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Affordable Housing Through Smart Mortgage Financing: Technology, Analytics, And Innovation

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Abstract

Toward achieving affordable housing for lower- and middle-income individuals, this book proposes a family of new smart mortgage origination, servicing, and secondary-market technologies and systems that are built on artificial intelligence, advanced data analytics, and blockchain technology, as well as on transaction-cost economics. A critical mission for government, quasi-government, and private-sector housing finance initiatives whose combined annual outlays total roughly $600 billion is to bridge the gap between soaring home prices and stagnant middle-class income growth that has persisted for many years. To meet this challenge, our book proposes a family of smart, tech-enabled, nutritionally stamped mortgage technologies that shift traditional mortgage origination and servicing tasks away from highly compensated professionals to low-cost service partners, but in a careful and compliant way. We propose a new slate of smart, stakeholder-supported, mortgage origination, servicing, and secondary-market technologies that are founded on strategic partnerships among lenders, servicers, nonprofits, housing agencies and institutions, real estate and technology companies, and investors. New collaboration-rewarding technologies offered as add-on modules to successful customer relationship management systems will facilitate the construction of transactional information links that will lower structural transaction costs among the various stakeholders associated with smart mortgages.

We believe that our proposed innovation in mortgage finance technology is both practical and achievable within the existing structure of public policy and that it can be realized through active public-private collaboration and cooperation. Our approach is to innovate in small steps, learning from the positive and the negative experiences of the various housing initiatives undertaken at all levels of government, both domestically and abroad. The proposed new mortgage origination, servicing, and secondary market technologies that will be discussed in this book have been designed and tested by some of my graduate students and their friends.

Keywords: Smart Mortgage, Affordable Housing, Lower-Income, Middle-Income, Artificial Intelligence, Data Analytics, Blockchain Technology, Transaction-Cost Economics, Housing Finance, Mortgage Origination, Mortgage Servicing, Secondary Market, Public-Private Collaboration, Stakeholder Partnerships, Lenders, Servicers, Nonprofits, Housing Agencies, Transactional Information Links, Structural Transaction Costs, Customer Relationship Management.

1. Introduction

Affordable housing is one of the most significant challenges facing communities throughout the world, including the U.S., Europe, and emerging markets. Government efforts, both in terms of provision and subsidy, have been inadequate in meeting the demand. The financial resources simply do not exist to build sufficient new housing for those earning an amount that is below the median. Thus, many of the housing units necessary to meet demand will not be new. Rather, the rent or mortgage on these homes will be financed by loan and rental subsidies supplied directly or indirectly by government. While affordable rental units are a must, they are not the primary answer to the challenge. The goal of affordable housing is to permit those with limited incomes to move out of living situations that are inadequate for a wide variety of reasons, including overheating, indoor air quality problems, inadequate plumbing, infestation, and overcrowding. The ultimate objective is to enable those in need to achieve the American dream of home ownership. Mortgage financing has developed over the last half-century from a local, highly personalized, idiosyncratic relation between borrower and lender to a highly-regulated market using a highly-structured note form marketed by the secondary market, thereby allowing the borrowing cost to be driven mainly by market-

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level factors. Instead, mortgage financing can and should be an instrument in the drive for affordable housing. Local conditions and localized needs should determine the collateral terms in the mortgage transaction, providing the community with a more focused solution to its problems.

1.1. Overview of the Study

The underpinning arguments and ideas presented in this essay have been significantly augmented and developed further. The mortgage finance industry is large and growing, and thus continues to generate profits to those providing the services in that space. However, certain realities have begun to create problems for those involved in that industry, including rising home prices and rising interest rates, with less emphasis on affordability and social impact than could be used for income-deprived segments of the population.

This study attempts to focus not on what the problems are, meaning how and why are they occurring, but rather focus on what some alternative solutions to those problems are, and how and why these can be used to increase the availability of affordable housing. Specifically, and via an eclectic collection of ideas, models, and initiatives contributed to us by many experts in this field, we attempt to address the following important questions: What is the mortgage finance problem? What do we mean by affordable housing? What are some key ideas, issues, innovations, and initiatives involving technology, analytics, and innovation that can be brought together to help solve the "affordability problem"? How can these solutions be scaled? What about other countries and regions? What is the future of smart mortgage finance for affordable housing?

