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# Household Mortgage Choice

## An Econometric Inquiry into the Microeconomic variables Influencing Italian Preferences for Fixed versus Adjustable Mortgages 2010-2024

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# Index

*Abstract* ..... 3
*Introduction* ..... 4
*Chapter 1 – The Mortgage Choice* ..... 6
*1.1 - Presenting of the Papers* ..... 6
*1.1.1 Campbell and Cocco 2003* ..... 6
*1.1.2 KHN* ..... 9
*1.2 - Building the Mathematical Models* ..... 11
*1.2.1. Campbell and Cocco 2003* ..... 11
*1.2.2. KHN* ..... 15
*1.3 - Conclusions* ..... 18
*1.3.1. Campbell & Cocco 2003* ..... 18
*1.3.2. KHN* ..... 19
*Chapter 2 – The Italian Scenario '06-'24* ..... 20
*2.1 - Income Trends Analysis: 2010 - 2024* ..... 20
*2.2 - Debt Levels of Italian Households: 2010-2024* ..... 23
*2.3 - Integrated Analysis of Italian House Value Trends: 2010-2024* ..... 27
*2.4 - Real income against House Value: 2006-2024* ..... 32
*Chapter 3 - The Sample* ..... 35
*3.1 - Sample Foundations Analysis* ..... 35
*3.2 - Composition of the Sample* ..... 37
*3.2.1 Demographics* ..... 37
*3.2.2 Income Distribution* ..... 40
*3.2.3 Real Estate Value* ..... 42
*3.2.4 Mortgage Interest Rates and Distribution* ..... 44
*3.3 - Statistical significance models* ..... 46
*3.3.1 F-Test & Welch's T-Test* ..... 46
*3.4.2 - Linear Regression* ..... 49
*3.4.3 Analysis sum up and Cambpell&Cocco 2003* ..... 55
*3.4.4 KHN Period Application* ..... 59
*Chapter 4 - Financial Education and Biases* ..... 62
*4.1 - Italian Financial Education* ..... 62
*4.1.1 The Indicators* ..... 62
*4.1.2 The Statistics* ..... 63
*4.2 - Behavioral Finance Applied to Mortgage Choice* ..... 74
*4.2.1 The Biases* ..... 75
*Chapter 5 - Conclusions* ..... 78

*Chapter 6 - Limitations and Future research* ..... *81*
*Appendix A: Mortgage Models and Pricing Framework* ..... *83*
*Appendix B: Campbell & Cocco (2003) – Consumption, Wealth, and Mortgage Choices* ..... *85*
*Appendix C: Parameter Sensitivity and Model Applications* ..... *90*
*Appendix D: Statistical Results* ..... *96*
*Bibliography* ..... *101*

# *Abstract*

This study explored the key household factors that influenced mortgage choices in Italy between 2010 and 2024, a period defined by historically low interest rates. Common sense might suggest that a fixed-rate mortgage would always be the best option, as it allows borrowers to lock in these low rates for the long term. The aim of this thesis was to understand why, despite such conditions, a notable portion of Italian borrowers still chose adjustable-rate mortgages. To investigate this, two major economic theories were applied to a sample from a bank operating in the Italian market during that time. One theory focused more on the borrower's personal conditions, such as wealth, income, and risk tolerance, while the other explored the connection between the bond market and the term structure of interest rates. The findings were then compared to the broader Italian macroeconomic landscape to support the conclusions. The results showed that ARMs were the best option for a specific group: wealthier, more risk-tolerant, and financially literate individuals with the flexibility to manage potential rate fluctuations. While this may seem counterintuitive in a low-rate environment, ARMs provided lower overall costs compared to FRMs taken out in the same period, thanks to a combination of short-term savings (due to lower initial rates) and long-term benefits (as those rates offset future rate spikes). On the other hand, the results also demonstrated that choosing an FRM was often a sensible choice, especially for borrowers with lower incomes, less financial literacy, and a greater need for stability. In cases where the bond risk premium is not high, as was the case during this period, FRMs tend to be the safer and more predictable option. Therefore, results said that the decision depended on the borrower's financial profile and ability to handle future interest rate changes. In conclusion, understanding the profile of the borrower helps explain why, during the 2010-2024 period, part of the Italian households chose ARMs, even when fixed-rate options appeared more straightforward.

# *Introduction*

Historical records from ancient Rome show that people have always looked for the best way to buy houses through mortgages, seeking the most advantageous options available. Purchasing a home is one of the most significant milestones in a person's life, and the choice of a mortgage type becomes a crucial decision. However, the complex and ever-changing nature of the modern economy makes this decision far more complicated than one might initially think.

Over time, mortgages have become essential tools for accessing property ownership. At the same moment, they highlight a clear distinction between two financial approaches: the stability of a fixed-rate mortgage and the flexibility of a variable-rate mortgage. But is it truly possible to determine which is the better choice for every individual in any economic context? On one hand, some economists argue that during periods of low interest rates, fixed-rate mortgages are the most logical choice, as they lock in a favorable rate for the entire duration of the contract. On the other hand, many borrowers continue to opt for variable-rate mortgages, defying this apparent logic.

This phenomenon has attracted the attention of economists and experts, who have sought to understand the reasons behind the choices of Italian households. Notable contributions in this field include the theories of *Campbell and Cocco (2003)* and *Koijen, Van Hemert, and Van Nieuwerburgh (2009*), who analyzed borrower behavior, considering both economic and psychological variables. These theories emphasize how personal factors such as income, wealth, and risk tolerance, along with market dynamics related to interest rates, significantly influence the decision between a fixed-rate and a variable-rate mortgage. Using the two theories, the aim of this thesis is to analyze how Italian households have faced the mortgage decision-making process in a context of historically low interest rates. The analysis will be based on an econometric study of the microeconomic factors influencing the choice between fixed-rate and variable-rate mortgages, using a sample from a bank operating in the Italian market in the 2010-2024 period.

Following a brief introduction to the relevant economic theories, the first chapter will detail the mathematical models used for the analysis, with reference to the work of *Campbell and Cocco (2003)* and *Koijen, Van Hemert, and Van Nieuwerburgh (2009)*. Key concepts from each model will be explored, explaining how they apply to the choice between fixed-rate and variable-rate mortgages.

The second chapter will examine the Italian economic context during the 2010-2024 period, analyzing trends in household income, property values, and debt levels, providing a comprehensive overview of the macroeconomic conditions that influenced the mortgage market in Italy.

The third chapter will focus on the econometric analysis, based on data collected from a sample of mortgages provided by an Italian bank. This chapter will describe the characteristics of the sample, and the statistical methodology used to investigate the microeconomic factors that affect the choice between fixed-rate and variable-rate mortgages.

In the fourth chapter, data on financial literacy in Italy will be analyzed and compared to international standards. Italy tends to rank lower in financial education, which can influence important decisions such as mortgage selection. Additionally, cognitive biases that commonly affect financial decision-making will be briefly discussed, as they can further complicate the choice between different mortgage types.

Finally, the fifth chapter will present a comprehensive conclusion that considers all the factors discussed in the previous chapters. This will allow for a clearer understanding of the conditions under which it is more advantageous to choose one type of mortgage over another.

# *Chapter 1 – The Mortgage Choice*

In the first chapter, the theories of *Campbell&Cocco (2003*) as well as *Koijen, Van Hemert, and Van Nieuwerburgh (2009*), or KHN, are presented. This chapter will begin with a brief overview of the respective theories, followed by an in-depth analysis of the mathematical models and their practical applications, leading to the results and final conclusions. These parts will be organized into subchapters, each titled according to the major themes that form the structure of both papers. The two theories, while distinct, are complementary and together offer valuable insights that contribute to addressing the central question:

“Why choose an ARM, when interest rates are the lowest in history?”

## *1.1 - Presenting of the Papers*

The Purpose of the first subchapter resides in the introduction of the two theories, trying to analyze common points and highlighting differences, giving the basis for the upcoming developments.

### *1.1.1 Campbell and Cocco 2003*

***“Our goal is to discover the characteristics of a household that should lead it to prefer one form of mortgage over another. “***

Focusing on the American population during the 1980s and 1990s, *Campbell&Cocco 2003* sought to identify the main factors influencing households in areas such as consumption, welfare, and housing. Their analysis was conducted through what they called the "Consumer Life Model," a dynamic framework that tracks how these variables evolve over the course of a mortgage contract. Unlike a static framework, which looks at the buyer's situation at a fixed point, such as when the contract is signed, this approach offers a broader view of financial decisions over time.

The model captures the various stages households go through in managing their mortgage. It begins with the initial down payment, followed by the decision to opt for either a Fixed-Rate or Adjustable-Rate Mortgage based on the household's financial position. As time goes on, households may use tools like prepayment or refinancing to adapt their mortgage terms to changing economic conditions. The contract ultimately concludes either through default, if payments are not met, or when the mortgage is fully paid off. Some of the most important variables subject of the study are: labor income, refinancing moving probability, interest rates and borrowing constraints.

- *Labor Income*

Starting from labor income, it is important to underline that this is “non tradable” and cannot be "capitalized" i.e. it is not possible to turn it into a financial product that can be bought or sold. This point is especially important because households that rely on labor income often deal with uncertainty regarding how steady that income will be in the long run. Factors like job security, economic shifts, or personal challenges can influence earnings, making it harder to predict future income with confidence. Unlike assets that can be sold or converted into cash, labor income cannot be easily transformed into a tradable or investable asset. This limitation exposes households to greater financial risk, especially if their income declines or becomes unstable, making it a critical factor in determining their ability to meet mortgage payments.

- *Moving probability*

During House Purchasing, the buyer must consider even non-economic aspects , such as his *Moving Probability.* This is the possibility or not for the family, or single buyer, to move from one property to another, in a determined amount of time. If the homeowner is willing to stay for a long period of time, this probability is near to zero, while if he thinks to move in a short period of time, like 2 to 5 years, this factor significantly improves.
This is important in a view of minimizing costs, because if the household knows that he is going to move in a few years, it is logical to think that his choice will be more linked to minimize short term costs, thus choosing the contract that is subject to lower interest rates in the first period. The authors suggest that : “ *If a household knows it is highly likely to move in the near future, [...], the most appropriate mortgage is more likely to be the one with the lowest current interest rate. Unconditionally, this is the ARM [...]*” *(Campbell&Cocco 2003).* This is true most of the time, but always has to be contextualized.

- *Borrowing Constraints*

Mortgagors must face another pressure, represented by *Borrowing Constraints*.
A borrowing constraint refers to the limitations or restrictions placed on the amount of credit that individuals or entities can access from lenders. These constraints are often imposed due to factors such as low or unstable income, a poor credit history, frequent missed payments, or high personal debt levels, all of which make lenders uncertain about the borrower’s ability to manage repayments without facing financial difficulties.
Lenders can use many useful financial tools to understand if the investment will be worth it. For example, the level of debt by itself can be useless if not related to something else, this is why it is calculated through the debt-to-income ratio, which measures how much debt an individual has relative to their income, assessing the borrower's capacity to handle additional debt in the future. In practical scenarios like mortgage selection for a household, these constraints can greatly impact the ability to finance a home purchase and dictate choices between different mortgage types.

- *The Contracts*

After talking about household-related variables, now the focus moves on the pros and cons of the two contracts, starting from *FRM's and ARM's sensitivity to inflation.* Fixed-rate mortgages are characterized by income stability i.e. certainty of the nominal number of payments over time. This trait can be considered as a "double-edged sword", since, if on one side it enables the buyer to predict the exact nominal amount he will pay in the future, on the other it presents as a risk. *"A nominal FRM, without a prepayment option, is an extremely risky contract because its real capital value is highly sensitive to inflation" (Campbell&Cocco 2003).*In the context of nominal FRMs, two important features can help increase the flexibility for borrowers: the prepayment option and refinancing. While they might seem similar, they serve different purposes.

The first is the *prepayment option*, found in the quote from the paper, which allows the borrower to pay off part or all the mortgage early, before the scheduled due dates. This can be useful if the borrower has extra funds or wants to reduce the total interest paid over the life of the loan. It gives the borrower the flexibility to get rid of the debt faster, especially in times of favorable personal financial conditions, like receiving a large sum of money or higher income.

*Refinancing*[1], on the other hand, involves replacing the existing mortgage with a new one, usually to take advantage of better terms, like lower interest rates. This is helpful when macroeconomic conditions improve, such as when interest rates drop, allowing the borrower to reduce their monthly payments or the total cost of the loan. Unlike the prepayment option, refinancing creates a completely new loan agreement with potentially different terms. It is important to underline that this option has a financial cost that must be accounted for during the change of the contract and most importantly Refinancing is possible only if the value of the home, minus the initial down payment, becomes higher than the remaining balance of the mortgage. Both features are important for different reasons: the prepayment option gives flexibility in managing personal cash flow and interest costs, while refinancing allows borrowers to respond to changes in the broader economic environment. Together, they provide borrowers with the tools to manage the risks associated with inflation and interest rate fluctuations, making a nominal FRM more adaptable to changing circumstances.

*"An ARM, on the other hand, is a safe contract in the sense that its real capital value is almost unaffected by inflation" (Campbell&Cocco 2003).* This is because the interest paid on adjustable-rate mortgages is not fixed but adjusts with ongoing inflation. This adjustment ensures that the gap between nominal and real debt values, which is a concern with FRMs, is effectively minimized, with any discrepancies only occurring over very short periods. The problem with ARMs lies in the *income risk* due to the short-term variability in real monthly payments. These payments can increase significantly if inflation and nominal interest rates rise, which can be challenging if prices haven't adjusted accordingly. This is what happened

[1] Appendix B gives mathematical relevance to the advantages and the value of refinancing

between July 2022 and June 2023, where in just one-year interest rates increased from 0,5% to 4%, hitting hard on ARM owners. Such variability could be manageable if homeowners had the flexibility to borrow against future income, i.e. the possibility to obtain loans by using their anticipated future earnings as collateral. However, for those facing tight borrowing constraints, this leads to severe financial stress. To manage these risks, ARM borrowers also have access to the prepayment option and refinancing, although these tools work slightly differently compared to FRMs. The prepayment option allows borrowers to pay off part or all their mortgage early. This can be helpful if they expect interest rates to rise further or if they have improved financial conditions. By paying off the loan early, borrowers can avoid the risk of higher payments in the future. About Refinancing in ARMs, the paper mentions the possibility of for this to happen, converting the contract into a Fixed-Rate Mortgage, when conditions make it advantageous, such as rising interest rates. However, it does not include detailed calculations or modeling of this refinancing option in the same way it does for FRMs.

### *1.1.2 KHN*

***"We study how the term structure of interest rates relates to mortgage choice at both household and aggregate levels.*** *A simple utility framework [...] points to the long-term bond risk premium [...] as a theoretical determinant of mortgage choice: when the bond risk premium is high, fixed-rate mortgage payments are high, making adjustable-rate mortgages more attractive." (Koijen, Van Hemert, and Van Nieuwerburgh,2009*)

From the abstract of the Paper, it's immediately clear the primary aim of the study: to identify a straightforward yet reliable way for households to choose the best mortgage contract for their needs at any given time. This is explored through a simple utility framework, focusing on the long-term bond risk premium. The bond premium becomes especially relevant when the expectations hypothesis of the term structure fails, a situation that has been well supported by empirical evidence. The authors begin the discussion with a simple but important question: "*What makes the bond risk premium a palatable determinant of observed household mortgage choice?*" *(Koijen, Van Hemert, and Van Nieuwerburgh,2009*). It is clear how FRM and ARM payments work, but ARMs are more complex because future payments depend on short-term interest rates, which are unknown at the start of the contract. How, then, can they be predicted?

- *The Rule*

The paper explains that most households lack advanced financial tools to accurately forecast short-term interest rates. Instead, they often look to recent history, averaging past short-term rates to estimate what they might pay in the future. While this makes decision-making easier, it may not fully reflect potential rate changes. To help households make this choice, the model proposes a simple but reliable metric: calculating the difference between the current long-term interest rate and the average of recent short-term rates. This decision rule, referred to as $\kappa_t$ in the paper, guides households in selecting between an FRM and an

ARM. The application of this rule can be spread both to aggregate and loan-level data. In both cases authors' calculations reveal an important correlation between the outcomes of the model and the share of adjustable-rate mortgages of the period. Studying aggregate data, correlation touches the value of 81%, working well either using Treasury interest rates or mortgage interest rates. Looking at loan level data, the study analyzes a significant dataset comprising more than 650 thousand loans issued between 1994 and 2007 in the Results indicate that the household decision rule alone, correctly classifies 69.4% of the loans over the sample chosen, outperforming other widely used financial indicators like loan balance at origination (BAL), credit score of the borrower (FICO) and loan-to-value ratio (LTV), even combined.

- *Bond risk Premium against Yield Spread*

The text emphasizes the key differences between the bond risk premium and the yield spread.

1. The *yield spread* is the difference between the yields of long-term bonds (such as 10-year bonds) and short-term bonds (such as 2-year bonds). This measure is often used as an economic indicator to assess the shape of the term structure of interest rates or to compare the credit risk of bonds with different credit qualities, such as corporate versus government bonds.
2. In contrast, the *bond risk premium* represents the additional return that investors demand for holding long-term bonds compared to rolling over short-term risk-free investments, such as Treasury bills. This premium accounts for the risks associated with holding long-term bonds, including interest rate fluctuations, inflation risks, and overall market uncertainty. Investors require this extra yield to compensate for the greater exposure to these risks over time.

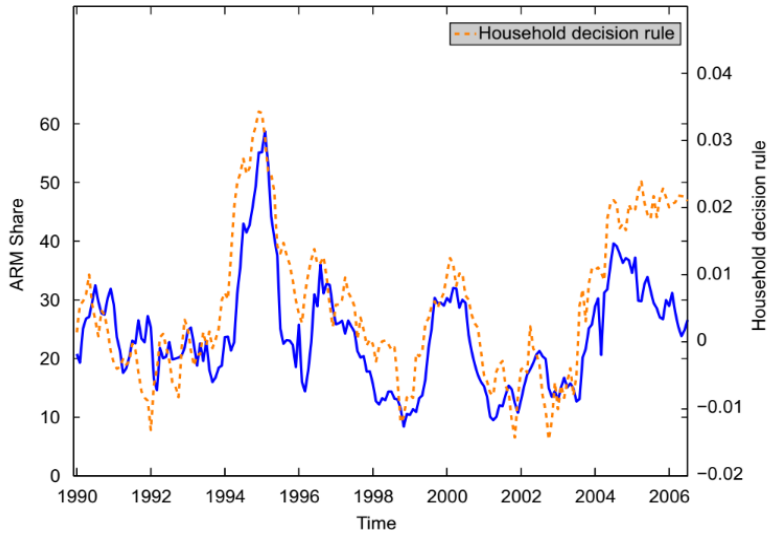


*FIGURE 1*

*This graph represents the relationship between the household decision rule (HDR) and the ARM share in the us between 1990 and 2006, computed by the authors. On the right there is the value representing the oscillations of the HDR applied on the 5y T-bills with a 3y span, represented by the dotted line. The solid line is the ARM share. (original graph from Koijen, Van Hemert, and Van Nieuwerburgh (2009))*

The study's findings underscore the importance of the bond risk premium in mortgage decision-making. While the household decision rule, based on this premium, showed a strong 81% correlation with the share of adjustable-rate mortgages , the yield spread between five-year and one-year bonds performed poorly as a predictor, with a correlation of -6%. This highlights the much lower predictive power of the yield spread when compared to the bond risk premium

## *1.2 - Building the Mathematical Models*

Mathematical models are fundamental tools in economics, serving as the pillars of theoretical frameworks. The following subchapters will explore two such models, focusing on balancing technical details with contextual explanations.

### *1.2.1. Campbell and Cocco 2003*

- *Households Utility Function*

Campbell and Cocco begin their model by focusing on the household, aiming to maximize its utility. To achieve this, several key variables must be determined. Starting with the buyers, each is represented by index *j*, and purchases a house of size *Hj*, financed over a period of *T* years. The model assumes that households do not alter the size of their homes in response to changes in income and that the utility they gain from housing remains unchanged. As a result, housing is not considered part of the household's utility function. Also, the rental market is excluded.

In each period t (from *1 to T*) the household's decision-making only depends on the consumption of real goods other than housing, $C_{jt}$, and the utility from real wealth $W_{j,T+1}$, which represents the "*remaining lifetime utility*" at age *T+1* with wealth $W_{j,T+1}$. In simpler terms, the formula consists of two parts: the sum of consumption choices made during the mortgage period and the utility remaining after the mortgage expires.

The objective function formula is so composed:

$$\boldsymbol{max}\, \boldsymbol{E_0}\ \sum_{t=0}^{T} \boldsymbol{\beta^t} \frac{\boldsymbol{C_{jt}^{(1-\gamma)}}}{\boldsymbol{(1-\gamma)}} + \boldsymbol{\beta^{T+1}} \frac{\boldsymbol{W_{j,T+1}^{(1-\gamma)}}}{\boldsymbol{(1-\gamma)}} \qquad (1.1)$$

Other than *Cjt* and $W_{j,T+1}$, two key variables are *β* and *γ*.

*β* represents the *time discount factor*, measuring how much a household values future utility versus present utility, reflecting their preference for consumption now or in the future

1. A value of $\beta$=1 means that the household values present and future utility equally, showing no preference between consuming now versus later.
2. If $\beta$<1 the household prefers present consumption over future consumption. In economic literature $\beta$'s value generally fluctuates between 0.96 and 0.99, indicating a general slightly preference in present consumption.

*γ,* is the coefficient of relative risk aversion:

1. If *γ>1*, the household is highly risk-averse, preferring to incur a more stable consumption path, saving more to protect against future uncertainties.
2. If *γ<1* the household tolerates fluctuations in consumption, gaining more satisfaction from increased consumption and being less worried about potential losses. Looking at *Marginal Utility* of Consumption**:**

$$\frac{\partial U(C_{jt})}{\partial C_{jt}} = C_{jt}^{-\gamma} \qquad (1.2)$$

This expression shows how the utility function changes with consumption. The right side of the equation highlights how *γ* affects utility. When *γ* increases, the household places less value on additional consumption, causing the marginal utility from consuming more to decrease faster. This makes the households more conservative, preferring to smooth consumption over time rather than spend too much in any single period, as they worry more about future uncertainties and risk

To understand how objective function works, it is important to see where households derive their utility and how. To do so is important to identify *Temporary utility*, and *Long term utility*.

- *Temporary utility* is linked to the level of consumption $C_{jt}$: higher consumption during the mortgage period increases this utility.
- *Long term utility*, linked to final wealth $W_{j,T+1}$, is the utility that the household gains from the remaining savings at the end of the mortgage.

This means that if a household consumes all its liquidity in each period, it will maximize temporary utility at the expense of savings, thus final wealth. In a situation where households face borrowing constraints, consumption tends to be tightly linked to their current income. The formula illustrates that to optimize utility, families must carefully balance their immediate consumption with the need to save for the future. This decision-making process requires them to consider not only potential income fluctuations but also external factors that could further affect their financial stability in the long run. Among these, inflation plays a significant role in shaping consumption patterns. To mitigate its impact, the model reduces short-term uncertainty by assuming that the expected inflation for the next period is known.

- *FRM's Mortgage payment stream*

To truly understand how fixed and adjustable-rate mortgages work, it's essential to examine how their payment streams are structured. Starting from FRMs, at date 1, the household finances the purchase of a house of size Hj with a nominal loan amounting to:

$$(\mathbf{1}-\boldsymbol{\lambda})*\boldsymbol{P}_{\boldsymbol{j1}}^{\boldsymbol{H}}*\boldsymbol{H}_{\boldsymbol{j}} \qquad (1.3)$$

- $\lambda$, is the initial down payment percentage,
- $P_{j1}^{H}$, is the nominal price per square meter at date 1,
- $H_j$, is the size of the house in square meters.

This part of the formula represents the numerator, and states that the loan amount is determined by multiplying the price per square meter by the house size, then subtracting the down payment (equal to the 20% of the total value).

The denominator includes:

- $\boldsymbol{Y}^{f}_{\boldsymbol{T}1}$, which is the interest rate at the mortgage's origination. The higher this interest rate, the greater the burden on the household.
- $\boldsymbol{P}_t$, the nominal price per square meter at time t, which explains why fixed-rate mortgages can be risky in terms of real value. As the authors point out, "*Since nominal mortgage payments are fixed at mortgage initiation, real payments are inversely proportional to the price level Pt*" (*Campbell&Cocco* 2003). In practical terms, economic fluctuations, market trends, and inflation can influence this variable, affecting the real value of mortgage payments. If $\boldsymbol{P}_t$ falls, real payments may exceed nominal ones, making the loan costlier than what is economically justified.

These two factors are the primary risks that prepayment and refinancing options help mitigate, as they offer flexibility to adapt to changing economic conditions and ensure that households do not end up paying more than necessary.

The mortgage is structured with a maturity of T, meaning it should be fully paid off by period $\boldsymbol{T}$+1. Combining all these variables, the real fixed-rate mortgage payment, $\boldsymbol{M}_{jt}^{F}$, is determined:

$$\boldsymbol{M}_{\boldsymbol{jt}}^{\boldsymbol{F}}=\frac{(\mathbf{1}-\boldsymbol{\lambda})*\boldsymbol{P}_{\boldsymbol{j1}}^{\boldsymbol{H}}*\boldsymbol{H}_{\boldsymbol{j}}}{\boldsymbol{P}_{\boldsymbol{t}}\sum_{\boldsymbol{j}=\mathbf{1}}^{\boldsymbol{T}}(\mathbf{1}+\boldsymbol{Y}_{\boldsymbol{T1}}^{\boldsymbol{F}})^{-j}} \qquad (1.4)$$

- *ARM's Mortgage payment stream*

Passing to ARMs, the real mortgage payment $M_{jt}^{A}$ *formula* will be*:*

$$M_{jt}^{A} = \frac{Y_{1t}^{A} D_{jt} + \Delta D_{j,t+1}}{P_t} \qquad (1.5)$$

$D_{jt}$ represents the outstanding loan principal at time t, or the remaining amount the borrower owes, excluding future interest. With each payment, this balance gradually decreases. The change in principal, $\Delta D_{j,t+1}$, indicates how much of the loan has been paid off after each payment. A portion of each payment goes toward interest for that period, while the residual reduces the principal. In summary, $D_{jt}$ shows the remaining debt, and $\Delta D_{j,t+1}$ reflects the progress in reducing the loan's principal. Furthermore, the formula shows a direct relationship between the interest rate, $Y_{1t}^{A}$ ,and real payments, highlighting why ARMs are highly sensitive to rate fluctuations and the associated income risk for the borrower. However, the formula clearly illustrates why ARMs avoid the real capital value issue that affects FRMs. Since both the price per square meter at time *t* ($P_t$) and the interest rate tend to rise with inflation, increases in the denominator are usually offset by those in the numerator, maintaining the real capital value. Through an example it is possible to better understand how ARM's real mortgage payment works, assuming:

- $Djt$, decreasing annually by €10,000. Year 1: €190,000 - Year 10: €100,000
- $\Delta Djt$+1, set at €10,000 each year. For simplicity, is assumed equal to the average nominal loan reduction that occurs at date *t* in a FRM, for the same initial loan
- $Y$: Represents the annual interest rate oscillating between 3% and 7%.
- $Pt$: Represents the price level, adjusted to reflect a 5% annual increase in house prices.

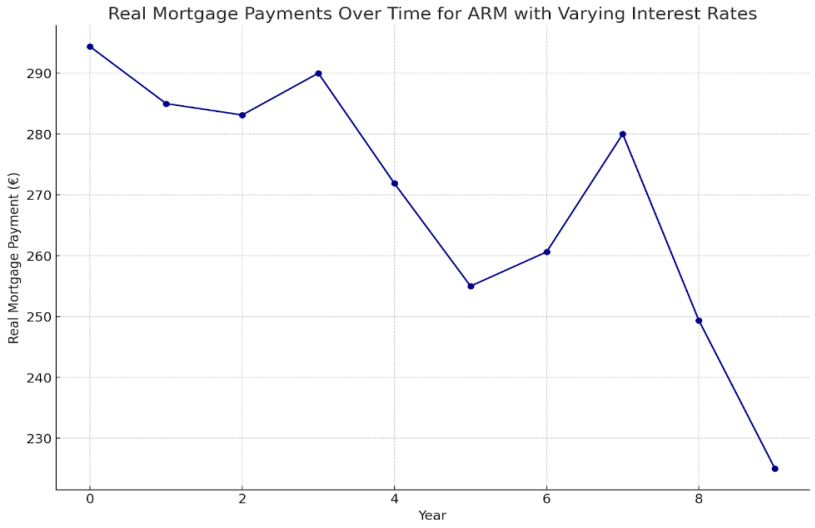


*FIGURE 2*
*Adjustable-rate mortgage's real payment fluctuations*

Plotting of the formula, figure 2 shows how ARMs are particularly sensitive to interest rate fluctuations when it comes to real mortgage payments. Even though the mortgage principal decreases notably at the start of each year, a slight rise in interest rates can cause real payments to increase significantly, underscoring the critical role these variable plays in ARM contracts. This is the main reason why Arm contracts are those with a higher level of loan Default.

- *Lender's Point of View*

Households can choose to default at any time, allowing the bank to seize the property and pushing the household into the rental market. From the bank's perspective, its profit hinges on whether the household defaults. In the event of default, the bank loses the remaining principal despite gaining ownership of the property. If the household continues with the ARM, the bank benefits from the interest premium on the outstanding loan. In contrast, with FRMs, if a household refinances, the bank stops receiving interest but recovers the remaining principal.

### *1.2.2. KHN*

- *Households Utility*

This section outlines an economic model that studies how households make decisions regarding mortgage types in the context of their income, housing values, and attitudes toward risk. Each household is located on a unit interval indexed by j, with a unique risk aversion coefficient $\gamma j$, distributed according to a cumulative distribution function F($\gamma$).

At period 0, households purchase a house financed entirely by a mortgage, assuming a loan-to-value ratio of 100%, meaning the balance loan "$B$" equals the initial house value called $H^s0$. The mortgage has a two-period term: households make interest payments at the end of each period and repay the principal by selling the house at the end of the second period for $H^s2$. The interest rates is named $qi$, where i∈{ARM,FRM}.

Since households are borrowing constrained, their consumption ($Ct$) in each period depends on their disposable income after making mortgage payments. The model assumes that households aim to maximize their expected utility from real consumption, adjusted for inflation. This is expressed as $Ct/\boldsymbol{\Pi}$t, where $\boldsymbol{\Pi}$t represents the price index, with $\boldsymbol{\Pi}0$ set to 1. The utility function follows constant relative risk aversion, consistent with the framework established by the risk aversion coefficient $\gamma j$.

- *Mortgage payment streams*

Starting from ARM, the rate for a given period $t$, denoted by $q^{\text{ARM}}$, results in approximately aligning the one-period nominal short rate derived from the term structure:

$$\boldsymbol{q_t^{ARM} = P_t^{\$}(1)^{-1} - 1 \cong y_t^{\$}(1)} \qquad (1.6)$$

But how does this relationship come about[2]?

