

1 Standards in Service Industries: The Case of Mortgage Lending

There are various types of home mortgages. Here we focus on an interesting category called ARM (Adjustable Rate Mortgage)¹.

1.1 ARM Basics

Initial rate and payment: The initial rate and payment amount on an ARM will remain in effect for a limited period of time—ranging from just 1 month to 5 years or more. For some ARMs, the initial rate and payment can vary greatly from the rates and payments later in the loan term. Even if interest rates are stable, the mortgage rates and payments could change a lot. If lenders or brokers choose to quote only the initial rate and payment on a loan, the borrower should ask them for the annual percentage rate (APR). If the APR is significantly higher than the initial rate, then it is likely that the mortgage rate and payments will be a lot higher when the loan adjusts, even if general interest rates remain the same.

The adjustment period: With most ARMs, the interest rate and monthly payment change every month, quarter, year, 3 years, or 5 years. The period between rate changes is called the adjustment period. For example, a loan with an adjustment period of 1 year is called a 1-year ARM, and the interest rate and payment can change once every year; a loan with a 3-year adjustment period is called a 3-year ARM.

The index: The interest rate on an ARM is made up of two parts: the index and the margin. The index is a measure of interest rates generally, and the margin is an extra amount that the lender adds. Payments will be affected by any *caps* (limits) on how high or low your rate can go. If the index rate moves up, so does the borrower's interest rate in most circumstances, and the borrower will probably have to make higher monthly payments. On the other hand, if the index rate goes down, the monthly payment could go down. However, not all ARMs adjust downward. Lenders base ARM rates on a variety of indexes. Among the most common indexes are the rates on 1-year constant-maturity Treasury (CMT) securities, the Cost of Funds Index (COFI), and the London Interbank Offered Rate (LIBOR). A few lenders also use their own cost of funds as an index, rather than using other indexes.

The margin: To determine the interest rate on an ARM, lenders add a few percentage points to the index rate, called the margin. The amount of the margin may differ from one lender to another, but it is usually constant over the life of the loan. The fully indexed rate is equal to the margin plus the index. If the initial rate on the loan is less than the fully indexed rate, it is called a discounted index rate. For example, if the lender uses an index that currently is 4% and adds a 3% margin, the fully indexed rate would be 7%. If the index on this loan later rise to 5%, the fully indexed rate will be 8%. If the index falls to 2%, the fully indexed rate will be 5%. Lenders generally base the amount of the margin on the borrower's credit record.

1.2 Types of ARM

Base example: Some of the loan types are easier to understand with an example. Consider a borrower obtaining a mortgage for \$200,000 with a 30-year term. The monthly payments at 6 percent is \$1,199.10. To find this monthly payment, first convert annual ARP of 6% to monthly interest of $0.5\% = 6\%/12$. This is how mortgage companies compute monthly rates. Since $1.005^{12} = 1.617 > 1.06$, this computation by mortgage companies actually makes the actual rate 6.17% rather than (mis-)quoted 6%. The constant monthly payment of \$1,199.10

¹The discussion below is based on the information at www.federalreserve.gov/pubs/arms/arms_english.htm

over 30 years leads to a present value of

$$\begin{aligned}
 1,199.10 \left(\frac{1}{1.05^1} + \frac{1}{1.005^2} + \cdots + \frac{1}{1.005^{360}} \right) &= 1,199.10 \frac{1}{1.005^1} \left(1 + \frac{1}{1.005^1} + \cdots + \frac{1}{1.005^{359}} \right) \\
 &= 1193.1343 \left(\frac{1 - (1/1.005)^{360}}{1 - 1/1.005} \right) \\
 &= 1193.1343(167.6256) = 199999.85 \\
 &\approx 200000
 \end{aligned}$$

No-Doc/Low-Doc Loans: Lenders usually require documents (pay stubs, income tax filings and bank account statements) to ascertain the borrower’s income. In a no-doc or low-doc loan, the lender does not require a proof of income, but the borrower will usually have to pay a higher interest rate or extra fees to get the loan.

