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Assessing Alternative Options in Home Financing

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Author Note: I am honored to present this paper as a systems engineer within the Systems Engineering Department at the United States Military Academy. The views expressed herein are those of the authors and do not reflect the position of the United States Military Academy, the Department of the Army, or the Department of Defense.

Abstract: Despite numerous financial instruments available to consumers purchasing a home, the 30-year fixed-rate mortgage remains the most common instrument used to finance a home. This paper seeks to understand whether other financial instruments offer a less costly method of financing to consumers in the housing market. Specifically, this paper uses deterministic and stochastic modeling of a particular financial instrument, a Home Equity Line of Credit (HELOC), and shows that a less costly method of financing may exist but requires a more sophisticated investor willing to assume additional risk.

Keywords: Home Financing, Home Equity Line of Credit, 30-Year Mortgage, Prime Rate, Premium Rate

1. Introduction

In the elaborate landscape of home financing in the United States, the predominant reliance on the traditional 30-year mortgages has long been a cornerstone of homeownership. However, as financial dynamics evolve, the exploration of alternative financing strategies emerges, with a specific focus on Home Equity Lines of Credit (HELOCs) in the first lien position. This report aims to unravel the complexities of HELOCs, exploring their unique features and potential advantages. As we navigate this financial ground, the narrative will culminate in a groundbreaking revelation—derived from stochastic modeling—that challenges conventional norms. HELOCs may present a more economically advantageous way to homeownership. This paper seeks to not only outline the existing knowledge but also pave the way for a shift in our understanding of optimal home financing strategies.

In recent years, the landscape of financial instruments for real estate financing has undergone significant evolution, prompting individuals to seek optimal solutions for their borrowing needs. The HELOC in the first lien position, secured by the equity in one's home, offers flexibility in borrowing against the equity built up in the property, while the traditional 30-year mortgage remains a conventional choice for long-term financing.

This report aims to provide insights into the comparative advantages and drawbacks of these two instruments, shedding light on their implications for borrowers in terms of loan repayment duration and interest payments. By analyzing historical interest rate trends and median income data, we seek to offer valuable guidance to individuals navigating the uncertain terrain of real estate financing.

Through this analysis, we aim to provide an understanding of the trade-offs inherent in choosing between HELOC and traditional mortgage options, empowering borrowers to make informed decisions aligned with their financial goals and circumstances.

2. Literature Review

A 30-year fixed rate mortgage is one of the most used home loans in the United States. Although home buyers have various options to choose from when deciding on the home loan to use, 90% of homeowners still choose the traditional 30-year home loan (Fay, n.d.). The traditional loan is characterized by having an unchanging interest rate and affordable payment plan. There is also the option that allows homeowners to make extra payments towards the principal amount to pay off the mortgage faster. The benefits of having a 30-year mortgage are the identical monthly payments the buyer will make for the next 30 years. Another benefit is being able to make additional principal payments to lower the principal balance on the loan.

The third benefit is having a locked interest rate for 30 years allowing for predictable payments every month. This could also be a downside, if the interest rates lowers, the buyer is tied to the high fixed rate unless they refinance for a fee (Fay, n.d.).

A home equity line of credit, or HELOC, is a type of loan that allows homeowners to borrow against the equity in their home. It is typically calculated as the appraised value of the home minus the amount of the mortgage. Unlike a traditional loan, the interest rate on a HELOC is variable. One of the most beneficial features of a HELOC is that the homeowner can access funds up to the credit limit as soon as the credit line opens. There are various forms of HELOC plans, some of which require monthly payments on the principal portion, while others only require interest-only payments, with no payments towards the principal, such as the interest only HELOC. This borrowing period typically lasts for 10 or 15 years, depending on the specific plan. The variable interest rate of a HELOC consists of two components: the index and the margin. The index is a measure of interest rates that reflects trends in the economy, often based on the prime rate. The margin is an additional percentage that the lender adds to the index, also known as the premium. Some HELOC plans offer the option to convert a portion of the balance into a fixed interest rate, typically after the draw period ends. However, it's important to note that the fixed interest rate is usually higher than the variable interest rate (Consumer Financial Protection Bureau, 2022). After the draw period ends, the repayment period begins, during which the borrower must repay the outstanding balance, often with a higher fixed interest rate.

