Journal of African Real Estate Research
Volume 10 Issue 2
www.journals.uct.ac.za/index.php/JARER/

Residential Real Estate Market Characteristics and Mortgage Origination in Emerging Economies: The Case of Ghana

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To cite this article: Akinsomi, O., Anim-Odame, W. K., and Owusu Junior, P. (2025) Residential real estate market characteristics and mortgage origination in emerging economies: The case of Ghana. *Journal of African Real Estate Research,* Volume 10(2), pp. 87-109. DOI: 10.15641/jarer.v10i2.1844

Abstract

This study analyses the relationship between mortgage origination and residential real estate property characteristics in Ghana. Using transaction-based data on 1476 mortgages from 2008 to 2016, we apply the hedonic pricing model and multivariate regression to establish the role of structural property characteristics and residential real estate sub-markets in determining mortgage origination, separated into loan amount and loan-to-value (LTV) ratio. Further, the risk of default in the mortgages is estimated as an additional risk assessment tool for lenders. The findings reveal that residential sub-markets are important variables to consider when mortgages are originated. In Ghana, properties in Upmarket, Emerging upmarket, and Middle-income sub-markets tend to attract lower loan values in comparison to properties in Gated communities, primarily due to their neighbourhood characteristics. In addition, properties in emerging, upmarket, and middle-income sub-markets attract higher LTV ratios. It was revealed that in upmarket areas, the number of bedrooms, detached, and outhouses does not contribute to determining the risk of default in mortgages. We also find that the risk of default by mortgage borrowers is negligible, indicating that lenders can safely expand their customer base. The findings offer rare insights into the emerging mortgage market in Africa for both policy and investment purposes.

Keywords: *Mortgage Origination, Market fundamentals, Residential Sub-Markets, Ghana, Emerging Market*

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1. Introduction

Mortgage markets play an important role in shaping the development of residential real estate markets. It is more crucial for African countries, where residential real estate markets are vital for both population growth and employment in the construction industry. However, the residential real estate market in Ghana differs from those in developed economies in terms of size, mortgage financing, and availability of data. These can be attributed to the fledgling stage of this market. Mortgage transaction-based data in Africa, specifically across sub-Saharan African (SSA) countries, is generally scant, and housing financing is usually informal (Donkor-Hyiaman & Owusu-Manu, 2016). The mortgage market also struggles with attracting investors due to weak credit markets (Billmeier & Massa, 2009; UN-Habitat, 2008).

Nonetheless, mortgage markets are gradually developing in SSA (Sub-Saharan Africa) countries. The real estate market is generally facilitated by the availability and affordability of loans to middle-class workers in the economy (Agnello et al., 2020; Ambrose & Diop, 2014; Hochstenbach & Aalbers, 2023). However, among other factors, the creditworthiness of borrowers determines the willingness of banks and financial institutions to lend for housing. In the absence of reliable credit data and indirect support from the government[1], in Ghana, for instance, lenders are left with the income of borrowers and property characteristics to originate mortgages. While access to long-span transaction data is a challenge in Ghana's mortgage market, it does not justify the scarcity of studies on mortgage origination, given the rapid growth in the sector. Studies that have broached the subject of mortgage origination in Ghana have relied on survey data and macroeconomic variables (see Boamah, 2011; Gavu & Adamu, 2015; Teye et al., 2015; Ampofo, 2020) without recourse to mortgage transaction data (see also Asres et al., 2020). These studies do not present a more accurate picture of the situation regarding mortgage origination, as we have done in this study for the first time in the Ghanaian residential real estate literature.

The empirical literature on mortgage origination encompasses defaults (Mian & Sufi, 2009; Guiso et al., 2013; Campbell & Cocco, 2015), the cost of mortgages (Titman et al., 2005), and property characteristics (Asres et al., 2020). Campbell and Cocco (2015), in particular, indicate that high loan-to-value (LTV) and loan-to-income ratios can increase the probability of negative home equity and thereby trigger defaults (see also Borgersen, 2020). Guiso et al. (2013) also find, through survey data, that proximity to strategic defaulters and non-financial factors, such as fairness and morality, affect default behaviour. In terms of costs, Titman et al. (2005) discovered a weak relationship between the LTV ratio and spreads in the US, which may be attributed to the endogeneity of the LTV choice. They further reveal that the average LTV ratio per lender has a strong positive relationship with credit spreads, confirming the notion that high LTV mortgages require substantially higher spreads.

Property characteristics also tend to influence mortgage spreads and origination, since they affect default risks. For instance, Von Furstenburg and Green (1974) document the importance of location in terms of mortgage default risk and show that property loans made in suburban locations were less risky than those made in central city locations. Again, Mian and Sufi (2009) reveal a sharp increase in mortgage defaults in 2007 in the United States, which was significantly amplified by subprime ZIP codes. However, the LTV ratio is claimed to be the

[1] Such as improvement in economic and regulatory environment for the housing sector, creation of land banks, and subsidising infrastructural costs to developing sites (Bank of Ghana, 2007).

single most important determinant of mortgage defaults, whilst other factors, such as property characteristics, may or may not have an impact on defaults (Qi & Yang, 2009).

For the mortgage market in Ghana, Soyeh et al. (2021) reveal the importance of property types in determining their values, with Gated communities attracting premium prices or rents compared to non-gated communities in Accra. This study is a clear revelation of price differentials in property values in major cities in Ghana. This is also evident in other major cities around the world, as shown in the disparities of urban forms and functional zones in 10 megacities in China (Huang et al., 2024). The literature on mortgage origination in Ghana mostly covers the influence of macroeconomic variables (Boamah, 2011), the potential for a secondary market for financing (Boamah, 2009), affordability and volume (Gavu & Adamu, 2015), supply and demand factors (Teye et al., 2015), and repayment mortgages (Ampofo, 2020), often utilising survey data. Furthermore, the results in these studies are subject to unstable macroeconomic conditions and respondent sentiments (see Smith & Yezer, 2023). This setting is unlike advanced markets, such as the United States, which has available data on mortgage transactions and reliable national survey data that includes borrower characteristics (Sirignano et al., 2018).