Interest-rate caps: An interest-rate cap places a limit on the amount the interest rate can increase. Interest caps come in two versions: i) periodic adjustment caps, which limit the amount the interest rate can adjust up or down from one adjustment period to the next after the first adjustment, and ii) lifetime caps, which limit the interest-rate increase over the life of the loan.

i) To understand periodic adjustment caps, suppose you have an ARM with a periodic adjustment interest-rate cap of 2% in the base example. However, at the first adjustment, the index rate has risen 3%. The second year’s monthly rate increases from 1,199.10 at 6% to 1,600.42 at 9% without an increase rate cap. But the interest rate cap of 2% keeps the rate at 8% in the second year and the corresponding monthly payment at 1,461.72. Said differently, the interest cap of 2% reduces the second year’s monthly payments by 138.70. Some ARMs allow a larger rate change at the first adjustment and then apply a periodic adjustment cap to all future adjustments. A drop in interest rates does not always lead to a drop in the monthly payments.

The increase in the interest that was not imposed because of the rate cap might carry over to future rate adjustments. This is called carryover. So at the next adjustment date, your payment might increase even though the index rate has stayed the same or declined. The following example shows how carryovers work. Suppose the index on your ARM increased 3% during the first year. Because this ARM limits rate increases to 2% at any one time, the rate is adjusted by only 2%, to 8% for the second year. However, the remaining 1% increase in the index carries over to the next time the lender can adjust rates. So when the lender adjusts the interest rate for the third year, the rate increases by 1%, to 9%, even if there is no change in the index during the second year.

i) To illustrate lifetime caps, let us say that your ARM starts out with a 6% rate and the loan has a 6% lifetime cap—that is, the rate can never exceed 12%. Suppose the index rate increases 1% in each of the next 9 years. The first year’s monthly payment at 6 percent is \$1,199.10. With a lifetime cap, if the interest rate rose one percent per year over the next 9 years, and reached the lifetime cap of 12 percent, in year 10 the monthly payments would be \$1,998.84. However, without a lifetime cap, if the interest rate rose one percent per year over the next 9 years, in year 10 the interest rate would be 15 percent and the monthly payments would be \$2,409.11.

Payment caps: In addition to interest-rate caps, many ARMs limit, or cap, the amount your monthly payment may increase at the time of each adjustment. For example, if your loan has a payment cap of 7.5%, your monthly payment will not increase more than 7.5% over your previous payment, even if interest rates rise more. For example, if your monthly payment in year 1 of your mortgage was \$1,000, it could only go up to \$1,075 in year 2. Any interest you do not pay because of the payment cap will be added to the balance of your loan. A payment cap can limit the increase to your monthly payments but also can add to the amount you owe on the loan. This is called negative amortization.

Let’s assume that your rate changes in the first year by 2 percentage points but your payments can increase no more than 7.5% in any one year. The first years monthly payment at 6 percent is \$1,199.10. If the interest rate rose two percent to 8 percent in the second year but there was a seven and one-half percent payment cap, monthly payments in the second year would be \$1,289.03. If the interest rate rose two percent to 8 percent but there was no payment cap, monthly payments in the second year would be \$1,461.72. The difference in the monthly payments with and without the payment cap is \$172.69. While your monthly payment will be only \$1,289.03 for

the second year, the difference of \$172.69 each month will be added to the balance of your loan and will lead to negative amortization.

Some ARMs with payment caps do not have periodic interest-rate caps. In addition, as explained below, most payment-option ARMs have a built-in recalculation period, usually every 5 years. At that point, your payment will be recalculated (lenders use the term *recast*) based on the remaining term of the loan. If you have a 30-year loan and you are at the end of year 5, your payment will be recalculated for the remaining 25 years. The payment cap does not apply to this adjustment. If your loan balance has increased, or if interest rates have risen faster than your payments, your payments could go up a lot.

Hybrid ARMs: Hybrid ARMs often are advertised as 3/1 or 5/1 ARMs—you might also see ads for 7/1 or 10/1 ARMs. These loans are a mix—or a hybrid—of a fixed-rate period and an adjustable-rate period. The interest rate is fixed for the first few years of these loans—for example, for 5 years in a 5/1 ARM. After that, the rate may adjust annually (the 1 in the 5/1 example), until the loan is paid off. In the case of 3/1 or 5/1 ARMs, the first number tells you how long the fixed interest-rate period will be while the second number tells you how often the rate will adjust after the initial period. You may also see ads for 2/28 or 3/27 ARMs—the first number tells you how long the fixed interest-rate period will be, and the second number tells you the number of years the rates on the loan will be adjustable. Some 2/28 and 3/27 mortgages adjust every 6 months, not annually.