The 30-year traditional rate mortgage, which has become the most popular home loan option, began around 7.3 percent in 1971. This high starting rate was influenced by the Federal Reserve's expansionary policy at the time, driving inflation and borrowing costs up (Foster). By 1980, the average cost of U.S. homes was $63,700 (United States Census Bureau), which surged to a median of $123,900 by 1990. During the period of high inflation known as the Great Inflation, interest rates peaked at 18.4% in October 1981 before gradually declining back to the 9% range once the Fed intervened. By 1990, the average mortgage rate had dropped to about 6.91%, partly attributed to the rise of the internet and the growth of technological companies and investments. However, the housing market crash in 2000 caused the average mortgage rate to plummet from 8% to 5.4%. Throughout the COVID-19 epidemic, the Treasury deliberately lowered rates to stimulate the economy, with rates dipping just under 3% in 2020. From 2022 to 2023, rates climbed to 7% before falling back to 6%, and currently, they are trending towards 8% (Caginalp).

The prime rate, defined as the interest rate banks charge their most creditworthy customers, is set by the Federal Reserve and serves as a benchmark for other interest rates. This rate, commonly used by banks and lenders, affects various products such as credit cards and home loans. Customers with good credit scores are typically charged the prime rate plus a certain percentage known as the premium, which serves as additional compensation for lenders to mitigate risk. In the United States, the prime rate was set at 8.5% on July 27, 2023, while the federal funds rate ranged between 5.25% and 5.5%. The prime rate fluctuates daily and primarily impacts small loans and lines of credit. Any increase in the prime rate could potentially result in higher monthly payments for borrowers (Chen, 2023).

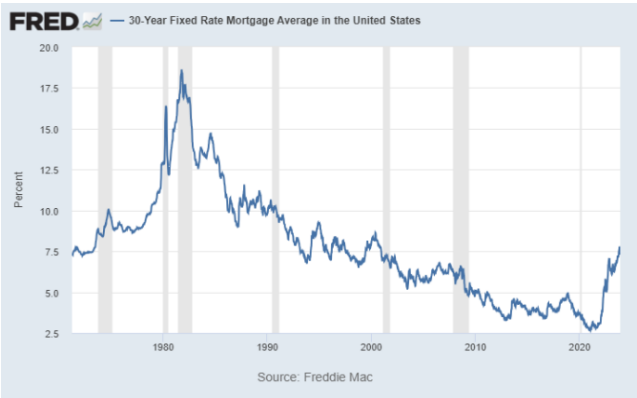


Figure 1: Fixed Rate through Time (Freddie Mac, 2023)

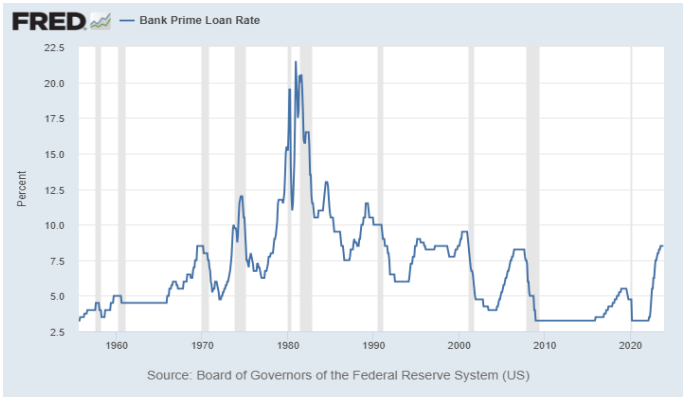


Figure 2: Prime Rate through Time (Freddie Mac, 2023)

The 30-year mortgage stands as the cornerstone of the U.S. housing market, constituting more than 90% of home loans. With fixed monthly payments, this loan enables consumers to budget within their expenses, providing a sense of security due to the predictability of payments. The federal government demonstrates support for the fixed mortgage by offering subsidized loan rates. Additionally, the creation of the Federal Housing Administration and the promotion of long-term mortgages with fixed rates were responses to defaults with other loans. This government backing, along with the Federal Reserve's efforts to maintain low rates, has encouraged millions of borrowers to secure their interest rates (deRitis, 2013).