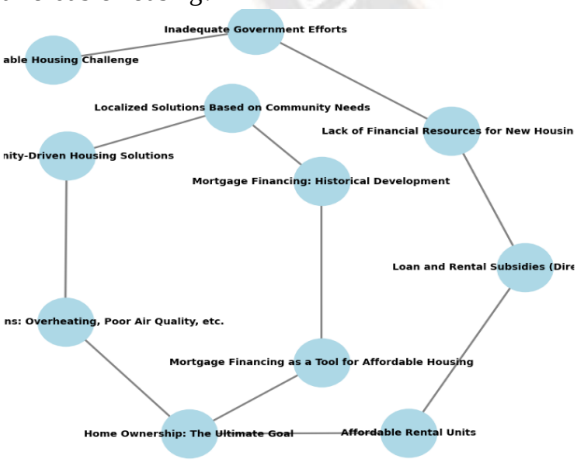

Fig 1 : Engaging Flow of Affordable Housing Solutions and Mortgage Financing

2. Understanding Affordable Housing

Affordable housing is generally understood as the housing that is financially accessible to the low and moderate income households. These low and moderate income households act as the backbone of any economy and society across the nations. They provide services and products that are crucial for economic sustainability and growth. It is often seen that moderate income households who earn too much to qualify for government assistance, often live paycheck to paycheck and struggle with high housing costs. These are the households which are most sensitized to housing cost increases, especially housing costs for rental properties. For many communities, it is these families, with their need for affordable housing, that constitutes the majority of new job seekers. Their standard of living and their ability to raise and educate their children in safe and decent neighborhoods also determine the needs for government services. But providing them with affordable housing has been an issue for many nations globally. This affordable housing has been made available through the large part of Government efforts, in terms of loses. In a country's economy, the level of housing is small compared to other levels of investment spending – for example, in surplus endowed countries with a high level of government consumption as a share of GDP, housing levels can be neglected for long periods of time. Additionally, growth of housing may also be delayed due to capital market imperfections or because housing supply is policy manipulated short term since large volumes of house building cannot be made as efficient as other sectors in an economy. However, even in the most prized markets, housing demand has never been fully inelastic. Over long periods housing demand has also exhibited great shifts and swings because of its socio economic implications. Reducing housing costs is, of course, only one element of making housing truly affordable but, housing is a more likely significant component of the cost of living in wealthier countries where housing quality is generally higher relative to other goods.

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Equation 1 : Technology-Driven Affordability Score:

$$A_t = \frac{F_m \cdot D_r}{I_l}$$

A_t = Technology-driven affordability score

F_m = Financial flexibility of mortgage products (e.g., low rates, longer terms)

D_r = Data-driven risk assessment (using AI and predictive analytics)

I_l = Income level of the target demographic

2.1. Definition and Importance

As long as few people live, not in a house, but in a hut or a tent, any community is socially incomplete, and is moving toward more complete organization of social life. There is a strong public good definition of affordable housing which touches the bottom of our society in an invaluable way. Our economic growth should provide good living for all, but public policy negligence, interplay of political parties, special interest groups, and gross hyper-inequality push people towards marginality by leaving empty affordable housing while a portion of the workforce experience a lot of hardships. Largely, experience indicates that, when establishing a new community, building houses of sufficient quality at about $1,500 or less would be affordable to families with 5 children at the poverty level. Minimum quality houses, apart from the splash of paintings and screen doors, should have a foundation, at least 500 square feet of useable space, electrical and plumbing installations, and be built for permanent occupancy. They should be large enough to adequately house a family at the poverty level, but not so large as to seem luxurious. House costs should include a reasonable relationship of the costs of land, labor and materials, and balance to avoid under-subsidizing the wealthy or over-subsidizing the poor. Their construction, where feasible, should employ as many people on welfare as possible and should employ them for as long as possible. Federally sponsored agencies and private builders together should be prepared to initiate at least 200,000 houses a year; both should be ready to experiment and innovate to identify the most effective strategies. Federal sponsorship of private objectives in affordable housing and mortgages finance may demonstrate that the greatest unmet demand for affordable housing in the entire economy is that of lower middle-class families for decent shelter at a price turning more housing into less housing.

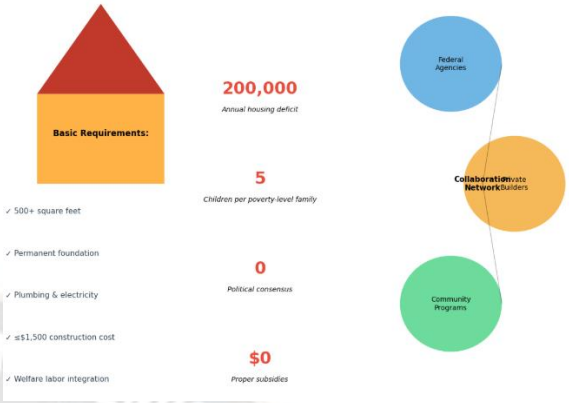

Fig 2 : The Affordable Housing Imperative

2.2. Current Challenges in Affordable Housing

In the midst of a global housing crisis, affordable housing is scarce and the pressures facing the housing sector are significant. The affordability bottleneck is felt at every level of the housing ladder since low-income households and middle-income households alike have seen rising costs and stagnant wages. More than 100 million people below the poverty line have inadequate housing or are homeless; as many as 800 million people worldwide are estimated to be living in slum-like conditions. With historic levels of housing insecurity from the repercussions of natural and man-made disasters—such as hurricanes, heat domes, floods, droughts, famine in Eastern Africa, and wars; widespread recognition of the impact of climate change; and further polarizing demographics and social divides, the world is in desperate need of solutions to building, maintaining, and financing affordable housing.

Yet access to affordable housing has become increasingly out of reach for many families despite rising consumption levels. To finance their needs, over 180 million households worldwide—about 10% of the global population—live in homes they are buying with mortgages or are renting from landlords with mortgages. These households often spend more than 30% of their incomes on housing, or 50% if they are considered extremely low-income; for these families, a critical illness, temporary loss of income, or maintenance issues can put them into precarious financial situations. At the same time, over 75 million households live in inadequate housing conditions, in poor neighborhoods, or need housing renovations and improvements. Creating policy solutions for affordable housing must be a priority for world leaders, but it takes money to build houses, especially to build houses that are affordable to those with limited to no income.