In financial markets, bond prices and yields are inversely related. For a one-period bond, denoted as $P_t^{\$(1)}$, the yield is calculated by comparing the bond's price to its face value. For instance, if a bond with a face value of 1€ is priced at 0.95€, the yield can be determined using the formula: $Yield = (1 - 0.95)/(0.95) \approx 0.0526$ or 5.26%. This means that purchasing the bond at 0.95€ will generate an effective return of about 5.26%, as the investor receives 1€ at maturity, earning a 0.05€ profit over the initial investment. This same principle applies to adjustable-rate mortgages, where the interest rate often mirrors the yield on a one-period bond, reflecting short-term interest rates. As a result, ARMs adjust based on market conditions, tracking short-term rates, which are influenced by factors like economic trends, central bank policies, and other financial indicators.

For fixed-rate mortgages, the interest rate is usually based on the two-period nominal bond rate, ensuring that the rate remains fixed throughout the mortgage term:

$$\boldsymbol{q_0^{FRM} = \frac{1 - P_0^{\$}(2)}{P_0^{\$}(1) + P_0^{\$}(2)} \cong \frac{2y_0^{\$}(2)}{2 - y_0^{\$}(1) - 2y_0^{\$}(2)} \cong y_0^{\$}(2)} \qquad \textit{(1.7)}$$

This rate is calculated by comparing expected bond prices over the next two periods with the current price, helping determine whether it's more beneficial to secure the mortgage now or later. Since bond prices can be translated into yields, the FRM rate typically aligns closely with the two-year bond yield. This approach provides borrowers with payment stability by reflecting medium-term market trends.

From the lender's viewpoint, linking the FRM rate to two-year bond yields is an effective way to manage risk. It ensures that the offered rates are competitive with market conditions while protecting against future interest rate changes that could impact returns. This strategy helps attract reliable borrowers while maintaining profitability through sustainable and competitive mortgage rates

Once mortgage rates are set, households need a way to assess which option is more beneficial. The authors tackle this by comparing the payments of both types of contracts and considering the risks involved. The comparison is split into two parts. On the left side, the focus is on the difference in expected payments, represented as $q_0^{FRM} - q_0^{ARM}$. Households tend to favor ARMs when the expected payments for an FRM are higher. However, the result must also exceed the value on the right side of the equation, which accounts for the risks tied to each contract.

These risks are linked to the volatility of payments for both ARMs and FRMs. ARM payments are typically influenced by income fluctuations, while FRM payments are more closely connected to changes in real capital value. Additionally, the household's specific risk

[2] Appendix A. provides further explanations related to the mechanisms behind the working of the model

tolerance, represented by the risk aversion coefficient $\gamma j$, plays a significant role in the decision. Thus, for an ARM to be the better choice, it's not just about having lower payments, it must also present less risk compared to the FRM, providing stronger guarantees for the household.

The simplified mathematical formulation is as follows:

$$\mathbf{2}\boldsymbol{q}_{\mathbf{0}}^{\boldsymbol{FRM}} - \boldsymbol{q}_{\mathbf{0}}^{\boldsymbol{ARM}} - \boldsymbol{E}_{\mathbf{0}}(\, \boldsymbol{q}_{\mathbf{1}}^{\boldsymbol{ARM}}) \cong \mathbf{2}\boldsymbol{y}_{\mathbf{0}}^{\$}(\mathbf{2}) - \boldsymbol{y}_{\mathbf{0}}^{\$}(\mathbf{1}) - \boldsymbol{E}_{\mathbf{0}}\left[\boldsymbol{y}_{\mathbf{0}}^{\$}(\mathbf{1})\right] = \mathbf{2}\boldsymbol{\phi}_{\mathbf{0}}^{\$}(\mathbf{2}) \qquad (1.8)$$

- $q_o^{FRM}$, which represents the fixed mortgage payment for one period,
- $q_o^{ARM}$ indicating the pricing of the rate for a given period $t$,
- $t$ represents the rate pricing for a specific period,
- $y_0$ refers to the term interest rate,
- $E[y_0(1)]$ is the expected value of the term interest rate in one period,
- and $\phi_0^{\$}(2)$ represents the two-period bond risk premium.

This formula brings to the paper's key finding: "*the difference between the expected mortgage payments on the FRM and ARM contracts approximately equals the two-period bond risk premium* $\phi^s(2)$*" (Koijen, Van Hemert, and Van Nieuwerburgh 2009*)

Recalling that the bond risk premium reflects the extra return investors require for taking on additional risk on investing in a long-term bond instead of a short-term risk-free investment, such as Treasury bills, the formulation shows that as this variable increases, ARMs become more attractive. This is because the term structure of interest rates, which reflects expectations for future rates, directly affects both mortgage types. FRMs function much like bonds, offering fixed payments over time. When uncertainty in the market is high and the bond risk premium rises, FRM rates become more costly. Consequently, as FRM rates rise compared to ARM rates, which adjust according to short-term rates, households are more inclined to choose ARMs, as they offer a cheaper alternative to locking in a higher long-term FRM rate.

- *How to find the Bond risk premium*

To apply the formula *(1.8),* the bond risk premium has to be determined. This is where the *Household decision rule* proves most effective. Unlike more complex models, this approach requires only a few simple inputs:

- $y_t^{\$}(\tau)$, The long-term interest rate (e.g., the 5-year Treasury yield), which reflects the cost of long-term borrowing.
- $y_{t-u}^{\$}(1)$ The average of short-term interest rates (e.g., the 1-year Treasury yield) calculated over a certain period (usually 3 or 5 years). This value provides insight into the household's expectations for future short-term rates

- $\rho$,The number of months or years considered when calculating the moving average of short-term rates (e.g., 36 months for a 3-year average).

$$\boldsymbol{\phi_0^{\$}(\tau) \cong y_t^{\$}(\tau) - \frac{1}{\tau}\sum_{j=1}^{\tau}\left\{\frac{1}{\rho}\sum_{u=0}^{\rho-1} y_{t-u}^{\$}(1)\right\} =}$$
$$\boldsymbol{y_t^{\$}(\tau) - \frac{1}{\rho}\sum_{j=1}^{\rho-1} y_{t-u}^{\$}(1) \equiv k_t(\rho;\tau)} \qquad (1.9)$$

With this simple approach, households can easily calculate a useful proxy for the bond risk premium, denoted as $k_t(\rho;\tau)$. This indicator assists in determining whether a FRM or an ARM would be the best choice.

The rule is straightforward:

- When $k_t(\rho;\tau)$ is high, it indicates that long-term rates are significantly higher than recent short-term rates, making ARMs more attractive due to their lower expected payments.
- When $k_t(\rho;\tau)$ is low, FRMs become more favorable as the premium for locking in long-term rates is smaller.

The simplicity of this model enables households, even without extensive financial expertise, to make informed mortgage decisions based on basic interest rate data. This approach effectively captures the time-varying nature of bond risk premiums, offering a practical tool for households to "time" their mortgage choices without relying on complex forecasting models.

## 1.3 - Conclusions

This is the last subsection of the first chapter. Here the conclusions of the authors of both the theories are presented.

### 1.3.1. Campbell & Cocco 2003

In conclusion, *Campbell and Cocco (2003)* provide valuable insights into how households make mortgage decisions through their "Consumer Life Model," which explains how financial situations evolve over the life of a mortgage. A key point in the study is the uncertainty of labor income, which introduces financial risk when repaying a mortgage. Other factors, such as house prices, risk aversion, inflation, and a household's tolerance for risk, also influence whether they choose an adjustable-rate mortgage, especially if they don’t plan to stay in their home for a long time.

The paper compares the wealth risk associated with fixed-rate mortgages to the income risk of adjustable-rate mortgages outlining the conditions under which each is more advantageous. Prepayment and refinancing options in FRMs offer flexibility to manage financial risks, while ARMs are more sensitive to inflation and come with fluctuating payments, which can be riskier for households with unstable incomes.

Campbell and Cocco also highlight the differences in mortgage choices between singles and couples, emphasizing that income levels play a crucial role in both mortgage selection and broader financial planning. They further explore how income risk and wealth risk are interconnected and shape borrowing decisions.

Finally, they acknowledge the limitations of their model, noting that it doesn't account for factors like changes in household size, income volatility, or specific mortgage features such as teaser rates. They suggest further research to explore these aspects and how mortgage markets differ internationally.

### *1.3.2. KHN*

The KHN paper examines how the bond risk premium influences household mortgage choices, particularly between fixed-rate mortgages and adjustable-rate mortgages. When the bond risk premium is high, ARMs become more attractive due to their lower expected payments, while FRMs become more expensive.

A key finding of the study is the introduction of a simple decision-making rule that compares long-term and short-term interest rates. This rule explains 70% of the variation in the share of ARMs in the market and accurately predicts 70% of individual household mortgage choices. It even outperforms traditional financial indicators like loan balance, credit score, and loan-to-value ratio, suggesting that households can make good decisions without relying on complex tools.

The study also shows that other measures, such as the yield spread, are less effective at predicting mortgage choices compared to the bond risk premium. Additionally, while prepayment options in FRMs provide flexibility, their value decreases as the bond risk premium rises, making it less necessary to lock in lower rates.

In conclusion, KHN's research connects mortgage decisions to interest rate structures, especially the bond risk premium. This offers households a practical tool for making informed mortgage choices and provides policymakers with insights into how economic conditions shape mortgage preferences and encourage rational financial decisions.

# *Chapter 2 – The Italian Scenario '06-'24*

The 2008 financial crisis profoundly affected the global economy, severely impacting the real estate sector and leading to a significant drop in property prices. In certain moments, this downturn enabled buyers to acquire homes at 30% of their pre-crisis values. However, the fluctuating income levels during this period directly influenced borrowers' capacity to afford new homes, thereby affecting the overall demand for mortgages. In response to these challenges, robust interventions were necessary. Governments and financial institutions such as the European Central Bank played a very important role, with the latter lowering interest rates, a crucial move to revitalize the mortgage market and the former implementing laws that would kickstart the real estate market.

To gain a deeper understanding of how Italians navigated through this tumultuous period, this chapter examines data coming from:

- The surveys conducted by the Bank of Italy (BOI), Known as the "*Survey on Household Income and Wealth*" (*SHIW*),
- ISTAT's and EUROSTAT's databases, which are respectively the Italian and the European statistic centers,
- Other relevant components of the real estate sector such as real estate agencies and consulting firms

## *2.1 - Income Trends Analysis: 2010 - 2024*

***Overview***

From 2010 to 2020, the trend in Italian household incomes was characterized by a prolonged period of recovery from the deep impacts of the global financial crisis, followed by modest improvements in the mid-2010s, and new economic challenges towards the end of the decade exacerbated by the COVID-19 pandemic. The decade highlighted the vulnerability of Italian households to global economic shifts and internal challenges, with a recovery that was uneven and susceptible to setbacks from external shocks.

- *2010-2013: Post-Financial Crisis Recovery Efforts*

The period following 2008 was defined by high unemployment and austerity measures across Europe, which stifled economic growth and reduced consumer spending. Financial insecurity, along with strict fiscal policies, made the recovery of household incomes slow and difficult.

Data on equivalent income, which adjusts for family size, show clear disparities among different demographic groups. While individuals with higher education, executives, and entrepreneurs generally enjoyed higher incomes, blue-collar workers, residents of the south,

and foreign-born individuals had lower earnings. This highlights significant income inequality, worsened by economic hardship and uneven recovery rates across sectors and regions. Interestingly, retirees were an exception. While most groups saw income stagnation or decline, retirees' incomes remained stable and even grew, likely due to steady pension payments during the economic turbulence that affected other sources of earnings. Overall, the early 2010s were characterized by ongoing recovery efforts, but also persistent economic disparities. This period underscored the need for targeted economic policies to address the vulnerabilities of the most affected groups and to promote sustainable growth.

- *2014 - 2016: Positive Signs in a still difficult context*

By 2014, Italy was witnessing a significant improvement in household incomes, a trend primarily fueled by a revitalized labor market. The number of earners and their wages started rising, reflecting a broader economic recovery that was taking shape across the Eurozone. This recovery was supported by a relaxation of the austerity measures previously imposed during the financial crisis. However, despite these positive shifts, the real average household income in 2016 remained approximately 15% below the 2006 levels. This gap highlights the profound and lasting impacts of the financial crisis, illustrating how deep the economic problems went and how gradual the recovery has been.

The trend in equivalent income showed a milder decline than in previous years. This change was partly driven by an increase in the average size of family units, a phenomenon not seen since the early eighties. Despite these improvements, a significant portion of the population still struggled with low income, defined as earnings below 60 percent of the median income. Interestingly, while the rate of low-income individuals increased among the middle-aged, it decreased among the elderly, who seemed to benefit from more stable income sources during these turbulent times. When it comes to wealth, inequality remains stark. By the end of 2014, the average net wealth of Italian families was around 218,000 euros, but the distribution was highly uneven. The poorest 30% of families had almost no wealth, while the richest 5% owned over 30% of the total wealth, mostly tied to their homes. From 2012 to 2014, total family wealth dropped by 11%, hitting wealthier households the hardest due to falling property prices. Interestingly, families with less wealth saw a slight improvement, as their financial burdens eased and fewer were in debt, reflecting a cautious sense of financial optimism among lower-income families.

Anyway, financial vulnerability, measured by how much loan repayments weigh on income, showed signs of easing. By 2014, fewer families were categorized as financially vulnerable compared to 2012, pointing towards a slight improvement in financial health for indebted families. This trend underscores the complex interplay of economic recovery, where improved labor market conditions and changes in debt structures have begun to alleviate some of the financial strains experienced by Italian households.

- *2016-2020: Continued Economic Adjustments and New Challenges*

From 2016 to 2020, Italy's economy continued to show signs of gradual recovery, driven by improvements in employment and wage growth. This period brought stabilization, although the long-term impacts of the previous decade's economic struggles were still felt.

In 2016, the number of families without income earners decreased but remained higher than in 2006. Similarly, families with multiple income earners declined, reflecting broader demographic changes. Despite these challenges, the average equivalent income rose to around 18,600 euros in 2016, a 3.5% increase compared to two years earlier. Financial resilience also shifted, with more families able to save, but many low-income households still needing to use savings or take on debt. By 2017, fewer families reported struggling to make ends meet, especially those with incomes below the median. Optimism about future income was also on the rise, with many households expecting gains above inflation. However, income growth wasn't experienced equally. Younger and older households saw the biggest improvements, while middle-aged families continued to face income declines. By 2020, even though average income had increased by 3.7% since 2016, it was still about 8% below the peak levels of 2006. Wealth inequality also grew, with the Gini index showing increasing disparities in family wealth. In 2019, new challenges emerged, including political instability and a global economic slowdown, which began to undermine Italy's fragile recovery. These issues hit different regions and sectors unevenly. The situation worsened in 2020 with the onset of the COVID-19 pandemic. As one of the hardest-hit countries, Italy faced severe economic disruptions. Lockdowns, reduced consumer and industrial activity, and rising unemployment took a toll on household incomes, potentially worsening inequalities and reversing some of the recovery gains from earlier years. This backdrop shows that while there was progress, Italy's road to full economic recovery remains uncertain, with ongoing challenges and vulnerabilities.

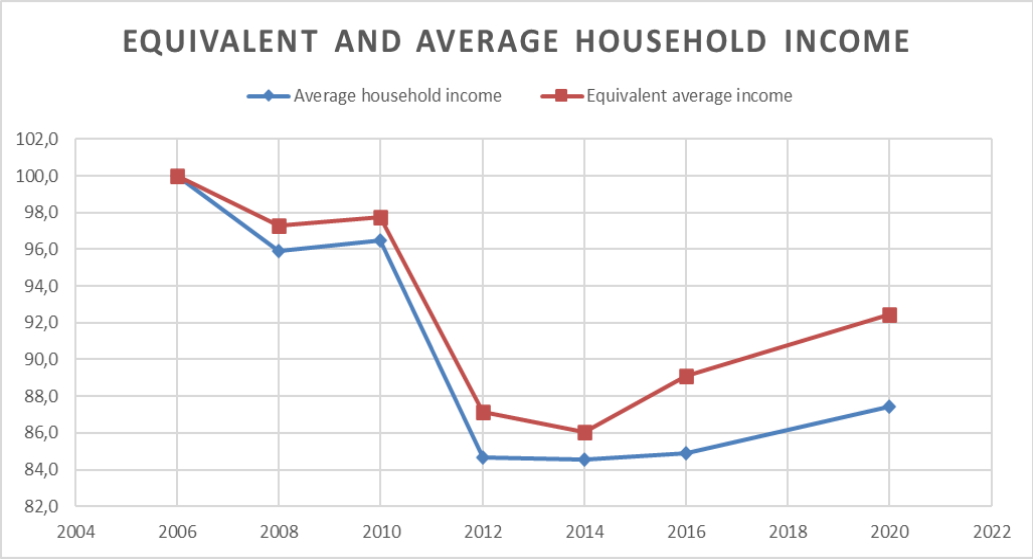


*Figure 3*
*Equivalent and average household income in Italy in the period: '06 - '20.*
*Source: "Survey on Household Income and Wealth, 2022"*

"Equivalent income" is usually higher than average income because it adjusts for family size and composition, giving a more accurate picture of economic well-being per person. It considers economies of scale, where larger families can share resources, lowering the cost per individual.

- *2021- 2024: From Post Pandemic to Nowadays*

Following the significant economic disruptions caused by the pandemic, including reduced industrial activity, and increased unemployment, the Italian government introduced financial help and debt mitigation to reduce these effects. While average household income saw a slight increase by the end of 2020, income inequality persisted, with lower-income households bearing the brunt of the economic downturn.

In 2021, the foundation for economic recovery was laid. Employment rates improved, and more households reported financial stability. However, inflation started to rise, mainly due to major events like the war in Ukraine and the Gaza conflict, which began to erode purchasing power. Despite wage increases, the rising prices affected disposable incomes. To face the sharp inflation, which hit 11.8% in Italy by November 2022, the European Central Bank quickly raised interest rates. The Euribor, which was -0.567% in 2021, jumped to 4% by 2023, making the cost of living higher and changing household spending and saving habits. Still, income growth continued through 2022 and 2023, with household disposable income increasing, allowing more families to save. But lower-income families continued to struggle, often having to dip into savings or take on debt to cover their costs

In 2023, the Italian economy showed signs of stabilization, with a 4.7% increase in gross disposable income. However, purchasing power decreased slightly due to persistent inflation (ISTAT). The economic environment remained fragile, influenced by global economic trends and internal political stability. Despite these challenges, fewer households reported financial difficulties by early 2024, where there are signs of improved financial resilience.

## *2.2 - Debt Levels of Italian Households: 2010-2024*

Debt level is a major indicator that reflects a household's ability to afford significant expenses. The stronger an individual's economic position, the better they can manage debt. However, a country with high average debt levels doesn't necessarily mean its population is more financially vulnerable. High debt could simply reflect the inability to pay it off, with debts accumulating over time. This makes debt levels complex to interpret, requiring careful analysis to truly understand the state of the economy. Over the decade, Italian households experienced fluctuations in this sense, influenced by economic conditions, lending practices, and housing market dynamics. Part of the personal debt is composed of mortgage debt, which will be the focus of this subchapter.

- *2010-2012: The Immediate Throwbacks of the Financial Crisis*

In the years following the global financial crisis, the Italian real estate sector faced a significant downturn, with marked declines in house prices and a surplus of unsold properties. This period of economic uncertainty led to reduced buying activity and reflected broader economic stagnation. The combination of the previously described job losses and reduced consumer spending further depressed the market, intensifying the challenges in the housing sector.

As the economic crisis progressed, the level of debt among Italian households, particularly mortgage debt, started to decrease. By 2012, the percentage of indebted families was 26.1%, which represents a decrease of nearly 4% points from the data collected in 2008. This contraction marked a reversal of a trend that had seen debt levels consistently rising over the previous decade. A closer examination reveals that when debts associated with professional or business activities were excluded from the calculations, the percentage of families with debt dropped, meaning that personal and consumer debts, including mortgages, were significant contributors to the overall debt figures, underscoring their importance in the financial strategies of households.

Despite a decrease in the percentage of indebted families, the average debt per household rose to €51,175, indicating that many families continued to rely on borrowing even during the economic crisis. Specifically, the number of families taking out loans for property purchases or renovations increased, partly due to government incentives for energy-efficient upgrades and home improvements. These incentives encouraged younger and larger families to invest in property, despite ongoing economic challenges. The families benefiting most from these housing incentives were typically those securing the largest mortgage amounts. Mortgages were more common among larger households, especially those headed by individuals aged 35 to 54, who were employed and had higher education levels. In contrast, mortgage debt was less prevalent among low-income families, single-member households, and those living in Southern Italy, highlighting the importance of income stability and collateral in securing credit. This pattern shows that families with higher incomes and better creditworthiness had easier access to mortgage loans.

Consumer credit use also declined, with fewer families relying on it compared to previous years. However, it remained relatively common among larger families and those with modest incomes, who used it to manage everyday expenses. Informal credit, such as loans from family and friends, became a crucial support for families struggling to access formal financial institutions. This was particularly true in Southern Italy and among households with foreign-born heads, who faced greater economic difficulties.

Italy’s participation in the credit market, particularly in mortgage lending, remained lower than in other major industrialized countries. This lower rate reflects a more cautious approach to borrowing and a preference for safer financial practices.

- *2014-2016: Signs of Recovery and Evolving Household Debt*

Between 2014 and 2016, as the economy started to recover, consumer confidence slightly improved, leading to a modest increase in mortgage uptake. However, overall household debt growth remained low due to ongoing economic uncertainty and strict bank lending rules. People were borrowing cautiously, reflecting the fragile economic environment.

By the end of 2014, the percentage of indebted households in Italy fell to 23%, continuing a downward trend that had begun in 2010. The average debt per household also decreased, showing that many families were managing their finances more conservatively. While mortgage debt remained a major part of household liabilities, the number of families with mortgage loans slightly declined—from 12.2% in 2012 to 10.9% in 2014. This decrease happened despite government incentives aimed at encouraging property investments through tax benefits for renovations and energy efficiency. Many families were still hesitant to take on new debt given the uncertain economy. The distribution of mortgages followed familiar patterns. Younger families and those with higher incomes were more likely to have mortgages because they had better access to credit and could provide stronger guarantees. Mortgages were more common among households with heads aged 35 to 54, those with multiple members, and those with higher education and stable employment. On the other hand, mortgages were less frequent among low-income families, single-member households, and those living in Southern Italy.

The debt burden, defined as how much households paid annually in loan repayments, including interest, slightly decreased during this time. In 2014, the average indebted family paid 5,600 euros per year, or about 17.3% of their income, down from 5,800 euros and 18.9% in 2012. However, this burden was much heavier for lower-income families. For those earning below the median income, debt payments took up 30% of their income, highlighting how debt still weighed more heavily on less affluent households.

Despite this, financial vulnerability—where debt becomes overwhelming—affected fewer households than in previous years. This shows that while the economic strain remained for some, especially lower-income families, overall financial management had improved.

- *2016-2020: Economic Shifts, Mortgage Trends, and the Impact of COVID-19*

Between 2016 and 2020, Italy experienced notable shifts in household debt, particularly in mortgage borrowing. Historically low interest rates made it easier for families to secure mortgages for home purchases and renovations, which led to a moderate rise in borrowing as consumer confidence slowly recovered from earlier economic challenges. Despite these favorable lending conditions, overall household debt growth remained cautious. Many families were still hesitant to take on new debt, held back by ongoing economic uncertainties and stricter lending regulations from banks.

Mortgages remained a significant component of household debt, driven by a persistent demand for housing. Younger families and those with higher incomes were more likely to

secure mortgage loans, benefiting from their better creditworthiness and ability to provide necessary guarantees. Government incentives, such as tax benefits for renovations and energy efficiency improvements, also played a crucial role in encouraging mortgage borrowing, even in a cautious economic climate. The onset of the COVID-19 pandemic in 2020 brought unprecedented challenges to the mortgage landscape. In response, the Italian government and financial institutions implemented mortgage deferrals and assistance programs to help homeowners manage their financial obligations. These measures were crucial in preventing a surge in defaults and stabilizing the housing market during the crisis.

Throughout this period, financial vulnerability remained a critical issue, particularly for lower-income families. The burden of mortgage repayments was disproportionately high for these households, underscoring ongoing economic disparities. Wealthier families managed their mortgage obligations with relative ease, while lower-income households faced significant financial strain, often dedicating a large portion of their income to debt service.

The period from 2016 to 2020 built on the gradual recovery seen in the preceding years. Following the post-crisis downturn from 2010 to 2012, Italy's real estate market began to show signs of stabilization and recovery. The economic environment improved, with Northern regions leading the recovery due to their stronger industrial bases and employment rates. Meanwhile, Southern regions continued to struggle with higher unemployment and slower economic growth.

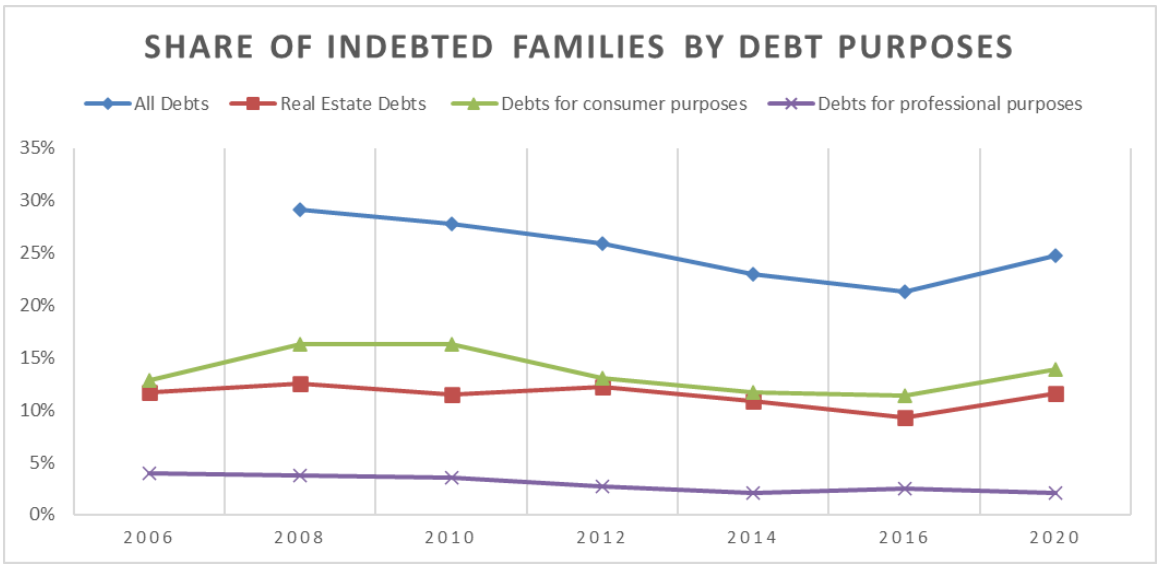


*Figure 4*

*Trends in Italian family debt from 2006 to 2020, divided by type of debt. The graph categorizes the data into real estate debts, debts for consumer purposes, and debts for professional purposes, along with a cumulative total labeled as 'all debts'.*

*Source: "Survey on Household Income and Wealth, 2022"*

The previous graph summarizes the overall situation. It compares different types of debt, including real estate debt, and debt for consumer and professional purposes. The total debt shows a decline from 2008 to 2016, followed by a modest recovery between 2016 and 2020, though it remained significantly below pre-2008 levels.

- *2021- 2024: From Post Pandemic to Nowadays*

Between 2021 and 2024, Italian household debt, especially mortgage debt, showed notable trends shaped by the aftereffects of the COVID-19 pandemic, changing economic conditions, and policy measures. After the pandemic, household debt saw a cautious recovery. Government programs like mortgage deferrals and homeowner support helped stabilize the situation. As the economy improved, consumer confidence grew slightly, leading to a modest rise in mortgage borrowing. However, overall debt growth remained limited due to ongoing economic uncertainties and stricter bank lending rules.

During this time, mortgage debt continued to make up a large part of household liabilities. Younger families and higher-income earners were more likely to secure mortgages, benefiting from better credit ratings and the ability to provide necessary guarantees. Government tax incentives for home renovations and energy efficiency improvements also encouraged borrowing. By 2022 and 2023, household debt levels showed clearer signs of stabilizing. The ratio of household debt to GDP remained steady, indicating that households were managing debt more effectively as the economy recovered. Low-interest rates supported mortgage borrowing, though many households remained cautious about taking on new debt. The average household debt rose slightly, reflecting ongoing borrowing for home purchases and renovations, with government incentives continuing to support the housing market.

Heading into 2024, Italy experienced stronger economic growth, which further influenced household debt levels. The mortgage market became more active, driven by low-interest rates and a recovering housing sector. Despite this growth, many households maintained a cautious approach, focusing on financial stability rather than accumulating new debt

## *2.3 - Integrated Analysis of Italian House Value Trends: 2010-2024*

The Italian real estate market from 2010 to 2020 experienced significant fluctuations due to a series of economic challenges and policy interventions. The 2007 Bersani reform and the measures taken by the ECB after 2008 achieved the desired effects. The total capital disbursed by banks to mortgage borrowers was quite high between 2008 and 2010, though not at the levels of 2005-2007. The Eurozone crisis of 2011-2012, however, caused a sharp decline in mortgage approvals due to tightened lending criteria. From 2012 to 2014, the mortgage market contracted significantly, with capital disbursed being half that of the previous three-year period. From 2015 to 2019, there was a gradual but significant recovery. Mortgage issuance grew year by year, and by 2019, volumes had returned to the levels seen in 2010-2011. The ECB's policies led to historically low interest rates, which translated into lower mortgage rates in Italy, making borrowing more attractive and accessible to potential homebuyers.

- *Focus on Government Interventions and Policies*

As anticipated, several government interventions played a critical role in shaping the real estate market throughout the decade. The Bersani reform of 2007, for instance, significantly altered the dynamics between banks and mortgage borrowers by allowing mortgage transfers without costs and eliminating penalties for early repayment. These changes increased borrowers' negotiating power and contributed to a more flexible and competitive mortgage market.

To give an overall understanding of the main reforms produced from the Italian state the most important were collected:

1. *Tax Deductions for Home Renovations*: The "Bonus Ristrutturazioni," introduced in its current form around 2012, allowed homeowners to deduct up to 50% of renovation costs, stimulating investment in property improvements and supporting the construction sector.

2. *Eco-bonus for Energy Efficiency:* Introduced in 2007 and expanded significantly in 2013, this incentive provided tax credits for energy-efficient upgrades, including solar panels and better insulation. This measure not only supported environmental goals but also increased property values by making homes more energy efficient.

3. *First-Time Homebuyer Tax Credits*: Implemented around 2014, these credits aimed to reduce the financial burden on new homeowners, making it easier for younger buyers to enter the housing market.