Many consumers are hesitant to take out a HELOC due to several factors, including the variable interest rate, fluctuating monthly payments, the option for interest-only payments, and the ease of accessing funds. When the prime rate increases, the interest rate on a HELOC also rises, leading to higher monthly payments. These increases can occur unpredictably, making it challenging for consumers to budget effectively and potentially impacting their credit score if they miss payments. Rising interest rates also mean less disposable income for expenses and savings. While making principal-only payments may appear beneficial in the short term, it can lead to higher monthly payments once the interest-only period expires, potentially causing financial strain if not properly budgeted. Additionally, since interest-only payments do not contribute to reducing the principal balance, the loan remains outstanding. On a positive note, HELOCs often have minimal upfront costs, making them easily accessible to consumers. However, for individuals who are not financially responsible, this immediate access to funds could lead to dependency on such access (Fontinelle, 2023).

3. Methodology and Analysis

Under what conditions does the Home Equity Line of Credit (HELOC) outperform the 30-year mortgage in terms of paying it off faster and/or with less interest? This question explores the intricate dynamics of borrowing against home equity and the various factors influencing loan repayment strategies. The answer may lie in a nuanced examination of variables such as prevailing interest rates, borrower income levels, and individual financial goals. By analyzing these factors through analysis and stochastic modeling, we seek to uncover the circumstances under which HELOCs may emerge as a potentially advantageous choice for expedited loan repayment and minimized interest expenditure, compared to traditional mortgages. Such insights have the potential to refine conventional ideas regarding optimal home financing strategies, offering borrowers a pathway to enhanced financial efficiency and homeownership attainment. Through exploration and empirical validation, this study aims to interpret the conditions under which HELOCs could potentially outperform traditional mortgages, paving the way for informed decision-making in real estate financing endeavors without predisposed bias towards either financial instrument.

The objective of this project is to analyze two different financial instruments, namely Home Equity Line of Credit (HELOC) in the 1st Lien position and the 30-year traditional mortgage, in terms of their impact on loan repayment duration and the total interest paid. The analysis will utilize past interest rates from 2022 and median salary data for US owners in 2022 as foundational elements for the examination.

3.1 Critical Modeling Variables and Assumptions

A key variable in our model is the salary of the individual. We chose to use the median salary for an American in 2021 which came to be $76,330 (Freddie Mac, 2023). In order to find the maximum allowed mortgage for the average American, we used the 28% rule. The 28% rule is comply recommended to find out the upper limit one should pay each month for a mortgage (Federal Deposit Insurance Corportation). When we used the annual salary of $76,330, we divided it by 12 to find the salary per month. We then multiplied the monthly salary, $6,360.83 by 28% and got the maximum mortgage allowance of $1,781. By using this variable, we were able to create an amortization table to find out what house the average American can afford, which came out to be $250,000. We then used this loan amount for both the 30-year fixed rate mortgage and the HELOC loan.

Another key variable is the interest rate. In some cases, the interest rate variable will be fixed and in other cases it will be variable. This is to add a level of realism, specifically in the HELOC stochastic model as the interest rate changes daily as shown in Figure 2 above.

Another key variable is earned to spent ratio. The earned to spent ratio is the percentage of monthly income that will be used for expenses. Essentially, it depicts the ‘saver’ against the ‘spender’. At the 50% we have an individual who spends only 50% of the income on expenses and the rest would go into the HELOC. This enables us to look at different instances when the individual has to allocate more of their salary towards expenses and emergencies than to the HELOC.