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3. The Role of Mortgage Financing

The obstacles to creating affordable housing are several. Understanding them requires an analysis of housing economics. The provision of housing involves combining land, labor, and material over time. With a largely fixed component of land, labor, and material, while also over time, some other factors such as financing and subsidies have a more controlling probabilistic influence on both the pricing and stratification of the housing stock. The financial component is usually greatly increased by debt financing in the form of a mortgage loan. A mortgage is a debt instrument secured by real estate. The term “mortgage” commonly refers to the agreement or contract to loan money for the purchase of real estate rather than the actual note that obligates the buyer to pay back the borrowed money under defined conditions. Mortgages are typically characterized by the loan amount, the payback period, the payment amount and frequency, the interest rate, the interest type, the amortization method, and any other loan-specific conditions or features.
A limited choice of access to existing mortgage financing, or inability to obtain the loan amount required to purchase a house of interest, or avarice-based loan sorting within the home mortgage market can make housing unaffordable. Largely because they consist of large amounts of money for long periods of time, mortgage loans pose the greatest economic risk. Moreover, payment of mortgages consumes a large fraction of disposable income and render homeowners less resilient in a rising interest rate environment. In addition, high levels of household leverage, especially in relation to asset price sensitivity, increases the risk of housing bubbles becoming exponentially larger during boom times to the extent prices diverge from collateral values.

3.1. Traditional Mortgage Financing Models

The key role of loan financing in facilitating the purchase of housing is undeniable, and it is this privileged aspect of mortgages that traditional economic analysis focused upon. Relying on the same theoretical tools observed with other forms of debt–capital structures or long-term borrowing–the traditional approach rationalizes the ubiquity of housing loans by both the presence of inter-temporal preference and leisure satisfaction as well as the factors determining the amount borrowed relative to future income streams. Such relationship is governed by an equation according to which the evolution of the ratio between current and expected accumulated consumer goods along optimum trajectories entails a negative relationship with the market interest rate, all observations that coincide with typical species of consumer behavior common to the economic theory. Disposable income also has a positive effect on the share of gross housing costs paid through mortgages, while positive future income expectations stimulate borrowing, whereas uncertainty or drawbacks to private ownership reduce the demand for mortgage loans.
Clearing these tensions implies that borrowing is optimal for a certain consumer class characterized by future steady increases in disposable income and holding wealth in the form of other owners' equity. House price increases will also lead to temporary borrowing equity and it is this offer of borrowing that must establish the maturity structure, interest payments, rates of administrative costs and default risks for the various types of loans offered, since lenders cannot easily hedge long-term commitments in an illiquid private contracts market. Theoretical models of mortgage finance have either been parametric extensions of a model, or have explored alternative methodological roots. Such models have been utilized to address different issues, including the analysis of capital subsidy schemes to stimulate home ownership and empirical interventions aimed at assessing the impact of differential loan incentives on market support or expansion, while also addressing optimal borrowing problem aspects necessary to determine reasonable debt and mortgage service to disposable income ratios over time.

3.2. Limitations of Conventional Financing

With the housing bubble bursting in 2007, it became apparent that the processes associated with the pre-screening and origination of single-family residential mortgage loans were in great need of modernization, technological upgrading, and innovation. Our mortgage financing system required and still requires substantial improvements, including the expeditious and less costly assessment of credit risk; meticulous and prompt document compliance checks; schematic analytics in underwriting; tremendous funding expansion; investor appetite attraction; portfolio diversification; risk reduction; liquid secondary market for mortgage-backed securities; mortgage insurance for negligible equity down payment; and insurance regulation flexibility. Quite often, the mentioned upgrades and innovations were put into practice just shortly after we had the problems and were enjoying a booming housing market. Conventional mortgage financing is still a long, cumbersome, costly, tedious, stressful, and highly intimidating ordeal for homebuyers. To this day, there is no

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single window system in place to cover the entire mortgage loan process — operations are conducted in a piecemeal, back-and-forth fashion; documentation is voluminous and painful to assemble; packaging the loan is an involved process that necessitates a detailed understanding of the requirements of each loan investor; costs are high due to the extensive loan documentation and the time involved in the process; and processes introduced to ameliorate lender credit risk and reputational risk — compliance checks performed for virtually every mortgage loan, credit risk rating systems, risk-based pricing systems, subordination of seller and servicer profit margins — have culminated in complex and rigid workflows and longer total turnaround times. We may one day hope for more affordable costs and faster times if lenders improve their processes through standardization and automation, notwithstanding the serious compliance and regulatory burdens with which they are currently faced.

4. Technological Innovations in Mortgage Financing

Preventing a boom and bust cycle in housing is an important goal in mortgage financing. Recent innovations provide mechanisms to improve consumer welfare through increased efficiency and reduced response latency in financing, closing, and servicing mortgage payments. Digital platforms accelerate the application and underwriting process, allowing buyers to compete more aggressively as mortgage offers made through technology have come to rival discounted offers for rates from traditional lenders. Consumer friendly platforms that automate the stress testing of underwriting criteria for adverse selection and loan default risk are also being developed. Smart contracts may eliminate lenders from functional roles in the real estate transaction under evolving service models but could equally result in greater control of mortgage quality by lenders in lieu of servicing by putting lien transfers and payments into smart contracts. The social value of loans secured by physical assets can be preserved on chain by utilizing surrogate tokens of property ownership to define sublien levels of value. Creation of mortgage-backed securities can also take place on chain to facilitate resale. Capital market liquidity is an important feature in housing finance since homes are illiquid assets that do not produce income while interest payments are due.

