



# Differential default risk among traditional and non-traditional mortgage products and capital adequacy standards<sup>☆</sup>

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## ABSTRACT

We develop a framework to quantify credit risks of non-traditional mortgage products (NMPs). Ex ante probabilities of default are caused by willingness-to-pay and ability-to-pay problems and the high default rates for NMPs confirm that payment shock is a critical default risk indicator. Monte Carlo simulations are conducted using three correlated stochastic variables (mortgage interest rate, home price, and household income) under normal and stressed economies. Results confirm that the default risk of 2/28 and option ARM contracts requiring a minimum monthly interest payment have a greater probability of default than other mortgage products in all economic scenarios. Additionally, the credit risk of NMPs is primarily systematic risk, suggesting that these products should require higher risk-based capital. Due to the non-linear distribution of credit risk, even the advanced internal-based rating approach of the Basle II framework can understate the risk involved in these NMPs.

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## 1. Introduction

During the past seven years, numerous non-traditional mortgage products (NMPs) have been introduced in the US to improve the affordability of home ownership. These products generally entail creative features, such as hybrid fixed-rate and adjustable-rate periods and provide various payment options for borrowers. However, the products have also caused an increase in the subprime mortgage market. Moreover, the delinquency and default rates of these NMPs are much higher than originally anticipated.

Because most NMP defaults were caused by a shock to the scheduled payment, Lin, Chu and Prather (2011) point out that the conventional put-option valuation framework is not adequate to analyze NMPs. Thus, evaluating the riskiness of NMPs requires considering the payment shock, which is influenced by the home price trend, interest rate changes, and household income fluctuations.

From a consumer welfare perspective, the choice between fixed-rate mortgages (FRMs) and adjustable-rate mortgages (ARMs) is a seasoned research topic. Campbell and Cocco (2003), Miles (2004, 2005), and Miles and Pilonca (2007) demonstrate the key trade-offs involved with these two types of mortgage contracts in the context of life-cycle consumer utility maximization. Their findings suggest that ARM contracts generally enhance the affordability of a home purchase because a lender is able to offer the mortgage at a lower initial interest rate by shifting the interest rate risk to the borrower. However, ARMs carry higher credit risk than FRMs, particularly for borrowers who purchase expensive homes relative to their income.

From a mortgage pricing standpoint, there are a paucity of studies that consider the key economic risk factors. While there are numerous option-theoretic mortgage-pricing studies (e.g., Calhoun & Deng, 2002; Deng, Quigley, & Van Order, 2000; Foster & Van Order, 1984), few studies (e.g., Buist & Yang, 1998; Yang, Buist, & Megbolugbe, 1998) explicitly deal with income volatility, home price changes, and interest rate changes to analyze the default risk in mortgage contracts. We attempt to fill that gap by using the simulation framework of Buist and Yang (1998) to compare various NMPs with their counterparts in the conventional mortgage market.

We have three research objectives. First, we assess different mortgage types in terms of their affordability and the two drivers of default risk – the probability of negative equity (PnegQ) and the probability of

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a liquidity shortage (PSHORT). Following Yang et al. (1998), we analyze the probability of default as the probability of both events occurring simultaneously. Second, we use Monte Carlo simulations with three correlated stochastic variables (mortgage interest rate, home price, and household income) to determine the default risk of various ARM and FRM contracts under normal and stressed economies. Third, we extend the work of Lin et al. (2011) to examine the implications of our findings in terms of mortgage portfolio management and risk-based capital requirements. The results show that NMPs improve income affordability at the cost of higher credit risk.

The remainder of the paper is organized as follows. Sections 2 and 3 discuss recent market trends, relevant literature, present the model, and detail the products being analyzed. Sections 4 and 5 discuss the results of our simulations under a variety of economic conditions and the risk management implications of our findings in terms of Basel-II like risk-based capital requirements, respectively. Section 6 concludes.

## 2. Market trends and prior studies

### 2.1. Background on mortgages and default risk

A mortgage is a personal loan collateralized by the borrower's home. The ability of the borrower to pay the monthly payment has been considered as one of the most important credit risk factors and typically a mortgage will not default if the borrower can afford to pay the monthly payment. An "ability-to-pay problem" occurs when the borrower cannot afford to pay the required payment. Traditionally, ability-to-pay problems have been managed by setting maximum allowable payment-to-income ratios (PTI).<sup>1</sup>

Option theory suggests that a borrower would have an incentive to default when the unpaid mortgage principal balance (UPB) exceeds the market value of the house used as collateral. This occurs because the negative equity makes the mortgage similar to an out-of-the-money option. While many states permit lenders to pursue deficiency judgments, most US lenders depend solely on selling the house to recover their money.<sup>2</sup> Defaults caused by negative equity are referred to as "willingness-to-pay problems." Traditionally, willingness-to-pay problems have been managed by setting a maximum allowable loan-to-value ratio (LTV) which is intended to mitigate negative equity situations.