Due to contextual differences, the large body of literature, which focuses on advanced markets, may not apply to Ghana. Hence, the main objective of this study is to determine the relationship between mortgage origination (separated into loan amount and LTV ratios) and property characteristics (structural attributes and neighbourhood qualities - market segmentation) and estimate default probabilities. There is no evidence of this kind in the available literature, and hence, this presents an opportunity to expand the discourse on mortgage origination in sub-Saharan Africa, with Ghana as a case.

We employ the hedonic pricing model (HPM) (Rosen, 1974) to analyse how residential property characteristics determine loan amount and LTV ratio. The value of a property is essentially the sum of the price of the structure and the land on which it is built. These are the two most important determinants that should be included in the model (Eurostat (European Commission), 2013). House prices are determined by structural features (i.e., floor size, bedrooms, outhouse, etc.) and location (sub-markets) (Fernández-Durán *et al*., 2011). By extension, we estimate default probabilities for mortgages through a logistic regression approach using the same attributes applied in the HPM.

Based on our findings, it is possible to understand how mortgage providers originate loans in such a highly constrained and illiquid mortgage market. The results would be relevant to the government in understanding how mortgage originators make decisions, as well as to financial institutions and non-governmental organisations in designing and recalibrating housing finance systems in Ghana. This study also contributes to affordable housing policies aligned with SDG 11, which aims to make cities and human settlements inclusive, safe, and sustainable. By addressing housing deficits and promoting homeownership, Ghana can simultaneously develop its mortgage and housing sectors (National Development Planning Commission (NDPC), 2017).

2. Literature review

In this review, we capture the evolution of the Ghanaian mortgage market, the determinants of loan amounts, LTV ratios and mortgage defaults, as well as a theoretical framework to justify the relationships examined.

2.1 Ghanaian mortgage market evolution

In Ghana, the mortgage market has experienced slow development, constrained by high lending rates, low incomes, and inconsistent collateral systems. The Ghana mortgage market remains nascent, ranking 10th in Africa, with outstanding transactions estimated at US$747 million and a mortgage-to-GDP ratio of 0.14% (Centre for Affordable Housing Finance Africa [CAHF], 2019), while South Africa ranks 1st on the continent, with outstanding mortgage markets valued at around US$67 billion and a mortgage-to-GDP of 19.56% (CAHF, 2019). The informal private sector, accounting for 80% of the housing supply in Ghana, primarily targets low-income groups (Ehwi et al., 2020; Andreasen et al., 2021). Formal mortgages primarily serve middle- and upper-class brackets (Asante et al., 2022). Recent financial reforms, such as the Ministry of Works and Housing securing US$17.2 million from government and private sector sources in 2018 and a US$237.7 million funding injection in 2019 (Ministry of Finance, 2019), aimed to expand access to housing. These interventions were not only target-oriented but also strategic in accelerating mortgage market development.

The mortgage markets in Africa, with the exception of South Africa, are nascent. Boamah (2010) reveals the inadequacy in housing delivery in Ghana and accounts for poor and inadequate housing consumption. The result is underpinned by the fact that most people might have financed their home acquisitions from personal savings (Boafo et al., 2017). In Nigeria, low incomes, high interest rates, and inadequate lending institutions limit mortgage access (CAHF, 2016; Nwuba & Chukwuma-Nwuba, 2018), while Uganda faces low formal mortgage access (Kalema & Kayiira, 2008).

2.2 Determinants of mortgage (loan) amounts

The stalling in the development of the housing markets in Africa, especially Ghana, can be attributed to the small size of the mortgage market (see Agnello et al., 2020; Ambrose & Diop, 2014; and Hochstenbach & Aalbers, 2023). The few banks and financial institutions willing and able to lend to potential homeowners assess the amount and risk based on borrower incomes, mainly generated from salaries and property features (segmentation or sub-market). Only 8 of Ghana's 31 banks offer mortgages officially, typically requiring a 20% upfront payment and targeting new residential properties[2]. The risk premium factor is deemed the most important determinant in the affordability of mortgages in Ghana (Owusu-Manu et al., 2016).

Mortgages are contracted as long-term transactions for 30 years or more in developed economies. In Ghana, the period ranges from 10 to 20 years. Loans (mortgages) are typically denominated in foreign currencies (USD or GBP) with fixed rates or in local currency (GHS) with variable rates and are subject to Bank of Ghana guidelines. For instance, if the cheapest newly built house for sale is US$25000, a buyer needs to deposit 20% of this amount and earn US$970/month to afford a 20-year mortgage at 13.5% per annum (Sarfoh et al., 2017). Given the historical and prevailing economic conditions in Ghana, this cost is not affordable, despite the insistence by the country's largest mortgage provider, Republic Bank (Sarfoh et al., 2017). The Home Mortgage Finance Act, 2008 (Act 770) regulates home mortgage financing and related matters, including foreclosures. However, it remains challenging for banks and home finance companies to recover properties from defaulting customers. Thus, in line with the assertion by Teye et al. (2015), the government needs to ensure that better loan pricing and repayment mechanisms are in place to promote mortgage financing in Ghana.