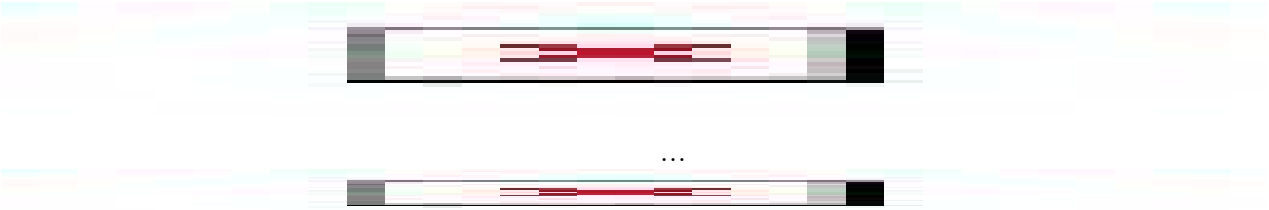
A key assumption in the models is the potential for financial growth. Using the data from Freddie Mac on median salary throughout the years, we were able to calculate the geometric mean of the median salary. This value came to be 0.007722. This value accounts for the growth rate every year to be 0.7722%. We implemented this after every year in our model to add a layer of realism in terms of salary growth and allowance the earned-spent ratio.

Another assumption is that the HELOC is in the 1st lien position. This means that the HELOC is a line of credit and mortgage in one, or simplistically, replaces your mortgage. This allows us to use the same loan value for both the 30-year mortgage and the HELOC. It provides a control over our model.

3.2 Deterministic

The first thing we modeled was the 30-year traditional mortgage. This included a fixed rate and a basic amortization table. By employing this deterministic model using the basic amortization table, we confirm the conventional 30-year mortgage's adherence to its fixed-rate interest rate structure, predicting a complete repayment of the house within the given period. Over the mortgage's duration, the buyer is anticipated to lock in a mortgage at 7.57% and expend a total of $383,612.61 in interest, providing a baseline for comparison against alternative financing strategies. The reason the interest rate was locked in at 7.57% was because it was the benchmark for December 1, 2023 (Fontinelle, 2023). This deterministic analysis lays a foundation for evaluating the financial landscape associated with the traditional 30-year mortgage and sets the stage for following comparative examinations.

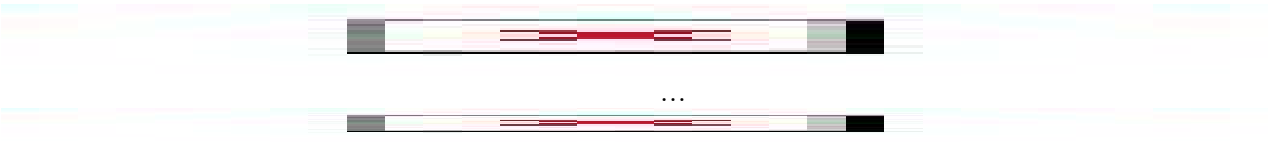
Table 1: 30-Year Mortgage Loan Payment



After doing the model for the traditional mortgage payment, we wanted to model the HELOC in a similar way. Notable differences in the model include the addition of salary, putting in, and expenses. The variable for salary represents the amount of money an average American would make in any given month, as computed in section 3.1. The variable "putting in" represents how much money is being input into the HELOC. For example, Payment Number 1 in Table 2 below, the entire salary of $6,360.83 is paid into the HELOC at the beginning of the month. Specifically, $1,573.09 pays the interest bill for the month and $6360.83 - $1573.09 = $4787.74 serves as a principal payment. The Expenses variable represents the amount of expenses that was incurred by the individual's credit card throughout the month, which is determined by their earn to spent ratio. At the end of the month, the amount in the expenses column is withdrawn from the HELOC to pay off the individual's credit card bill. So in practice, an effective principal payment of only $4784.74 - $4445.74 = $342 was made in month one. Critically important however, for 30 days of the month, the interest charged on the account was based on a balance that was $4784.74 lower.

This more accurately represents the human behavior of either being a saver or a spender. Additionally, in order to compare the model to the conventional loan, we used an effective interest rate of 7.70%. This is slightly higher than the 30-year loan because HELOCs also include a premium as mentioned above. Using this interest rate, the total interest paid was $343,778.68 at a period of only 346 months. This simulation provides valuable insights into the dynamics of the HELOC, offering a comparative lens to the traditional mortgage and laying the groundwork for more in-depth modeling.