Digital Platforms for Mortgage Applications

The decision to replicate or discontinue traditional service models in order to reduce frictional transaction costs and the level and structure of origination fees along with decisioning time depends upon the product/service complexity of the mortgage type and borrower screening process upon which lender competition is based. As the application process begins to be simplified through artificial intelligence to the point where consumers can prequalify for as many products from as many lenders as possible, the idea of a digital display window that allows lenders to compete on level service playing fields with similar price signals for conventional single family loans for low and middle income buyers is gaining traction. Risk-based pricing will better serve low, middle and upper-income borrowers as lenders begin to apply the risk criteria that traditionally characterized the decisioning of investor owner mortgage applications to the decisioning of owner occupied investments.

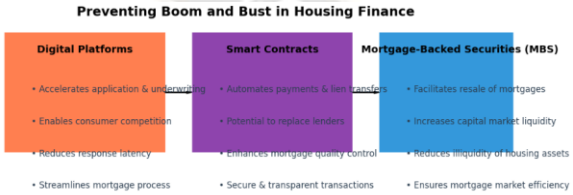

Fig 3 : Preventing Boom and Bust in Housing Finance

4.1. Digital Platforms for Mortgage Applications

The digitalization of the mortgage application process makes it much faster and easier than traditional applications. Unlike older systems that required borrowers to return to banks or third-party lenders to submit paper forms, verifications, and documents, digital mortgage platforms can allow complete 'self-service' mortgage applications within tightly-defined regulatory and process rules. Services use dozens of data connections to provide instantaneous prequalification and in some cases even rapid pre-approval of applicants. For many applications, digital system verification of creditworthiness and ability-to-repay can allow lenders to measure risk with little or no human intervention, which benefits lenders in screening and processing applications, borrowers in terms of speed and ease, and regulators with internal controls and oversight. The mortgage underwriting function has traditionally required long lead times, owing in part to the tediousness of the process and the use of human labor in evaluating and underwriting the loans. Fintechs hope to change this with online platforms that will rapidly connect borrowers to investors, pairing small loans with retail investors in a similar manner to lending clubs. Home-equity loans that had historically been based on credit factors for risk assessment are increasingly using big-data-based underwriting platforms that evaluate a wider variety of

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borrower characteristics in creating custom loans. Refinancing applications that had relied on telemarketers or referral companies are increasingly being pushed online, with services allowing homeowners to connect with multiple lenders for rate shopping.

Equation 2 : Mortgage Default Probability Reduction:

$$P_d = \frac{T_r \cdot A_s}{L_v}$$

P_d = Probability of default reduction

T_r = Technological risk mitigation (e.g., AI-powered monitoring)

A_s = Affordability scoring improvement through analytics

L_v = Loan volume issued in targeted affordable housing markets

4.2. Blockchain in Mortgage Transactions

There is a tendency in the financial markets to reduce the use of intermediaries between agents in secondary transactions, in order to reduce costs and minimize risks. In that sense, blockchain technology appears as a powerful instrument in mortgage financing systems. A blockchain is essentially a decentralized database that infers trust in agents from the validity and immutability properties of the registered transactions. It allows closing agreements or contracts between different entities or persons without any reliance on a trusted intermediary institution. Once an agreement is recorded in the blockchain, the transaction cannot be modified and, therefore, it is much less susceptible than traditional transactions to fraudulent activities. Besides immutability and the finality of transactions, the other intrinsic property of a blockchain is that it serves as a secure store of value, thus allowing the transfer or exchange of assets or values that have been tokenized. Any asset can be tokenized, simply by representing its ownership by means of a digital key generated by asymmetric cryptography.

In the case of mortgages, the financing is initiated by a bank, but the bank must often sell a portion of the loan to investors or funds that consider the loan as a financial asset. The fiscalization of the transaction and the structure of its legal agreements are usually very complex, especially in the case of securitized loans. More than ten million transactions involving real estate or personal assets occur annually. These transfers are subject to fiscal controls for the collection of taxes. In the case of property sales, there are transfer taxes and taxes on the capital gains generated from the sale. However, if these transfers were recorded and taxed directly in real time via a blockchain, the amounts due would be automatically transferred to local tax offices, reducing or eliminating fraud.

5. Data Analytics in Mortgage Financing

This chapter makes a case for the mortgage financing business to jump on the burgeoning data analytics bandwagon, around which a number of sectors have seen their fortunes grow. The rapid delivery of technology solutions at affordable costs, coupled with available knowledge resources and a globalized work environment are key reasons that data analytics have become usable at a much wider scale in these sectors. The chapter describes a few advanced analytic techniques that can bring about precision and speed in critical processes in the mortgage financing business. However, most of the big mortgage lenders are missing out on the great advances being made in analytics, both in terms of speed and affordability. The implementation of state-of-the-art predictive analytic techniques for core lending processes would result in huge gains for mortgage lenders in terms of lower costs and better quality, leading to greater bottom-line realizations. New approaches, exemplified by nano leaders in the finance and other sectors – newer-age banking institutions in particular – are eating into their hard-won market positions. The use of analytics in related sectors of lending and borrowing also establishes this fact. The chapter describes some of the data analytic techniques that the mortgage lenders can use for predictive answer questions that plague them. Can they quickly dispense their approval of a mortgage loan for some first-time borrowers applying for loans, without having to go through a torturous paperwork process? What will be the performance of the mortgage loan for first-time borrowers at the end of certain specified durations after loan disbursement? Will the residents of a certain geographical region – particularly the lower economic strata – be able to service their mortgage loans disbursed for their data up to a few years in the past?