[2] https://lakesideestate.com/mortgage-providers-ghana/#:~:text=your%20dream%20home.-,1.,leading%20mortgage%20provider%20in%20Ghana.

In racially homogeneous countries like Ghana, housing finance and mortgage origination are primarily based on individual borrower income levels and property characteristics. The lack of credit data, which is crucial for evaluating the creditworthiness of borrowers, significantly contributes to this. Past literature shows that residential characteristics, such as location, type of property, landscaping quality, gross internal areas and plot size, explain both property rentals and property transactions in Ghana (Anim-Odame & Stevenson, 2010).

In terms of mortgage origination, Boamah (2011) found that exchange rates had an influence, given that mortgages are dollar-denominated. Nonetheless, there has been a gradual increase in the volume of mortgages as Ghana's mortgage origination increased from GHS 58 million in 2008 to GHS 342 million in 2013 (Gavu & Adamu, 2015). Boamah (2009), however, argues that the secondary mortgage market is not the best way to solve the housing finance problem in Ghana because basic challenges (such as land title security, long-term funding, and macroeconomic stability) need to be resolved first.

2.3 Determinants of LTV ratios

Borgersen (2018) deduces that moral hazard, risk pricing, lending volumes, and collateral values, among others, influence the optimal LTV ratio for mortgagees. In the Netherlands, outstanding LTVs are driven by household characteristics, life-cycle effects, and mortgage type. The LTV follows a decline over time from mortgage commencement, but is higher by about 10% for non-repayment mortgages compared to repayment mortgages (Cunha et al., 2013). Specifically, Thebault (2017) examines property location (prime and vulnerable locations) and property price changes from the European Data Warehouse and finds overwhelming evidence of their effect on LTV ratios. This evidence supports the direct relationship expected between the LTV ratio and property characteristics in Ghana. In a study on LTV in mortgage lending for over 4000 banks across 46 countries, Morgan et al. (2019) find that mortgage loans have been successfully managed in countries with an LTV policy and suggest the inclusion of other macroprudential tools to complement the effects of LTV (Borgersen, 2018).

2.4 Determinants of mortgage repayment and default

On repayments, Ampofo (2020) indicates through a survey of mortgage lenders in Ghana that fixed-rate repayment plans are the most common, with higher-income borrowers and smaller household sizes demonstrating better repayment performance. Default mortgage risks are common among females, older, unmarried, and divorced individuals, and those who are financially illiterate (Owusu-Manu et al., 2019). In the Ashanti Region of Ghana (the next biggest city), demographic factors such as income level, property value (Belete & Yilma, 2020), and property location determine mortgage default rates (Awunyo-Vitor et al., 2015).

While loan-to-price (LTP) instead of LTV and borrower income are seen as key determinants of mortgage default in Spain (Galán & Lamas, 2019), US studies emphasise default costs over the LTV ratio (Harrison et al., 2004). Campbell and Dietrich (1983) indicate that payment/income and loan/value ratios, as well as unemployment rates, age and the original loan/value ratio can determine default propensity in a direct relationship.

Additionally, exchange rate fluctuations, high interest rates, and high house prices lead to higher initial monthly payments. Teye et al. (2015) also examined the interconnectedness of factors that determine the demand and supply of mortgages in Ghana. Among other challenges, the inability of financial institutions to establish the creditworthiness of potential borrowers

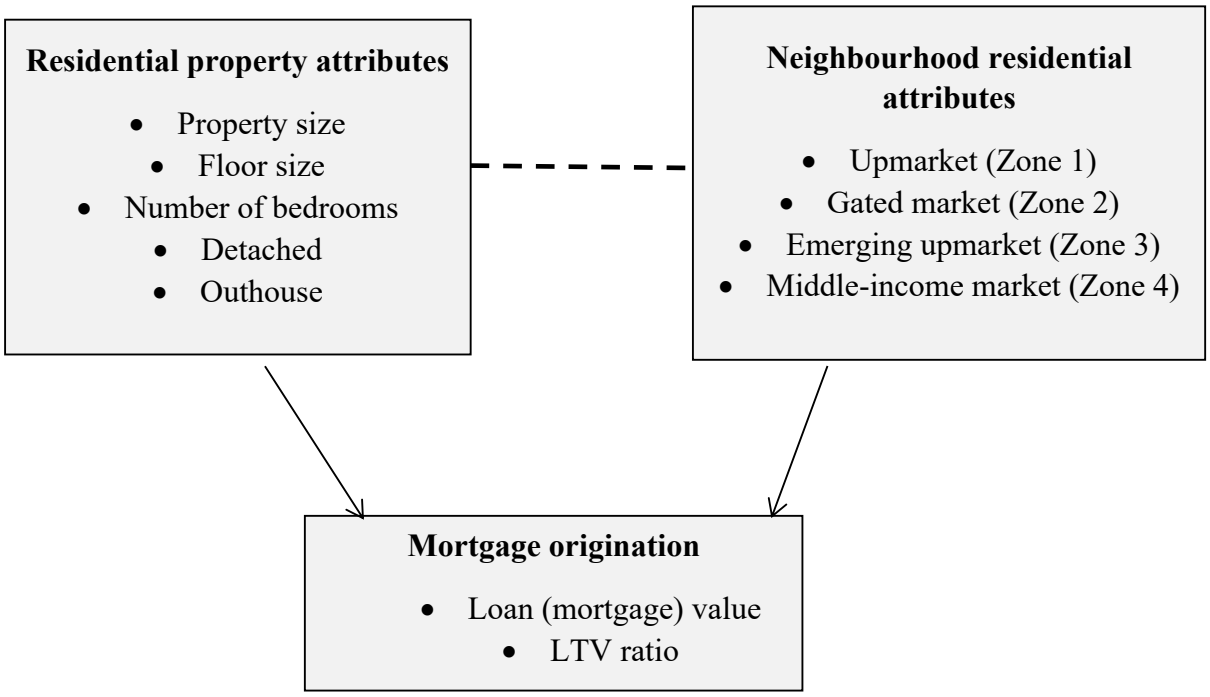
remains a significant obstacle to mortgage financing. The literature advocates for awareness creation on property rates and penalties to reduce the rate of default in Ghana (Awunyo-Vitor et al., 2015) and policies aimed at reducing mortgage rates (Owusu-Manu et al., 2016).