Table 2: HELOC Loan Payment

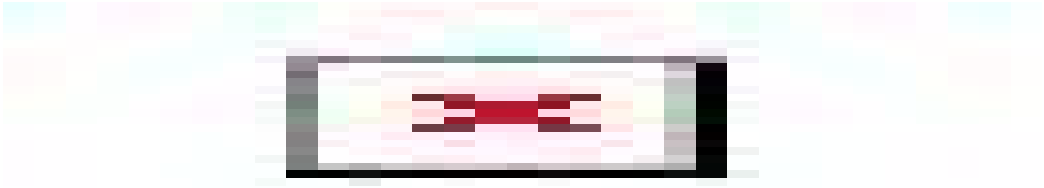


3.2.1. Sensitivity Analysis

When doing a sensitivity analysis, we decided to depict this in a two-way table. Across the X-Axis we have the interest rates and across the Y-Axis we have the earned-to-spent ratio. The first table shown, Table 3, is a representation of how fast the loan is paid in months. When analyzing this table, we are able to see that an interest rate that remains constant at and after 10% is not worth taking due to it being 360 months or longer. After this point, we would recommend taking the traditional 30

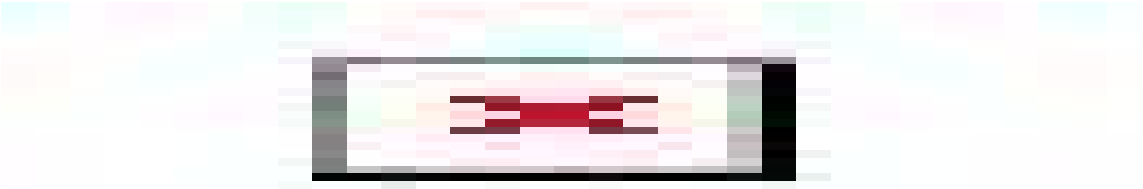
year mortgage. We recognize that the HELOC interest rate is constantly changing, but are using this as an instrument to see the ranges of feasibility.

Table 3: Deterministic 2-Way Table of Time Period HELOC Repayment due to Changing Consumer Ratio



When doing the same sensitivity analysis but instead of measuring months, we measured the total amount of interest paid, we have a similar conclusion. At a constant interest rate at or over 10%, the individual is paying more than the 30 year mortgage at $383,612.61. Again, we recognize that the HELOC's interest rate is constantly fluctuating but are not able to view the feasibility of the changing interest rates and ratio of savers to spenders.

Table 4: Deterministic 2-Way Table of Total Interest Payment due to Changing Consumer Ratio



3.2 Stochastic

After making sure our deterministic models work, we moved on to adding a layer of complexity and realism to the next model. Due to the variability in HELOC interest rates and the amount of money one spends in a month, we decided to represent these variables as stochastic. The two functions we used to provide this complexity were @Risk BMMRJD and the @Risk Trigen.

The utilization of the @Risk BMMRJD (Beta-Martin Model with Jump-Diffusion) function in our financial modeling methodology complements the sophistication brought by the @Risk Trigen function, offering a comprehensive approach to understanding the dynamics of interest rates and their impact on financial outcomes. By incorporating both continuous movements (diffusion) and sudden jumps (jump diffusion) in interest rates, the BMMRJD function captures realistic behavior commonly observed in financial markets, shown in Figure 1 and 2. Leveraging historical interest rate data spanning several decades, this function identifies patterns and trends, enabling us to forecast future interest rate trends with a certain degree of accuracy. This predictive capability, coupled with the BMMRJD function's ability to assess both long-term trends and short-term volatility, provides valuable insights into potential variations in interest rates and their implications for financial scenarios. Furthermore, by considering the risk associated with interest rate fluctuations, the BMMRJD function enhances our ability to make informed decisions and assess the potential risks and opportunities associated with HELOCs and other financial instruments. Overall, the integration of the @Risk BMMRJD function alongside the @Risk Trigen function contributes to a more comprehensive and accurate financial analysis, ultimately enhancing our understanding of the complexities of financial markets and their impact on financial outcomes.