Interest-only ARMs: An interest-only (I-O) ARM payment plan allows you to pay only the interest for a specified number of years, typically between 3 and 10 years. This allows you to have smaller monthly payments for a period of time. After that, your monthly payment will increase—even if interest rates stay the same—because you must start paying back the principal as well as the interest each month. For some I-O loans, the interest rate adjusts during the I-O period as well.

For example, if you take out a 30-year mortgage loan with a 5-year I-O payment period, you can pay only interest for 5 years and then you must pay both the principal and interest over the next 25 years. Because you begin to pay back the principal, your payments increase after year 5, even if the rate stays the same. Keep in mind that the longer the I-O period, the higher your monthly payments will be after the I-O period ends.

A payment-option ARM: This is an adjustable-rate mortgage that allows you to choose among several payment options each month. The options typically include the following:

- a traditional payment of principal and interest, which reduces the amount you owe on your mortgage.
- an interest-only payment, which pays the interest but does not reduce the amount you owe on your mortgage as you make your payments.
- a minimum (or limited) payment that may be less than the amount of interest due that month and may not reduce the amount you owe on your mortgage. If you choose this option, the amount of any interest you do not pay will be added to the principal of the loan, increasing the amount you owe and your future monthly payments, and increasing the amount of interest you will pay over the life of the loan. In addition, if you pay only the minimum payment in the last few years of the loan, you may owe a larger payment at the end of the loan term, called a balloon payment.

The interest rate on a payment-option ARM is typically very low for the first few months (for example, 2% for the first 1 to 3 months). After that, the interest rate usually rises to a rate closer to that of other mortgage loans. The payments during the first year are based on the initial low rate, meaning that if you only make the minimum payment each month, it will not reduce the amount you owe and it may not cover the interest due. The unpaid interest is added to the amount you owe on the mortgage, and your loan balance increases. This is called negative amortization. This means that even after making many payments, you could owe more than you did at the beginning of the loan. Also, as interest rates go up, your payments are likely to go up.

Regular recasting: Payment-option ARMs have a built-in recalculation period, usually every 5 years. At this point, your payment will be recalculated (lenders use the term *recast*) based on the remaining term of the loan. If you have a 30-year loan and you are at the end of year 5, your payment will be recalculated for the

remaining 25 years. If your loan balance has increased because you have made only minimum payments, or if interest rates have risen faster than your payments, your payments will increase each time your loan is recast. At each recast, your new minimum payment will be a fully amortizing payment and any payment cap will not apply. This means that your monthly payment can increase a lot at each recast.

Recasting due to owed principal limits: Lenders may recalculate your loan payments before the recast period if the amount of principal you owe grows beyond a set limit, say 125% of your original mortgage amount. For example, suppose you made only minimum payments on your \$200,000 mortgage and had any unpaid interest added to your balance. If the balance grew to \$250,000 (125% of \$200,000), your lender would recalculate your payments so that you would pay off the loan over the remaining term. It is likely that your payments would go up substantially.

2 Outsourcing Turns into Quicksourcing

Manufacturing in the US have dropped year after year due to outsourcing to East Asia. Although the trade route from East Asia to US (think of Shanghai to Los Angeles) is long, the lower labor rates in East Asia have been sufficient to justify outsourcing of manufacturing. The outsourcing trend had initially started with manufacturing but lately it reached services such as product design. The unanswered question in this process was the failure of Mexico to replicate or improve over the outsourcing model established with East Asia. Mexico certainly has the advantage of geographical proximity but there might be some factors that have held it back from becoming a major US supplier. This may change according to the NYT article “Mexico: The New China” by C. Anderson, Jan 28, 2013 ². Anderson runs 3D Robotics ³, which sells planes, multicopters and drones for shooting photographs and videos.

Some excerpts are as follows:

... my company ... [faces] a familiar challenge: its main competitors are Chinese companies that have the dual advantages of cheap labor and top-notch engineering. So, naturally, when we were raising a round of investment financing last year, venture capitalists demanded a plausible explanation for how our little start-up could beat its Chinese rivals. The answer was as much a surprise to the investors as it had been to me a few years earlier: Mexico. In particular, Tijuana.