2.5 Research gap

Overall, existing literature has provided some evidence on the development of the mortgage markets and mortgage origination in Ghana. However, there exists no study on the relationship between mortgage values, LTV ratio and property characteristics using the housing market transaction data. The current paper differs from previous works because we seek to understand the determinants of mortgage values and high LTV ratios in Ghana. We also seek to estimate the probability of default on mortgages with the same residential property attributes for HPM. With the HPM, we examine how and to what degree property characteristics, market value, and neighbourhood qualities interact with financial burden to influence loan originations in Ghana's housing market. This approach provides a broader insight that is directly related to the market dynamics.

2.6 Theoretical framework

Figure 1 depicts the theoretical relationship between residential property attributes and mortgage origination as described in Sub-sections 2.2 and 2.3. The HPM is based on these connections. In this framework, property attributes and neighbourhood attributes are related to one another, especially given that we conceptualised the latter as sub-markets. It is inherent that property size, floor size, number of bedrooms and other property features correspond to the markets in which they are found (either Upmarket, Gated, Emerging, or Middle-income markets[3]). However, the relationship is not a straightforward "cause-and-effect" nexus. Hence, we have linked them with an undirected dashed line.



[3] Refer to the Appendix for the definition of Zones.

***Figure 1*: Residential property attributes and mortgage origination link**

Nonetheless, it is clear from the literature that the price or value of a property is a function of its structural features (i.e., property size, floor size, bedrooms, detached, and outhouse) and location (i.e., neighbourhood attributes). In this study, we have conceptualised neighbourhood attributes as sub-markets, including Upmarket (Zone 1), Gated market (Zone 2), Emerging upmarket (Zone 3), and Middle-income market (Zone 4). We also argue that both structural features and the location of properties have a "cause-and-effect" link with the value of the property. In terms of mortgage origination, the value of a property is proxied by the loan (mortgage) value. Lastly, to gauge the risk of this mortgage, the LTV ratio is used. We have used solid directed lines from property attributes and neighbourhood attributes to mortgage origination to indicate this "cause-and-effect" relationship.

3. Materials and Methods

In this paper, we employ the semi-log HPM to determine mortgage origination based on the linkages in Figure 1. We also use logistic regression to estimate the risk of default on mortgages.

3.1 Data

The data was obtained from the First National Bank (FNB) Ghana (formerly GHL Bank Ltd.). Data were provided for each of the 1,476 mortgage loans from 2008 to 2016[4], representing total mortgages originated in the Greater Accra region of Ghana. Greater Accra is chosen because it is the region with the most developed real estate market in Ghana. As of 2018, Ghana recorded 6,000 mortgages in a country of 6.6 million households (CAHF, 2018). Ghana currently has 8 mortgage providers, and FNB Ghana is the market leader and dominant player in mortgages in Ghana, with about 50 per cent market share.

3.2 Model specification

We employed two dependent variables (i.e., log of loan amount and LTV ratio) as in $logloan = f$ (I, L) and $LTV =$ (I, L), where I and L denote house characteristics (i.e. floor area, plot area, and bedrooms, etc.) and location (i.e., Zones[5] 1, 2, 3, and 4), respectively. The models to estimate are:

$$logloan_i = \mathrm{a_o} + \mathrm{a_1}\, \mathcal{X}_\mathrm{i} + \mathrm{e}_i \quad (1)$$

$$LTV_i = \mathrm{a_o} + \mathrm{a_1}\, \mathcal{X}_\mathrm{i} + \mathrm{e}_i, \quad (2)$$

Where $logloan_i$ is the log of the value of the loans originated, LTV denotes loan-to-value, $\mathcal{X}_\mathrm{i}$ is the vector of explanatory variables (outlined in Table 1), and e_i is the error term. The loan is logged to reduce the level variance to make it more appropriate for the linear model

[4] It is to be noted data is old because it was special and retrieved privately. This is not publicly available so it is difficult to obtain the current values. Private data on mortgage loans in African is difficult to obtain and hence the reasons why research in this topic is rare. Hence the importance of this research even with this available data which is rare.

[5] Refer to the Appendix for the definition of Zones.

specification[6]. Empirically, the log form of the HPM performs well, especially when certain property characteristics are unavailable.

The main aim of this paper is to understand how mortgage banks in Ghana make decisions when originating loans, and specifically how the sub-markets in which a property is located may influence the mortgage originator's decision. The results of models (1) and (2) are presented in Tables 5 and 6 using the multivariate linear regression approach with the Ordinary Least Squares (OLS) estimator to implement the HPM. For a cross-section of transaction data, the OLS seems appropriate at the level of analysis.