4. *Superbonus 110%*: Introduced in 2020 as part of the COVID-19 economic recovery efforts, this measure offered substantial tax deductions for energy efficiency improvements and seismic upgrades, covering up to 110% of the costs. This initiative aimed to boost the construction industry and improve the quality of Italy's housing stock.

- *2010-2012: Post-Crisis Downturn*

During this period, house prices in Italy experienced a sharp decline, with drops of up to 30% in some areas outside major cities and tourist hotspots. The surplus of unsold properties worsened the situation, creating a buyer's market, though few were willing to purchase due to the uncertain economic climate.

Data from ISTAT, the Italian statistical center, say that 2012 marked a particularly grim period for the Italian real estate market, registering the most significant price contraction of -10.2% within a single year. Transaction volumes declined by 25.8% compared to 2011, driven by a lack of confidence, persistently negative economic conditions, and increased mortgage costs that made access to credit more challenging. Additionally, higher property taxes, especially on second homes, contributed to an increased supply in the market.

- *2014-2016: Signs of Recovery*

As the European and global economies began to stabilize, Italy's real estate market showed signs of a gradual recovery. House prices became more stable, though the rebound varied by region. Northern areas, with stronger industries and higher employment rates, saw property values recover more quickly, with average prices rising by about 5%. In contrast, the southern regions faced slower economic growth and higher unemployment, which kept real estate prices depressed By 2014, the mortgage market began to recover as household credit demand increased. The European Central Bank's (ECB) implementation of Quantitative Easing injected liquidity into financial markets, which, coupled with renewed confidence among businesses and consumers, resulted in an increase in real estate demand. However, this demand was more selective, leading to a rise in transactions, although prices had yet to show significant improvement. By the end of 2016, house values remained generally below the pre-crisis peaks, reflecting the depth and enduring impact of the economic downturn. Nationally, the property price index, a measure tracking changes in residential property values over time, began to show a gradual upward trend.

- *2016-2020: Gradual Improvement and New Challenges*

The latter half of the decade saw steady improvements in the housing market, building on earlier government policies and favorable lending conditions. Low mortgage rates and tax incentives for first-time buyers and home renovations boosted demand. Mortgage rates reached historic lows, with average rates for new loans falling below 2%, making home ownership more affordable for a wider range of people.

These measures aimed not only to make housing more accessible but also to stimulate economic activity in construction and related sectors. However, growth remained limited due to ongoing economic uncertainties and regional disparities. Political instability and shifts in fiscal policy introduced new risks, dampening investor confidence.

By 2019, housing prices were rising steadily, though modestly. Nationally, average house prices increased by 3-4% annually from 2016. Yet, regional disparities remained stark. Major cities like Milan and Rome saw stronger growth, while rural areas and smaller towns experienced minimal or no price increases.

- *Impact of COVID-19 in 2020*

The COVID-19 pandemic in 2020 caused major disruptions in Italy’s real estate market. Activity slowed significantly as health concerns and uncertainty took priority over normal economic behavior. Real estate transactions plummeted by nearly 50% in the early months of the pandemic, reflecting widespread economic anxiety and the logistical difficulties of buying and selling homes during lockdowns. However, as the initial shock of the pandemic eased, the market started to recover by the end of the year. This recovery was fueled by delayed demand and low mortgage rates, which motivated people to buy homes even with the ongoing economic difficulties. Government measures, such as mortgage deferrals and

stimulus packages, were key in stabilizing the market. By the close of 2020, while the market hadn't fully bounced back, the drop in house prices was softened, and there was cautious optimism about a potential recovery.

- *2021- 2024: From Post Pandemic to Nowadays*

As Italy emerged from the immediate effects of the COVID-19 pandemic, the housing market began to recover. A combination of increased demand, favorable lending conditions, and government measures like the Superbonus 110% helped revive the market. House prices rose slightly to €1,775.92 per square meter, and real estate transactions picked up, although they remained below pre-pandemic levels. Low-interest rates made mortgages more accessible, encouraging many buyers to enter the market. In 2022, the recovery continued, with house prices increasing to €1,793.08 per square meter. However, challenges such as rising inflation and increasing interest rates started to affect consumer confidence, causing a slight slowdown in real estate transactions. Despite these hurdles, government incentives helped maintain market activity. By 2023, the housing market stabilized further, with house prices reaching €1,819.83 per square meter. However, rising interest rates and tighter credit conditions led to a decline in new mortgage applications and approvals. Banks became more cautious in lending, which affected overall transaction volumes. In early 2024, cautious behavior from both buyers and lenders persisted, with the housing market continuing to stabilize as prices reached €1,839.00 per square meter. The construction sector faced difficulties due to changes in tax incentives and rising costs, though infrastructure investments from the National Recovery and Resilience Plan (NRRP) offered some support.

One segment of the market that consistently grew throughout this period was luxury real estate. High-net-worth individuals continued to invest in properties, especially in major cities like Milan and Rome, where demand for high-end homes remained strong. The next graphs summarize the overall situation described above.

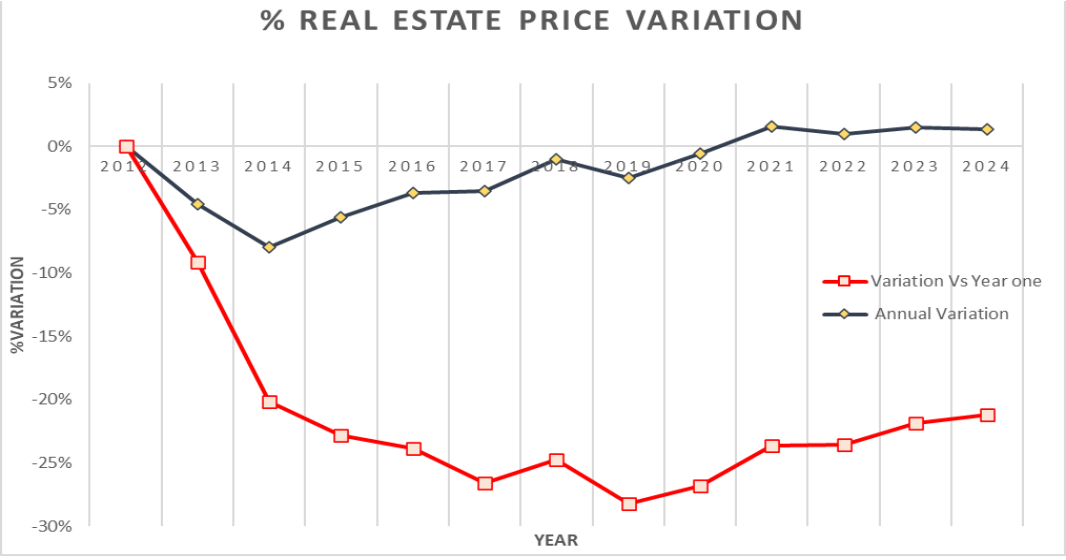


*Figure 5*
*Trends in Italian housing prices: Annual and year-over-year one changes, 2012-2024.*
*Source: Idealista*

The first graph shows two key indicators: the year-on-year percentage change in house prices, represented by blue and yellow dotted lines, and the percentage change in house prices compared to 2012, shown by the red line. These variations are based on changes in the average price per square meter of homes in Italy. The graph highlights a sharp decline in house values starting in 2012, which continued until prices stabilized in 2019. During this period, house prices fell by an average of 4.11% per year. The average price dropped from 2,374 €/m² in 2012 to 1,764 €/m² in 2019, marking a 26% decrease. This decline was particularly significant for Italians, who are among Europe's most active property investors. By 2021, after the pandemic, house prices began to rise again, with a steady annual growth rate of 1.34% projected through 2024. Despite this recovery, prices in 2024 are still 23% lower than in 2012, standing at 1,839 €/m².

The second and final graph illustrates the trends in property sales and purchases from 2011 to 2024 in hundreds of thousands. It is important to note that the data for the last year is provisional, as the latest available figures only cover the first quarter of 2024.The graph clearly shows how the market responded to the economic events described in this section. In 2011, the market was relatively stable. However, it experienced a significant downturn, reaching its lowest point in 2013, a period heavily impacted by the aftershocks of the financial crisis.

Starting in 2014, the number of transactions began to increase, spurred by several factors: low interest rates, government initiatives, rising incomes, and lower house prices. These favorable conditions contributed to a steady growth in property transactions, which continued until 2022.


*Figure 6*
*Annual sales and purchases in the Italian Housing Market (units in hundreds of thousands)*
*Source: Idealista*

However, in 2022, the market dynamics shifted due to a sudden increase in interest rates implemented by the European Central Bank as a measure to combat rising inflation,

exacerbated by the war in Ukraine. This policy change led to a deceleration in the growth of property transactions.

Looking ahead to 2024, the real estate market in Italy is expected to continue experiencing some volatility. The luxury segment is likely to remain robust, supported by international buyers and the appeal of Italy's lifestyle and tax incentives for high-net-worth individuals. However, the broader market may see a slowdown in transaction volumes and price growth due to ongoing economic uncertainties and higher interest rates.

## *2.4 - Real income against House Value: 2006-2024*

This subchapter combines the house value oscillations with the income oscillations of the same years, giving a more accurate view of how these two factors together affect the wealth of the population.

- *The Ratio*

An important insight given from BOI is the "ratio between the average value of a 100 $m^2$ house and the average annual equivalent income" is an economic indicator used to assess housing affordability relative to household incomes, measuring how many years of average equivalent income are needed to purchase a 100-square-meter house. For example, if the average value of a 100$m^2$ house is 300,000€ and the average annual equivalent income is 30,000€ , the ratio would be 10. This means that, on average, a household needs to allocate 10 years of income to buy a house of that size.

This ratio is important because it helps understand how heavy it is for an average household to purchase a home, influencing housing policies and economic decisions at both personal and governmental levels. In this case, it synthesizes the insights from earlier subchapters, providing a concise and clear overview of the real challenges faced by the Italian population regarding housing affordability during the 2006-2020 period. The ratio fluctuates based on the described factors, housing, income, monetary and government policies. Primarily, there are housing market conditions. If property prices rise faster than incomes, the ratio increases. This is often seen during housing booms when demand outpaces supply, leading to higher prices. Conversely, in areas where housing supply meets or exceeds demand, prices tend to stabilize or decrease, potentially lowering the ratio. On the other side there are economic conditions. In periods of growth, incomes generally rise, which can help keep the ratio in check even if housing prices are increasing.

During economic downturns, if incomes stagnate or decrease while housing prices remain high, the ratio will rise, signaling that houses become less affordable.  Interest rates are another critical factor. Lower interest rates typically make borrowing cheaper, which can increase demand for housing and drive-up prices, potentially raising the ratio. Higher interest

rates, however, can reduce demand for mortgages, possibly stabilizing or lowering house prices and the ratio. Government policies, such as tax incentives for homebuyers, subsidies, or restrictions on foreign ownership, can also influence the housing market and, consequently, the ratio. The next graph represents the evolution of the ratio from 2006, before the global financial crisis, to 2020, during Covid Pandemic.

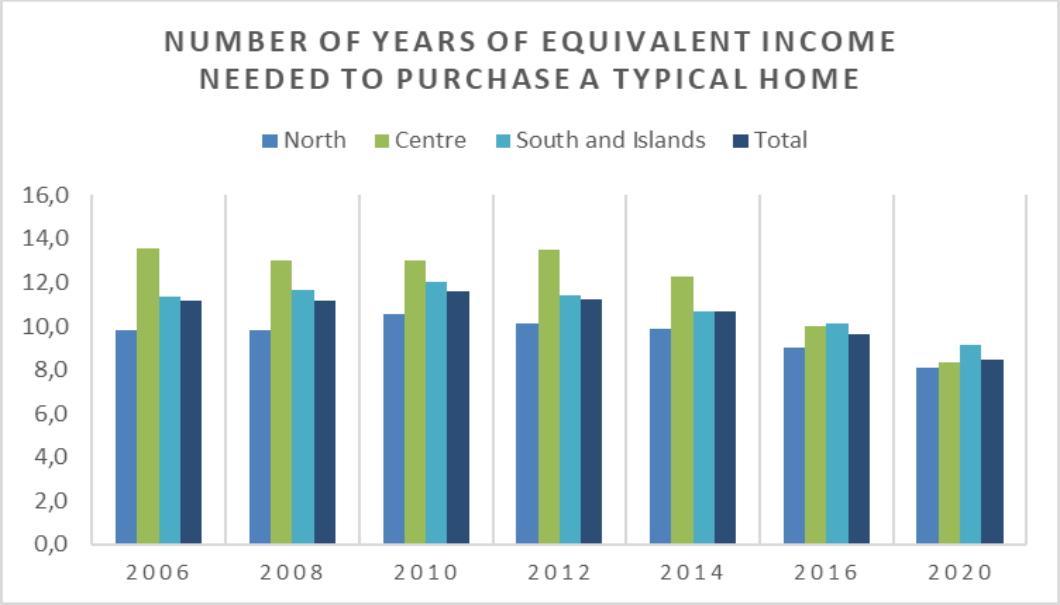


*Figure 7*

*Number of years of equivalent income needed to purchase a 100k€ home. Data are divided by region (South Italy and Islands, Centre, North) and two-time periods - Source: "Survey on Household Income and Wealth, 2022"*

Between 2006 and 2008, Italy witnessed a housing boom fueled by low interest rates and strong demand, which significantly drove up property prices. Despite still high incomes during this period, they were unable to keep pace with the rapid escalation in housing costs, leading to an increase in the affordability ratio. When the global financial crisis struck in 2008, its effects were not immediately fully realized in the housing market, but by 2010, the economic uncertainty and reduced consumer confidence had slowed economic growth, causing incomes to stagnate or decline and exacerbating housing affordability issues. The period between 2010 and 2012 marked the beginning of a correction in the housing market as property values started to stabilize or decline in response to prolonged economic challenges and the European sovereign debt crisis, which prompted austerity measures, higher unemployment, and reduced household incomes. These factors combined to slightly lower housing prices, resulting in an improvement in the affordability ratio as the market adjusted to more sustainable levels.

From 2012 through 2016, the Italian housing market underwent further corrections, with property prices stabilizing or decreasing due to weakened demand. This period also saw economic recovery measures take effect, which, along with government policies like tax incentives for homebuyers and subsidies, contributed to stabilizing household incomes and improving financial stability. This led to an important decrease in the housing affordability ratio. Continuing this trend, from 2016 to 2020, the economy was more stable, and modest growth in household incomes, supported by persistent low interest rates and government

measures, encouraged home buying and helped maintain demand for housing. This stability allowed property prices to grow at a slower rate compared to incomes, leading to a continued decline in the affordability ratio. By 2020, with the economy largely stabilized and incomes rising more consistently, the housing market had adjusted to a more sustainable level. Demographic shifts such as a trend towards renting and slower population growth also reduced pressure on housing prices, culminating in significant improvements in housing affordability relative to incomes.

# Chapter 3 - The Sample

This chapter is dedicated to a comprehensive examination of the sample used. It aims to demonstrate the robustness of the sample by detailing its composition and the methods employed to ensure its representativeness and reliability. Diving into various attributes of the sample, such as its size, demographic diversity, and the data collection process, the goal is to see how these factors contribute to the accuracy of the findings. Additionally, this section will compare the sample characteristics with the results discussed in the previous one, establishing a clear link between the methodology used here and the broader implications for the mortgage market.

## 3.1 - Sample Foundations Analysis

This section is dedicated to demonstrating the robustness of the sample, explaining its composition and establishing the foundational aspects that ensure the reliability and applicability of the subsequent analyses.

- *The robustness*

The sample contains 2534 different mortgages, where data encloses: the age at origination and the gender of the household, if it is an employee or a freelancer, the duration of the contract with relative number of rates, the financed amount, the value of the house, the type of the contract (ARM or FRM), if it is a joint mortgage or not. Data arrived from a bank that mostly works in northern Italy, so, the next graph displays how the distribution of the mortgages is higher in this part of the country, with a prevalence in Lombardy (22%) and Piedmont (20%). The percentage in other regions is smaller but still relevant, fr example in Tuscany (4%) and Apulia (4%).


*Figure 8*
*Sample's regional mortgage distribution*

Other than this bias, it must be considered that data are not the same for each contract. These were collected manually and then entered the dataset, leading contracts to lack certain information due to transcription issues. As a result, depending on the combination of data considered, the amount of information used for a specific study may vary each time. This is why the sample will be often compared and inserted in the context of chapter 2.1 where BOIs' Survey on Household Income and Wealth or "SHIW", to give a broader view of the context, understanding how the sample responds to high level aggregate data.

t's important to note that this bank was founded in the early 2000s to manage funds from an existing insurance company and entered the mortgage market in 2009. As a result, the amount of data for the first two years is limited, as the bank was gradually building its client base.

This said, the sample is strong for many reasons:

*Adequate Sample Size*. It's important to acknowledge that a larger sample typically provides a more accurate estimate of population characteristics, thereby reducing sampling error and enhancing the precision of estimates. In this study, there are 2,534 mortgages linked to 3,154 properties, indicating that a single financing agreement may cover multiple properties. Although data limitations always prevent a comprehensive joint analysis, the smallest sample size studied never falls below 1,364 units. Considering that the Bank of Italy, during its large-scale surveys, utilizes samples ranging from 4,000 to 6,000 units, it is reasonable to assert that the sample size used for this research is sufficiently large.

*Representativeness*. This refers to the extent to which a sample accurately mirrors the characteristics of the population from which it is drawn. A representative sample effectively reflects various attributes of the population, including age, gender, socio-economic status, and other relevant factors. In this research, the sample demographics cover a broad age range, from 18 to 75 years old, encompassing many different social classes, which enhances the representativeness of the study.

*Variability*. Variability is related to the extent to which data points in a dataset deviate from each other and from the mean. High variability indicates that data points are widely dispersed around the mean, while low variability suggests they are more concentrated. Considering the age data, the average age in the sample is approximately 44 years, with significant clusters around ages 33 and 51, and another smaller but important peak at age 25. This distribution confirms a considerable distance from the mean, demonstrating the dataset's high variability.

*Randomness*. A random sample, where every member of the population has the same chance of being selected, tends to be stronger because it reduces selection bias. In the context of this study, the randomness of the sample is considered adequately preserved, reflecting a fair and unfiltered distribution of individuals who have opted for a mortgage. This ensures that, despite the natural self-selection associated with the decision to purchase a home through financing, the sample remains robust and representative of such a segment

of the population. It is important to emphasize that self-selection is an intrinsic characteristic of any study involving individuals who have chosen to take out mortgages, as also demonstrated by the practices of the Bank of Italy. Therefore, this principle is common and does not compromise the uniqueness of our sample. These aspects make the sample robust and comparable to the standards used in similar studies in the mortgage sector. Given these fundamentals, the next sections will be dedicated to a deep dive into the specificities of the sample.

## 3.2 - Composition of the Sample

This is the subchapter dedicated to the detailed analysis of sample's components.

### 3.2.1 Demographics

- *Age*

The age distribution within the sample is broad, ranging from 18 to 71 years. The average age within this group is 44 years, closely accompanied by a median of 43 years. This near alignment suggests a relatively symmetrical distribution of ages, even if the sample is considered multimodal with peaks at ages 51, 33, and 48, among others. Such a distribution indicates multiple prevalent age groups, which could reflect varied life stages and social demographics within the sample. Further insights are obtained from survey data indicating that populations with greater economic capability, those more likely to invest in stable assets such as housing, generally match this age range. Next Graph shows the age distribution of households related to the sample's data.

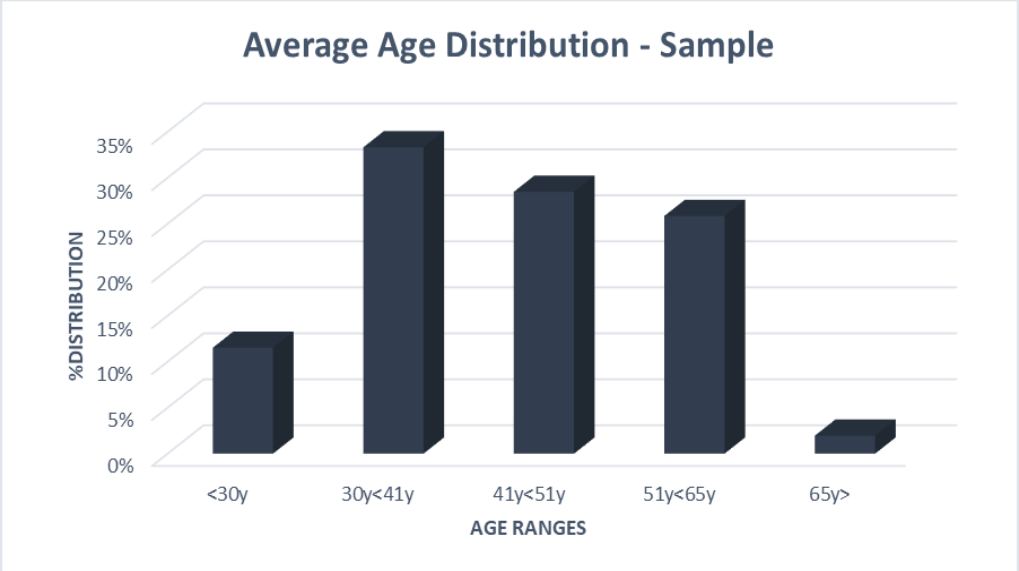


*Figure 9*
*Sample's average age distribution*

Diving deeper into the SHIW data, an even higher average age is observed, corresponding to 56 years, with a median slightly above 56.3 years. This alignment of the average and median ages further reinforces the notion of a symmetric age distribution.

The presence of such a pattern, especially in Italy, supports the hypothesis that higher incomes are often associated with older age groups. This demographic appears to be in a life stage were securing mortgages and making substantial life investments are most pertinent, influenced heavily by both socio-economic status and individual life circumstances. This correlation between age and economic capability highlights a broader socio-economic trend: as individuals age and presumably accumulate wealth, their financial activities, such as purchasing property or investing in long-term assets, become more feasible and frequent. The modal ages within the general and SHIW datasets underscore the specific life moments when such financial decisions are most likely to occur, painting a detailed picture of the economic landscape and its impact on personal life choices and stability. It is then possible to say that the studied sample is 'younger' than the one from BOI's research. The former registers a high prevalence of households aged between 31 and 41 years, while the latter is strongly influenced by the segment over 65 years of age. Next Graph shows the age distribution of households related to SHIW's data.

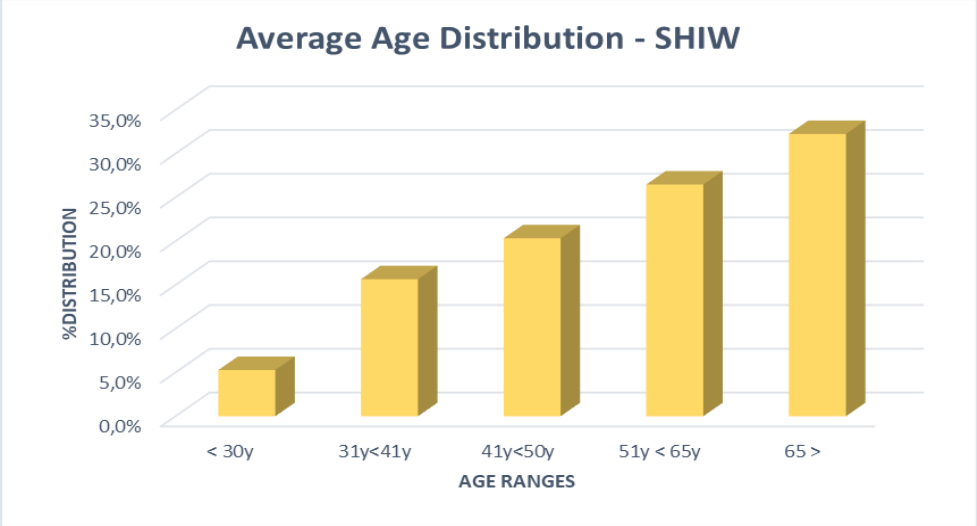


*Figure 10*
*SHIW's average age distribution.*
*Source: "Survey on Household Income and Wealth, 2022"*

- *Gender*

Another important insight into demographics is related to gender distribution. Data about sample's gender are resumed in next figure:

It is readily apparent that the distribution shows a high male component, constituting approximately 65% of the total model. This disparity highlights the still persistent differences between genders which do not allow women to manage the financial demands of mortgage payments as comfortably as men. It is crucial to emphasize that, unlike in the study by Cocco and Campbell, the female component is included in the calculations in this analysis due to its significance within the sample. Notably, from the 1990s, when the authors conducted their research, to the 2010s, where the data for this thesis is sourced, there has been a marked increase in the proportion of female-led households.

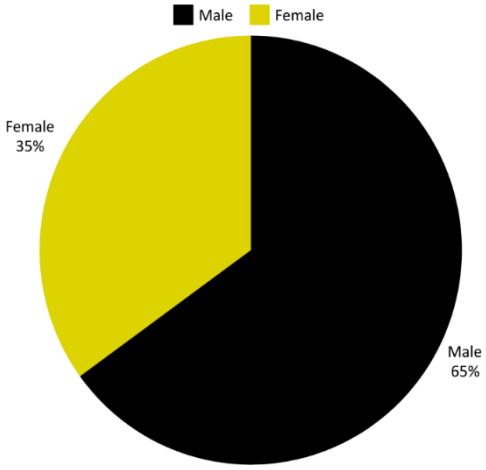


*Figure 11*
*Sample's gender distribution*

Although the original data were gathered in America and the latter in Italy, the trends from these respective periods show similar patterns, underscoring a gradual but steady decline in gender disparities over time. Resembling the definition of "household" as the person that has the highest income in the family, the data of the sample are further validated from the average gender distribution of the households from 2006 to 2020 coming from the SHIW, which allocates 65,37% to males and 34,63% to females.
In the next graph is represented the pattern of gender distribution of households, based on the surveys on the bank of Italy

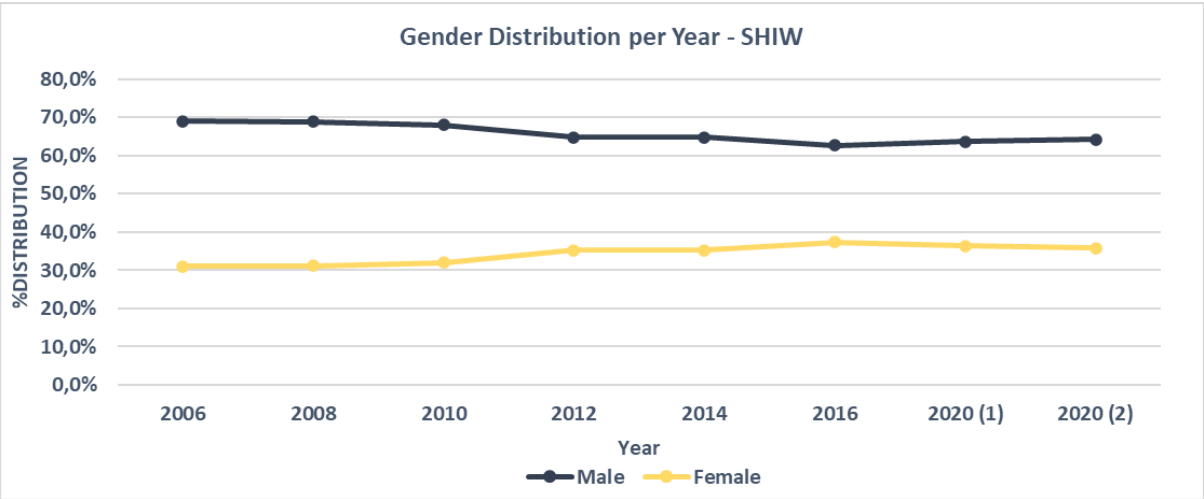


*Figure 10*
*Annual distribution of mortgage originations in Italy by gender*
*Source: "Survey on Household Income and Wealth, 2022"*

### *3.2.2 Income Distribution*

Net income gives important insights into the wealth of a population. In this case the sample gathers a very wide range that spans from people without property to millionaires. Eliminating the few outliers for study purposes, (less than 15 over more than 2500 data), the overall average sample's net income corresponds to 31,887€. This is demonstrated even from the next graph that shows how the highest percentage of the households of the study gain between 10k-20k and 20k-30k. Average income coming from the SHIW is around 30.800€, delineating a slightly poorer specimen, but substantially confirming previous results.

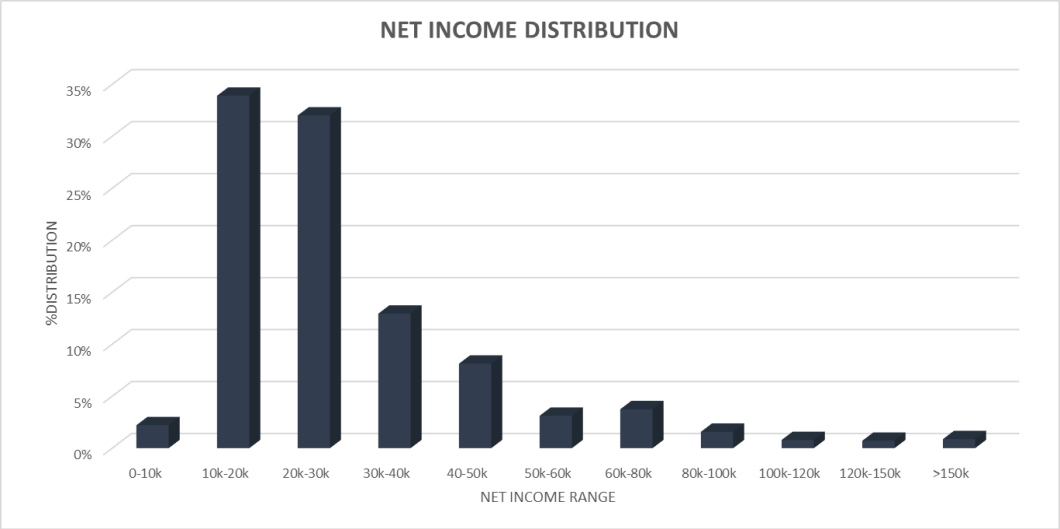


*Figure 11*
*Sample's Net Income Distribution, Grouped in 10k€ Intervals*

- *Age*

Comparing this income distribution with the ages in the sample is crucial, as lower wages generally correspond to younger ages, a pattern already outlined in Chapter 2.1.

