of the cost only for bank's variable rate. If the ARM rate under consideration is linked to Libor the spread does not show correlation

with the cost. Future research could aim to propose an alternative to the interest rate spread for FRM/ARM comparison.

When we investigate risk characteristics we find that the risk insured fluctuate a lot. Maximum severity ranged from 0 to 37% of a monthly payment while average severity went to 12% of the monthly payment. In a world where insurance premium reflect the underlying risk we should expect premium to be positively correlated with risk characteristic. Future investigation about the nature of the relationship between the cost of the insurance, the pricing of the FRM and the risk characteristic should be made.

We also investigate the relative popularity of the FRM during a short period of time. While the period is very short and cannot lead to conclusion, an interesting pattern can be observed. The pattern suggests that FRM popularity is linked to the cost of the underlying insurance. If this pattern could be verified on a longer period it would suggest that the mortgage market is efficient in assessing the cost of FRM. Future investigation on the matter would need broader data that cover periods where FRM was less popular.

Future research

Switzerland had a real estate crisis, in the 90s, the relative cost, risk and popularity during this period would certainly teach something about the market.

The actual model with few modifications for transactions costs is a good basis for international comparison of the cost of FRM. FRM popularity studies could help understand the market dynamic. We could easily model future mortgage rate and use ex-ante cost based on Monte Carlo simulation in order to predict the cost of the FRM at the moment of the mortgage type choice. With a cost evaluation model such as the one described in this paper we could provide information about the economic properties that would minimise the cost of FRM. Here are few other questions that could be investigated with the method and risk characteristics presented in this paper.

- If ARM rate increase in the future, is the cost of actual FRM higher?
- Is analyst interest rate forecast can be used in order to predict FRM cost?
- For the period under study we see that ARM is the better choice 83% of the time. Is it possible to find in which circumstances we find ourselves in the 17% where FRM is the best choice?
- Which characteristics of risk severity would trigger the need of insurance for a typical household?

For our part we will focus our future work on the development of an alternative to spread as assessment tool, risk-adjusted measure of the cost of FRM implied insurance and international comparison.

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