In furtherance of risk assessment for mortgage lenders, we develop an additional model to estimate the probability of default based on the LTV ratios, separating borrowers into two groups (i.e., Groups 1 and 2). Group 1 has an LTV ratio of 80% or higher, and Group 2 has an LTV ratio of less than 20%, in line with Epley and Liano (1999). Thus, we define the default (DF) as a dummy.

$$\mathrm{DF} = \begin{cases} 1, & if\ LTV \geq 80\% \\ 0, & if\ LTV < 20\% \end{cases} \qquad (3)$$

Therefore, we modify equation (2) as

$$DF_i = \mathrm{a_o} + \mathrm{a_1}\, \mathcal{X}_\mathrm{i} + \mathrm{e}_i \qquad (4)$$

with all variables retaining their descriptions. Given that equation (4) has a dummy as the dependent variable, we employ the logistic regression technique as opposed to the OLS regression. The logistic regression determines the probability between 0 and 1 (see Jackson & Kaserman, 1980), from which we can infer the chance of default by a mortgage borrower based on the house characteristics. We perform the appropriate diagnostic tests on all estimated regression models to confirm the reliability of the results.

Details of the variables are presented in Table 1. Location, in the context of this study, is defined as a dummy corresponding to four different zones. Location plays a significant role in securing mortgages. A detached house and outhouse are also included as dummies. According to past literature, such as Leow and Mues (2012), detached properties tend to have a higher forced sale value to valuation ratio at the time of default. A positive relationship is expected from outhouse, number of bedrooms, plot size and floor area.

Table 1: Variable specifications

Variable	Specifications	Expected sign
Log Loan Amount	Amount of mortgage in log form	-
LTV Ratio	Amount of mortgage divided by the property price	-
Upmarket (Zone 1)	1 = Property in Zone 1, 0 = others	Positive
Gated Market (Zone 2)	1 = Property in Zone 2, 0 = others	Positive
Emerging Upmarket (Zone 3)	1 = Property in Zone 3, 0 = others	Positive
Middle-Income Market (Zone 4)	1 = Property in Zone 4, 0 = others	Positive

[6] This is also a special case of the Box-Cox transformation (with $\lambda = 0$) popularly used to centre data (Asar et al., 2017).

Number of Bedrooms	Number of bedrooms per property	Positive
Log Plot Size	Plot size measured in square meters in log form	Positive
Log Floor Area	Floor area measured in square meters in log form	Positive
Detached	1 = Detached property, 0 = others	Positive
Outhouse	1 = Outhouse, 0 = others	Positive

The classification of residential real estate markets in Ghana into sub-markets, namely; Upmarket (Zone 1), Gated market (Zone 2), Emerging upmarket (Zone 3) and Middle-income market (Zone 4) is based on the Ministry of Local Government of Ghana nomenclature. The categorisation is along the lines of density, size of houses, and infrastructure of the area. The detailed description of the zones is presented for brevity reasons.

4. Results and discussion

4.1 Preliminary results

In Figure 2A, we present the average logged values of originated loans, purchase prices, and LTV[7] ratios from 2008 to 2016. Loan amount and purchase (property) price are directly related, as high property prices tend to attract high mortgages. The property price is the primary determinant of the loan amount (Fitzpatrick & McQuinn, 2007). We shed light on the corresponding average amounts in US dollars in Figure 2B. The average loan from 2008 to 2016 is US$61,208. There are variabilities in the average loans originated per year, with 2008 providing the lowest average value of US$49,235. This decline could be as a result of the global financial crisis, but 2009 recorded the highest average loan during the period investigated, at US$70,664, which could also be attributed to a recovery from the shock in 2008. Over the rest of the period, the loan amount hovered around US$67,424 in 2016 and US$55,511 in 2010.

As expected, the purchase prices of houses in Ghana vary, with the average house price during the period being US$112,836. The Lowest average house price purchased is US$71,290, recorded in 2010, whilst the highest average price registered is US$178,597 in 2013. From Figure 2 (A and B), the average LTV ratios were 96.20% from 2008 to 2016, with the lowest LTV ratio, originating from the bank, being 70.03% in 2014, while the highest LTV ratio was 120.13% in 2009.

[7] LTV ratios are not logged in this plot.