5.1. Predictive Analytics for Borrower Assessment

The Federal Housing Finance Agency 2020 Report on Equity and Homeownership states that "homeownership is a critical asset-building tool; yet, unlike other wealth accumulation milestones, such as graduating from college or starting a family, there is no safety net when it comes to learning or preparing to become a homeowner." More specifically, many lower-wealth and disadvantaged borrowers simply have no source of support or finance to access homeownership. Much

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of the guidance available for the first-time homebuyer is directed toward the latter stages of the homebuying process, such as shopping for property, selecting mortgage options, and comparing alternate solutions. Excepting government-supported loan products with minimal down payments, the incoming borrower sometimes is expected to be at the ready with a large amount of cash for the down payment and any other closing costs. Borrowers can easily get discouraged during the long process of saving, particularly when they are literally living paycheck-to-paycheck.

This situation became much worse with the onset of the COVID-19 pandemic, which caused widespread business closures and unforeseen job losses. This prompted mortgage lenders to loosen qualification guidelines in order to broaden access for first-time homebuyers, particularly in communities of color, settlement-servicing areas, and low- and moderate-income areas. The challenge that mortgage lenders and policymakers face is how to create a system that provides timely access for deserving borrowers. The use of nontraditional risk indicators during the qualification process can play a key role in accessing the creditworthiness of first-time homebuyers. Nontraditional indicators can expedite the qualification process, allowing deserving borrowers to access homeownership earlier.

5.2. Risk Management through Data Analytics

Sound management of risk is a pivotal priority for most mortgage lending institutions. Technology and analytic solutions can have a significant and positive impact, enhancing enterprise efficiency and reducing enterprise-wide financial risk. Commercial banks and nonbank lenders are traditionally more exposed to reach risk, prepayment risk, credit default risk, and operating revenue risk compared to other verticals of financial institutions. Housing finance plays an instrumental role in the domestic financial system of various countries. Highly cyclical in nature, mortgage lending is subject to booms and busts, influenced by several factors, including monetary policy, homebuyer credit availability, and mortgage interest rates, which are largely driven by the global capital markets. Model risk in housing finance typically arises from coordination failure among multiple care-based real estate risk models operating in silos. This chapter highlights several aspects of risk management through predictive analytics — and its applications in the realm of housing finance. The objective is to serve as a primer on the high-impact domains where data analytics applications can enable a transformative impact. The data side relies on more granular datasets containing geo-coded data and commercial property datasets combined with machine learning tools.

A large part of the mortgage lender's risk of a given loan relates to the characteristics of the property used for the mortgage. Borrower risk models capture only a proportion of the mortgage lender's loss exposure for any specific loan and consequently are by nature limited in their utility and accuracy. Loan-to-value (LTV) ratio information are both borrower and property-dependent. Borrower risk is more time-varying, especially for low-income first-time home buyers, while property risk varies more according to changing real estate cycles. The nature of the risk in the mortgage lending involves correlated property prices for loans originated both at a point in time and originated at different points in time but secured with the same geographic concentrations.

6. Smart Mortgage Solutions

The need for affordable housing has challenged governments and markets for decades and threatens the achievement of the UN Sustainable Development Goals. What if we used wealth-sensitive Artificial Intelligence technologies to guarantee affordability – and quality – for every borrower, every time? What if we used technology to customize both the price and product to each and every consumer? We illustrate in this section how such AI-driven Smart Mortgage products can deliver affordable financing to promote global growing equitable homeownership through advanced analytics accessible to borrowers to decide distress warning signals to pay them for early AML.

The primary function of a mortgage is to provide debt capital for the borrower's primary residence. The primary measure of mortgage credit quality is the borrower's ability to meet fixed monthly payments. Mortgages, however, are fairly unique from most other forms of debt capital. Most mortgages charge a price to finance the house that is "locked in" for a long period of time – usually 15 to 30 years. Such long-term fixed rates provide consumers with price security. The question of affordability is one of product pricing and cost not underwriting. Consumers, however, match themselves with products that meet their risk tolerance to personalize their mortgage plan. It is they – not lenders – who have the most risk on the line. It is they who are most likely to voluntarily default when they can no longer afford their mortgage payment. Using analytics and new data sources, technology can provide this additional perspective on default risk. Our

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goal is to offer borrowers an "investment tip" with analytics providing positive financial incentives to undertake precautionary measures ranging between standard risk and private insurance protections to minimize distress or risk-cutting strategies during the term.