The @Risk Trigen function played a crucial role in introducing variability into the earned-to-spent ratio, a fundamental aspect in capturing the dynamic nature of monthly expenses. By configuring the Trigen function with parameters such as a minimum of 0, a most likely value of 0.75, and a maximum of 1, along with a 10% chance of deviating beyond these bounds, we were able to accurately model the nuanced fluctuations in financial habits over time. This level of granularity provided a more comprehensive understanding of how spending patterns may evolve, enabling us to better assess the potential impact on financial outcomes. Similarly, the @Risk BMMRJD function proved invaluable in addressing uncertainties related to interest rates. By analyzing historical interest rate data spanning the past 30 years and leveraging it to predict future interest rate trends, the BMMRJD function enabled us to gain insights into potential variations in interest rates. This predictive capability was essential for assessing the financial landscape and understanding the potential risks and opportunities associated with interest rate fluctuations.

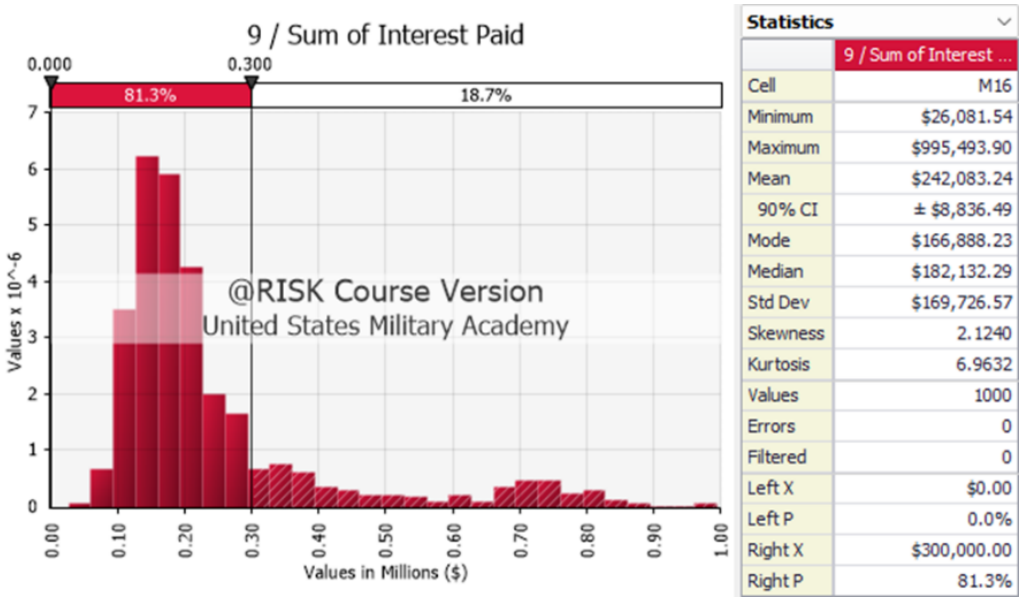


Figure 3: CDF of Total Interest Paid

The stochastic model, using 1000 iterations and 1 simulation, yielded compelling results, including an 81.3% probability that the interest paid would remain below $300,000, with the observed median standing at $182,132.29, shown in Figure 3. One important risk is the tail, which is skewed past the $300,000 amount even touching the $1,000,000 amount. This is important to consider especially with the variable interest rates and expenses. However, these findings underscore the robustness of our modeling approach and highlight the effectiveness of incorporating stochastic elements to capture the inherent uncertainties in financial scenarios. Overall, the utilization of @Risk functions enhanced the realism of our model by incorporating essential variability into key parameters, ultimately contributing to a more thorough and accurate assessment of the potential outcomes associated with HELOCs.

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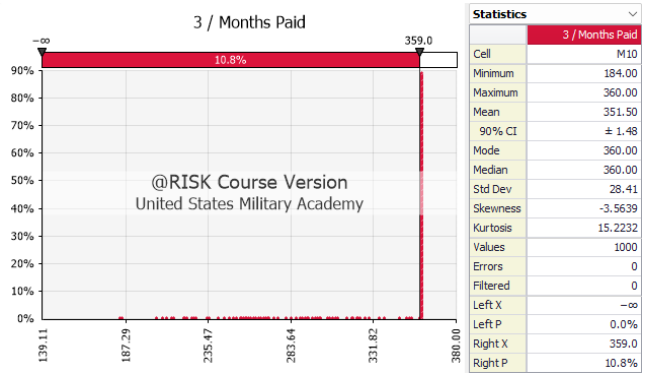