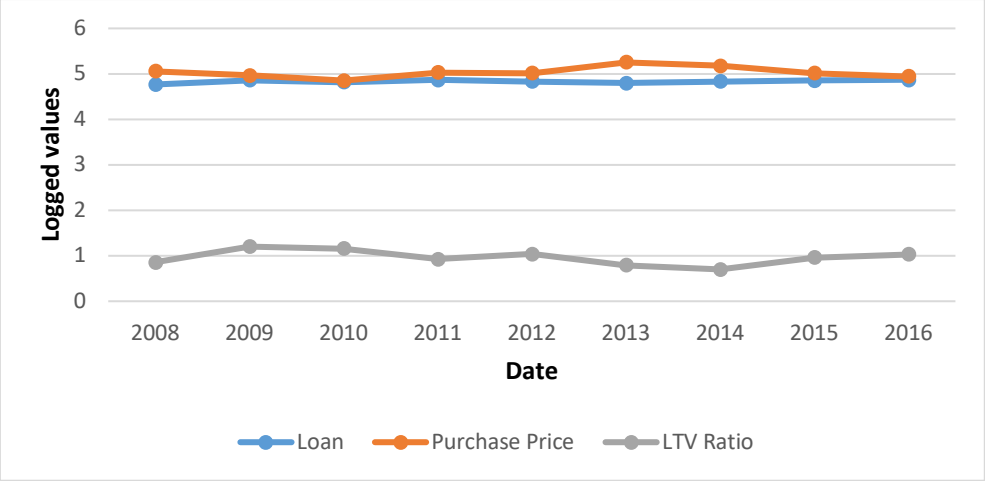


Figure 2A: Logged average residential mortgages in Ghana

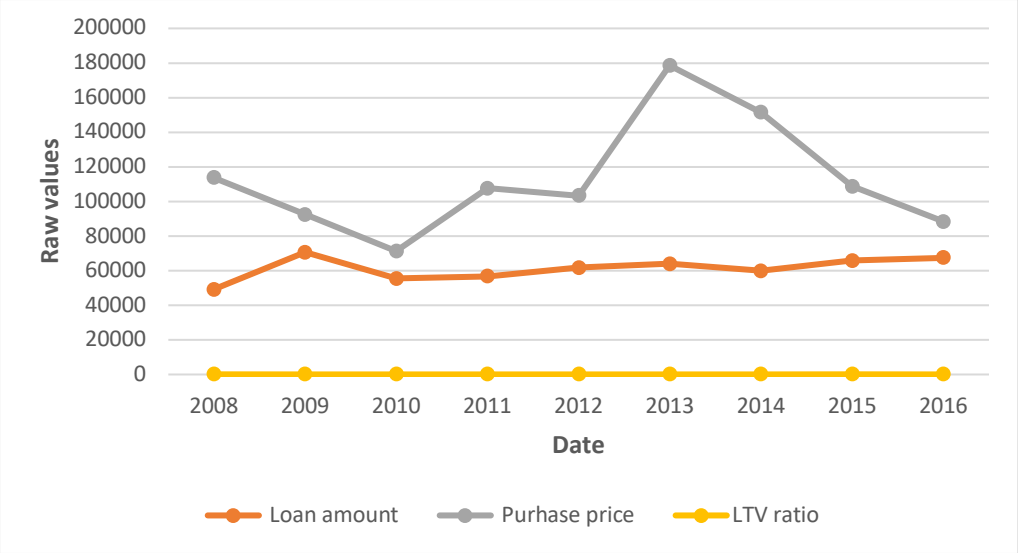


Figure 2B: US$ average residential mortgages in Ghana

Figure 3 illustrates loan values across residential sub-markets from 2008 to 2016, clearly highlighting the disparities. Properties in Upmarket areas (Zone 1) and Gated communities (Zone 2) tend to attract higher loan values from banks in comparison to Zone 3 (Emerging markets) and Zone 4 (Middle-income). As expected, this trend is observed across the period 2008 to 2016 for the top end of the market, with properties located in very expensive neighbourhoods.

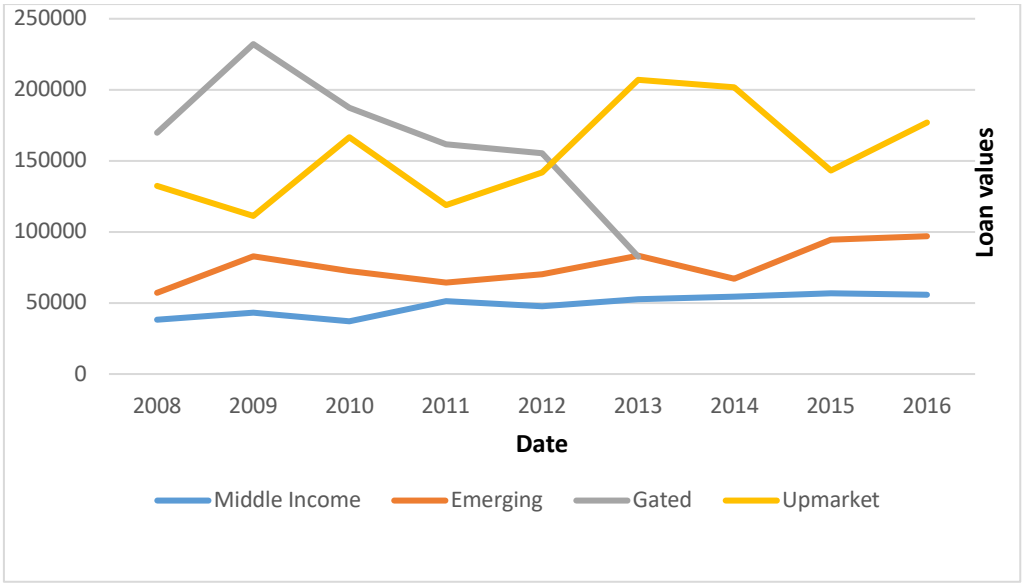


Figure 3: Loan values (US$) and residential sub-markets in Ghana

In Figure 4, we present the LTV ratios according to residential submarkets from 2008 to 2016. It shows the variations and disparities across the LTV ratios for each residential sub-market. Properties in Emerging (Zone 3) and Middle-income (Zone 4) tend to attract higher LTV ratios from banks compared to Zone 1 (Upmarket) and Zone 2 (Gated market), accounting for the relatively higher default risk associated with lower-income brackets.