Tijuana ... is a city of more than two million people (larger than neighboring San Diego), and it has become North Americas electronics assembly hot spot: most of the flat-screen TVs sold in the United States, from companies like Samsung and Sony, are made there, along with everything from medical devices to aerospace parts. ... And its not just TJ. To the east, in Juárez, Dell computers are built by Foxconn, the company that manufactures more than 40 percent of the worlds electronics (including Apples iPhone and iPad). To the south, in Querétaro, a factory builds the transmissions that General Motors installs in its Corvettes. The design of General Electrics GENx turbine jet engine and the production of interior elements of Boeings 787 Dreamliner also happen in Mexico.

Shuttling between the [3D Robotics'] two factories in San Diego, where we engineer our drones, and in TJ, where we assemble them Im reminded of a similar experience I had a decade earlier. In the late 1990s and early 2000s, I lived in Hong Kong ... and saw how that city was paired with the “special economic zone” of Shenzhen across the border on the Chinese mainland in Guangdong Province.

What all these pieces add up to is a model – one that might hold the long-sought answer for how American manufacturers can compete with those in China, India and the next generation of economic powerhouses. Thats because the TJ template isn't so much about outsourcing as it is quicksourcing. And thats also the way to create thousands of good jobs in the United States.

²Also see: A. Thomson. 2013. Mexico: Aztec Tiger. January 30 issue of Financial Times.

³<https://store.diydrones.com>

As any entrepreneur can tell you, the shorter and more nimble a supply chain is, the better:

1. First, a shorter supply chain means that a company can make things when it wants to, instead of solely when it has to.
2. Second, there's less risk. If we make an error in a design, we've wasted at most a few days' worth of production.
3. Finally, a short supply chain is an incentive to innovate. If you're outsourcing the manufacturing of huge parcels of a product, you can't change that product until you've sold all the ones you've already made (at least not if you want to stay in business). So that often means sitting on your hands, waiting for Version 1 to sell out before starting to make Version 2.

3 Homework Questions

1. [**Loan officers**] The difficulty of measuring service operations has been emphasized in the lectures. As an example of service operations, consider the ARM mortgage lending discussed above and a loan officer selling these mortgages. Can an average MBA/Master student evaluate how much finally be paid in total by a borrower getting an ARM loan?
 - If you say yes, explain how this evaluation can be made; mention the name of the financial evaluation method, describe it, or give a reference to a book or a paper where the appropriate method is described.
 - If you say no, explain what the challenges/difficulties of evaluating an ARM are.In order to put this question into perspective, consider Bear Stearns which had \$46 B of mortgages and mortgage-backed securities on its books on November 30, 2007. According to Bear Stearns, \$29 B of them were valued using models derived from some kind of observable market data. The value of the remaining \$17 B was an estimate based on internally developed models utilizing inputs that were less observable. Bear Stearns basically went bankrupt on March 14, 2008 after its stock value dropped from \$170 to \$2 in a year, and was sold to JPMorgan only at \$270 M. Can “respected” financial institutions evaluate the value of their mortgages and mortgage-backed securities?

What are the measures that can be used to evaluate the performance of a loan officer? Comment if you expect to find “the proper explanation of the loan terms to the mortgage buyer” among a loan officer’s performance measures. Do you think that loan officers are given incentives to properly explain the ARM conditions? Explain.
2. [**LIBOR or LIE-BOR**] In asset evaluation, such as the expected present value of mortgage portfolios, the easiest input to obtain arguably is the London Interbank Offered Rate (LIBOR). LIBOR is the assumed interest rate in many calculations. For example, financial derivatives are pegged to LIBOR and 100% of subprime mortgages. Roughly speaking, LIBOR is an average of interest rates reported by big banks. This average is reported back to all banks and financial institutions. There have been some concerns with the rates reported by banks. Allegedly, banks fixed the rates low to gain a financial advantage and reported this rate rather than the true rate. Banks preferred a lower LIBOR, which sounds counterintuitive for banks. Banks traditionally earn revenue by loaning money and should prefer a higher LIBOR. In the mid 2000s, this traditional role was replaced by a role of trader where banks were borrowing as much as they were loaning, if not more. Hence they preferred a lower LIBOR; see Figure 1 for the history of the scandal. Written communications released on Dec 19, 2012 by regulators paint a picture of “routine and widespread attempts by bank employees to rig LIBOR:

On Nov 8, 2006. Senior Yen Trader: have put some pressure on a few people i know to get libors up today.