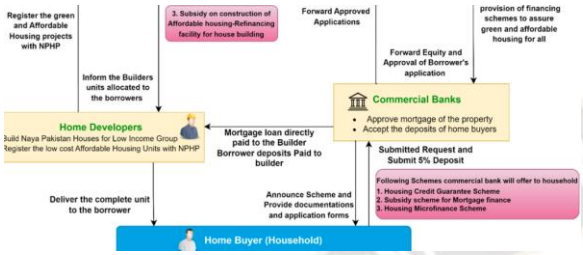

Fig 4 : Financing Options for Green and Affordable Housing

6.1. AI-Driven Mortgage Products

The chief user experience goal of the American mortgage market is to keep the mortgage loan approval process correctly automated and instant. Lenders accomplish this task by recruiting and training hundreds of engineers to design and upgrade their tech platforms. Once tech sides are enhanced, the loan applications are instantly transformed into a Predictive Index based on AI learning from millions of mortgage loans handled by the lenders over the years. This Predictive Index captures applicants' life characteristics such as defaults experienced by similar cohorts in the past and lenders' own sensorial inclusiveness, or conscious/unconscious biases, in accepting and rejecting applicants. Instead, lenders who are risk-averse and hesitant about investing in tech have their costs of processing loans kept index-linked, generating long waits for applicants and multiple disbanded loan applications that worsen both lenders' and borrowers' relationships. These lenders leave good business on the table which, instead, could be collected by investing in innovative technologies fed by advanced Artificial Intelligence algorithms. Other financial companies, which are also eyeing their cashflows related to mortgage-backed securities, are also recruiting engineers to invent snappy tools for improving various aspects of the mortgage market with borrowed assets.

The comment raised by technological bias and by the Behavioral Economic theory is that lenders' AI models cannot replicate nor simulate the countless factors that drive their final loan decisions and those of non-outsourced appraisers, before whose subtlety and disclosure lenders would look for surprising clarifications. Thus, the joined effort of regulators and lenders would be needed to enforce that lenders utilize large enough and accurate Predictive Indexes that support as many as possible lending characteristics, whose achievement would motivate and serve diversity-inclined initiatives and laws against discrimination in Housing Lending.

6.2. Personalized Mortgage Plans

Creating Personalized Mortgage Plans for borrowers is paramount to enhancing the affordability, sustainability, and accessibility of homeownership. We propose an innovative framework, along with several design principles, for the development and deployment of internally consistent PMPs that link together all the significant features of a mortgage. Using real-world mortgage data, we show that the average senior mortgage costs can be reduced by 23% to 50%, depending on the borrower's risk category, if personalized mortgage plans are used rather than typical single-product approaches and quantitative metrics correction. By eliminating asymmetric risk-sharing and ensuring full offsets to additional risks, PMPs allow to focus on the borrower's unique circumstances and hence reduce originations and servicing costs and minimize coupon rate marks-up and downside loss exposure for the investors and risk issuers.

Using PMPs, loans can be funded with the cheapest rate for a particular risk level, with less overall servicer costs and profits going to servicers and more remaining with the end-user borrowers. We conclude with a vision for PMPs, and how they can transition the market for 30-year fixed-rate loans to a new paradigm that emphasizes affordability, customization, and simplicity and minimizes barriers to entry for working-class households. Systematic reliance on average coupons and terms is now a hindrance instead of an aid to increasing home ownership, especially for first-time buyers with major student debts. We present a unique mortgage funding and distribution framework capable of delivering PMPs to borrowers, every month of the year. The unique aspect of this paper is that we are able to state explicit results on PMPs for duration-matched loans, as well as for other relative risk measures.

7. Future Trends in Mortgage Financing

As can be seen from the national direction of the 2020s, technology, analytics, and innovation will play an increasing role in the mortgage financing space. One can expect to see emerging technologies such as blockchain, artificial intelligence, virtual reality, and machine learning solutions all helping in the directions set by the administration:

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modernization, accessibility, efficiency, and transparency. These technologies will help make mortgage financing faster, cheaper, easier, less risky, less costly, and more gratifying for borrowers and investors alike. Digitalization will enable the paperless and automatic creation and packaging of loans and the generation of transparency for investors at all points in the securitization and servicing lifecycles. Native digital and cashless payments will enable instant funding and borrowing. Creditworthiness analysis will be made better and less biased with enhanced data analytics. Longer loan terms may be made more feasible and less costly with new cash flow recycl
ing concepts and products.

These technologies will also affect the mission of Ginnie Mae. The guarantee of a safe and liquid market by the government will remain essential, but new technological solutions will enable Ginnie Mae to focus more on its role of enabling access to affordable housing and less on creating a machine that is just big for the sake of being big. That focus will still require a clear link between investor returns and the risk of loans with priority to mission because access to affordable housing is an essential part of the national purpose.

7.1. Emerging Technologies

This chapter assesses how advances in several emerging technologies can help mortgage financing improve. In particular, increases in the adoption and use of smart mortgage products can, once they become widely accepted, enhance the financing of housing. Smart mortgages allow the integration of a range of innovative technologies and analytics to be deployed in financing. They usually rely on the use of the Internet, mobile technology, and in particular the development of distributed ledger technology. A range of additional emerging technologies can help usher in more affordable housing: Big Data analytics, Artificial Intelligence and Machine Learning, Cybersecurity, Cloud Computing, and the Internet of Things – sensors.

Smart mortgages can also contribute to making housing production, especially housing targeted at low and moderate-income families, more affordable. Other products, smart construction products, that rely on technologies such as 3D printing, industrialized construction, advanced building materials, prefabrication and off-site construction, along with innovative and forward-looking regulatory and planning frameworks, can help lower the costs of construction. Once the costs of raising and maintaining services and amenities in the built environment are taken into account, smart housing products can help lower the overall costs of affordable housing. Third, smart locations will rely on the coordination of transportation infrastructure, smart commuting and transit options, land use and zoning approaches that take advantage of the technology platforms being used to allocate housing resources. A growing range of successful examples are already in place that can validate how these domains can be combined to facilitate the matching of people and housing to reduce housing-related costs for families and the economy as a whole, which in turn can help the health and productivity of communities and regions.