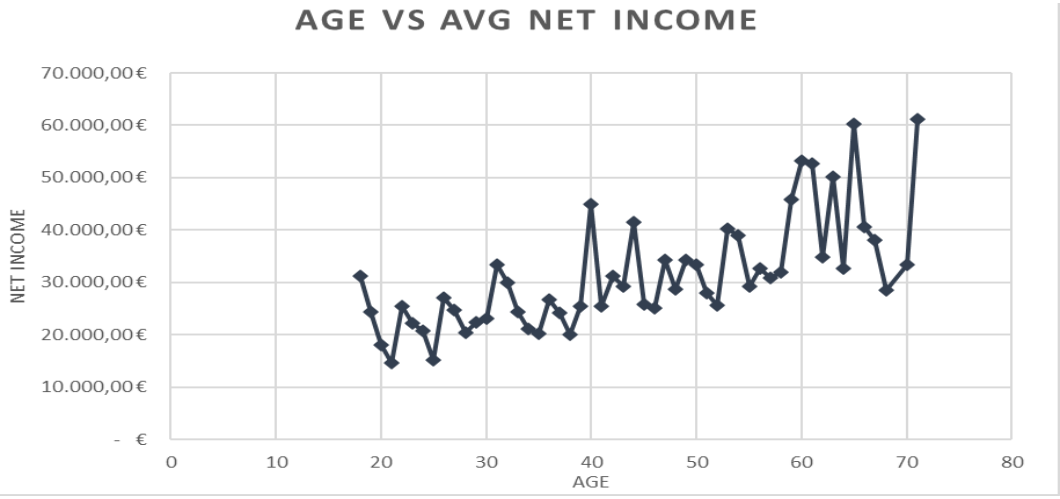


*Figure 12*
*Sample's average net income compared to age distribution*

This correlation underlines observations from the demographics section, where it was noted that the average age at mortgage origination is significantly influenced by monetary capability, which tends to increase with age. These findings reiterate the substantial impact that age has on economic conditions, an aspect thoroughly discussed earlier, reinforcing the interplay between age-related financial growth and economic opportunities.

Next graph shows how this relationship holds in the sample.

- *Gender*

Looking at the gender side, it is curious to notice a slight difference between the different data. While BOI's research fundamentally confirms the important difference in income between male and women, data coming from the local bank demonstrate controversial results.

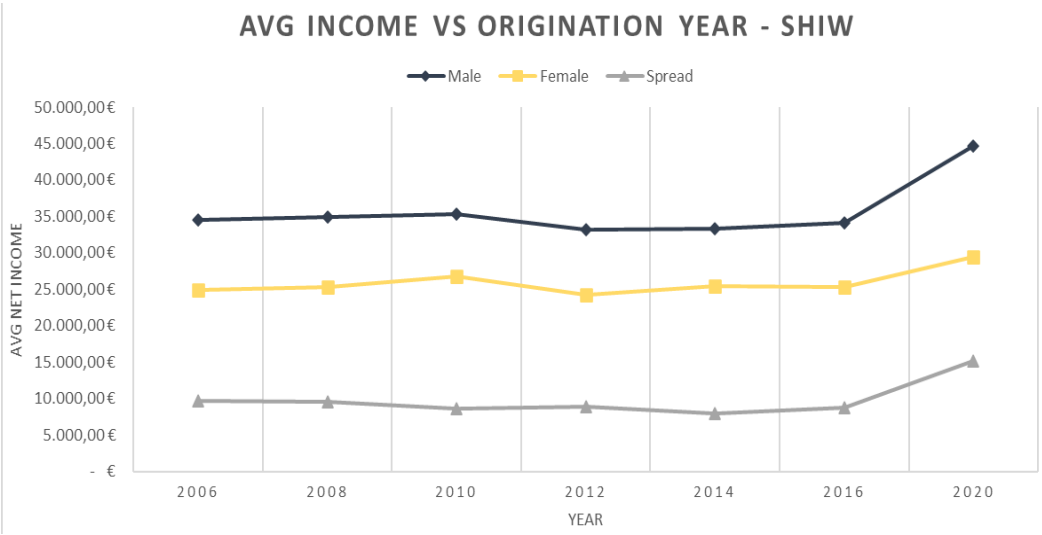


*Figure 13*

*Average Income of borrowers based on gender and year of origination of the mortgage- Source: "Survey on Household Income and Wealth, 2022"*

Starting with the former, the figure 13 shows a consistent path with an average income difference over time, indicated by the gray line. The difference in average male incomes compared to female incomes is around 9,800€.

In contrast, the sample studied in this research shows periods of substantial differences, such as in 2014 when the average difference was around 20,000€, or in 2019 when the income of women originating mortgages was even 4,000€ higher than that of men.

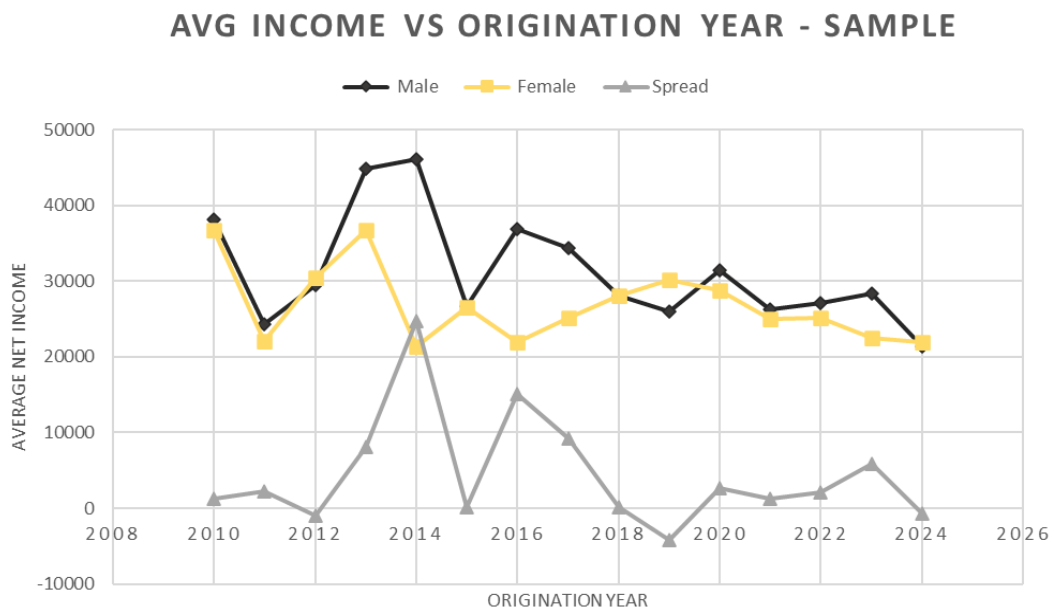


*Figure 16*

*Average Income of borrowers based on gender and year of origination of the mortgage – Sample's data*

Even in this case, the average difference favors males, with a value of around 4,500€. What is curious is that there are still similarities between the two cases. The average income for women is nearly the same, at 27,000€ in the first case and 26,000€ in the second. The real difference is found in the male incomes, which drop from 35,700€ to 31,300€. These data illustrate how the studied sample, excluding outliers, has a less wealthy male component. It is important to consider that the first dataset stops at 2020, while the second extends to 2024.

### *3.2.3 Real Estate Value*

The SHIW lacks comprehensive data related to the values of houses purchased within the specified period. However, the data presented in Section 2.1.3 adequately depict the contextual background. The house values of the bank's sample from this period display significant fluctuations, notably in 2011 and 2009, years characterized by a few outliers. Despite these anomalies, a general declining trend in house values is evident, with the notable exception of the period between 2016 and 2017, which saw a marked increase. This was followed by another decline that continued until 2024

- *Financing*

The average financing provided corresponds to 73% of the total real estate value. This indicates that, throughout the entire period, the bank never fully financed a property purchase but always required households to make an initial payment. Buyers benefit from lower interest costs on the portion they pay upfront, while banks enjoy greater security by receiving a substantial part of the amount immediately. For instance, for a typical 100,000€ apartment, the initial payment required would be €27,000. Therefore, it's essential to consider whether buyers had sufficient financial reserves or familial support to meet this requirement.

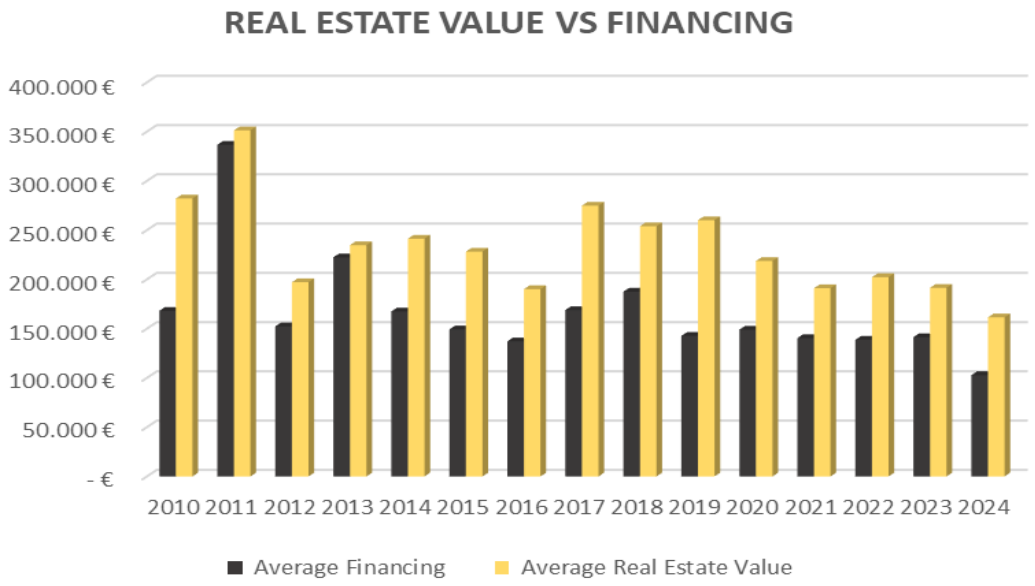


*Figure 17*

*Comparison between Average Real Estate Value and corresponding Average Financing per year – Sample's data*

- *Age*

Analyzing the correlation between a buyer's age and the value of real estate, a clear trend emerges: as age increases, so does the ability to purchase higher-value properties. This is largely due to older buyers typically having more financial stability, savings, and accumulated wealth, as well as longer credit histories that make securing larger loans easier. The data shows that younger buyers, around 20 years old, tend to purchase homes with an average value of €152,000. In contrast, buyers aged 63 can afford properties averaging €450,000, reflecting their greater financial resources and more established creditworthiness over time. Additionally, older buyers may have already built equity in previous homes, allowing them to invest in more expensive properties.

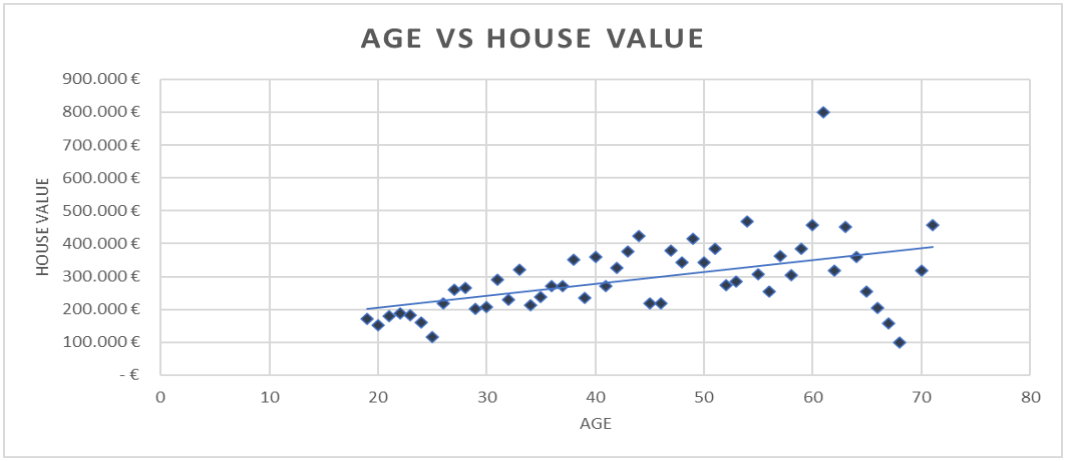


*Figure 18*

*Comparison between borrowers' age and corresponding average Real Estate value – Sample's data*

- *Gender*

On the gender front, data shows differences in real estate purchasing power. Notably, in 2017 and 2019, women, on average, bought higher-value properties compared to men.

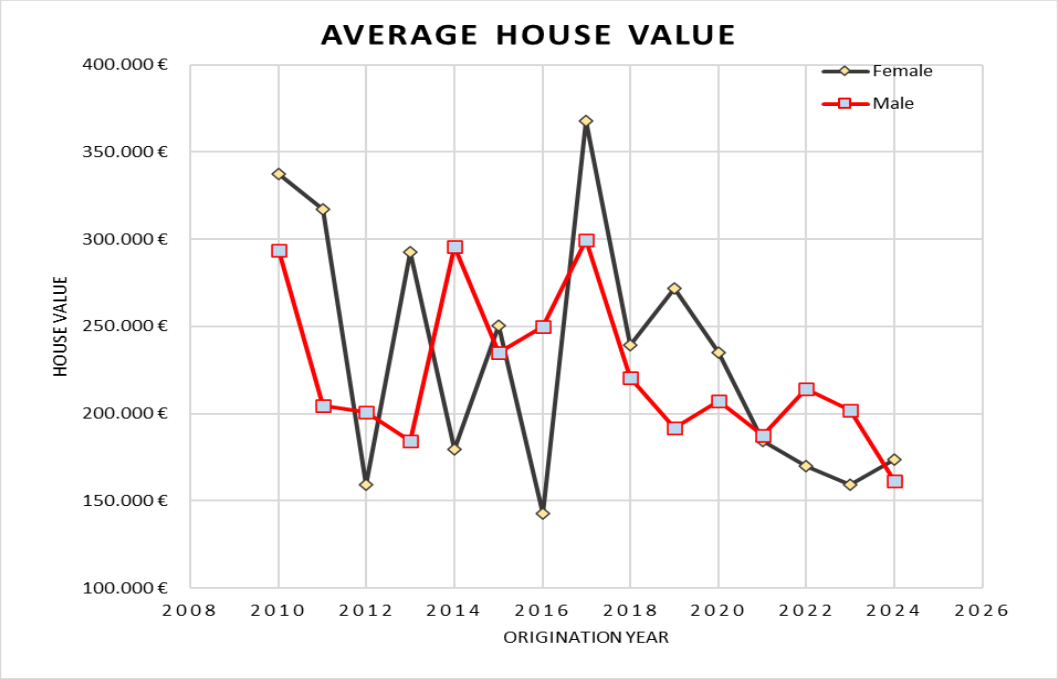


*Figure 19*
*Average House Value of borrowers based on gender and year of origination of the mortgage – Sample's data*

This discrepancy could be explained by several factors:

- *Income Homogeneity*: As seen in the previous section, income differences between women and men were less pronounced in respect to BOI's survey results. This certainly influenced women's ability to invest in more expensive properties.
- *Impact of Outliers*: A small portion of high-value transactions skewed the results, particularly in 2017. Since fewer women were in the sample, these outliers had a greater effect on the average property value for female buyers.

### *3.2.4 Mortgage Interest Rates and Distribution*

- *Interest Rates*

One important insight from the sample is the average interest rates at which the bank issued mortgages from 2012 to May 2024. However, data for the years 2009, 2010, and 2011 is missing.

Data indicates that the average spread of ARMs over 5y EURIBOR is 1.68%. Analysis of the trends in interest rates, depicted in figure 20, reveals that ARMs, represented by the red line, typically exhibit rates slightly lower than those of FRMs, except during 2013 and from 2022 to 2024. Several factors contribute to this phenomenon, often related to future market expectations and periods of uncertainty. For instance, the recent cuts in interest rates by the ECB, with further reductions

anticipated before the end of 2024, enhance the appeal of ARMs justifying their current higher pricing.

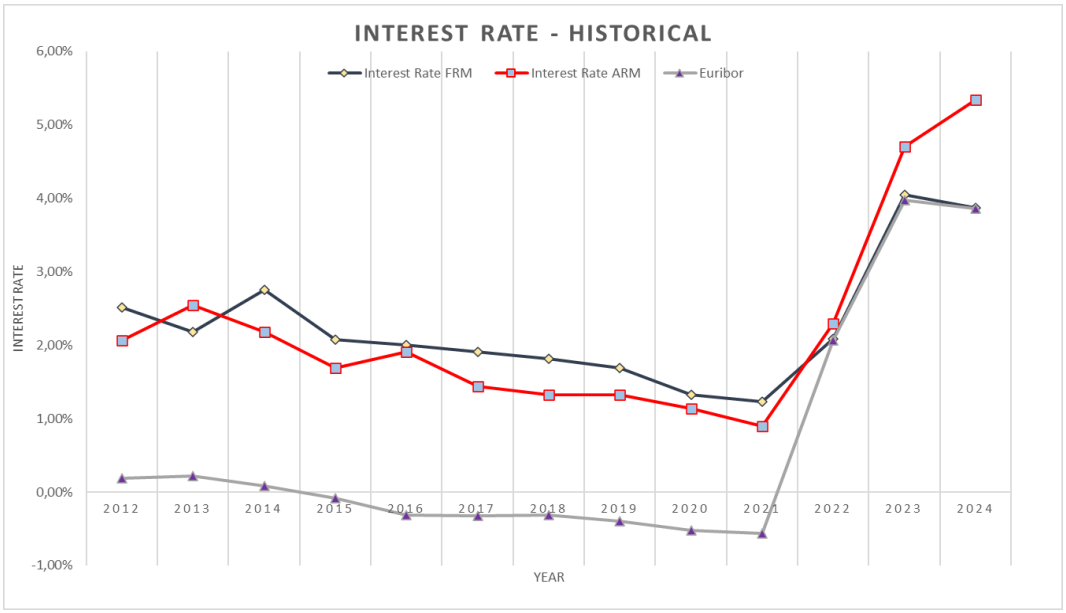


*Figure 20*

*Fixed and Variable mortgage interest rates compared with 5y EURIBOR, '12 – '24 – Sample's data*

*Source: "European Central Bank Database"*

- *Distribution*

The aim of this study is to understand the mortgage choice of Italians in the 2010-2022 period, which, as described, was characterized by the lowest interest rates in finance history. The next graph gives an anticipation of the next section, in which results will be studied.

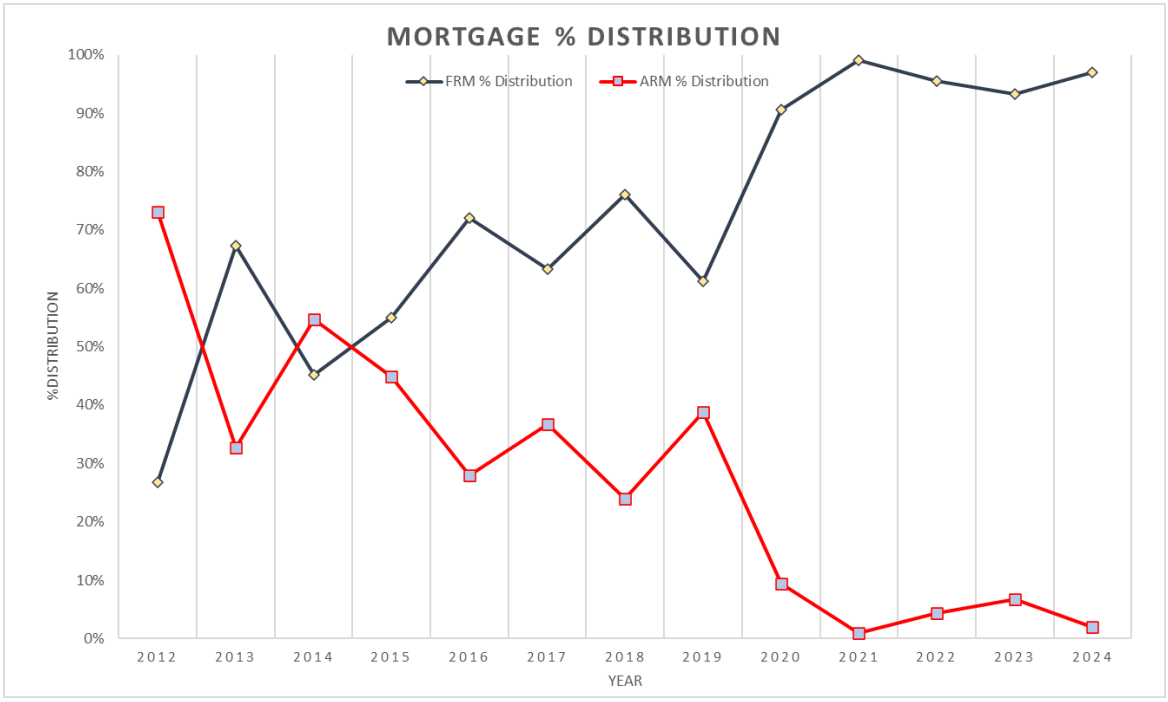


*Figure 21*

*Sample's Mortgage distribution divided per year, '12 – '24*

Indeed, the trend shows how ARMs were mostly chosen in 2012, and started decreasing, reaching the lowest levels in 2021, while FRMs had the exact opposite trend, reaching their peak in 2024. The duration at origination of the 2 types of contracts is similar, accounting for 20 years for the first one and 21 for the second one.

## 3.3 - Statistical significance models

### 3.3.1 F-Test & Welch's T-Test

The Welch's t-test is useful here because it allows for comparing the means of two groups, like borrowers who choose FRMs versus those who pick ARMs. For instance, an independent t-test can compare the average net income of borrowers with fixed-rate versus variable-rate mortgages to see if income impacts the decision. The t-test can also be used to explore differences in other factors, like mortgage duration or the financed amount, offering insights into how these financial characteristics vary between the two mortgage types.

On the other hand, the F-test is essential when dealing with multiple independent variables, especially in the context of multicollinearity and regression analysis. The F-test for equality of variances enables to assess whether the variability in factors like house value or mortgage duration differs significantly between the groups. This is important because differences in variance can impact the reliability of the regression results.

Therefore, using the F-test first to examine variance differences, followed by the t-test with different variances in a combined approach, is crucial. This method ensures a more accurate understanding of how various factors influence the choice of mortgage type by accounting for both differences in group means and variances. It helps to identify not only whether there are significant differences between the groups but also whether the variability within these groups might affect the overall results, leading to more reliable and comprehensive conclusions.

- *F-Tests*

The F-test was used to compare several variables between borrowers with fixed-rate mortgages and those with adjustable-rate mortgages. This provided important insights into the differences between these groups. For instance, when looking at home values, there was a noticeable difference in variability. Borrowers with ARMs had much more variation in home values compared to those with FRMs. This likely suggests that ARM borrowers are purchasing homes across a broader price range, possibly reflecting different financial situations and preferences. Because of this unequal variance, it made sense to use Welch's t-test, which is designed for situations where the group variances are not the same, like in this case with home values.

On the other hand, when income and home values were analyzed together, the results showed that the variances were quite similar. This is probably since income and home value are highly correlated. Borrowers with higher incomes typically purchase more expensive homes, so the variation in these two variables tends to align.

When mortgage duration was examined, a different pattern emerged. Although there was a difference in the average mortgage length between borrowers with FRMs and ARMs, the F-test showed no significant difference in variances. This indicates that while ARM borrowers tend to have slightly longer mortgages on average, the spread in mortgage lengths is similar for both groups. This is a contrast to the greater variation seen with home values. A similar trend was found when analyzing borrower age at the time of taking out the mortgage. The F-test showed that age variability was nearly the same for both groups. Even though fixed-rate borrowers tend to be a bit older, the range of ages was consistent across both groups.

In conclusion, the F-test helped identify significant differences in variability for certain variables, like home values and income, while for others, such as mortgage duration and borrower age, the variances were quite similar between the two groups. This analysis has provided a clearer understanding of what distinguishes FRM borrowers from ARM borrowers and why different statistical methods, like Welch's t-test, are necessary in some cases. Overall, these findings offer a more detailed view of borrower behavior, showing that mortgage choices are influenced by various factors such as income, home value, mortgage length, and age, though some variables show more consistent variability than others.

- *Net Income*[3]

The results of section 3.3.2 show a strong connection between net income and several financial variables. Given this, it is important to examine how different mortgage types, whether fixed or variable, might be influenced by net income.

Table X presents the findings from Welch's t-test, offering key insights into the comparison of net incomes between borrowers with fixed-rate and variable-rate mortgages. The analysis shows that the average net income for borrowers with fixed-rate mortgages is €30,263.75, while for those with variable-rate mortgages, it is higher at €38,019.02. This suggests that, on average, individuals with variable-rate mortgages tend to have a higher income compared to those with fixed-rate mortgages.

There are additional differences between the two groups. The variances between the two groups are significantly different, and the sample sizes are unbalanced, with 2,069 observations in the fixed-rate group and only 465 in the variable-rate group. This imbalance further supports the use of Welch's t-test. The statistical analysis produced a t-statistic of -2.592. At a 95% confidence level, this indicates a significant difference between the two groups. The p-value for the one-tailed test is 0.0049, and for the two-tailed test, it is 0.0098. Both p-values are much lower than the 0.05 threshold, leading to the rejection of the null

[3] Refer to Appendix D for a detailed breakdown of the statistical results.

hypothesis. This confirms that there is a statistically significant difference in net incomes between fixed-rate and variable-rate mortgage borrowers.

These findings suggest that individuals with higher net incomes may prefer or qualify for variable-rate mortgages. This could be because they are better able to handle the risks of changing interest rates or because they prefer the lower initial payments that variable-rate mortgages often offer. Overall, the analysis highlights the importance of income levels in determining mortgage choices.

- *House Values*

The results of the F-test and Welch's t-test for the house values show that the mean house value for borrowers with FRMs is approximately 265,854.36, while for those with ARMs, it is significantly higher at 353,396.50. Welch's t-test confirms a statistically significant difference in house values between fixed-rate and variable-rate mortgage borrowers, with a t-statistic of -2.723 and p-values well below 0.05. The higher mean house value among ARM borrowers aligns with their higher net income, confirming earlier results that income strongly influences both mortgage choice and house value. This finding reinforces the conclusion that financial decisions are closely tied to income levels.

- *Mortgage Duration*[4]

The analysis of mortgage duration using the t-test reveals that the average duration for fixed-rate mortgages is approximately 19.86 years, while for adjustable-rate mortgages, is about 20.89 years.

These outputs carry important implications. The data indicates that borrowers who choose adjustable-rate mortgages tend to have slightly longer mortgage durations on average compared to those who opt for fixed-rate mortgages. This significant difference, highlighted by the p-values, suggests that the type of mortgage a borrower selects may influence the length of their loan, possibly due to different financial strategies or needs. The similarity in variances, as shown by the F-test, indicates that the variability of mortgage durations is stable across both types, even though the average duration differs.

When considering these findings alongside previous analyses of net income and house value, a clearer picture emerges. Borrowers with higher net incomes, who tend to purchase more expensive homes, may also be opting for longer mortgage durations as a way to manage their cash flow and financial commitments more effectively. Choosing a longer duration could be a strategic decision to reduce monthly payments or to align with long-term financial planning, underscoring the importance of understanding how various financial factors and strategies influence mortgage choices. Indeed, mortgage duration is not solely determined by the type of mortgage but is also likely influenced by the borrower's overall financial situation and long-term goals.

[4] Refer to Appendix D for a detailed breakdown of the statistical results.

- *Age at origination*[5]

The statistical analysis of age of the borrower at the date of contract origination offers a deeper understanding of the demographic characteristics of borrowers who opt for different mortgage types. The F-test highlighted a difference in variances between the age distributions of borrowers with FRMs and ARMs.

Welch's t-test results reveal that borrowers who opt for fixed-rate mortgages tend to be slightly older, with an average age of approximately 43.31 years, compared to an average age of 41.63 years for those who choose adjustable-rate mortgages. This difference is supported by a t-statistic of 2.299 and a two-tailed p-value of 0.022. This significant difference in average age suggests that older borrowers might be more inclined towards fixed-rate mortgages, perhaps due to a desire for the financial stability that comes with consistent payments over time. This preference for stability could be particularly appealing as borrowers approach later stages in life, where predictability in financial obligations becomes increasingly important. On the other hand, younger borrowers may find adjustable-rate mortgages more attractive, potentially because of the lower initial payments and the anticipation of future income growth, which could provide them with greater flexibility to manage any fluctuations in interest rates.

### *3.4.2 - Linear Regression*

Regression models are designed to clarify the relationship between one dependent variable and several influencing factors, known as independent variables. These independent variables are so named because their values are not constrained by the model. Linear regression is the simplest among such models, relying on a linear approximation as suggested by its name. While linear models are straightforward, more complex and often more accurate models can be constructed using higher orders of approximation. The decision on which model to use depends on the nature of the phenomenon being studied; some situations are adequately captured by a linear model, whereas others (such as those in thermodynamics) may require more detailed approaches.

The fundamental equation of a linear regression is expressed as:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta n Xn + \varepsilon$$

Where:

- $Y$: represents the dependent variable
- $X_1, X_2, \ldots, Xn$: are the independent variables
- $\beta_0$ is constant
- $\beta_1, \beta_2, \ldots \beta n$: are the coefficients linked to the independent variables
- $\varepsilon$: is the error related to the approximation

[5] Refer to Appendix D for a detailed breakdown of the statistical results.

In this context, the dependent variables being considered are the type of chosen mortgages, while the independent variables include the variables studied in the correlation analysis section.
To recall them these are: the age of the borrower, the net income, the value of the house, the interest rate, the total amount financed at the time the mortgage was originated. Additionally, the model takes into account the borrower's net income and the binary variables such as whether the property is privately owned or co-signed, the borrower's occupation (distinguishing between employed and self-employed individuals), and the borrower's gender. These variables collectively aim to predict the type of mortgage chosen, whether fixed or variable, by examining the relationships between these influencing factors and the dependent variable.

In this analysis, multiple regressions will be run, each time including only one of the highly correlated variables along with the other independent variables. For instance, since the correlation matrix[6] shows that Net Income and Financed Amount are highly correlated (correlation of 0.89), one regression model will include Net Income while excluding Financed Amount, and another will include Financed Amount while excluding Net Income. Similarly, Net Income also has a moderate correlation with House Value (correlation of 0.59), so additional models will be run where Net Income is included while excluding House Value, and vice versa.

This method allows for a clearer interpretation of the impact of each variable, minimizing the confounding effects that can arise when both are included in the same model. By systematically varying the inclusion of these highly correlated variables, the analysis will provide a more precise understanding of the relationships between the independent variables and the dependent variable, ensuring that the results of the regression analysis are as accurate and informative as possible.

The chosen combinations are

- *Net Income, Interest Rate, Duration, Gender, Occupation or Property*
- *House Value, Interest Rate, Duration, Occupation or Property*
- *Financing, Interest Rate, Duration, Age, Occupation or Property*

Occupation and Property were divided significantly correlated, while Gender for lack of data combination with the previous two variables.

As an output of linear regressions, the Analysis of Variance or ANOVA must be considered too. This is a statistical technique used to determine whether there are any statistically significant differences between the means of three or more independent groups. Essentially, ANOVA resembles *T-Tests* but has the power to test the hypothesis that the means of more than two groups are equal.

[6] Refer to Appendix C for a detailed breakdown of the statistical results.

This means that ANOVA is particularly useful in comparing the effects of different independent variables on a dependent variable, especially when those variables have multiple levels. This is the case of regression analysis where ANOVA provides a way to evaluate the effectiveness of the predictors in the model, allowing to determine whether the relationships identified in the model are statistically significant, meaning that the observed patterns are likely not due to chance but rather to the influence of the variables being studied. For these reasons, the Analysis of Variance will be included in further subchapters.