On Mar 29, 2007. Senior Yen Trader-Submitter: i dun mind helping on your fixings, but im not

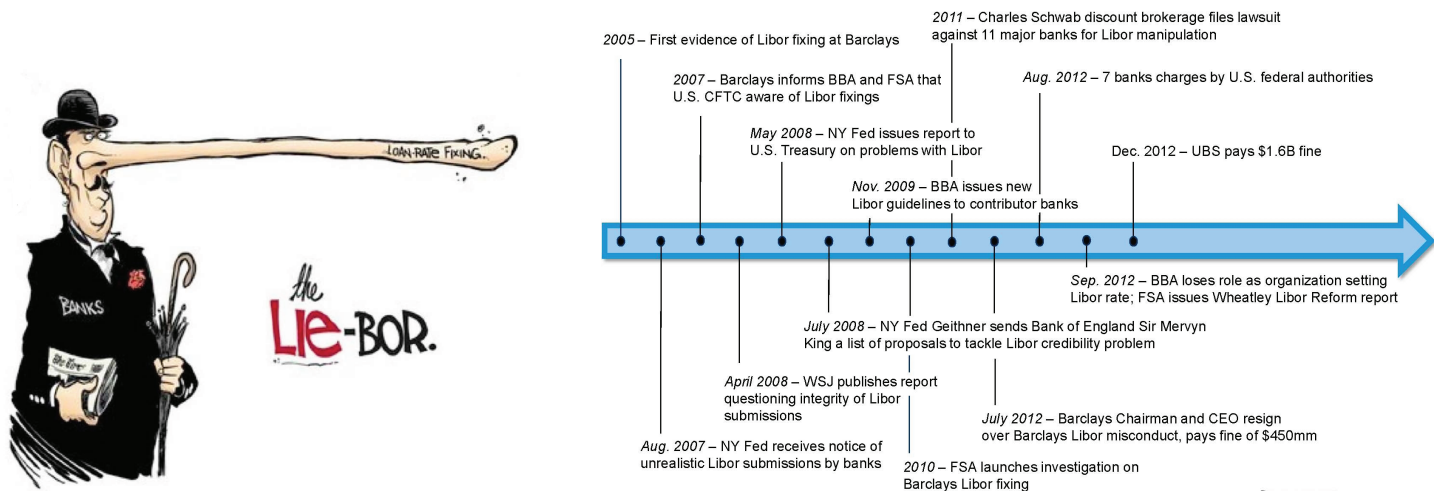


Figure 1: Left panel: Ridicule of the banks by msnbc.com. Right panel: History of the LIBOR Scandal according to R. Maxim and A. Poster, Dec 20, 2012 GARP webcast titled “Libor Fallout: The good, bad and ugly”.

setting libor 7bp away from the truth ill get [our bank] banned if i do that, no interest in that.

On Nov 1, 2007. Senior Yen Trader: hello mate, real big favour to ask. could you try for low 6m fix today pls wld be most appreciated. thx mate.

Follow up on Nov 1, 2007. Derivatives Broker B1: yeah i know mate ...ill try and push a few fictitious offers ard this mng see if tahts helps.

Senior trader stated:libors are going down tonight.

Junior trader asked: why you think so?

Senior trader explained:because i am going to put some pressure on people.

What are the measures that can be used to evaluate the performance of a trader? May some of these measures be giving incentives to traders to rig the LIBOR? What can be done to eliminate these incentives? Explain.

3. **[Quicksourcing]** Consider quicksourcing discussed above:
 - a) “First, a shorter supply chain means that a company can make things when it wants to.” Explain why a company benefits from the flexibility of making things when it wants to?
 - b) “Second, there’s less risk. If we make an error in a design, we’ve wasted at most a few days’ worth of production.” Explain how the speed of sourcing is related to the inventory in the supply chain.
4. **[Disease Management]** A U.S. politician has recently mentioned that “the healthcare management system” in the U.S. ought to be called “a disease management system”. In view of the difficulty of measuring/standardizing the performance of service providers and incentives of the medical doctors, explain what this politician might have meant.