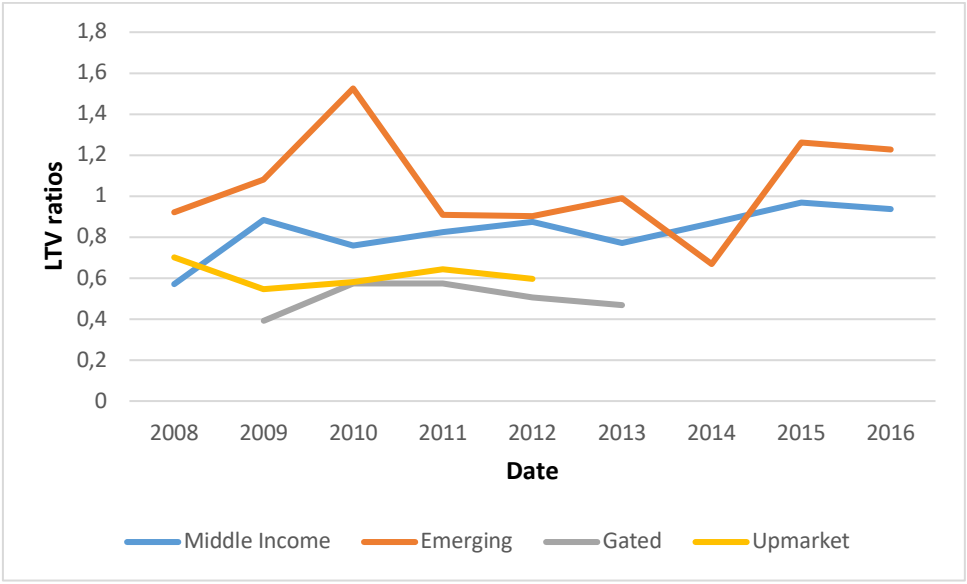


Figure 4: LTV ratio and residential sub-markets

Table 2: Comparison across residential sub-markets

Sub-market	Bedrooms	Plot size	Floor size	Loan value (US$)	LTV ratio
Upmarket (Zone 1)	3.33	1141.31	275.55	145,949	62%
Gated market (Zone 2)	3.04	1153.89	206.85	163,415	61%
Emerging upmarket (Zone 3)	3.16	927.16	444.99	74,669	67%

Middle-income market (Zone 4)	2.65	973.98	160.50	48,312	71%

Table 2 shows a breakdown of four key property sub-markets in Ghana. Loan values and property characteristics are disparate and vary across the property market classifications. Properties in Zone 2, which are predominantly Gated communities, attract the highest average loans from the bank at US$163,415, while Zone 4 (Middle-income properties), at the low end of the residential real estate market in Ghana, attracts the lowest average loans from the bank at US$48,312. However, the highest LTV ratio is observed in the Middle-income markets at 71%, while the lowest LTV ratio is recorded for the Gated communities at 61%, which is expected to account for the associated default risk. In terms of property characteristics, the Emerging upmarket has the highest average number of bedrooms per property at 3.16, as well as floor area at 444.99, while the highest average plot size is observed in Gated communities at 1,153.89, reflecting the bourgeois status of the borrowers (mortgagors). This can be likened to the sense of high self-esteem, self-efficacy, and pride in Mexican residents who construct their own homes as compared to those in state-provided turnkey houses (see Elizondo, 2024).

Table 3: Correlations[8]

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Log floor size	1								
(2) Log loan amount	0.6788***	1							
(3) Log plot size	0.6280***	0.5088***	1						
(4) LTV ratio	-0.2287***	-0.0005	-0.1548***	1					
(5) No. of bedrooms	0.6893***	0.5284***	0.4535***	-0.1969***	1				
(6) Upmarket	0.2552***	0.3902***	0.1383***	-0.1405***	0.2140***	1			
(7) Gated	0.0722*	0.2738***	0.1426***	-0.0180	0.0300	-0.0547	1		
(8) Emerging	0.1254***	0.1569***	0.0420	-0.0426	0.1354***	-0.2397***	-0.1080***	1	
(9) Middle-income	-0.2992***	-0.4749***	-0.1696***	0.1333***	-0.2698***	-0.3824***	-0.1723***	-0.7552***	1

[8] Note that in this correlation involving dummy variables (in this case Zones), any statistical tool works by taking the actual values corresponding to 1 and 0 for those corresponding to 0.

Table 3 presents the correlation matrix for all variables in this study. Except for LTV ratio-loan, Emerging-plot size, LTV ratio-Gated, LTV ratio-Emerging, and number of bedrooms-Gated pairs, all other pairs of correlations are significant at all conventional levels of significance. The insignificant correlation pairs pose an empirical concern for this study. Nonetheless, we base our analysis on the theoretical premise of the hedonic pricing model to examine these in the regression models. For the rest, there is a mix of both positive and negative correlations of various magnitudes. For instance, the Middle-income market has an inverse relationship with plot size, floor size, number of bedrooms, and loan amount, unlike the Emerging market. This confirms the difference in the market, also established by the negative correlations among all of them. Further, there is a significant positive correlation between loan value and the number of bedrooms and the floor area. On the other hand, there is a significant negative correlation between the LTV ratio and the number of bedrooms, plot size, and floor area. These correlations provide preliminary insight into the characteristics of properties that could explain the loan value and the LTV ratio in Ghana.

4.2 Main results

In this subsection, we first present the main results of the study from the two regression models, with loan value (equation 1) and LTV ratio (equation 2) as the response variables for each model. In each of these two models, we create three models (Models 1, 2, and 3 as seen in Tables 4 and 6) with an increasing number of covariates to understand how the different log loan and LTV ratios respond to these sets. Model 1 includes the four zones as regressors, which represents a pure dummy variable regression where Zone 2 (Gated market) is set as the reference zone. In Model 2, we augment Model 1 with the number of bedrooms, the plot size, and the floor area. Finally, in Model 3, we add Detached and Outhouse to Model 2, making it the complete model with all explanators. We note that the R^2 in the models, which supposedly denotes the explanatory power of the model, is small (i.e. between 28% and 35% in Table 5 and between 4% and 8% in Table 6), despite many parameters being significant. Nonetheless, we note the weakness of R^2 in being monotonically increasing with the number of covariates, so we do not give it much importance. Instead, we focus on the significant parameters.