- *Net Income, Interest Rate, Duration, Gender, Occupation or Property*[7]

The first multiple regression was computed twice, accounting for 5 variables the first time and 4 the other. The "shared variables", i.e. those that were studied in both regressions, were *Net Income, Interest Rate* and *Duration.* In the 5 five variables regression were included *Occupation* and *Gender*, while in the other there was only *Property*.

Occupation proved to be the important variable in the combined model with Gender, since p-value was found at about 0.038 and had a negative coefficient. On the other hand, Gender was revealed to have a p-value at around 0.074 and a small negative coefficient. These numbers indicate that being self-employed, as opposed to being an employee, decreases the likelihood of selecting the fixed rate mortgage, while differences in genders, even if giving results close to significance, have a marginal influence on mortgage choice. So, this sample says that lower financials and risk preferences typically associated with employment may lead these individuals into choosing more stable payments, reflecting a more cautious approach. Sexual category instead, gives less information, probably due to the low differences in income between "Females" and "Males" explained in chapter 3.2.2.

*Property Ownership* was not statistically significant, with a p-value of 0.742. The lack of significance in this model indicates that other factors, such as interest rates or income, may overshadow the impact of ownership status in this specific context.

Looking at shared variables, these were consistently included as predictors of mortgage choice. However, their impacts varied slightly depending on the other components included in the model.

*Net Income* consistently showed a negative coefficient across all models, indicating that higher net income was associated with a reduced likelihood of choosing FRMs. While this was statistically insignificant in the combined Occupation and Gender model, the p-value of 8.75e-7 in the Property model demonstrated that Net Income was a key factor.

The significance of Net Income in the Property model suggests that when Property Ownership is considered, income level becomes more decisive in mortgage choice. Specifically, it highlights that joint ownership strengthens the positive relationship between

[7] Refer to Appendix D for a detailed breakdown of the statistical results.

higher Net Income and the preference for ARMs. Conversely, those opting for individual ownership are more likely to choose FRMs for their stability.

The *Interest Rate* exhibited a more complex pattern. In the model including *Property*, the variable was highly significant, with a very low p-value (equal to 0.009), and a strong negative coefficient. Such results suggest that higher interest rates, combined with joint ownerships decrease the likelihood of choosing the FRMs in this context. This can be explained considering that as said, when interest rates are high these are likely going to fall in the future, so ARMs can be more convenient in a middle-long view, while it has already been explained several times how couples' financial stability brings them to choose in this way. In contrast, in the models including *Occupation* and *Gender*, the *Interest Rate* was not statistically significant. This variation suggests that the impact of the interest rate on mortgage choice may be more context-dependent and becomes more pronounced when considered alongside financial factors like property ownership, which may make borrowers more sensitive to rate changes.

*Mortgage Duration* was the most consistently significant predictor across all models. It had a negative coefficient, indicating that longer mortgage durations reduced the likelihood of selecting the fixed rate mortgages, again confirming Welch's test results. This effect was highly significant in each case, with p-values well below the 0.05 threshold, specifically $1.15^{-5}$ in the combined *Occupation* and *Gender* model.

The ANOVA results strengthen, under variance point of view, the results explained until now in this section. In the first model, which includes both Occupation and Gender the results demonstrate that the model is statistically significant. The F-statistic indicates that the combination of these variables provides a meaningful explanation for differences in mortgage choices. However, the overall explanatory power, as reflected by the R-squared value of 0.025, remains relatively modest. In the second model, which includes *Property Ownership,* The ANOVA results to strengthen the findings discussed earlier. The F-statistic of 12.03 indicates the model is statistically significant, with a p-value of $1.10^{-9}$. However, the R-squared value of 0.0187 remains modest, suggesting that while Property Ownership, Net Income, Interest Rate, and Mortgage Duration provide some explanation for mortgage choices, their overall explanatory power is limited

In conclusion, both ANOVA and comparative analysis reveal that while demographic factors like occupation and gender do have some influence, financial factors, particularly property ownership and mortgage duration, play a more substantial role in determining mortgage choice.

- *Financing, Interest Rate, Duration, Occupation or Property and Age*[8]

For the second combination 3 different multiple regression models were derived. The fixed common variables were *Financing, Interest Rate and Mortgage Duration.* The first multiple

[8] Refer to Appendix D for a detailed breakdown of the statistical results.

regression was computed with Property alone, while the other two with *Age* and *Occupation* the first time and *Age* and *Property* the other.

Property was often a significant variable, though its level of importance varied across the models. In the model where it appeared only alongside shared variables, the coefficient wasn't statistically significant. However, when combined with Age, it became significant, showing a p-value of 0.01 and a negative coefficient.

Age itself was proved statistically significant when included in the model alongside Property, showing a small positive coefficient and a p-value of 0.003. When Age was included with Occupation, its significance was retained but slightly reduced, with a dropped coefficient and a lower p-value of 0.022, continuing to influence mortgage choice, but with an impact somewhat diminished when occupational factors are also considered. Occupation itself was negative and significant too, even if less, since its p-value was around 0.38.

All these results confirm that, even considering Financing instead of Net income as combined variabile, what described in previous T-Tests and regressions holds: Older people with a non-joint ownership or self-employed are more likely to choose a FRM,

Moving on to shared variables, the Interest Rate remained negatively correlated with FRMs and was significant in all three multiple regressions. This suggests that higher interest rates consistently reduce the likelihood of choosing FRMs, aligning with previous findings. Mortgage Duration also emerged as a consistently significant predictor in all models, with negative coefficients, indicating that longer mortgage durations reduce the likelihood of selecting a FRM.

As for Property, Occupation and Age, it is important to notice how, even for interest rates and Mortgage Duration, results coming from different analyses are always more accordant with each other.

Financing was found to be highly significant in all models, with stable negative coefficients. For example, in the model with Property and Age, the coefficient was $-2.49^{-7}$, with a p-value of $1.65^{-5}$, indicating that as the amount financed increases, the likelihood of choosing a FRM decreases. A slight variation was observed in the model with Occupation and Age, where the coefficient remained negative ($-2.21^{-7}$), with a p-value of 0.0001.

This suggests that individuals who finance larger amounts tend to prefer ARMs, likely to benefit from initially lower interest rates. There are different reasons behind these results. The first is the relationship between Financing and Net Income. As seen in the statistical tests, Net Income shows a strong negative relationship with the FRM share, similar to the effect of Financing. This is due to the high correlation between the two variables, which makes sense economically, as wealthier individuals can support higher debt levels. The other important reason is linked to technical aspects. In Italy, the main and only mortgage system is the so-called "French amortization" system. Without falling into complex mathematical explanations, with this formula, the installments are increasing for the capital

and decreasing for the interest, so initially the payment is mainly composed of interest, while as the due date approaches, the portion of the capital repaid increases. This can bring a person that is asking for a higher Financing to be more attracted to choosing a ARM, since they will initially benefit from lower interest payments, making the early installments more manageable compared to a fixed-rate mortgage, where the interest rate is typically higher.

Passing to the ANOVA results, these indicate that all models were statistically significant, but the explanatory power was modest. For the Property model, the R-squared value was 0.016, meaning that only 1.6% of the variance in mortgage choice was explained by the variables in the model. This increased slightly in the Property and Age model (R-squared 0.019) and the Occupation and Age model (R-squared 0.018). While these values suggest that much of the variance remains unexplained, the models highlight significant relationships between predictors.

- *House Value, Interest Rate, Duration, Occupation or Property*[9]

In the end in the third combination two different standard deviations were to be compared. The common variables were always House Value, Interest Rate and Duration, while the changing variables were Property and Occupation since highly correlated.

Starting with shared variables, House value emerges as a significant predictor in both models, though the effect is slightly more pronounced in the Property model. In this model, house value has a negative coefficient of $-6.1778^{-8}$ with a p-value of 0.00013, indicating that higher property values reduce the likelihood of choosing an FRM. A similar trend is seen in the Occupation model, where the coefficient is $-5.7359^{-8}$ with a p-value of 0.00046. The slightly smaller coefficient in the Occupation model suggests that while house value is important in both models, it plays a slightly stronger role when the focus is on property-related factors. The results are similar to those of Financing and Net Income.

Interest rate and Mortgage Duration confirmed previous results.

Passing to uncommon variables, in contrast to other results, Property ownership does not show significant results in either model. In the Property model, it has a positive coefficient of 0.0195 but a non-significant p-value of 0.204, indicating that whether a mortgage is owned individually or jointly does not substantially affect the choice between FRMs and ARMs. These findings imply that property ownership status, whether independent or joint, does not heavily influence mortgage preferences when combined with house value.

Occupation, instead, has a very high p-value of 0.426, indicating that combined with house value it becomes drastically insignificant.

The overall significance of the models is confirmed through ANOVA results. In the Property model, the F-statistic is 9.58 with a p-value of $1.08^{-7}$, indicating that the model is statistically significant. However, the R-squared value of 0.0149 suggests that the model explains only

[9] Refer to Appendix D for a detailed breakdown of the statistical results.

a small portion of the variance in mortgage choice, implying that other factors may play a larger role. Similarly, the Occupation model has an F-statistic of 9.33 and a p-value of $1.73^{-7}$, with an R-squared value of 0.0145. While the models capture some important predictors, they have limited explanatory power, highlighting the need for additional variables to better explain the factors influencing mortgage choices.

### *3.4.3 Analysis sum up and Cambpell&Cocco 2003*

The comparative analysis of mortgage choices highlights both key similarities and differences between the findings from this study and those of Campbell & Cocco (2003). While both sets of research explore the influence of various factors on the decision to choose fixed-rate mortgages or adjustable-rate mortgages, they arrive at nuanced conclusions about the roles of income, interest rates, borrower characteristics, and overall financial stability. In analyzing the determinants of mortgage choice, results showed how various factors like income, property ownership, interest rates, and occupation all play interconnected roles, shaping a household's decision between fixed-rate mortgages and adjustable-rate mortgages. These factors don't operate in isolation, and their effects often overlap, reinforcing or moderating each other's impact on mortgage decisions.

- Income and Ownership

One of the most significant variables in this study is net income, which was consistently found to have a negative relationship with the selection of FRMs. Borrowers with higher incomes, particularly those who are self-employed, were more inclined to choose ARMs. This finding aligns with Campbell & Cocco's (2003) conclusions, where higher-income households benefit more from ARMs due to their financial flexibility. Such households can handle interest rate fluctuations more easily and enjoy the potential cost savings ARMs offer through lower initial payments.

The t-tests in this study revealed that ARM borrowers had an average net income 27% higher than FRM borrowers, reinforcing the connection between income and the preference for ARMs. While it is true that in the Occupation and Gender model, income's importance diminishes when other factors are considered, the Property Ownership model tells a different story. In this study, non-joint property ownership was positively correlated with FRM selection, meaning that singles or those without joint ownership were more likely to choose the certainty of FRMs.

This pattern mirrors Campbell & Cocco's finding that couples, with their higher income stability, are better suited for ARMs. The reasoning is clear: couples have dual income streams, making them more financially secure and better able to handle the payment fluctuations associated with ARMs. However, singles ( or non-joint owners) with high income tend to behave similarly to couples, while singles with lower income still gravitate toward the safety of fixed payments.

- Interest Rates

The influence of interest rates adds another layer to this relationship. Both this study and Campbell & Cocco ultimately reach the same conclusion regarding mortgage choice in relation to interest rates, albeit through different approaches.
Here, the joint ownership variable showed a negative correlation with higher interest rates and the likelihood of choosing FRMs. This means that couples are less inclined to choose FRMs when interest rates are high, instead favoring ARMs. Conversely, singles or those with non-joint ownership are more likely to choose FRMs in high interest rate environments, seeking the stability of fixed payments. Campbell & Cocco explain this under a utility-based framework, arguing that FRMs are more attractive when rates are high, but couples, with their higher combined income and greater financial flexibility, can still prefer ARMs slightly, even in these conditions. Singles, on the other hand, strongly favor FRMs due to the predictability and stability of fixed payments, as they are less able to manage interest rate volatility.

Anyway, both studies converge on the idea that low interest rates make ARMs generally more attractive, as they allow for lower initial payments.
In the real world, however, mortgage decisions are not only influenced by current interest rates but also by interest rate forecasts for the near future. If today's interest rates are low but are expected to rise sharply in the short term for a presumably long period of time, locking into a fixed-rate mortgage might still be the better option. In such cases, borrowers may prefer the certainty of fixed payments, even if it means accepting slightly higher payments initially, to avoid the risk of rapidly rising rates with an adjustable-rate mortgage.

Furthermore, in extreme scenarios where interest rates are expected to drop significantly after locking into an FRM, borrowers might find it advantageous to refinance to secure a lower rate. However, lenders often apply preemptive price adjustments in anticipation of such fluctuations. This means that when future interest rate declines are expected, initial ARM rates tend to be higher than FRM rates, as lenders compensate for the potential drop in rates. As a result, in real-world mortgage markets, extreme interest rate movements are typically already reflected in the available mortgage products. This makes it crucial for borrowers to evaluate the long-term spread and cost differentials between FRMs and ARMs. In other words, the long-term cost spread between the two mortgage types plays a critical role in decision-making, and borrowers should consider not only current rates but also expectations for future rate changes and price adjustments that may already reflect those expectations.

- Mortgage duration

Mortgage duration also consistently emerged as an important predictor across both studies. Longer mortgage durations were associated with a higher likelihood of selecting ARMs, as borrowers seem to value the flexibility ARMs offer over extended periods. Both studies suggest that households with longer-term mortgages prefer ARMs to keep refinancing

options open or avoid locking into high fixed rates for extended periods. For higher-income households, especially couples, ARMs make sense over long durations because the initial lower payments offer immediate consumption benefits while preserving flexibility for future rate changes.
The main motivation for choosing ARMs with longer durations is the potential for greater long-term savings, even with interest rate fluctuations. Campbell & Cocco highlight that ARMs offer higher utility over time, particularly for the higher-income households and couples, as the lower initial payments allow for immediate consumption benefits. Over the long term, this can lead to greater final wealth, as future rate reductions could further enhance savings, making ARMs a more attractive option for long-term mortgages.

- Occupation and Gender

In this study, occupation emerged as an important variable when considered alongside gender. The results indicate that self-employed individuals were less likely to choose fixed-rate mortgages, likely reflecting a preference for reducing costs rather than opting for the stability FRMs provide. Gender, while close to significance, did not have a strong enough influence to draw definitive conclusions.
While Campbell & Cocco did not directly analyze occupation or employment status, a parallel can still be drawn regarding income levels. In this sample, self-employed individuals earn nearly 19% more on average than employees, a finding consistent with data from the Bank of Italy, which also reports higher average incomes for the self-employed. These findings reach similar conclusions to those distinguishing mortgage preferences for couples and singles, where higher financial stability (as seen with joint ownership or higher income) leads to a preference for ARMs, while individuals with more limited or predictable incomes lean toward FRMs.

- *Conclusion*

The key takeaway from both this study and Campbell & Cocco's analysis is that mortgage choice is driven by a combination of income, financial stability, risk preferences, and flexibility needs. Higher-income households, especially those with dual incomes or stable employment, tend to prefer ARMs, as they can better manage the risk of fluctuating interest rates. In contrast, households with lower or more predictable incomes, whether due to employment status, property ownership, or being single-income, lean toward FRMs to minimize risk and ensure stable payments. While income is a central factor, its impact is closely tied to other variables such as occupation, property ownership, and interest rates. These factors are interdependent, shaping mortgage decisions in a nuanced way, where cost, risk, and flexibility are carefully balanced.

*Financial flexibility* is the key differentiator. Households with more flexibility, due to higher incomes, joint ownership, or longer mortgage horizons, tend to choose ARMs to take advantage of potential savings. Those with less flexibility prioritize the certainty of FRMs for security against payment fluctuations.

For example, a couple of self-employed, high-income borrowers in a context of low interest rates that are not expected to rise would almost certainly choose an ARM. In contrast, in a scenario of high interest rates, a single self-employed borrower with low income would more likely choose an FRM. The couple benefits from the flexibility and savings of ARMs, while the single borrower seeks the security of fixed payments in a high-rate environment.
Campbell & Cocco introduced two additional factors in their study: uncertainty and house value. By analyzing these factors with two levels of variation each, they showed that in cases of high uncertainty and higher house values, fewer people found utility in ARMs. These extreme conditions made it even clearer that the choice between ARMs and FRMs is highly dependent on the borrower's financial situation and market conditions. To further illustrate this, the study also looked at default rates and refinancing. Refinancing is common when interest rates decline, allowing borrowers to secure a lower rate for the long term. This option is particularly beneficial for FRM holders, who may switch to a lower-rate mortgage when market conditions are favorable. Borrowers can refinance from FRM to FRM or from ARM to FRM.

Default rates are also a significant factor. ARMs tend to have higher default rates due to the risk of income fluctuations. An unexpected increase in interest payments can lead to financial strain, making it impossible for the borrower to continue making payments. In some cases, defaulting can be a strategic move: ARM holders may default if interest rates are expected to rise significantly, avoiding unaffordable payments. FRM holders, on the other hand, might consider default only when refinancing is not an option, although this scenario is rare, especially in countries like Italy where refinancing is more common.

This discussion highlights that default rates and refinancing trends are closely linked to the key factors analyzed in both this study and Campbell & Cocco’s research. ARMs pose greater risks for borrowers, particularly in uncertain or high-interest environments, while FRMs offer more stability. Refinancing serves as an important strategy for managing long-term financial plans, especially when market conditions change in favor of lower interest rates. In conclusion, as factors like interest rate expectations, housing prices, and market uncertainty come into play, borrowers must carefully weigh short-term savings against long-term financial security. They should also consider the potential for default and the advantages of refinancing to make informed mortgage decisions that align with their financial goals

### 3.4.4 KHN Period Application

- *Swap 10y Vs KHN*[10]

This analysis examines the relationship between the ARM Share and the bond risk premium derived from 10-year swap rates, following the framework of Koijen, Van Hemert, and Van Nieuwerburgh (2009). The reason why Interest rate swaps were used is because they provide a broad, market-driven perspective on future interest rates, incorporating expectations about inflation, central bank policy, and overall economic conditions. Unlike T-bills, which reflect risk-free government debt, swaps capture a more comprehensive view of market dynamics, including credit risk and liquidity premiums. This makes them particularly relevant for analyzing mortgage choices, as they reflect the real-world borrowing conditions that influence interest rates in markets like Italy, where both domestic and eurozone factors come into play. Using formula *(1.9),* the Household Decision Rule (HDR) was applied to the swap rates in order to compute the bond risk premium over the period 2012–2024. Specifically, it is important to recall that the rule calculates this premium by subtracting the moving average of short-term swap rates over the previous three years from the current long-term swap rate.

Although the dataset began in 2009, calculations for the HDR could only start in 2012, once sufficient short-term rate data became available to generate the necessary moving averages. Once the bond risk premium was calculated using this method, a regression analysis was conducted to assess its influence on ARM Share. The model's overall fit, indicated by an R-squared value of 0.403, suggests that approximately 40.3% of the variation in ARM Share can be explained by changes in the bond risk premium derived from the 10-year swap rate. While this is a substantial portion, it also implies that other factors contribute significantly to ARM Share fluctuations. This aligns in part with KHN, which as first noted that while the bond risk premium is a strong predictor, incorporating loan-specific factors and geographical differences could enhance the model's accuracy. The multiple correlation coefficient (R = 0.635) shows a strong link between the bond risk premium calculated through HDR and the ARM Share, though some variation is still unexplained.

In contrast, Koijen et al.'s original use of the Household Decision Rule with Treasury yields explained about 70% of the variation in ARM Share, showing higher predictive power. This discrepancy may indicate that the bond risk premium derived from Treasury bonds is a more accurate predictor of ARM Share compared to the one calculated from swap rates. However, a significant difference exists between the two measures. Statistical testing further validates the current analysis. The ANOVA test yielded an F-statistic of 7.425 with a p-value of 0.0198, confirming that the model is statistically significant at the 95% confidence level. The HDR-derived bond risk premium coefficient of 0.0198 suggests that for every unit increase in the

[10] Refer to Appendix D for a detailed breakdown of the statistical results.

bond risk premium, the ARM Share is projected to rise by 1.98%, assuming all other factors remain constant.

While this result aligns with the positive relationship observed in KHN's study, the magnitude is notably different. In their analysis, the authors found that a one-standard-deviation increase in the bond risk premium resulted in a significantly larger 8 percentage point rise in ARM Share, indicating a much stronger effect.

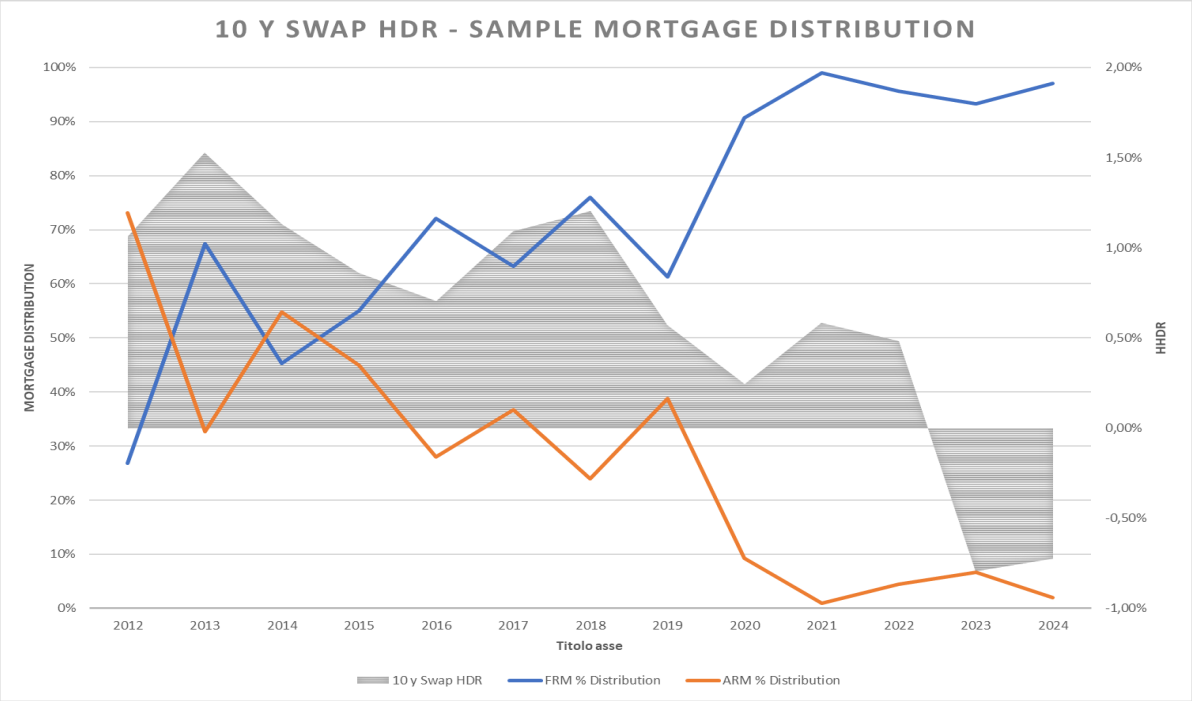


*Figure 22*

*Sample's mortgage distribution by year from 2012 to 2024, compared to household decision rules applied to the 10-year monthly swap as a long-term bond and the 1-year monthly swap as a short-term bond, with a 36-month moving average*

In conclusion, this analysis demonstrates a clear and positive relationship between the bond risk premium, calculated using the Household Decision Rule applied to swap rates, and the ARM Share. Nonetheless, the results show a more modest effect compared to the findings of KHN, who applied the HDR to Treasury yields. A key difference that likely contributes to this variation is the broader sample period used in their study, which spanned from 1985 to 2006. This wider window captured more diverse economic conditions and fluctuations in interest rates, allowing for a richer understanding of the relationship between bond risk premia and mortgage choice. By contrast, the present study, covering data from 2012 to 2024, may not capture the full range of market dynamics, potentially limiting the observed impact on ARM Share.

The difference in explanatory power between the two studies also suggests that the nature of the financial instruments used to calculate the bond risk premium could play a significant role. Bond risk premia derived from Treasury yields, as used by KHN, directly reflect market perceptions of government-backed securities, which are generally considered a safer, more stable measure. In contrast, swap rates introduce additional layers of complexity, including

market liquidity and counterparty risk, which might dilute the direct relationship between risk premiums and mortgage decisions. This could help explain why the bond risk premium derived from swap rates appears to have a slightly weaker influence on ARM Share in this analysis. Despite these differences, both studies reaffirm the importance of bond risk premia in shaping mortgage choice behavior. In particular, the present study aligns with KHN's findings in demonstrating the Household Decision Rule as a reliable tool for assessing mortgage market trends. However, the slightly lower R-squared value here underscores the need to consider other macroeconomic variables that may further clarify the forces driving ARM Share.

Future research could benefit from expanding the sample size and timeframe, capturing a wider range of economic cycles. Moreover, incorporating broader factors may provide a more nuanced understanding of mortgage decisions, especially when comparing different financial instruments like Treasury bonds and swap rates, offering a more complete picture of how borrowers navigate the mortgage market.

# Chapter 4 - Financial Education and Biases

This chapter is designed to identify additional micro-variables, i.e. those variables proper of the population itself, that influenced, and continue to influence, household mortgage choices. The first part is dedicated to understanding what the population's *Financial Education* (or *Literacy*) is, how it is defined and evaluated, and how it possibly affected Italian's mortgage choice. The second part delves in a brief explanation on what are behavioral biases, and which are the most common in the investment sector.

## 4.1 - Italian Financial Education

This subchapter aims to discern both the extent to which households can independently analyze the array of financial instruments at their disposal and to assess their foundational knowledge necessary for making informed financial decisions. To do so different papers were analyzed:

- The three versions, 2017, 2020 and 2023 of the "*Indagini sull'alfabetizzazione finanziaria e le competenze di finanza digitale in Italia: adulti*" ("*Surveys on financial literacy and digital finance skills in Italy: adults")* from the Bank of Italy.
- "*RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola*" (*"REPORT EDUFIN 2023, Financial education: Let's start with school")* written from the DOXA committee, which is an important and recognized Italian research organization, specialized in market analysis and opinion polling.
- (Committee for Financial Education - Ministry of Economy and Finance, 2023). This is the Organisation for Economic Co-operation and Development, an international organization that promotes policies aimed at improving the economic and social well-being of people around the world.

- The *"Standard & Poor's Ratings Services Global Financial Literacy Survey"* published in 2015, but related to 2014 written by *Leora Klapper, from the "World Bank Development Research Group", Annamaria Lusardi, from the "The George Washington University School of Business" and Peter van Oudheusden, form the "World Bank Development Research Group"*

### 4.1.1 The Indicators

Financial literacy is measured by a composite indicator that aggregates three dimensions: knowledge, behaviors, and attitudes.

*Knowledge*: assesses familiarity with key concepts such as inflation, interest rates, simple and compound interest, and risk diversification, known as the "Big Three." Scores range from 0 to 7.

*Behaviors*: involves short- and long-term financial management, including setting financial goals, budgeting, and saving. This dimension is rated from 0 to 9.

*Attitude*: evaluates individuals' orientation toward saving, particularly long-term and precautionary saving. Until 2020, scores ranged from 1 to 5; in 2023, this changed to 0 to 4.

Overall financial literacy is calculated by summing the scores from these three dimensions, resulting in values between 1 and 21 until 2020, and between 0 and 20 in 2023.

### *4.1.2 The Statistics*

- *General View*

In 2014, "*Standard & Poor's Ratings Services"* conducted a Global Financial Literacy Survey, published in 2015. The survey examined financial literacy levels across the world, revealing significant variations across the European Union, as shown in figure 22. The data highlights that financial literacy in Italy falls below the European average. While 52% of adults in Europe, on average, are financially literate, the highest rates are found in northern Europe. Countries like Denmark, Germany, the Netherlands, and Sweden report literacy rates where at least 65% of adults are financially literate. On the other hand, southern Europe shows much lower literacy rates. For instance, Greece and Spain have literacy rates of 45% and 49%, respectively, while Italy and Portugal are among the countries with the lowest rates in the region. The countries that joined the EU in 2004 or later have even lower financial literacy levels. Romania, for example, has the lowest literacy rate in the EU, at just 22%.

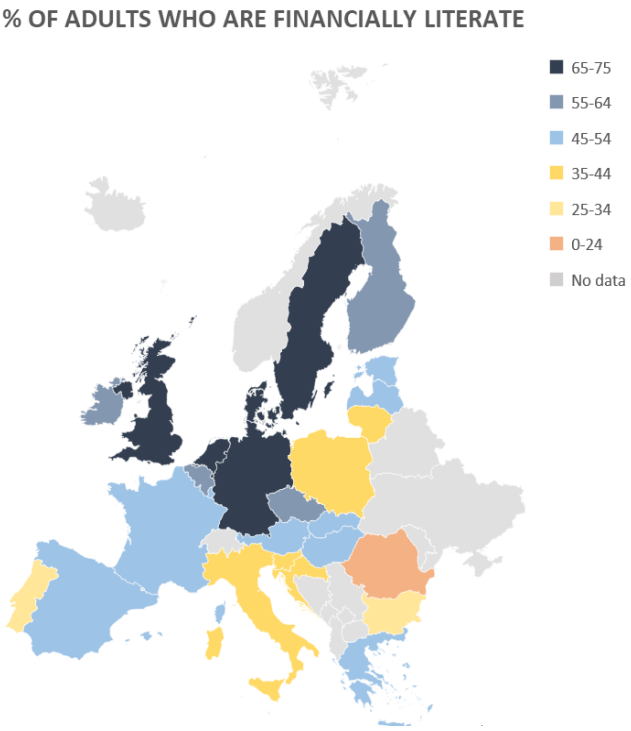


*Figure 23*
*Percentage of adults considered "Financially Literate" divided by European countries*

- *Bank of Italy's results*

Building on earlier findings, the Bank of Italy's surveys from 2017, 2020, and 2023 paint a consistent picture of both challenges and gradual improvements in financial literacy across Italy. These surveys focus on three key indicators: knowledge, behavior, and attitude, and reveal the significant role that factors like education, age, gender, and geographical location play in shaping financial outcomes.

1. *Knowledge, Behavior, and Attitude Trends*

The 2017 survey revealed major gaps in financial knowledge. Italians scored 3.5 out of 7 in understanding basic financial concepts such as interest rates, inflation, and portfolio diversification, falling short of the G20 average of 4.3. Only 27% of respondents had set long-term financial goals, and 37% reported using a household budget—indicating widespread issues with financial planning and discipline. On the positive side, 40% of respondents showed a positive attitude toward saving and future planning, which was more in line with G20 averages, though these optimistic attitudes were not reflected in actual behaviors or knowledge.