Figure 4: CDF of Total Months Less Than Traditional Mortgage

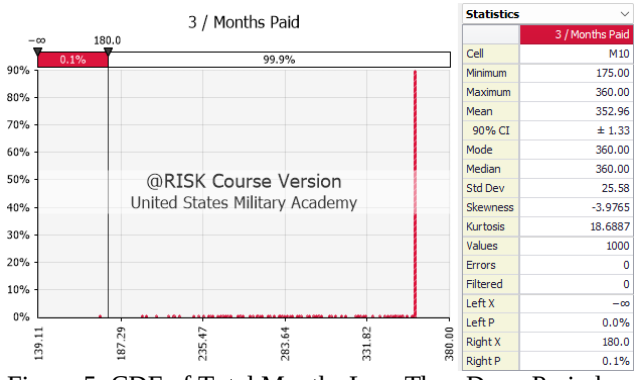

Figure 5: CDF of Total Months Less Than Draw Period (15 Years)

When analyzing the time period aspect of the loan, we decided to look at two different events. The percentage of time the HELOC is shorter than 360 months which is the total time for a traditional loan and the time it is less than 15 years which is the typical time or draw period a HELOC loan is given out for until it turns into a fixed rate loan.

First we will look at the percentage of time it is paid before the 360 month period. When looking at Figure 4, the percentage it is less than the traditional loan is 10.8%. The mode for this graph is 360 months. At this point in our analysis we are concluding that it would be better to take the traditional loan. When further looking at the CDF, we know adjusted it to the typical 15 year draw period and got a more significant result. The percentage it is paid off less than 15 years is 0.1%.

However, in the long run, if we were to obtain a HELOC, we can drastically reduce the interest paid from $383,612.61 to $182,132.29. The risk that we might have to further observe is the limitation with the 15 year draw period. We would have to use add more sophisticated limitations to this methodology to do so. One option is using another HELOC to cover the existing HELOC, since there is a high probability the loan is not paid in full. The timing component would have to be further looked at but overall in the long run, the HELOC could prove to be an effective strategy to faster homeownership.

4. Results

This comprehensive examination of home financing strategies in the United States, both deterministic and stochastic models, has provided valuable insights into the complexities of mortgage alternatives. The deterministic models explained the traditional 30-year fixed-rate mortgage and Home Equity Line of Credit (HELOC), establishing clear routes of payments and interest over time. The stochastic model, supplemented by @Risk Trigen and @Risk BMMRJD functions, introduced a dynamic layer to the analysis, capturing the variability in earned-to-spent ratios and interest rates. Notably, the HELOC stochastic model exhibited an 81.3% probability that the interest paid remains below $300,000, affirming its potential cost effectiveness. However, the simulation shows that there are conflicting results regarding the time it takes to pay off the loan. In many instances, it takes as long or longer than the conventional loan. These findings prove the importance of considering alternative financing strategies, especially in a dynamic landscape. For future work, exploring different buyer profiles, such as savers and spenders, could deepen our understanding of individual financial behaviors and their effects for optimal home financing strategies. This research contributes to the ongoing discourse on home financing, challenging conventional norms and paving the way for new considerations in the pursuit of sustainable homeownership.

5. Conclusion

The exploration of home financing strategies opens ways for future work that focus deeper into diverse buyer profiles. One direction involves the examination of case studies, such as buyers who adopt distinct saving habits, dual-income couples, and individuals with varying risk. By looking into these scenarios, we aim to unravel the complex dynamics that influence optimal financing choices aimed to unique financial profiles. Additionally, further research will be directed towards refining our understanding of the average ratio of earned to spent for the typical American, contributing to a more accurate depiction of monthly financial habits and seasonality spending patterns, such as around Christmas time. Exploring variations in interest rate scenarios and their impact on different financing strategies will also be important. As we broaden our scope, these additional case studies and examinations offer comprehensive insights, facilitating informed decision-making for a range of potential homebuyers.

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