In addition to PTI and LTV ratios, a third criterion to assess default risk gained importance in the 1990s because a borrower's past credit history proved to be among the most important determinants of mortgage defaults. Borrowers with bad credit histories carry lower credit scores, and tend to be more likely to default. Perhaps the credit score reflects the stability of a borrower's disposable income and borrowers with high volatility incomes are more likely to experience income shocks and face financial difficulties. As a result, the mortgage industry does not typically lend money to borrowers with credit scores lower than a specified level.<sup>3</sup>

### 2.2. Improving mortgage affordability

After the bursting of the dot-com bubble, the Federal Reserve Bank undertook a series of interest rate cuts intended to stimulate economic recovery. Interest rates steadily declined to 40-year lows by the beginning of 2004, and low mortgage rates considerably improved housing affordability. Mortgage origination volume reached historic highs during the 2003–2004 period and most mortgage lenders increased their work

force to meet the high demand for mortgages. When interest rates increased in 2004, mortgage application volume dropped sharply. In order to keep the mortgage demand volume high, many lenders introduced non-traditional loan programs and relaxed underwriting criteria so that borrowers could qualify.

One approach used to improve affordability was to decrease the required down payment. Two common methods were used to lower required down payments. The first method was to use mortgage insurance. If mortgage principal recovery was insured, a lender could accept a lower down payment and lend at a higher LTV. The second method used was a "piggy back" loan. Here, the borrower obtained an 80% LTV loan from a GSE and simultaneously obtained a second mortgage for part or all of the down-payment. By using two separate loans, the borrower could avoid mortgage insurance premiums on the first mortgage.

A second approach to improve affordability was to encourage borrowers to use ARMs instead of FRMs. Because lenders do not face interest rate risk, ARMs can be offered at lower interest rates than FRMs. Thus, borrowers receive lower monthly payments and therefore face lower income requirements. Most ARMs offered in recent years come with a "teaser" rate, which is a low rate for the beginning period. This approach was later modified to a complicated option payment ARM. Under an option payment ARM, the borrower has the option to determine the size of the monthly payment. The payment options range from a full amortization payment to a minimum payment that is not sufficient to cover the interest obligation. If the borrower chooses to make the minimum payment, the unpaid portion of the interest obligation is added to the mortgage balance, causing negative amortization. This product carries very low initial interest rates so that borrowers with limited income can qualify. Borrowers probably expected that house price increases would allow their equity to grow, but when house prices fell, they were unable to refinance their way out of the increased debt and higher monthly payments. Additionally, prepayment penalties in some of these loans exacerbated the borrower's ability to refinance the loan.

In addition to decreasing down payment requirements and encouraging the use of ARMs, lenders relaxed income, wealth, and minimum credit score requirements. Unfortunately, when lenders relax underwriting standards the credit risk of the mortgage rises. Yang et al. (1998) showed that credit risk can rise by multiples when LTV and the PTI thresholds are simultaneously relaxed.

### 2.3. Evolution of the mortgage market

The market share of ARMs in the US mortgage market increased from about 20% of the total origination in 2001 to nearly 50% in 2005. We have also seen the rise of various specialized ARM products such as 2/28 and 3/27 hybrid ARMs, negative amortization mortgages, option payment ARMs, and more conventional 3/1 or 5/1 ARMs with a cap structure. These NMPs pose a challenge both in terms of assessing their ex ante risk at origination and at point-of-sale to the secondary mortgage market. Due to the newness of those products, there is lack of performance data which prevents gauging the extent of the risks posed by these products in different stages of the economic cycle.

Characteristics of 2/28 and 3/27 mortgages make them difficult to properly value and they can be extremely risky. As Gorton (2008) pointed out, most subprime mortgages are 2/28 or 3/27 30-year amortization ARMs. These hybrid mortgages feature a fixed rate for two or three years, respectively, which depends jointly on prevailing interest rates and the borrower's credit rating. After the fixed period, the interest rate typically jumps and resets periodically afterward. This feature creates a potential ability-to-pay problem.

Several studies link mortgage choice to macroeconomic outcomes, by employing a life-cycle consumer choice model (Campbell & Cocco, 2003; Miles, 2004) or by examining the mortgage choice issue in an industrial organization perspective (Vickery, 2007; Wyman, 2005). ARM contracts create an income (or consumption) risk for a borrower

<sup>1</sup> Prior to 2003, the maximum PTI ratio allowed by most lenders was 36%.

<sup>2</sup> Even if lenders do not pursue deficiency judgments, borrowers that default face the negative consequences of having reduced credit scores and a more limited availability of credit.

<sup>3</sup> Traditionally, a FICO score of 620 is regarded as the minimum level that would be considered by a prime mortgage lender.

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