By 2020, there were some modest improvements. The knowledge score improved slightly, with 44.3% of respondents scoring 5 or more out of 7, compared to 32.6% in 2017. However, Italy remained well below the OECD average, where 38.9% of adults met the financial literacy threshold, compared to just 16.6% in Italy. In terms of behavior, the scores remained mostly stable, though some groups—especially women and older adults—saw declines, likely due to the economic impacts of the COVID-19 pandemic. Attitude scores also dipped slightly, reflecting growing uncertainty and a more pessimistic view of the future amid economic challenges.

By 2023, the survey sample increased to 5,000 individuals, providing a more detailed snapshot of financial literacy across demographics. The overall financial literacy score showed a slight improvement, rising from 10.2 to 10.7 (on a scale of 0 to 20). This was driven by gains in behavior, which climbed from 4.2 to 4.7, and attitude, which rose from 2.0 to 2.3. These improvements suggest that, despite economic challenges, more Italians were starting to adopt better financial habits and retain a more positive outlook on saving and planning. However, knowledge scores slipped slightly, falling from 3.9 to 3.7, indicating that while behaviors improved, understanding of key financial concepts continued to lag.

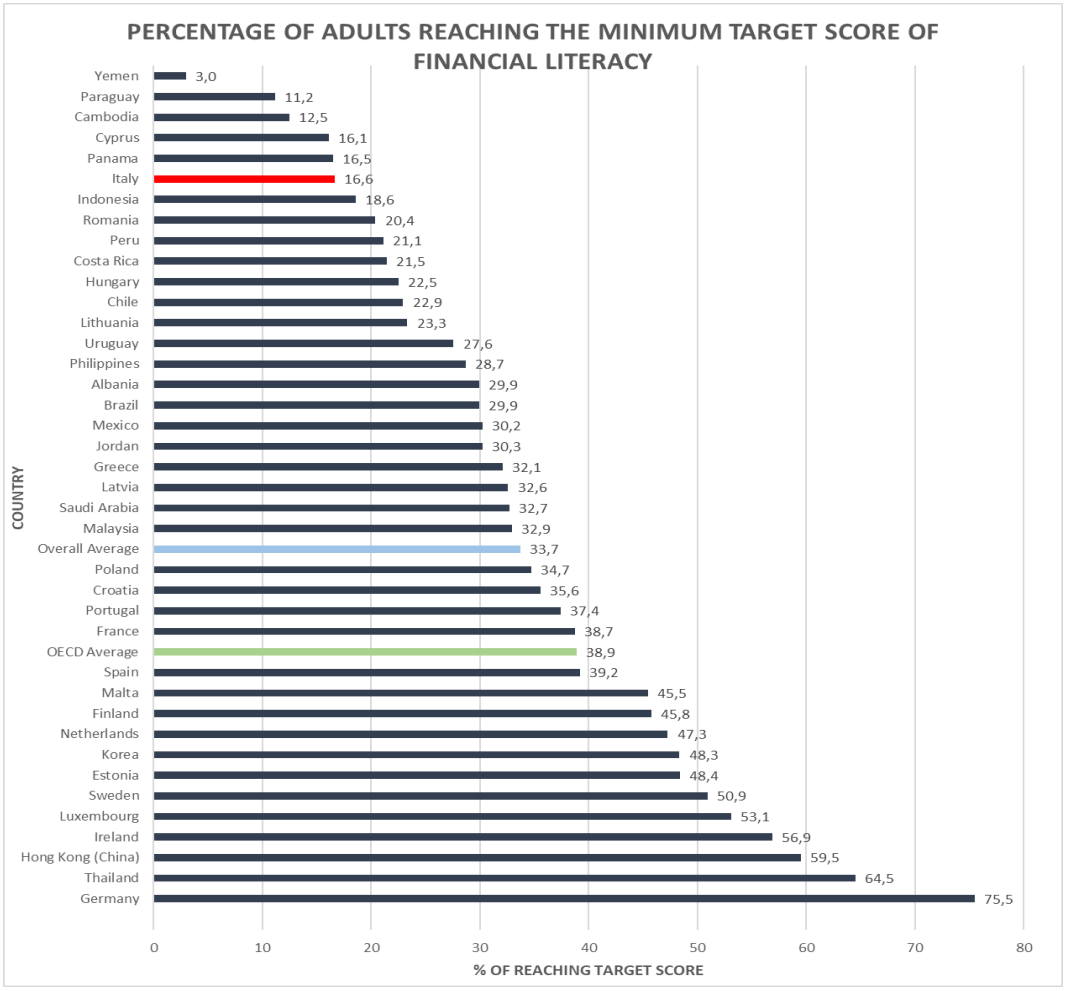


*Figure 24*

*The graph represents the percentage of adults reaching the minimum target score in financial literacy in 2023, data coming from "OECD/INFE 2023 International Survey of Adult Financial Literacy".*
*Italy is at one of the lowest positions, barely reaching 16,6% of adults reaching the threshold, way lower than Overall Average, which reaches a value of 33,7% and the OECD Average at 38,9%.*

### 2. *Regression Analysis: Key Factors Influencing Financial Literacy*

Regression analysis based on the 2017 and 2020 surveys, covering over 4,000 individuals, provided deeper insights into the factors affecting financial literacy. The analysis confirmed that education, age, and, to a lesser extent, gender and geographical location, were key variables in explaining differences in financial literacy across the population.

Education emerged as the most significant factor, affecting all three components of financial literacy—knowledge, behavior, and attitude. For example, individuals with a university degree not only scored higher in financial knowledge but also displayed better financial behaviors, such as setting long-term financial goals and maintaining a budget. This reinforces the importance of a strong educational foundation in developing essential financial skills.

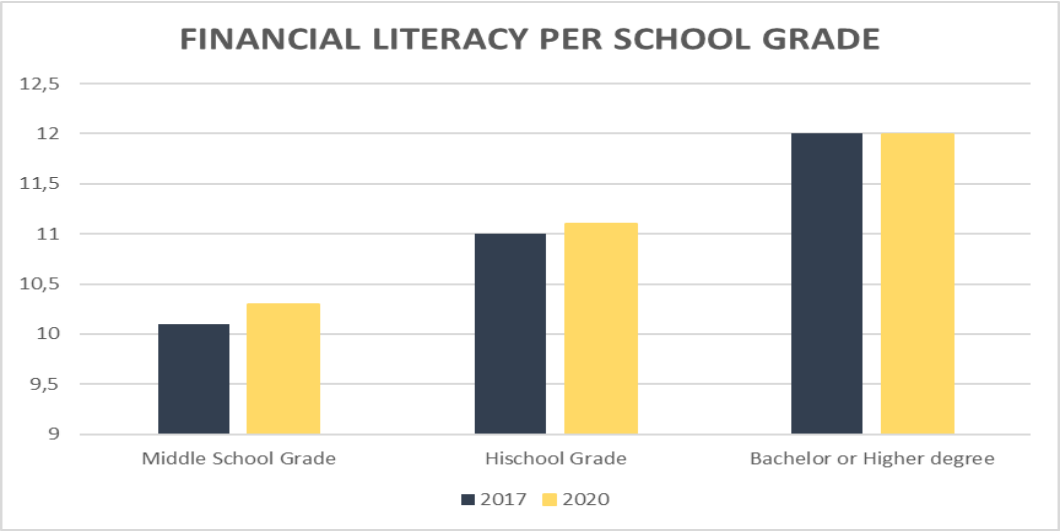


*Figure 25*
*Average results of Bank of Italy's financial literacy-tests divided per school grade.*
*Source: "Survey on Household Income and Wealth, 2022"*

Age also had a complex relationship with financial literacy. Younger adults (under 35) consistently scored lower than older adults (over 65), particularly in their attitudes toward long-term financial planning. This could be due to younger people focusing more on short-term financial pressures, such as student debt or early career instability, while older adults were more inclined to plan. Gender gaps were particularly significant in financial knowledge and overall scores. Men consistently outperformed women, especially in knowledge, with the gap most pronounced among women not active in the workforce, such as housewives and retirees. Finally, geographical differences played a role, with Northern Italy scoring higher than the South and Islands, reflecting broader socioeconomic disparities in the country.

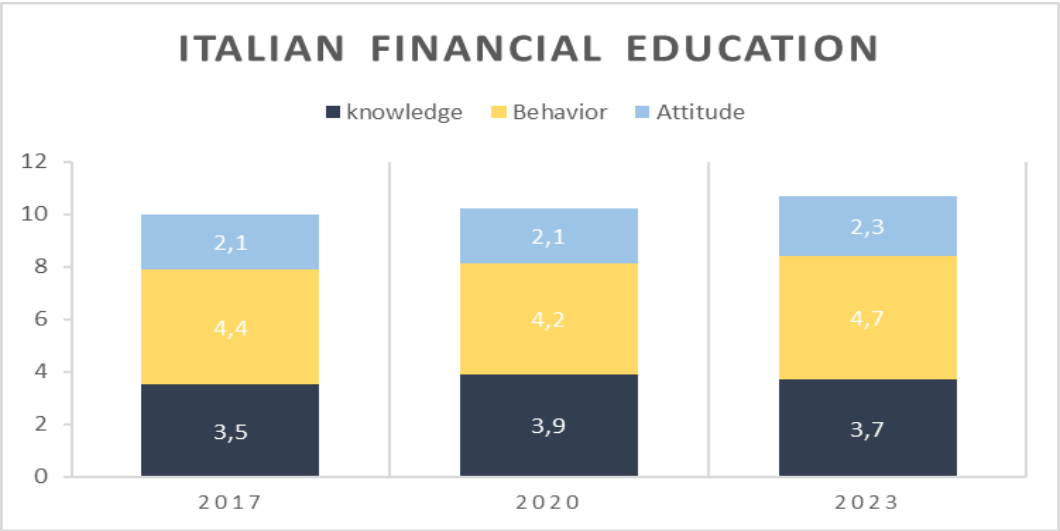


*Figure 26*
*Changes in financial literacy of Italian adults from 2017 to 2023*
*Source: "RAPPORTO EDUFIN 2023, Educazione finanziaria : Iniziamo dalla scuola"*

The 2023 survey reaffirmed the critical role of education in financial literacy. Those with middle school education or less scored an average of 9.6, compared to 11.1 for high school graduates and 12.0 for college graduates, underscoring how education significantly affects financial competence.

Gender disparities also persisted, with women scoring 10.5, slightly behind men's average of 10.9. This gender gap was most noticeable in financial knowledge and has been consistent across all surveys. Age was another important factor, with younger adults (aged 18-34) scoring 10.0, slightly below those over 64, who scored 10.4. Younger people, despite being more digitally savvy, often lacked financial experience, while older individuals might face challenges in keeping up with modern financial tools and concepts.

*3. Conclusion*

The surveys from 2017, 2020, and 2023 show that while Italy has made some progress in improving financial literacy, significant structural challenges remain. Education continues to be the most influential factor, affecting not only financial knowledge but also behaviors and attitudes toward long-term financial planning. Age and gender also play critical roles, with younger individuals and women, particularly those outside the workforce, falling behind in financial literacy. The slight improvement in 2023 is a positive sign, particularly in terms of financial behavior and attitudes. However, the decline in knowledge scores shows that there is still much work to be done. Addressing educational and gender disparities will be key to bridging these gaps. Additionally, tackling regional differences—particularly between Northern and Southern Italy, will be essential for fostering a more financially literate society across the country.

- *DOXA*

*1. Methodology*

Bank of Italy's data studied until now can be compared with those gathered from the DOXA committee in the same period. In this case it used the 2023 volume which outlines the fourth edition of a survey conducted for the first time in June 2020. At that time, 5,011 online interviews were completed with a nationally representative sample of individuals aged 18 and older, responsible for managing their household's finances and/or defined as "particularly knowledgeable" about their family's finances. Each year after, until 2023, efforts were made to maintain the same group of families and, where possible, to re-interview the same individuals to maintain the study's continuity, giving a different approach in respect to BOI. This approach, allowing for the collection of panel data, enabled detailed analysis and comparability of data over time, as well as the identification of emerging trends and changes. The annual return rate of the survey was approximately 80%, indicating high engagement among participating families and individuals. To ensure that the composition of the interviewed sample accurately reflected the target population, which includes heads of families responsible for economic and financial decisions of any age, social class, region, and type of municipality, the data were appropriately weighted according to the variables

deemed most significant. The fourth data collection took place in May 2023, using a sample size of 5,000 subjects, providing a maximum margin of error of 1.9% with a 95% confidence level. In the next section DOXA analyzes the 'big three', inflation, interest rates, and risk diversification, dividing in:  self-perception and actual knowledge.

2. *Interest rates*

The self-perception analysis begins by finding how confident Italians feel about specific financial concepts, such as simple and compounded interest. According to the data, simple interest is more familiar to people; over the last four years, an average of 46% of participants reported understanding how it works. Despite stable percentages during the 2020-2023 period, the familiarity with this concept of people that answered to the question of the survey saying that they “Heard of it” increased by 4 percentage points, reaching 38%.This increase primarily resulted from a shift of individuals from the "No" category, which includes who was previously unaware of the concept. This change is likely due to recent significant events, such as the European Central Bank's abrupt interest rate hikes, which strongly impacted the lives of the entire population.

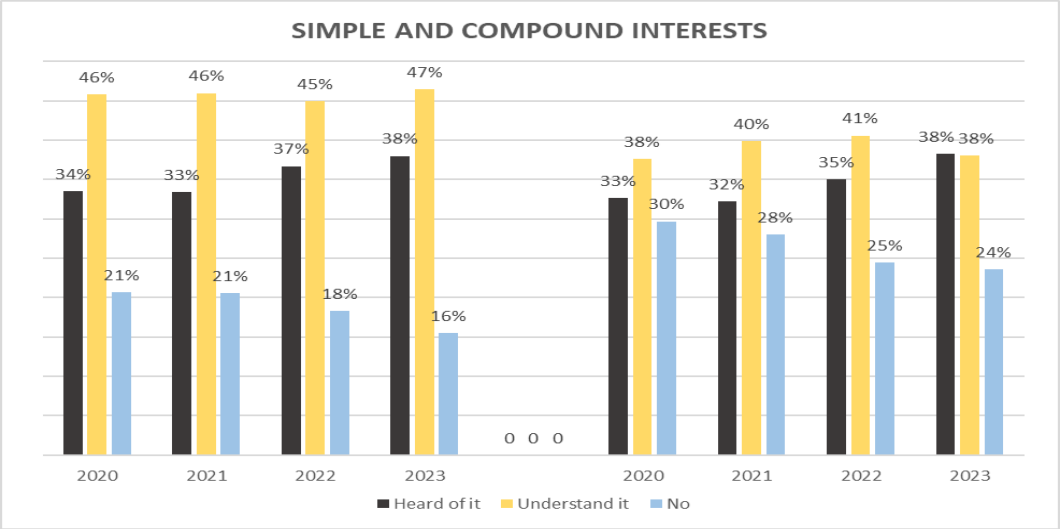


*Figure 27*

*DOXA committee data: comparing self-perceived knowledge of simple interest (on the left) with compound interest (on the right) of the Italian population. Source: “RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola”*

This trend is also evident in the section on compounded interest, where the percentage of individuals who have "Heard of it" rose from 33% to 38%, and those in the "No" zone decreased from 30% to 24% over the same four-year period. The group understanding this concept experienced slight fluctuations, peaking in 2022, a variation likely linked to the cited global events. The data indicate that while the Italian population is relatively more comfortable with the concept of simple interest, less than half of the respondents consistently understand it, confidence levels drop significantly when the subject turns to compound interest. Notably, in 2020, the percentages in all three segments (understand, heard of it, no knowledge) nearly converged, probably influenced by a decade of stable interest rates which diminished public engagement with the topic. These findings align with those from the Bank of Italy, which is concerning given that in DOXA’s survey, respondents

are those managing their family's finances so those that are presumed to possess the highest financial literacy.

3. *Risk Diversification*

Turning to risk diversification, the familiarity with this concept among respondents is higher, with an average of 56.25% understanding what it means. For the concept of the risk-return relationship, the average understanding slightly exceeds 48%. The percentages of individuals who have only "Heard of it" are comparable for both concepts, averaging 25.5% for the first and 28.5% for the second, while those answering "No" are 18.75% and 23%, respectively. This data suggests a better understanding of risk management principles among the surveyed group.

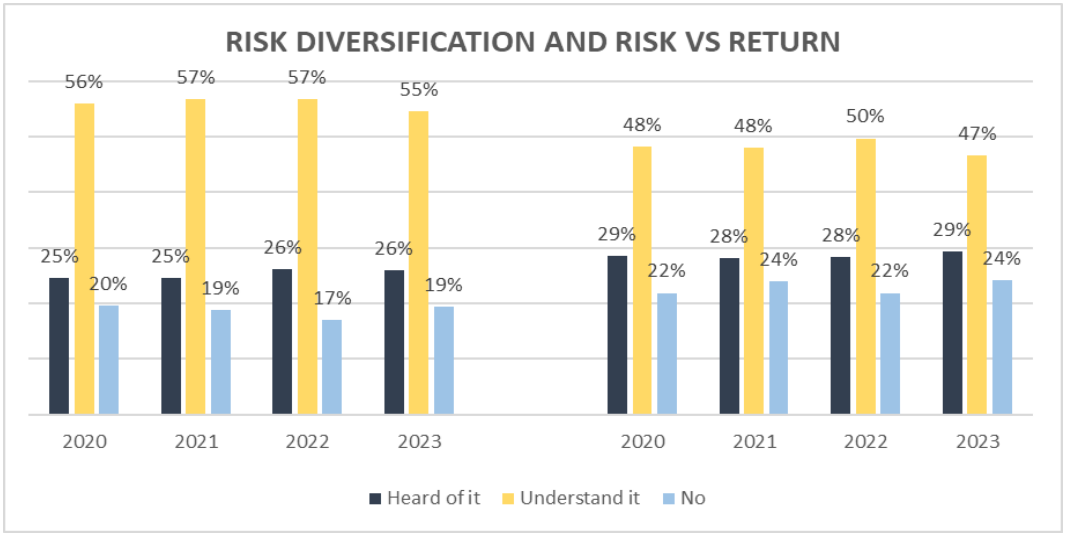


*Figure 28*

*DOXA committee data: comparing self-perceived knowledge of risk diversification (on the left) with risk vs return relationship (on the right) of the Italian population. Source: "RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola"*

The reason why these concepts are more familiar to people in respect to interest rates can be found in their same nature. Risks in fact are more intuitive since in many other fields, while borrowing costs are strictly related to finance. For example, when someone plans a trip, they intuitively apply the concepts of risk diversification and risk/reward ratio. It could happen that they might choose to book flights with different airlines or on different days to minimize the risk of cancellations (risk diversification). At the same time, the buyers might decide to spend more on a flexible ticket that allows them to change dates without additional costs, weighing the "reward" (in terms of flexibility and reduced stress) against the "risk" of losing money if plans change (risk/reward ratio). On the other side, understanding how central banks set base interest rates involves macroeconomic indicators like inflation, employment rates, and economic growth, which are not daily considerations for most individuals.

4. *Inflation*

Discussing inflation, the responses were quite positive, with 2023 marking a peak as 74% of participants indicated they understood the concept. Only 4% of the sample were unaware of what inflation means, showing that 96% of the population had some understanding of the concept.

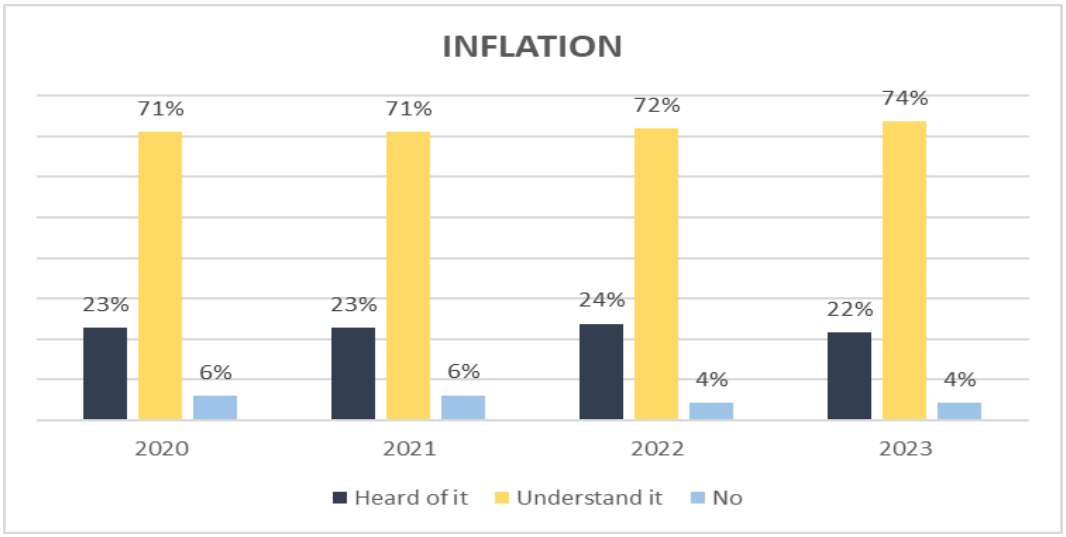


*Figure 29*

*DOXA committee data: comparing self-perceived knowledge of the concept of inflation of the Italian population. Source: "RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola"*

This is readily reliable in daily discussions, where inflation is frequently mentioned and debated.

5. *Mortgage Understanding*

In 2023, for the first time, the DOXA committee surveyed participants about their understanding of mortgage

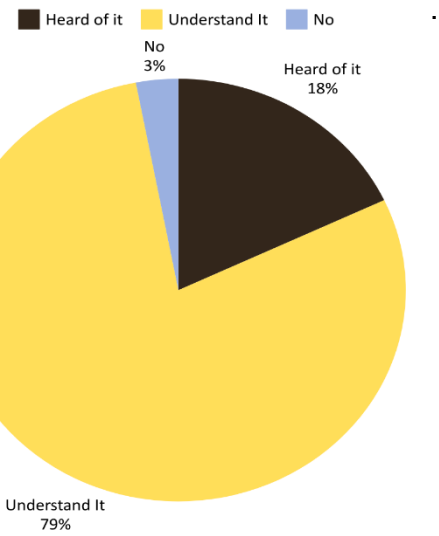


*Figure 30*

*DOXA committee data: self-perceived knowledge of mortgages of Italian population. Source: "RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola"*

This question garnered the highest rate of positive responses, with nearly 80% of the sample demonstrating knowledge on the topic. Only 3% of respondents had never heard of it. Several factors contribute to this. Firstly, as mentioned, the participants are responsible for managing their family's finances. These individuals often represent the household, and they typically face the financial challenge of a mortgage when purchasing a home. This is especially true in Italy, which has the highest rate of home ownership in Europe.

- *Actual knowledge*

Moving on to actual knowledge of the three fundamental concepts, a discrepancy is noted between real and perceived understanding. This gap reveals positive trends for the concepts of interest rates, with 71.6% of respondents correctly answering related questions in the latest survey, and risk diversification, where 63.8% of responses were correct. As for inflation, 69.8% of financial decision-makers are aware of its impact on purchasing power, a rate slightly below the perceived level of knowledge but an improvement over previous year.

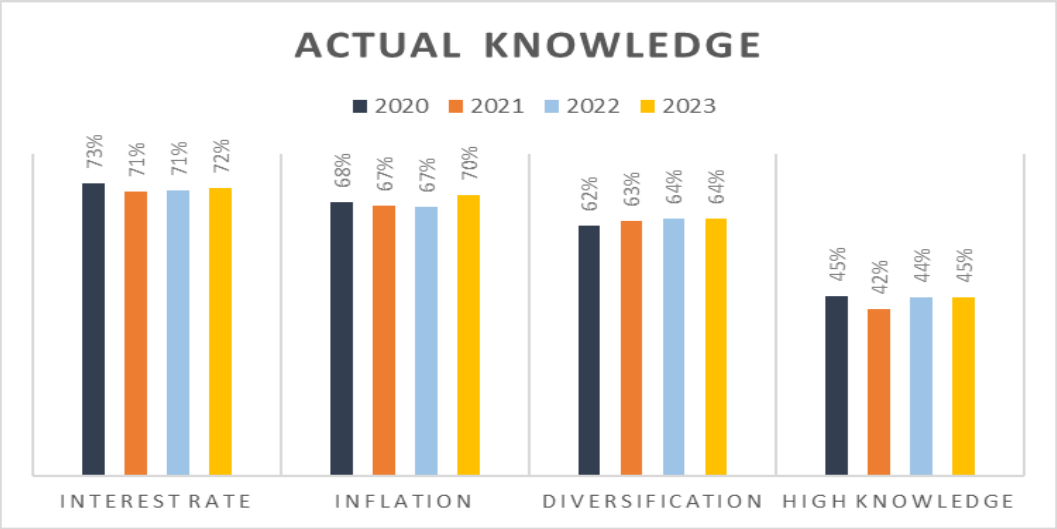


*Figure 31*
*DOXA committee data: Italian actual knowledge of the "big three"*
*Source: "RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola"*

Overall, financial knowledge remains limited: considering the economic decision-makers that gave correct responses to all three questions listed, it is noted that in 2023, on average only 44.5% of them demonstrated a high knowledge, a trend that is essentially consistent with results from previous years.

6. *High Knowledge*

When examining only the high knowledge indicator, the DOXA committee discovered that the percentage of correct answers varies significantly across different groups. In 2023, a notable gender gap exceeding 15% was observed between men and women. This discrepancy correlates with data presented in the income section of Chapter 2 of this paper, where data coming from the Bank of Italy, noted an average annual income disparity of about 10 thousand euros between males and females. Consequently, a higher proportion (specifically 65%) of men tend to be the financial managers within households, thus having greater familiarity with financial concepts like the big three.

Similarly, the quality of responses is closely linked to the age of the participants. In 2023, there was a 14.5% gap between those aged 65+ and those aged 18-44, with the older group scoring 52.5% correct answers compared to 38% from the younger group.

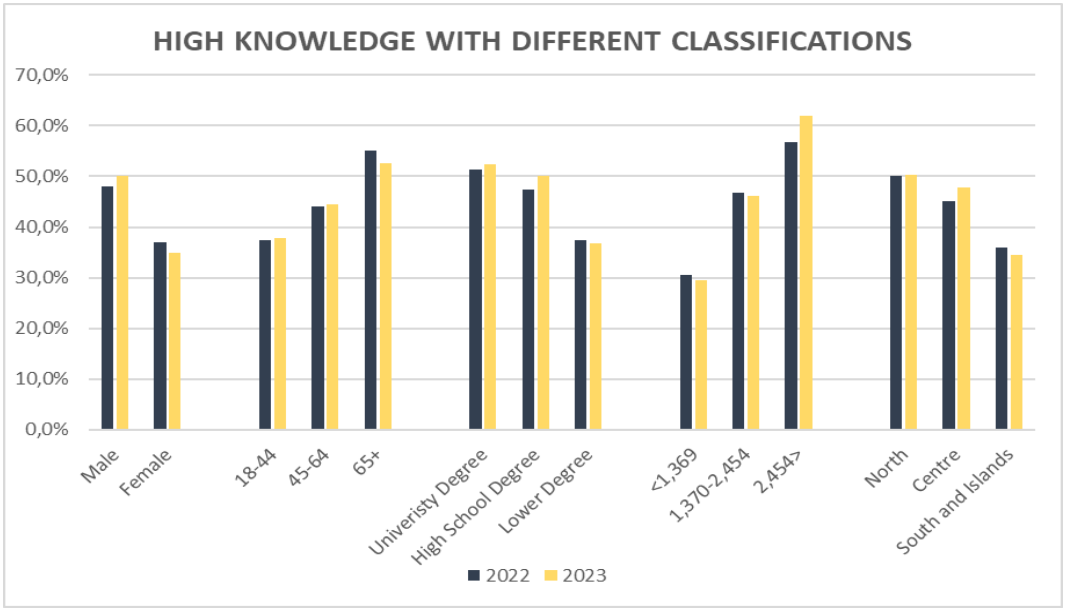


*Figure 32*

*DOXA committee data: italian 'high knowledge' levels analyzed by gender, age, education, income, and region. Source: "RAPPORTO EDUFIN 2023, Educazione finanziaria: Iniziamo dalla scuola"*

Education also plays a crucial role as a determinant factor. The data consistently show that higher education significantly boosts understanding of financial dynamics. Specifically, the gap between individuals with a university degree and those with only a lower education level, such as middle school, is 15.5%, with the latter group achieving only 36.7% correct responses across the three questions.

7. *Income Level and Provenience*

Last two factors are income level and provenience. The first one is the most influential factor in this research concerning differences in financial knowledge. Individuals earning more than €2,454 per month had a 62% correct response rate, more than double that of those earning less than €1,369 per month, who did not even reach 30%. Then there is Geographical origin.

In 2023, Northern Italy recorded the highest percentage of respondents with high knowledge at 50.4%, followed by Central Italy at 47.9% and Southern Italy at 34.4%. The disparities are attributed to the cumulative effects of higher income levels, better educational opportunities, and other complementary assets typically found in the North, compared to the South, which historically suffers from a lack of these resources.

These findings are in line with and supported by the statistical research conducted by the Bank of Italy in 2020, which identified significant variations in financial literacy based on education, gender, age, and geographic location.

8. *Global Financial Literacy Survey*

Finally, the "*Standard & Poor's Ratings Services Global Financial Literacy Survey,"* conducted in 2014 and published in 2015, offers another perspective. Focusing solely on households that originated a mortgage that year, the study sought to determine the percentage of individuals with high financial literacy across G7 countries.

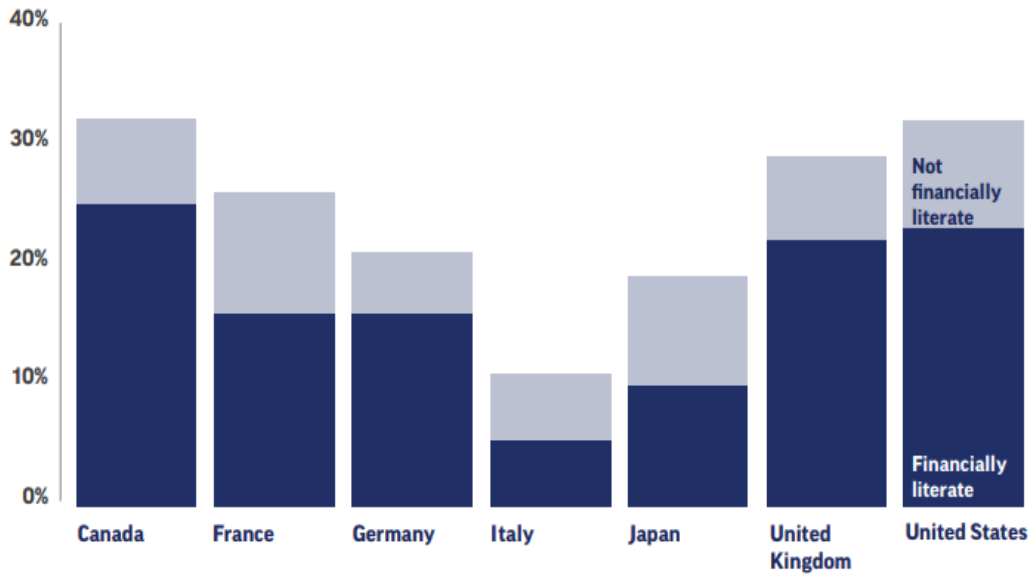


*Figure 33*

*Household's 'High Levell' of Financial Literacy divided by 7 major economies. The darker lower segment of each bar represents the percentage of households financially literate, while the lighter upper segment denotes those not financially literate. Source "Standard & Poor's Ratings Services Global Financial Literacy Survey, 2015"*

The data reveals that in major advanced economies, 26% of adults have an outstanding loan from a financial institution for purchasing a home or apartment. Given the complexity of financial calculations involved in home buying, it's expected that homeowners would possess superior financial skills compared to the general population. This indeed appears to be the case.