7.2. The Future of Affordable Housing

The U.S. housing policy has long emphasized the importance of homeownership as a vehicle to build wealth and financial security. Unfortunately, the homeownership gap between White families and Black and Hispanic families is at its widest since the American civil rights movement, as barriers to mortgage lending continue to stymie minority families and the housing choices they can make. A recent report estimates that 910,000 homes that would otherwise be listed for sale are not on the market because the owners would lose their low-interest-rate mortgage. The Fed's increase in interest rates has led the owners of nearly 81% of mortgaged homes to stay put to avoid high mortgage rates. That's why about two-thirds of would-be sellers say they are unwilling to list their homes unless mortgage rates drop to around 5%. And that creates stiff competition for a depleted pool of homes for sale, with approximately only 1.1 months of existing homes for sale in May 2023.

Despite the barriers to affordable housing, we remain optimistic about the role of mortgage financing and emerging technologies, especially for Millennials and Gen-Z. More than any other generation, Millennials and Gen-Z have seen their parents and grandparents struggle trying to make mortgage payments during economic downturns and prevent foreclosures during the pandemic. They want policies that will help build financial security, especially as middle-class families continue to feel left behind. The solution must balance the tensions between lenders managing risk and buyers managing affordability. In doing so, technology, analytics, and innovation will help lenders find creative ways to help qualified borrowers afford a first-time home in an efficient and scalable way, helping them on their path to homeownership.

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8. Challenges and Risks

Large datasets are the backbone of many decision-making processes. Sophisticated workflow analytics and process analytics help discover the connections and build smart mortgage data pipelines to mine all relevant data into useful metrics. It is very critical to combine this innovation with risk management and risk control. For many years in the financial services world, information technology has been used mostly as a cost-reducing factor. Financial institutions and banks have spent billions of dollars primarily to design and maintain expensive legacy systems. Our proposal of innovation is to expand risk management from the designated silos in banks to all aspects of the process from the customer beginning the inquiry to technical outsourcing and third-party vendors. This is possible because the mortgage industry is entering the new age of fully electronic, cloud-based mortgage processing, where all aspects of the lending process are carried out electronically with the adoption of true smart technologies with the help of enhanced workflow analytics and seamless process analytics. While new technologies and innovative approaches will deliver far more efficient and faster loan evaluations along with better borrower experience, we need to approach the sourcing, evaluating, and applying the new mortgage smart data computing pipelines with careful risk assessment and improve how financial employers assess and manage risk.

Obtaining improved mortgage technology innovation, pushing for enhanced mortgage risk assessment, and meeting the demands for adoption of state-of-the-art mortgage processing are met with roadblocks. For the most part, our proposed innovation, accuracy-enhanced automated risk-based mortgage evaluations are only being made available to only 40% of borrowers and mortgages being funded in the U.S. and to none in international markets. This is largely due to a fatally flawed and highly fragmented market in which economic pressures on banks make it extremely difficult for those prudent balance sheet entities to apply the smart technologies that exist today and comply with all accordance, regulatory, and legal requirements. Up until COVID-19, banking executives were afraid to innovate. Then they rapidly embraced the philosophy of innovate or die as they turned from balance sheet technology laggards to fast-moving technology progressives.

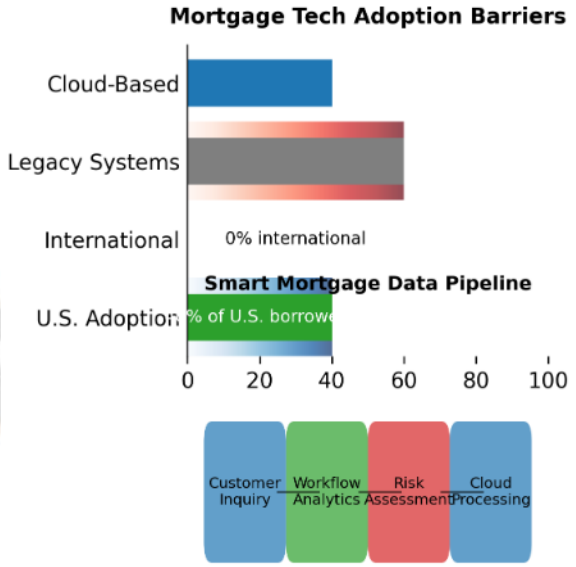

Fig 5 : Mortgage Tech Adoption Barriers

8.1. Technological Barriers

In this chapter, the emphasis is on the potential risks and challenges that face smart mortgage financing in order to create affordable housing. Although technology has a major role to play, we expect a high level of involvement by humans in the entire process, which could be affected if they do not adopt the necessary changes. It is clear to us that technology could build a huge demand for cheap smart homes using smart mortgage financing, yet it is also clear that certain identified risks and challenges have to be effectively solved in order to ensure smooth functioning. Regulatory authorities have to intervene in certain situations to enable the growth of the industry.

Risks and challenges also exist at the technology level, which could be differentiated further. First, technological constraints: this relates to the use of certain technologies that may not be completely ready. Certain examples are blockchains, which are being used but are not highly developed, or to make it specific, the lack of quantum resistant algorithms in creating new transactions. This is a risk for smart mortgage financing but not a very highly rated one. Another example could be the lack of good security protocols while making IoT powered homes. Such security and censorship problems have received a lot of attention and we touch a bit on that as well. The second type could be the architectural constraints. The limitation faced by developers, customers, and more people and services due to the new type of involvement in the ecosystem could be problems identified

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with the pillars developed in this document. The third type could be the requirement for primary infrastructure upgradation; indeed, developing nations may opt for upgradation in addition to cheap smart homes using smart mortgage financing.