However, gaps in financial knowledge persist among some homeowners, who may not fully comprehend how quickly debt can accumulate. In the United States, nearly one-third of

adults have an outstanding housing loan, with 70% of these individuals correctly understanding the topic of compound interest. Conversely, this means that 30% of adults with a housing loan lack the ability to perform basic interest calculations on their loan payments. Given that the global financial crisis was partly triggered by mortgage defaults in the United States, this lack of financial literacy is a concern not only for homeowners but also for policymakers. Moreover, this outcome is more favorable compared to Italy, where a third of new mortgages originated, but 50% of these households were classified as financially illiterate.

9. *Final Outlook*

Giving a final outlook, this section explored the comprehensive landscape of financial literacy across Italy, revealing significant disparities influenced by factors such as education, gender, age, and geographical location. Financial literacy in Italy, measured through a composite indicator encompassing knowledge, behaviors, and attitudes, consistently falls below the G20 average, particularly in financial knowledge and behaviors.

Significant studies, such as the Standard & Poor's Ratings Services Global Financial Literacy Survey and various Bank of Italy reports, demonstrate that Northern Italy exhibits higher literacy rates compared to the South, which suffers from educational and economic disadvantages. Moreover, a notable gender gap in financial understanding persists, with men generally demonstrating higher literacy levels than women.

Recent data from the DOXA committee highlights an overall trend of moderate improvement in behavior and attitudes towards financial management despite a slight decline in knowledge scores. However, challenges remain, especially in understanding complex financial concepts like compound interest and risk diversification.

The disparities in financial literacy underscore the need for targeted educational initiatives and policy interventions to enhance financial understanding and behaviors across different demographic segments in Italy, ultimately aiming to improve financial well-being and economic stability.

## *4.2 - Behavioral Finance Applied to Mortgage Choice*

Behavioral economics helps economists explore the factors that influence people's financial decisions, whether they are financially literate or not, by studying cognitive biases. These biases occur when someone makes decisions that deviate from what would be considered rational. A common way this happens is through the use of heuristics, or or "rules of thumb", that simplify complex decisions. While these shortcuts help make decisions faster, they can lead to irrational choices, as people often overlook basic information from past experiences. This contrasts with Bayes' theorem, which incorporates all known information when assessing the likelihood of an event.

It’s worth noting that studies on cognitive biases in mortgage decision-making are still in an experimental phase. Although not definitive, they provide useful insights that aid in understanding the broader topic.

### *4.2.1 The Biases*

- *Overconfidence.*

*“Is the tendency to overestimate our knowledge and abilities in a certain area. As people often possess incorrect ideas about their performance, behavior, or characteristics, their estimations of risk and success often deviate from reality” (Nikolopoulou, What Is Overconfidence Bias? | Definition & Examples, 2023b).*

Overconfidence, as described, occurs when an individual overestimates their own practical skills and judgment, particularly in the finance sector. It is a well-recognized bias that can significantly influence decision-making. The IACOFI survey highlights this bias, showing that many Italians believe their financial knowledge to be average or above, when in reality, it is often below. According to the survey, around 22% of Italians display signs of overconfidence, placing Italy, alongside Austria, among the countries with the lowest levels of this bias. In contrast, Germany and the UK report higher rates, with approximately a third of the population showing overconfident tendencies.

In Italy, the tendency toward overconfidence is more common among men, those with higher education, and self-employed individuals. This differs from patterns seen in other countries, where overconfident individuals are often women or those with lower educational attainment. Overconfidence in Italy is also linked to a greater likelihood of incurring debt, though the precise nature of this relationship is not entirely clear. Overconfident individuals may be more likely to borrow due to an overly optimistic outlook on their future income, or they may feel more knowledgeable about financial matters after securing loans, such as mortgages.

This excessive optimism can lead to increased risk-taking, potentially jeopardizing both financial and personal well-being. A clear example of this behavior is seen in the popularity of lotteries, where individuals tend to irrationally focus on the slim chance of winning. A similar trend is evident in the mortgage market, where many borrowers overestimate their ability to repay debt, particularly when dealing with adjustablerate mortgages. Some mistakenly believe they can predict long-term financial variables like inflation or EURIBOR movements, which often leads to poor financial decisions. As a result, these individuals may choose mortgage options based on misguided confidence in their own financial acumen, ultimately making choices that may not be in their best interest.

- *Framing*

The heuristic of framing plays a significant role in how individuals make decisions, particularly in financial contexts like mortgage choices. This phenomenon occurs when the way information is presented, whether positively or negatively, impacts a person's

perception and decision-making. Even if two options are essentially identical, framing can influence how attractive they appear. For example, presenting a price as a discount makes it more appealing than simply stating the regular price. A key psychological mechanism behind this effect is loss aversion, where individuals prefer certain gains over potential but uncertain rewards, even if the latter could yield higher returns. This leads people to favor options framed as gains over those framed as losses. In the context of mortgages, the way terms are presented can significantly sway borrowers' preferences. A study by University of Port (2022) explored the framing effect on mortgage decisions in Portugal. It involved six different questionnaires that tested two framing approaches: Content frames (Neutral, Insurance, and Cost) and Position frames (Active and Passive).

The content frames examined how varying emphasis (neutral information, highlighting security in fixed-rate mortgages, or focusing on costs) affected borrower preferences. The position frames analyzed whether placing key information at the beginning or end of a document impacted decisions. The study found that small changes in how mortgage options were framed significantly influenced borrowers' choices. Emphasizing the risks of adjustable-rate mortgages led respondents to prefer the safer option of FRMs, driven by a heightened perception of risk and the desire for financial stability. Conversely, highlighting the predictability of FRMs also increased their attractiveness, showing how powerful framing can be. Additionally, Active framing, where key information was presented early, proved more influential than Passive framing, suggesting that information encountered first has a lasting impact on decision-making. In conclusion, the way mortgage information is framed can shape consumer preferences, driving them towards more risk-averse or stable choices. This insight highlights the potential for targeted marketing strategies to manipulate consumer decisions, underscoring the importance of transparency in financial product presentations.

- *Availability*

The availability heuristic plays a pivotal role in how individuals make decisions, particularly in the realm of mortgage choices. This cognitive bias occurs when borrowers rely on easily recalled information, often causing them to overestimate or underestimate risks without fully assessing all relevant factors.

For example, if recent personal experiences or media coverage highlight rising interest rates, a borrower may overestimate the risks of adjustable-rate mortgages, even if data shows the risks are manageable. On the other hand, hearing about someone benefiting from a low ARM rate might lead the borrower to downplay the potential future risks of rate increases.

Another way the availability of heuristic manifests is through bias toward recent offers or advertisements. A borrower exposed to a mortgage promotion with attractive terms may give undue importance to that offer, even if other lenders provide better long-term options. Similarly, borrowers who rely on the first financial consultant they meet might assume that the advice given is comprehensive and feel no need to seek further guidance. This occurs because the information from the initial consultation is the most readily available, leading

borrowers to believe it represents the best or only option. By not comparing multiple sources, borrowers limit their exposure to better mortgage terms or more competitive rates. The convenience of sticking with one consultant or offer reinforces the bias, often resulting in overlooked opportunities for more thorough research or advantageous terms.

Media coverage further amplifies the availability heuristic. Reports of housing market crashes or economic crises can skew a borrower's perception of risk, making them overly cautious, even in stable conditions. Conversely, optimistic coverage of the real estate market can lead borrowers to choose riskier options, like ARMs, without fully considering the long-term consequences, such as rising interest rates. Lastly, borrowers might gravitate toward mortgage products that are easier to understand, such as FRMs, even if an ARM could be more cost-effective under stable interest rate conditions.

In conclusion, the availability heuristic can lead borrowers to base their mortgage decisions on immediate or easily accessible information, rather than conducting a comprehensive evaluation of their financial circumstances and options. To mitigate this bias, mortgage lenders and financial advisors should prioritize providing clear, objective data, ensuring that borrowers make informed decisions and avoid the pitfalls of relying on incomplete, short-term information.

# Chapter 5 - Conclusions

This study started with one specific question:

***"Why choose an adjustable-rate mortgage when interest rates are at their lowest in history?"***

This topic framed the analysis of mortgage choices among Italian households between 2010 and 2024. At first glance, it may seem counterintuitive for borrowers to opt for an adjustable-rate mortgage when fixed rates are historically low, offering long-term financial security. However, the decision is more complex than it appears, as shown by research and real-world data.

- *Reasons for Choosing Fixed-Rate Mortgages*

Recalling theoretical models, as highlighted by *Koijen, Van Hemert, and Van Nieuwerburgh (2009),* fixed-rate mortgages become a sensible choice when the bond risk premium is low, as they offer lower risk exposure compared to adjustable-rate mortgages. Similarly, Campbell & Cocco suggest that households with high loan-to-income ratios are more likely to choose FRMs, as they lack the financial flexibility to manage fluctuating payments associated with ARMs. In times of economic instability or heightened risk aversion, such as after financial crises, both theories agree in arguing that borrowers prefer FRMs to mitigate potential risks tied to interest rate fluctuations.

In the Italian context, these theoretical predictions find strong support, particularly in the years following the 2008 financial crisis. Many households faced reduced incomes, making the stability and predictability of FRMs more appealing. Surveys from the Bank of Italy underline how the crisis impacted household incomes, pushing borrowers with tighter financial constraints to opt for FRMs. This trend was further amplified by the increasing concentration of wealth, as reflected in the rising Gini index, which highlighted growing income inequality. As a result, a larger portion of the population found themselves in financial hardship, leading them to favor the stability of FRMs.

Additionally, the general low level of financial literacy in Italy, particularly among younger borrowers and those with lower educational attainment, reinforced this preference. Many borrowers struggled to understand key financial concepts like interest rates and risk diversification, leading them to perceive FRMs as a safer, more stable option. This was exacerbated by behavioral factors such as the availability heuristic, where borrowers, lacking confidence in their financial knowledge, often relied on advice from family or friends with similarly limited understanding. This created a feedback loop, where FRMs were viewed as the safer, more predictable choice, especially in an environment of economic uncertainty.

Furthermore, the sharp rise in interest rates in 2022, after a prolonged period of historic lows, validated the choice of FRMs for many borrowers. Those who had previously chosen ARMs faced increased payments as rates climbed, while FRM holders benefitted from stable payments, further reinforcing the appeal of FRMs among new borrowers looking to avoid similar risks.

From this point of view, it seems there is no reason why borrowers should have chosen an ARM over an FRM.

- *Reasons for Choosing Adjustable-Rate Mortgages*

Campbell & Cocco, in their theory, argue that wealthier borrowers benefit more from ARMs due to their higher "financial utility." Financial flexibility becomes a key factor in choosing an ARM, as it allows those with more resources to better manage potential interest rate fluctuations. Moreover, contrary to common belief, low interest rates make ARMs a particularly advantageous option. In low-rate environments, ARMs enable borrowers to pay less interest at the start, especially when the mortgage follows the French amortization system, as it does in Italy. With this method, interest payments are concentrated in the early years of the mortgage, meaning that those who benefit from low initial rates can save significantly over the long term. In the Italian context, these dynamics are clearly reflected. The rise in the Gini index has had two effects: on the one hand, the number of people in financial difficulty has increased, but on the other hand, the number of very wealthy individuals has also grown. These wealthy individuals, thanks to their financial flexibility and ability to handle future rate increases, tend to prefer ARMs, knowing they can benefit more from the low initial rates.

Moreover, the results of the study show that these individuals are often those with higher levels of education and, consequently, greater financial literacy, who frequently choose ARMs. In addition to focusing on short-term savings from lower initial interest rates, they are also capable of thinking long-term and better understanding how to take advantage of market dynamics. For instance, the market offers refinancing options that allow switching from an ARM to an FRM. This means that a borrower can switch to a fixed-rate contract when they see rates rising, locking in the contract. This way, they can enjoy the benefits of both types of mortgages. Take, for example, a borrower who chose an ARM in 2012: they were able to enjoy extremely low interest rates for a long period, significantly reducing their interest payments. A financially savvy person also understands the policies of the European Central Bank, which is oriented toward keeping inflation around 2%. This suggests that, aside from unexpected shocks, rates will not stay too high or too low forever, making it even more advantageous to seize opportunities when rates are at historical lows. However, this also reflects the issue of overconfidence, as noted in Chapter 4.2. Being too sure that rates will remain low for an extended period can lead to underestimating the risks of choosing an ARM.

Continuing with the example of someone who opted for a variable-rate mortgage in 2012: although they had to deal with rising rates starting from the period of the Ukraine war in 2022, it is likely that overall, they saved more compared to a borrower with an FRM. Considering the historically low rates they enjoyed for over a decade and the recent downward trend in rates, it is reasonable to assume that, despite temporary fluctuations, they paid less in total than someone who chose a fixed-rate mortgage. Of course, these dynamics can vary case by case, but in general, those who have the ability to plan long-term and take advantage of low initial rates have seen significant benefits.

- *In conclusion, was choosing an ARM a reasonable decision?*

Yes, but it depends. The decision to choose an ARM largely relies on the borrower's financial situation, risk tolerance, and ability to plan long-term. For wealthier, financially literate individuals with the flexibility to manage rate fluctuations, ARMs can lead to significant savings, especially during low-rate periods. However, for those with lower incomes, less financial knowledge, or a higher aversion to risk, the stability of an FRM is often the safer choice. Ultimately, it depends on how well the borrower can anticipate and manage future rate changes.

In practical terms, it makes sense that most of the Italian population opted for FRMs, especially as the country has seen economic difficulties and increasing inequality. For these households, FRMs are economically easier to manage and offer the predictability needed in uncertain times. However, for those with financial capacity and flexibility, ARMs have proven to be a valid and beneficial option, particularly during periods of historically low interest rates.

# Chapter 6 - Limitations and Future research

This thesis investigates the factors influencing mortgage choices among Italian households between 2010 and 2024, using econometric models to analyze data from a specific region. While valuable insights have been obtained, several limitations must be acknowledged, and there are numerous opportunities for future research.

- *Geographic and Demographic Limitations*

The study's data comes predominantly from clients of a Northern Italian bank, which limits the generalizability of the findings beyond this region. It's possible that mortgage preferences in other parts of Europe, influenced by varying economic and regulatory conditions, would show different trends. Future research should consider expanding the geographic scope to include data from different European countries. This would allow for a broader comparison of mortgage behaviors, potentially revealing both common patterns and country-specific differences. By integrating data from multiple regions, researchers could also examine how different economic climates, such as those seen during financial crises or periods of stability, affect mortgage decisions. This would provide a more comprehensive understanding of how households across Europe navigate mortgage choices and adapt to their economic environments.

- *Temporal Constraints*

The time frame covered by this research, from 2010 to 2024, encompasses significant economic events such as the European sovereign debt crisis and the COVID-19 pandemic. These events have likely influenced financial behaviors in ways that may not be typical during more stable periods. While the conclusions drawn from this study are relevant to the economic conditions of the time, they may not fully apply to other periods. Future research could extend the analysis to include different time periods, allowing for a more thorough examination of how households respond to both economic downturns and recoveries. A longitudinal approach would help in understanding how mortgage preferences evolve over time, providing deeper insights into long-term financial behavior.

- *Economic Models and Theoretical Frameworks*

This study relied on two economic models to analyze mortgage choices, providing a solid foundation for understanding household decision-making. However, these models may not capture the full complexity of the factors involved. While the models used are well-established and provide valuable insights, there is room for future research to explore alternative or even contrasting economic theories. Incorporating models from behavioral finance, for example, could shed light on how cognitive biases and psychological factors influence mortgage decisions. By broadening the theoretical framework, researchers could

gain a more nuanced understanding of the motivations behind mortgage choices and potentially uncover factors that were overlooked in this study.

- *Financial Consultancy and Decision-Making*

The role of financial advisors in shaping mortgage decisions was not deeply examined in this thesis. Financial consultations can have a significant impact on consumer choices, particularly for those with limited financial literacy. The strategies used by financial institutions and the transparency of the information they provide could influence how individuals approach mortgage products. Future studies could investigate this relationship in more detail, looking into how trust in financial advisors and the marketing practices of banks affect decision-making. Understanding the impact of personalized financial advice on mortgage preferences would help improve both financial education and the design of consumer-oriented financial products.

- *Range of Mortgage Products*

The research focused primarily on two types of mortgage products: fixed-rate mortgages and adjustable-rate mortgages. However, the mortgage market offers a wider range of products, such as hybrid ARMs and ARMs with rate caps, which present different risk profiles and terms. These other options could influence borrower decisions in ways that were not fully captured in this study. Future research should explore the broader spectrum of mortgage products to understand how they compare to traditional options. This could provide a more complete picture of how different risk levels and contract terms impact borrower preferences.

- *Behavioral Biases in Mortgage Decisions*

Lastly, there is limited research on how behavioral biases, such as overconfidence or anchoring, affect mortgage decisions. These biases can lead consumers to make suboptimal choices, potentially putting them at financial risk. Future research could focus on identifying these common biases and developing strategies to mitigate their impact. By understanding the psychological factors that influence mortgage choices, it would be possible to create tools that help consumers make more informed, rational decisions.

In conclusion, while this thesis provides valuable insights into mortgage decision-making in a specific region and period, there is much potential for future research to expand on these findings. By addressing the geographic, temporal, and theoretical limitations identified, scholars can gain a deeper and more comprehensive understanding of the factors influencing mortgage choices. This, in turn, could lead to more tailored financial products and policies that better meet the needs of consumers across Europe.

# *Appendix A: Mortgage Models and Pricing Framework*

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### *A.1. KHN Mortgage Payment Streams*

The KHN model prices mortgages based on Treasury rates, ensuring that mortgage payments meet a zero-profit condition. This condition implies that the expected mortgage payments must exactly cover the initial loan balance, $B$. Mortgages are priced such that lenders break even, considering both the loan amount and future interest rate risks.

The paper then dives into bond pricing, starting with the nominal short rate, denoted by $y^{\$}t(1)$. This rate consists of two key components: the real interest rate and the expected inflation rate, $xt$. The real interest rate reflects the true value of money over time, excluding inflation's effects, while the expected inflation rate forecasts changes in the general price level of goods. Together, these form the nominal short rate, which adjusts for future inflation to ensure lenders are compensated for any loss in purchasing power.

$$y_t^{\$}(1) = y_t(1) + x_t$$

The nominal short rate is fundamental to calculate the long-term nominal rate. This is simply the nominal interest rate applied for a long-term period (e.g. 10 years) and is calculated as the average of expected future short-term rates, plus the risk premium $\boldsymbol{\phi}^{s}$. This is the compensation that investors demand for taking on additional risk in a given investment over that of a risk free asset (e.g. US T-Bills).

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### *A.2. Time-Varying Market Prices of Risk*

The innovative aspect of this model is that "*the market prices of risk lambda t are time-varying*", meaning that, unlike traditional models, which assume constant risk premiums, the KHN framework accounts for the fact that market conditions are dynamic. Risk premiums can fluctuate due to various factors, including:

- Changes in macroeconomic conditions.
- Shifts in monetary policy.
- Political uncertainty
- Market volatility

This flexibility allows the model to more accurately reflect real-world conditions, making it a better tool for predicting borrower behavior and pricing decisions in the mortgage market. The recognition of time-varying risk premiums helps explain why mortgage rates and borrower preferences may shift significantly in response to changing external factors.

### *A.3. Two-Period Long-Term Interest Rate*

To illustrate the mechanics of long-term rate pricing, consider a two-period long-term interest rate, $y_0(2)$. This rate is derived as the average of the expected short-term rates over two periods, plus a risk premium to account for uncertainties over that timeframe. The formula is expressed as:

$$y_0^{\$}(2) = \frac{y_0^{\$}(1) + E_0(y_1^{\$}(1))}{2} + \varphi_0^{\$}(2)$$

Where:

- $y_0(1)$ is the short-term interest rate for the current period.
- $E_0(y_1(1))$ is the expected short-term interest rate for the next period.
- $\phi_0 s(2)$ is the risk premium for holding a two-period bond.

This equation shows that the long-term interest rate reflects not just the expected future short-term rates but also the compensation for the risks associated with holding a long-term investment. The risk premium increases as the investment horizon lengthens, reflecting the greater uncertainty over longer timeframes. In essence, the long-term interest rate helps investors decide between short-term and long-term investments by comparing the potential returns with the risks of holding a long-term asset. This mechanism is crucial for mortgage pricing, as it determines the cost of borrowing for longer-term loans like 30-year fixed-rate mortgages.

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### *A.4. Bond Pricing and Inflation Adjustment*

The KHN model also incorporates bond pricing, where the price of a one-period nominal bond, $P^{\$}t(1)$, is built on the assumption that actual inflation matches expected inflation. This means that bond prices adjust based on the nominal short rate, which includes the expected inflation component.

- Bond Prices and Inflation: If inflation expectations are accurate, bondholders are adequately compensated for the reduction in the purchasing power of future payments. If inflation is higher than expected, bondholders receive less in real terms, and the bond price declines.

This bond pricing framework is essential for mortgage pricing because mortgages, especially FRMs, resemble bonds in that they involve fixed payments over a long period. The nominal bond price therefore provides a benchmark for understanding how inflation and interest rate expectations influence mortgage costs.

# *Appendix B: Campbell & Cocco (2003) – Consumption, Wealth, and Mortgage Choices*

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### *B.1. Consumption and Wealth Analysis*

Campbell and Cocco (2003) focus on how different types of mortgages, particularly Adjustable-Rate Mortgages and Fixed-Rate Mortgages, influence household consumption and wealth under various economic conditions. Their analysis is particularly insightful for understanding how changes in mortgage types, income risks, and other factors affect consumer behavior over time.

#### *B.1.1. Average Consumption Growth and Volatility*

One key aspect of the study is the examination of average consumption growth and its volatility, based on three primary factors:

1. House Size
2. Income Risk Level
3. Type of Mortgage (ARMs vs. FRMs)

By separating households into singles and couples, Campbell and Cocco show that consumption growth rates are relatively stable across mortgage types. This stability is attributed to two key factors:

- A hump-shaped labor income profile, where income peaks in middle age and declines toward retirement.
- Borrowing constraints, which limit the ability of households to significantly change their consumption patterns.

#### *B.1.2. Hump-Shaped Labor Income Theory*

The hump-shaped labor income theory is based on the idea that individuals experience a peak in earnings in middle age, followed by a gradual decline as they approach retirement. This affects mortgage decisions because borrowers tend to adjust their financial commitments according to their expected future income. For example, households with ARMs, which often have lower initial payments, might maintain slightly higher consumption growth because they expect their incomes to rise in the short term. However, these borrowers also face higher risks due to the potential for fluctuating interest rates.

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## *B.2. Comparison of ARMs and FRMs*

*B.2.1. Welfare Gains from Mortgage Types*

Campbell and Cocco explore the welfare gains households derive from different mortgage types by focusing on refinancing options and interest rate risks. Their analysis uses Table III to compare welfare gains from:

- Nominal FRMs with and without refinancing at a $1,000 cost.
- ARMs, which generally offer lower initial payments but expose borrowers to future interest rate fluctuations.

Their findings suggest that households experience higher utility with ARMs in many cases, but this depends heavily on factors like income risk and house size. For example:

- A couple purchasing a large house with low-income risk may be 5.96% worse off with a refinanceable FRM than with an ARM.
- The welfare gap narrows for households with higher income volatility, indicating that ARMs might be less advantageous in these scenarios due to the higher cash-flow risks

*TABLE 1- THE TABLE DISPLAYS VARIOUS REAL ESTATE INVESTMENT STRATEGIES FOR BOTH COUPLES AND SINGLES. OPTIONS INCLUDE PURCHASING PROPERTIES VALUED AT $187,500 AND $150,000, EACH ASSOCIATED WITH TWO DIFFERENT LEVELS OF UNCERTAINTY, HIGH AND LOW. THE COLUMNS SHOW THE PERCENTAGE VALUES REPRESENTING THE WEALTH UTILITY OF FRMS COMPARED TO ADJUSTABLE-RATE MORTGAGES ARMS UNDER SCENARIOS WITH AND WITHOUT THE OPTION OF REFINANCING. AT THE END OF THE TABLE, THE MONETARY VALUE OF THE REFINANCING OPTION IS DETAILED*

WELFARE ANALYSIS OF NOMINAL MORTGAGES

| | FRM | | |
|---|---|---|---|
| Refinancing | Yes | No | Refinancing option |
| | | Panel A: Couple | |
| $\bar{H} = 125.0, \sigma_\omega = .141$ | −6.34 | −6.84 | 0.50 |
| $\bar{H} = 125.0, \sigma_\omega = .248$ | −5.72 | −6.32 | 0.59 |
| $\bar{H} = 187.5, \sigma_\omega = .141$ | −5.96 | −6.79 | 0.83 |
| $\bar{H} = 187.5, \sigma_\omega = .248$ | −5.40 | −6.31 | 0.91 |
| | | Panel B: Single | |
| $\bar{H} = 125.0, \sigma_\omega = .141$ | −5.77 | −6.51 | 0.74 |
| $\bar{H} = 125.0, \sigma_\omega = .248$ | −5.43 | −6.20 | 0.76 |
| $\bar{H} = 187.5, \sigma_\omega = .141$ | −5.71 | −7.29 | 1.58 |
| $\bar{H} = 187.5, \sigma_\omega = .248$ | −1.03 | −3.16 | 2.13 |

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### *B.3. Utility Function and Financial Decisions*

#### *B.3.1. Utility Analysis for Singles vs. Couples*

The authors apply a utility function to analyze mortgage decisions for a sample of 1,000 households, divided between singles and couples. They use the following parameters:

- Mortgage duration: 30 years.
- Discount factor (β): 0.98.
- Risk aversion (γ): 3.
- Consumption (Cij) and wealth (Wj,t+1) as key variables.

The results indicate that ARMs provide higher utility compared to FRMs for most households, but the gap in utility between singles and couples is substantial due to the financial flexibility that couples enjoy. Couples, with their combined income, are better able to manage the risks associated with fluctuating interest rates in ARMs, whereas singles are more vulnerable to such risks.

#### *B.3.2. The Role of Income and Wealth in Mortgage Decisions*

- Couples have more income stability, allowing them to take on more risk with ARMs, which typically have lower initial payments but greater potential for future fluctuations.

- Singles, with only one source of income, are more exposed to the income risks inherent in ARMs. As a result, they may prefer FRMs despite the higher initial payments, as these provide more predictability over the life of the loan.

This analysis underscores how mortgage choices are closely tied to a household's financial situation, with couples benefiting more from ARMs due to their greater financial resilience, while singles may lean toward the security of FRMs.

*TABLE 2 - THE TABLE PRESENTS A STUDY OF THE POTENTIAL FOR CONSUMPTION GROWTH BETWEEN ADJUSTABLE-RATE MORTGAGES (ARM) AND FIXED-RATE MORTGAGES (FRM), EXAMINING CASES SEPARATELY FOR COUPLES AND SINGLES. INVESTMENT OPTIONS INCLUDE PROPERTIES VALUED AT $187,500 AND $150,000, EACH WITH TWO LEVELS OF UNCERTAINTY, HIGH AND LOW. THE COLUMNS DISPLAY PERCENTAGE VALUES INDICATING THE UTILITY IN TERMS OF CONSUMPTION GROWTH FOR BOTH ARM AND FRM, CONSIDERING SCENARIOS WITH AND WITHOUT THE REFINANCING OPTION. ADDITIONALLY, THE VALUE OF THE REFINANCING OPTION IS SPECIFIED AT THE END OF THE TABLE*

CONSUMPTION GROWTH WITH NOMINAL MORTGAGES

| | $\overline{\Delta c_t}$ | | | $\sigma(\Delta c_t)$ | | |
|---|---|---|---|---|---|---|
| Refinancing | ARM | FRM Yes | FRM No | ARM | FRM Yes | FRM No |
| | | | Panel A: Couple | | | |
| $\bar{H} = 125.0, \sigma_\omega = .141$ | 1.5 | 1.5 | 1.5 | 12.1 | 13.6 | 13.7 |
| $\bar{H} = 125.0, \sigma_\omega = .248$ | 2.2 | 2.2 | 2.2 | 17.1 | 18.6 | 18.7 |
| $\bar{H} = 187.5, \sigma_\omega = .141$ | 2.0 | 2.0 | 1.9 | 13.9 | 15.6 | 15.9 |
| $\bar{H} = 187.5, \sigma_\omega = .248$ | 2.8 | 2.8 | 2.8 | 19.4 | 20.7 | 20.9 |
| | | | Panel B: Single | | | |
| $\bar{H} = 125.0, \sigma_\omega = .141$ | 1.9 | 1.9 | 1.8 | 13.5 | 15.2 | 15.5 |
| $\bar{H} = 125.0, \sigma_\omega = .248$ | 2.8 | 2.8 | 2.8 | 17.6 | 18.8 | 19.0 |
| $\bar{H} = 187.5, \sigma_\omega = .141$ | 3.0 | 2.9 | 2.8 | 17.9 | 19.5 | 20.0 |
| $\bar{H} = 187.5, \sigma_\omega = .248$ | 4.1 | 4.1 | 4.1 | 22.4 | 24.2 | 24.7 |

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### *B.4. Volatility of Consumption and Wealth*

#### *B.4.1. ARM vs. FRM: Consumption Stability*

The authors also explore the volatility of consumption patterns across different mortgage types:

- ARMs tend to lead to greater consumption volatility, as changes in interest rates directly affect mortgage payments.
- FRMs, particularly those with refinancing options, offer more stable consumption patterns, as payments remain fixed despite fluctuations in the broader economic environment.

The findings indicate that wealth risk, more than income risk, plays a dominant role in shaping the volatility of consumption over the life cycle of a mortgage contract. ARMs provide households with the potential for higher consumption in the short term, but they expose borrowers to future volatility.

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### *B.5. Implications for Mortgage Choices and Final Wealth*

In conclusion, Campbell and Cocco's analysis highlights the trade-offs households face when choosing between ARMs and FRMs:

- ARMs may provide higher short-term utility and more flexibility, but they come with greater risks in the form of interest rate fluctuations.
- FRMs offer more stable payments and less exposure to future interest rate changes, making them a better option for risk-averse households, especially those with high income volatility.

Overall, the study shows that mortgage decisions are influenced not only by current financial conditions but also by a household's expected future income and risk tolerance, with ARMs tending to favor wealthier and more financially flexible households like couples, while FRMs may be more suitable for individuals with higher risk aversion or more volatile incomes.

# *Appendix C: Parameter Sensitivity and Model Applications*

### *C.1. Alternative Parameterizations (Campbell & Cocco 2003)*

Campbell & Cocco tested the robustness of their model by adjusting key parameters to see how mortgage decisions change under different economic scenarios. This sensitivity analysis allows a deeper understanding of how various factors, such as income volatility, time horizons, and risk preferences, affect household preferences for Adjustable-Rate Mortgages and Fixed-Rate Mortgages.

*TABLE 3- THIS TABLE ILLUSTRATES THE AVERAGE WELFARE GAINS OF A NOMINAL FIXED-RATE MORTGAGE COMPARED TO AN ADJUSTABLE-RATE MORTGAGE UNDER VARIOUS PARAMETRIZATIONS. THE FIRST ROW PRESENTS THE BENCHMARK CONDITION, WHILE SUBSEQUENT ROWS SPECIFY THE VARIABLE MODIFICATIONS AND THEIR NEW VALUES. UTILITY CALCULATIONS ARE BASED ON A $187,500 HOUSE IN A LOW VOLATILITY SCENARIO FOR A COUPLE.*
*SOURCE: CAMPBELL & COCCO, 2003*

| | Nominal FRM |
|---|---|
| 1. Benchmark | −5.96 |
| 2. Correlated income and inflation ($\varphi = -1.00$) | −2.87 |
| 3. 1983–1999 parameters | −6.94 |
| 4. Lower second loan premium ($\theta^B = 0.01$) | −6.40 |
| 5. Higher moving probability ($p = 0.10$) | −6.60 |
| 6. Lower rental premium ($\theta^Z = 0.02$) | −6.08 |
| 7. Higher rental premium ($\theta^Z = 0.04$) | −5.79 |
| 8. Higher time discount rate ($\beta = 0.90$) | −6.49 |
| 9. Higher risk aversion ($\gamma = 5$) | −1.33 |
| 10. More volatile permanent income ($\sigma_\eta = 0.05$) | −5.11 |
| 11. Hybrid ARM contract | −6.75 |
| 12. Correlated income and real rates | −5.90 |
| 13. Term premium in the real term structure | −5.96 |

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#### *C.1.1. Negative Correlation Between Income and Inflation (Row 2)*

When nominal income and inflation are negatively correlated (set to a value of -1), the attractiveness of nominal FRMs increases. This scenario assumes that when inflation rises, wages decrease proportionally, and vice versa.

- With ARMs, rising inflation leads to higher interest rates, increasing mortgage payments at a time when households are earning less. This mismatch between income and mortgage payments can severely reduce consumption and force households to dip into savings.

- In contrast, FRMs, which offer fixed payments, are less affected by inflationary shocks, making them a safer option under these conditions. As a result, the utility gap between ARMs and FRMs narrows.

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*C.1.2. Shorter Mortgage Duration (Row 5)*

Campbell & Cocco consider a scenario where households are likely to move every 10 years (instead of the default 30-year period). This change shortens the mortgage contract duration and influences the relative benefits of ARMs versus FRMs:

- Since ARMs generally have lower interest rates in the early years of a contract, they become more attractive for shorter durations, as households are less exposed to future interest rate fluctuations.
- Frequent refinancing or early payoff of the mortgage reduces the impact of future rate changes. ARMs allow households to maintain lower payments in the initial period and refinance before significant rate increases.
- On the other hand, FRMs come with potential prepayment penalties and higher upfront costs, making them less appealing for households that do not plan to stay in the home long term.

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*C.1.3. Higher Time Discount Factor (Row 8)*

The model introduces a higher time discount factor, set at 0.90, which reflects a stronger preference for present consumption over future consumption. Households with this characteristic (referred to as impatient investors) prioritize immediate consumption and are less concerned about future risks.

- These impatient investors, typically with lower savings and higher default risks, are more likely to prefer ARMs due to the lower initial payments.
- Although ARMs pose higher long-term risks, such as fluctuating interest rates, the immediate benefits in the form of reduced mortgage payments outweigh these future risks for impatient households.

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*C.1.4. Increased Risk Aversion (Row 9)*

In this scenario, the risk aversion coefficient is increased from 3 to 5, meaning that households have a greater preference for certainty and are less willing to accept financial risks.

- FRMs become significantly more attractive for risk-averse households because they provide predictable, fixed payments over time, shielding borrowers from the uncertainty of rising interest rates.
- Households with higher risk aversion prefer the stability of FRMs despite the higher initial cost. The delta between the final wealth outcomes of ARMs and FRMs narrows as borrowers prioritize certainty over potential future gains from adjustable rates.

While ARMs still offer higher utility under certain conditions, the gap is significantly reduced when borrowers have a strong preference for minimizing uncertainty.

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### *C.2. KHN Model Extensions and Real-World Comparisons*

The KHN model extends its analysis by incorporating additional real-world considerations, such as prepayment options and financial constraints, to better simulate household mortgage decisions in dynamic economic environments.

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#### *C.2.1. Prepayment Option in FRMs*

The prepayment option allows households to pay off or refinance their mortgage early, often to switch from an FRM to an ARM when it becomes more financially advantageous. This option introduces flexibility, especially in times of fluctuating interest rates:

- If a household expects interest rates to drop, they can refinance their FRM into an ARM, potentially reducing overall mortgage costs.
- FRMs with prepayment options act similarly to callable bonds, where borrowers have the right to repay their loan early and take advantage of lower interest rates.

However, prepayment penalties can reduce the benefit of this option. Households must weigh the cost of early repayment against the potential savings from lower future interest rates.

---

#### *C.2.2. FRMs as Callable Bonds vs. Non-Callable Bonds*

In the context of bond pricing, the KHN model compares FRMs with a prepayment option (analogous to callable bonds) to FRMs without this option (similar to non-callable bonds). The key insight from this comparison is that the value of the prepayment option diminishes over time:

- Callable bonds (FRMs with prepayment options) offer lower initial prices because of the added flexibility, but over time, as the mortgage nears its end, the value of this flexibility decreases. By the end of the mortgage term, both callable and non-callable bonds converge in value.

This comparison helps explain why FRMs with prepayment options can be attractive early in the mortgage, but lose their appeal over time, particularly in low-interest-rate environments where prepayment penalties outweigh the potential benefits of refinancing.

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*C.2.3. Impact of Bond Risk Premiums on Utility*

The KHN model explores the utility differential between ARMs and FRMs, particularly under varying bond risk premiums. As the bond premium increases, ARMs become riskier, and the utility advantage of ARMs diminishes:

- When bond risk premiums rise, FRMs offer more utility stability, particularly when they include a prepayment option. The prepayment option helps mitigate some of the risks associated with higher interest rates, making FRMs with prepayment options less sensitive to increases in bond premiums.
- Conversely, when the bond risk premium is low, ARMs remain attractive due to their lower initial payments and the limited need for prepayment flexibility.

Overall, FRMs with prepayment options provide a middle ground between the stability of FRMs and the flexibility of ARMs, offering households a way to hedge against future interest rate volatility.

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### *C.3. Correlation Analysis and Descriptive Statistics*

In their empirical analysis, Campbell & Cocco and KHN utilize correlation analysis to quantify the relationships between key economic variables, mortgage decisions, and borrower characteristics. This provides valuable insights into how different factors interact in determining mortgage choices.

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*C.3.1. Correlations Among Variables*

First there are two important Boolean variables: *Property* and *Occupation.* The first one says if the house's ownership is joint (1) or not (0) and is the best proxy to the single/couple division given from *Campbell&Cocco 2003.* The second instead says if the buyer is an autonomous worker (1) or an employee (0).

TABLE 4- CORRELATION MATRIX

| | Age at origination | Interest rate at origination | Financed Amount | House value | Net Income | Mortgage Duratio | Gender | Property | Occupation |
|---|---|---|---|---|---|---|---|---|---|
| Age at origination | 1 | | | | | | | | |
| Interest rate at origination | -0,04 | 1 | | | | | | | |
| Financed Amount | 0,04 | -0,08 | 1 | | | | | | |
| House value | 0,47 | -0,11 | 0,56 | 1 | | | | | |
| Net Income | 0,69 | -0,11 | 0,89 | 0,59 | 1 | | | | |
| Mortgage Duration | -0,42 | 0,17 | 0,12 | -0,02 | -0,18 | 1 | | | |
| Gender | -0,01 | 0,03 | 0,01 | 0,01 | -0,02 | 0,02 | 1 | | |
| Property | N/A | N/A | -0,14 | 0,08 | -0,11 | -0,01 | N/A | 1 | |
| Occupation | 0,13 | -0,09 | 0,25 | 0,23 | 0,26 | -0,07 | 0,18 | 0,43 | 1 |

Most of the strongest relationships in the data are positive, with Net Income emerging as one of the highest influential variables. Two of the strongest correlations involve Net Income with the Financed Amount (0.89) and House Value (0.59). These two variables are also strongly linked with each other, with a correlation of 0.56. This relationship reflects standard banking practices, where the amount financed typically ranges between 50% and 80% of the property's value. Essentially this triple relationship says that wealthier individuals can afford to purchase more expensive homes and are also more capable of managing debt, making banks more willing to extend larger loans to them, and so higher value houses. Net Income also shows a significant relationship with Age at Origination, with a correlation of 0.69. This finding supports the discussion in the "3.2.2 Income Distribution" section, where it was noted that older borrowers generally have higher net incomes. Age at Origination is another variable with several notable correlations. In addition to its relationship with Net Income, it is also correlated with House Value (0.47) and Mortgage Duration (-0.42). The positive correlation with House Value is similar to the reasoning for income, older individuals tend to have more financial resources and can therefore afford higher-value properties. The negative correlation with Mortgage Duration provides an interesting insight: it indicates that younger borrowers are more likely to take out longer-term mortgages, while older borrowers prefer shorter terms

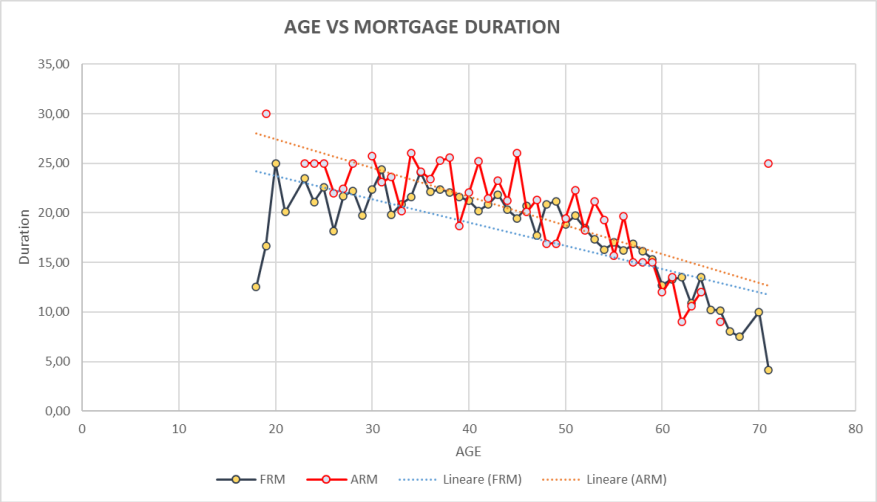


*Figure 1*

*Comparison of sample's households' age at origination and the term length of the underwritten mortgage*

The negative correlation between age and mortgage duration could mean that as people get older, they tend to choose shorter mortgages. This is likely because older borrowers want to reduce their debt before they retire. With more financial security, they might prefer to make higher monthly payments over a shorter period to pay off their mortgage faster. Lenders also might prefer offering shorter terms to older borrowers to reduce the risk associated with long-term debt. In short, as people age, they often prioritize paying off their mortgages more quickly to ensure financial stability as they approach retirement.

An additional notable correlation is between Occupation and Property, which shows a correlation of 0.43, suggesting that self-employed individuals are more likely to have private ownership of their property rather than co-ownership. This might reflect the financial capabilities and control often associated with self-employment, which allows for more straightforward property ownership. Furthermore, for the same reason autonomous workers can afford more expensive properties, thereby occupation also shows a modest correlation of around 0.25 with House Value, Financed Amount, and Net Income. Unfortunately, for lack of data, property was not comparable with *Gender, Age at origination and Interest rate at origination*

Lastly, gender was also considered as a Boolean variable, with 1 corresponding to male and 0 to female. The results coming from the quantitative analysis underline how this sample, differently from common narration, shows a lack of significant correlations between gender and the other variables, suggesting that gender does not have a meaningful impact on mortgage-related decisions.

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*C.3.2. Swap Rate and ARM Share*

The relationship between the 5-year swap rate and the ARM share provides insights into how interest rate environments affect borrower preferences:

- The correlation between the swap rate and ARM share is relatively weak, with an R-squared value of 0.217. This suggests that while the swap rate influences the share of ARMs, other factors (such as borrower risk preferences and market conditions) play a more significant role.
- ANOVA tests indicate that the relationship between the swap rate and ARM share is not statistically significant at the 95% confidence level, reinforcing the idea that borrower behavior is influenced by a broader set of factors beyond interest rate movements alone.

# Appendix D: Statistical Results

## D.1. General data Appllication – For Campbell&Cocco Comparison

### D.1.1.Net Income, Interest Rate, Duration, Gender, Occupation or Property

| Regression's Statistics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R Multiple | 0,158269852 | | | | | | | |
| R squared | 0,025049346 | | | | | | | |
| Adjusted R squared | 0,020956354 | | | | | | | |
| Standard Error | 0,370012213 | | | | | | | |
| Observations | 1197 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | df | SQ | MQ | F | F-Statistic Significance | | | |
| Regression | 5 | 4,189456059 | 0,837891212 | 6,120057697 | 1,31577E-05 | | | |
| Residual | 1191 | 163,0586642 | 0,136909038 | | | | | |
| Total | 1196 | 167,2481203 | | | | | | |
| | | | | | | | | |
| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 1,090088689 | 0,052244921 | 20,86496946 | 1,19422E-82 | 0,987586358 | 1,19259102 | 0,987586358 | 1,19259102 |
| Interest rate | -7,13615E-07 | 5,02315E-07 | -1,420652287 | 0,155679609 | -1,69914E-06 | 2,71906E-07 | -1,69914E-06 | 2,71906E-07 |
| Net income | -0,072429061 | 0,976628516 | -0,074162345 | 0,940893661 | -1,988533003 | 1,843674881 | -1,988533003 | 1,843674881 |
| Mortgage Duration | -0,009548444 | 0,002167594 | -4,405088903 | 1,15251E-05 | -0,013801171 | -0,005295716 | -0,013801171 | -0,005295716 |
| Gender | -0,040141051 | 0,022438037 | -1,788973375 | 0,073873159 | -0,084163533 | 0,003881431 | -0,084163533 | 0,003881431 |
| Occupation | -0,048803399 | 0,023527626 | -2,074301919 | 0,038265695 | -0,094963608 | -0,00264319 | -0,094963608 | -0,00264319 |

*Linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: net income, interest rate, duration, gender, and occupation. Data from the bank's sample is used.*

| Regression's Statistics | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| R Multiple | 0,136636421 | | | | | | | |
| R squared | 0,018669511 | | | | | | | |
| Adjusted R squared | 0,017117387 | | | | | | | |
| Standard Error | 0,383827995 | | | | | | | |
| Observations | 2534 | | | | | | | |
| | | | | | | | | |
| ANOVA | | | | | | | | |
| | df | SQ | MQ | F | F-Statistic Significance | | | |
| Regression | 4 | 7,088262391 | 1,772065598 | 12,02836224 | 1,10029E-09 | | | |
| Residual | 2529 | 372,5822191 | 0,14732393 | | | | | |
| Total | 2533 | 379,6704815 | | | | | | |
| | | | | | | | | |
| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
| Intercept | 1,014720741 | 0,035542277 | 28,54968336 | 1,2209E-155 | 0,945025804 | 1,084415678 | 0,945025804 | 1,084415678 |
| Interest rate | -1,833232118 | 0,703461032 | -2,606018008 | 0,009213909 | -3,212650582 | -0,453813654 | -3,212650582 | -0,453813654 |
| Net income | -1,09517E-06 | 2,22144E-07 | -4,9300169 | 8,75458E-07 | -1,53078E-06 | -6,5957E-07 | -1,53078E-06 | -6,5957E-07 |
| Mortgage Duration | -0,006309114 | 0,001506955 | -4,186663966 | 2,92763E-05 | -0,009264106 | -0,003354122 | -0,009264106 | -0,003354122 |
| Property | 0,005067219 | 0,015387935 | 0,329298145 | 0,741957615 | -0,025107021 | 0,035241458 | -0,025107021 | 0,035241458 |

*Linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: net income, interest rate, duration and property. Data from the bank's sample is used.*

## D.2.1. House Value, Interest Rate, Duration, Occupation or Property

| Regression's Statistics | |
|---|---|
| R Multiple | 0,120619585 |
| R squared | 0,014549084 |
| Adjusted R squared | 0,012990443 |
| Standard Error | 0,384632963 |
| Observations | 2534 |

ANOVA

| | df | SQ | MQ | F | F-Statistic Significance |
|---|---|---|---|---|---|
| Regression | 4 | 5,523857813 | 1,380964453 | 9,334466441 | 1,73459E-07 |
| Residual | 2529 | 374,1466236 | 0,147942516 | | |
| Total | 2533 | 379,6704815 | | | |

| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0,981597817 | 0,032726139 | 29,99430552 | 2,263E-169 | 0,917425051 | 1,045770584 | 0,917425051 | 1,045770584 |
| Interest rate | -2,047771012 | 0,705102172 | -2,904218841 | 0,00371363 | -3,43040759 | -0,665134434 | -3,43040759 | -0,665134434 |
| House Value | -5,73593E-08 | 1,63465E-08 | -3,508957377 | 0,000457721 | -8,94133E-08 | -2,53053E-08 | -8,94133E-08 | -2,53053E-08 |
| Mortgage Duration | -0,005074103 | 0,001486011 | -3,414580515 | 0,000648872 | -0,007988025 | -0,002160181 | -0,007988025 | -0,002160181 |
| Occupation | -0,016336412 | 0,02054528 | -0,795141864 | 0,426605601 | -0,056623703 | 0,023950878 | -0,056623703 | 0,023950878 |

*Linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: house value, interest rate, duration and occupation. Data from the bank's sample is used.*

| Regression's Statistics | |
|---|---|
| R Multiple | 0,122191624 |
| R squared | 0,014930793 |
| Adjusted R squared | 0,013372755 |
| Standard Error | 0,384558463 |
| Observations | 2534 |

ANOVA

| | df | SQ | MQ | F | F-Statistic Significance |
|---|---|---|---|---|---|
| Regression | 4 | 5,668781336 | 1,417195334 | 9,583076757 | 1,08921E-07 |
| Residual | 2529 | 374,0017001 | 0,147885212 | | |
| Total | 2533 | 379,6704815 | | | |

| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0,967311601 | 0,03344663 | 28,92104789 | 3,8789E-159 | 0,901726021 | 1,032897181 | 0,901726021 | 1,032897181 |
| Interest rate | -1,978317821 | 0,704423306 | -2,808421876 | 0,005016714 | -3,359623209 | -0,597012433 | -3,359623209 | -0,597012433 |
| House Value | -6,17782E-08 | 1,61602E-08 | -3,822863678 | 0,000135095 | -9,34667E-08 | -3,00896E-08 | -9,34667E-08 | -3,00896E-08 |
| Mortgage Duration | -0,005032385 | 0,001484852 | -3,389149227 | 0,000711845 | -0,007944035 | -0,002120735 | -0,007944035 | -0,002120735 |
| Property | 0,019554308 | 0,015399152 | 1,269830159 | 0,204261961 | -0,010641927 | 0,049750543 | -0,010641927 | 0,049750543 |

*A linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: house value, interest rate, duration and property. Data from the bank's sample is used.*

## D.3.1. Financing, Interest Rate, Duration, Age, Occupation or Property

| Regression's Statistics | |
|---|---|
| R Multiple | 0,136491158 |
| R squared | 0,018629836 |
| Adjusted R squared | 0,016688835 |
| Standard Error | 0,383911664 |
| Observations | 2534 |

ANOVA

| | df | SQ | MQ | F | F-Statistic Significance |
|---|---|---|---|---|---|
| Regression | 5 | 7,07319886 | 1,414639772 | 9,598055355 | 4,3501E-09 |
| Residual | 2528 | 372,5972826 | 0,147388166 | | |
| Total | 2533 | 379,6704815 | | | |

| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0,961478387 | 0,034219823 | 28,09711777 | 2,1159E-151 | 0,89437664 | 1,028580134 | 0,89437664 | 1,028580134 |
| Interest rate | -1,987080242 | 0,703859248 | -2,823121594 | 0,004793073 | -3,36727983 | -0,606880655 | -3,36727983 | -0,606880655 |
| Financing | -2,2155E-07 | 5,79754E-08 | -3,821447895 | 0,000135869 | -3,35234E-07 | -1,07866E-07 | -3,35234E-07 | -1,07866E-07 |
| Mortgage Duration | -0,004039065 | 0,001497988 | -2,69632575 | 0,007057394 | -0,006976474 | -0,001101655 | -0,006976474 | -0,001101655 |
| Occupation | -0,046944352 | 0,02251114 | -2,085383111 | 0,037134615 | -0,09108651 | -0,002802193 | -0,09108651 | -0,002802193 |
| Age | 0,000867126 | 0,00037969 | 2,283775988 | 0,022467288 | 0,000122592 | 0,00161166 | 0,000122592 | 0,00161166 |

*Linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: financing, interest rate, duration, age, and occupation. Data from the bank's sample is used.*

| Regression's Statistics | |
|---|---|
| R Multiple | 0,139648078 |
| R squared | 0,019501586 |
| Adjusted R squared | 0,017562309 |
| Standard Error | 0,383741112 |
| Observations | 2534 |

ANOVA

| | df | SQ | MQ | F | F-Statistic Significance |
|---|---|---|---|---|---|
| Regression | 5 | 7,404176406 | 1,480835281 | 10,05611182 | 1,5109E-09 |
| Residual | 2528 | 372,266305 | 0,147257241 | | |
| Total | 2533 | 379,6704815 | | | |

| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0,955629903 | 0,034269344 | 27,88585309 | 1,9435E-149 | 0,888431048 | 1,022828757 | 0,888431048 | 1,022828757 |
| Interest rate | -1,96178942 | 0,702927065 | -2,790886162 | 0,005295859 | -3,340161088 | -0,583417752 | -3,340161088 | -0,583417752 |
| Financing | -2,49436E-07 | 5,7799E-08 | -4,315579186 | 1,65307E-05 | -3,62775E-07 | -1,36098E-07 | -3,62775E-07 | -1,36098E-07 |
| Mortgage Duration | -0,003165695 | 0,001534195 | -2,063424157 | 0,039174217 | -0,006174102 | -0,000157288 | -0,006174102 | -0,000157288 |
| Property | -0,095153312 | 0,037037524 | -2,569105672 | 0,010253017 | -0,167780296 | -0,022526327 | -0,167780296 | -0,022526327 |
| Age | 0,002428312 | 0,000817829 | 2,969218339 | 0,00301366 | 0,000824629 | 0,004031994 | 0,000824629 | 0,004031994 |

*Linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: net income, interest rate, duration, age, and property. Data from the bank's sample is used.*

| Regression's Statistics | |
|---|---|
| R Multiple | 0,126815428 |
| R squared | 0,016082153 |
| Adjusted R squared | 0,014525936 |
| Standard Error | 0,384333659 |
| Observations | 2534 |

ANOVA

| | df | SQ | MQ | F | F-Statistic Significance |
|---|---|---|---|---|---|
| Regression | 4 | 6,105918645 | 1,526479661 | 10,33413618 | 2,66417E-08 |
| Residual | 2529 | 373,5645628 | 0,147712362 | | |
| Total | 2533 | 379,6704815 | | | |

| | Coefficients | Standard Error | t-Stat | Significance Value | Lower 95% | Upper 95% | Lower 95% | Upper 95% |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0,97547344 | 0,033663273 | 28,9773799 | 1,1379E-159 | 0,909463047 | 1,041483834 | 0,909463047 | 1,041483834 |
| Interest rate | -1,941985268 | 0,703980785 | -2,758577093 | 0,005847134 | -3,322422917 | -0,561547619 | -3,322422917 | -0,561547619 |
| Financing | -2,42598E-07 | 5,78423E-08 | -4,194135198 | 2,83344E-05 | -3,56022E-07 | -1,29175E-07 | -3,56022E-07 | -1,29175E-07 |
| Mortgage Duration | -0,004229827 | 0,001494051 | -2,831111868 | 0,004675312 | -0,007159516 | -0,001300138 | -0,007159516 | -0,001300138 |
| Property | 0,004822956 | 0,015452639 | 0,312112151 | 0,754981022 | -0,025478161 | 0,035124073 | -0,025478161 | 0,035124073 |

*Linear regression analysis to determine the choice between an ARM and an FRM based on variables the independent variables: net income, interest rate, duration and property. Data from the bank's sample is used.*

## D.2. Household decision rule statistical results

TABLE 5 - HOUSEHOLD DECISION RULE ANALYSIS USING MONTHLY 10-YEAR SWAP AS LONG-TERM BOND AND MONTHLY 1-YEAR SWAP AS SHORT-TERM BOND. THE COLUMNS, FROM THE LEFT, DETAIL THE YEAR OF DATA COLLECTION, THE CORRESPONDING SWAPS FOR EACH YEAR, THE MOVING AVERAGE CALCULATED FROM THE MONTHLY 1-YEAR SWAPS OVER THE PREVIOUS 36 MONTHS, AND THE HOUSEHOLD DECISION RULE DERIVED FROM THIS DATA

| Year | Swap 10 y | Swap 1y | Moving Avarage | HDR |
|---|---|---|---|---|
| 2010 | 2,93% | 1,41% | | |
| 2011 | 3,08% | 1,69% | | |
| 2012 | 1,91% | 0,65% | 0,94% | 1,07% |
| 2013 | 1,90% | 0,38% | 0,97% | 1,53% |
| 2014 | 1,38% | 0,25% | 0,64% | 1,13% |
| 2015 | 0,87% | 0,01% | 0,29% | 0,86% |
| 2016 | 0,50% | -0,20% | 0,11% | 0,70% |
| 2017 | 0,83% | -0,26% | -0,08% | 1,09% |
| 2018 | 0,94% | -0,26% | -0,21% | 1,20% |
| 2019 | 0,23% | -0,34% | -0,26% | 0,57% |
| 2020 | -0,18% | -0,42% | -0,31% | 0,24% |
| 2021 | 0,09% | -0,49% | -0,38% | 0,58% |
| 2022 | 2,02% | 1,54% | -0,21% | 0,48% |
| 2023 | 3,02% | 3,82% | 0,97% | -0,79% |
| 2024 | 2,70% | 3,42% | 2,13% | -0,72% |

*Table 6 - Household Decision Rule Analysis using Monthly 5-Year Swap as Long-Term Bond and Monthly 1-Year Swap as Short-Term Bond. The columns, from the left, detail the year of data collection, the corresponding swaps for each year, the moving average calculated from the monthly 1-year swaps over the previous 36 months, and the household decision rule derived from this data*

| Year | Swap 5y | Swap 1y | Moving Average | HDR |
|---|---|---|---|---|
| 2010 | 2,20% | 1,41% | | |
| 2011 | 2,37% | 1,69% | | |
| 2012 | 1,13% | 0,65% | | |
| 2013 | 1,07% | 0,38% | 1,03% | 0,77% |
| 2014 | 0,61% | 0,25% | 0,68% | 0,39% |
| 2015 | 0,30% | 0,01% | 0,31% | 0,29% |
| 2016 | -0,02% | -0,20% | 0,13% | 0,17% |
| 2017 | 0,22% | -0,26% | -0,07% | 0,46% |
| 2018 | 0,31% | -0,26% | -0,20% | 0,60% |
| 2019 | -0,19% | -0,34% | -0,26% | 0,17% |
| 2020 | -0,38% | -0,42% | -0,31% | 0,04% |
| 2021 | -0,18% | -0,49% | -0,38% | 0,27% |
| 2022 | 2,04% | 1,54% | -0,26% | 0,59% |
| 2023 | 3,05% | 3,82% | 0,85% | -0,73% |
| 2024 | 2,71% | 3,42% | 2,02% | -0,76% |

*Table 7 – Net income T-Tests*

| *T-Test* | *FRM* | *ARM* |
|---|---|---|
| *Average* | *30263,74717* | *38019,02178* |
| *Variance* | *596285572* | *4028584949* |
| *Number of Observations* | *2069* | *465* |
| *Hipostized difference for averages* | *0* | |
| *Degrees of freedom* | *495* | |
| *Stat t* | *-2,592038373* | |
| *P(T<=t) with one tail* | *0,004911421* | |
| *t critical with one tail* | *1,647937753* | |
| *P(T<=t) with two tails* | *0,009822842* | |
| *t critical with two tails* | *1,964767992* | |

*Table 8 – House value T-Tests*

| *T-test* | *FRM* | *ARM* |
|---|---|---|
| *Average* | *265854,3637* | *353396,4987* |
| *Variance* | *1,76465E+11* | *4,40905E+11* |
| *Number of Observations* | *2069* | *465* |
| *Hipostized difference for averages* | *0* | |
| *Degrees of freedom* | *550* | |
| *Stat t* | *-2,723124756* | |
| *P(T<=t) with one tail* | *0,003336064* | |
| *t critical with one tail* | *1,647628817* | |
| *P(T<=t) with two tails* | *0,006672128* | |
| *t critical with two tails* | *1,964286551* | |

*TABLE 9 – MORTGAGE DURATION T-TESTS*

| T-Test | FRM | ARM |
|---|---|---|
| Average | 19,8608426 | 20,89283154 |
| Variance | 26,62668418 | 29,33346742 |
| Number of Observations | 2069 | 465 |
| Hipostized difference for averages | 0 | |
| Degrees of freedom | 666 | |
| Stat t | -3,744598186 | |
| P(T<=t) with one tail | 9,81565E-05 | |
| t critical with one tail | 1,647144774 | |
| P(T<=t) with two tails | 0,000196313 | |
| t critical with two tails | 1,963532325 | |

*TABLE 10 – AGE AT ORIGINATION T-TESTS*

| T-Test | FRM | ARM |
|---|---|---|
| Average | 43,31390977 | 41,63133641 |
| Variance | 99,50061537 | 95,92827274 |
| Number of Observations | 1064 | 217 |
| Hipostized difference for averages | 0 | |
| Degrees of freedom | 314 | |
| Stat t | 2,299118056 | |
| P(T<=t) with one tail | 0,011077215 | |
| t critical with one tail | 1,649720831 | |
| P(T<=t) with two tails | 0,022154431 | |
| t critical with two tails | 1,967547698 | |

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