Equation 3 : Innovation Impact on Housing Market Reach:

$$I_m = \frac{N_f \cdot P_t}{C_i}$$

I_m = Market reach through innovation

N_f = Number of new financing models (e.g., fintech-powered mortgages)

P_t = Penetration of innovative products in underserved markets

C_i = Cost of innovation implementation (e.g., platform development, integration)

8.2. Market Risks and Economic Factors

One aspect of the risk of high mortgage financing volume is economic: are the macroeconomic assumptions of stable or improving prices for housing as collateral while home purchasing activity is increasing, historically possible? Those questions are addressed in this section. Other aspects of risk are time and market: both illustrated by the failure to build and to save earnings in the subprime and Alt-A bust. Both will happen again, suggestively when prices collapse at the bottom of the next major business cycle. How well HFA and FSmortGSE can continue to function, and how long will they be able to continue to function, is indeed an important issue, one not examined anywhere in the literature.

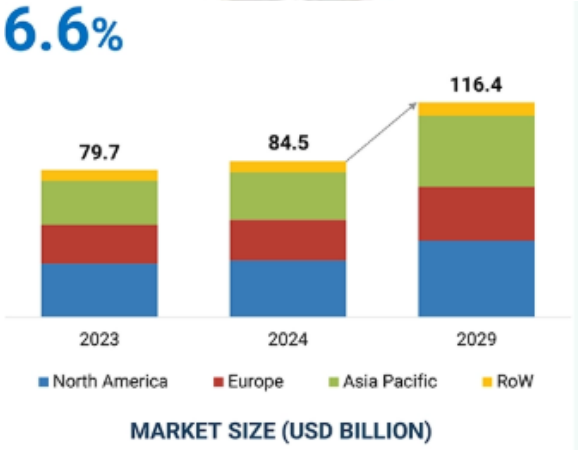

Fig 6 : Smart Home Market Size

The risks happen when the volatility of house price indices over time is large, as it is during wartime, and when the borrower force majeure of sudden unemployment during the recession is coincident with lack of support, especially, in the case of curtailment of further purchases, had put a major chill on demand at last 18-months of the recession. That is more likely to occur in a state of unintervened 100% LTV financing, and in an unfunded mortgage credit authority environment. Hence, economic risk is minimized by long-term ownership-supported funding, by both borrower and owner, found by the needs of other business cycles, and use of subsidized 100% LT financing sparingly, at least during mass homeownership transitional years, or only for country mortgages.

9. Conclusion

It is now widely recognized that the crisis in housing affordability facing a substantial segment of the population is a sustainable long-term trend and that solutions and alternatives need to be found. In this book, we outline some potential solutions and alternatives through the implementation and deployment of new and advanced technologies, including space technology, with proven successfully track records in other industries and sectors. Also included are empirical and quantitative data supporting the conclusion that technology, analytics, and innovation can provide proven solutions and alternatives resulting in realized savings in cost reduced time. These solutions and alternatives can go a long way toward institutional and process changes at the public, private, and non-profit sectors – all for the intent of providing affordable housing for all and supporting the right to housing.

In closing and as a set of final thoughts and recommendations, we would like to re-emphasize a few points made throughout the book that are important and relevant, especially for those who are entrusted and committed to the endeavor and mission of providing affordable housing for those in need. To this end, our first recommendation is to leverage and take advantage of new and advanced technologies, including space technology, alongside proven change management organizational and institutional practices. However, along with the leverage of new technology must come the commensurate investment in the provision of capacity, skill, and competency development and enhancement. Thereby building a work environment conducive to the sustenance of the advancement of workforce potential which, in turn, provides the value and value proposition of delivery of the critical target outcomes of housing affordability.

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9.1. Final Thoughts and Recommendations

Mortgage loan products are the primary and preferred option for accessing housing finance. This broad acceptance of mortgage loans, especially in developed countries, is laudable and demonstrates the tremendous success and achievement that this form of housing financing has attained. Sadly, this is NOT the case for developing economies. A review of the literature highlights that the level of penetration and sophistication of mortgage finance is meager and extremely low. As a result, the benefits of homeownership are not widely available, and the vast majority of the population continues to rent or live in informal settlements. To increase penetration, the supply of housing must not only be complemented by the provision of adequate access to housing finance but also efforts to make mortgage loans more affordable through the continuous reduction of loan margins, enhanced loan tenors, and the introduction of flexible repayment options.

This book makes the argument that these aspects of mortgage lending can be achieved through intelligent analytics and innovative technology. By keeping the cost of lending low and minimizing the overall risk of operations, advanced and innovative supplier-side solutions embedded in intelligent economic and risk models and tools would help reduce lending costs and thereby reduce margins without reducing profitability. The book concludes with a brief summary of the key recommendations made in the respective chapters for achieving the aim of affordable housing finance. Making suitable mortgage products affordable for all must be complemented by stringent housing supply side measures and mechanisms. These would include initiatives to ensure and facilitate an adequate supply of serviced land, policy measures to enhance housing supply for the working poor population and, wherever necessary, direct rental or purchase price subsidy mechanisms to increase affordability at targeted levels for the social strata that fail to qualify under any aspect of the mortgage products.

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