Model 1 (Table 4) reveals that Upmarket, Emerging and Middle-income sub-market housing attract 5.1%, 4.8%, and 4.6% lower loans, respectively, compared to the Gated market. With the addition of number of bedrooms, plot size, and floor, Gated market mortgages are still higher than Upmarket, Emerging, and Middle-income mortgages, but by about 1% less. This corroborates Soyeh et al. (2021), who reveal that housing in Gated communities is transacted at premium prices or rents (and by extension, high mortgage values) compared to those in non-gated communities in Accra. This result also conforms to the findings in Gardner and Mills (1989), which reveal that locations are important when loans are originated. This also connotes social disparities in African cities such as Johannesburg (Hofer et al., 2022), where Gated and access-controlled communities are prevalent, even for government urban developments.

Further, as anticipated, the number of bedrooms (aligned with Shilling et al., 1990) and plot size correspond to higher mortgage values, but a larger floor area tends to reduce house value marginally, as seen in Model 2. In Model 3, the addition of Detached and Outhouse also tends to increase house prices and hence mortgages compared to those without, as expected. Specifically, properties with Detached and Outhouse are priced about 1% more than those without. This result is also confirmed in Leow and Mues (2012) but not in Marinković et al. (2024) for house prices in Serbian cities. We note that all coefficients are significant at all

conventional levels. The predictive ability of the models is 28%, 32%, and 35% for Models 1, 2, and 3, respectively.

Table 4: Regression[9] of loan values and property market segmentation

Log Loan	Model 1	Model 2	Model 3
Zone 1 (Upmarket)	-0.0921**	-0.1010**	-0.1597***
Zone 3 (Emerging)	-0.3879***	-0.3884***	-0.4371***
Zone 4 (Middle-income)	-0.5488***	-0.5339***	-0.5724***
Number of Bedrooms		0.0315***	0.0255***
Log Plot Size		0.0000157***	0.0000123***
Log Floor Area		-0.00000212*	-0.00000244**
Detached			0.0853***
Outhouse			0.0983***
Constant	5.1735***	5.0601***	5.0556***
N	1,443	1,434	1,433
R^2	0.2751	0.3174	0.3478
F-statistic	167.6171 (0.0000)	151.7861 (0.0000)	115.3488 (0.0000)

*Note: The Table reports the regression models on log of loan values and property markets and property characteristics. *, ** and *** denotes significance at the 10%, 5% and 1% levels, respectively. For the F-statistic, p-values are in parentheses.*

Table 5 presents the results using the LTV ratio as the dependent variable, along with the additional three models. The LTV is an important risk measure of the mortgage, and hence, we need to understand the factors that determine it. In Model 1, on average, Emerging and Middle-income sub-markets determine LTV by about 0.5% and 1%, respectively, more than Gated markets. Upmarket plays no role in determining the LTV ratio. Thus, properties within the Emerging upmarket, as well as the Middle-income market, are more likely to attract higher LTV ratios. The findings persist in Models 2-3, confirming lenders' perception of Gated communities as lower-risk, in line with the literature. We again note that the adequacy of the models is not questionable in terms of R^2. Most certainly, we are aware that our model has not controlled for borrower characteristics, which are important variables to consider in terms of the loan value and LTV ratio. However, our model is constrained by limited data.

Table 5: Regression of LTV ratio and property market segmentation

LTV Ratio	Model 1	Model 2	Model 3
Zone 1 (Upmarket)	0.0129	0.0301	0.0256
Zone 3 (Emerging)	0.0612*	0.0627*	0.0565*
Zone 4 (Middle-income)	0.0992***	0.0859***	0.0785**
Number of Bedrooms		-0.0017	-0.00162
Log Plot Size		0.00000987	0.00000838
Log Floor Area		-0.0004***	-0.0004***
Detached			0.0148
Outhouse			-0.0152
Constant	0.6066***	0.6733***	0.6752***
N	630	623	622
R^2	0.0359	0.0788	0.0814

[9] Note that in regression involving dummy variables (in this case Zones), any statistical tool works by taking the actual values corresponding to 1 and 0 for those corresponding to 0.

F-statistic	7.7663894 (0.0000)	6.521336 (0.0000)	5.163049 (0.0000)

*Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. For the F-statistic, p-values are in parentheses.*

Our study and findings sit within the broader literature on the role of housing segmentation in predicting house prices. Adair et al. (1996) argue that housing market segmentations need not be small, homogenous and well-defined, and that models generated at the macro level could generate an acceptable level of explanation. Bourossa et al. (2003) empirically examine transaction prices from Auckland, New Zealand, and show that housing sub-markets are significant, and specifically, location plays a role in that significance. Segal (2002) examines the multi-family mortgage market; their results support the hypothesis that the mortgage market for multi-family properties is affected by segmentation, specifically that smaller properties with fewer than 50 dwelling units exhibit a number of characteristics that differ from larger properties. Francois and Marius (1996) examine five rental sub-markets in the Canadian region of Quebec; their results show significant differences in implicit prices across the different market segments investigated. The paper argues that resorting to a geographical information system permits the integration of neighbourhood analysis.

For further analysis and robustness tests, we estimate a logistic regression model to determine the probability of default. The rationale is that high LTV ratio loans indicate high risks, for which higher rates are charged (making them more expensive for borrowers) due to the risk of default. In this logistic model, we use all the given regressors to compositely determine the risk of default, as seen in Table 6.

Table 6: Logistic regression of DF and property market segmentation

DF	Estimates
Zone 1 (Upmarket)	-
Zone 3 (Emerging)	-1.034653***
Zone 4 (Middle-income)	-1.033111***
Number of bedrooms	-
Log plot size	-0.000680**
Log floor area	-0.011626***
Detached	-
Outhouse	-
Obs with Dep=0	1399
Obs with Dep=1	66
Total obs.	1465

*Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.*

In Table 6, we present the estimated model with only the significant variables in logistic regression. In logistic regression, the focus is not on the coefficients themselves but on how they combine to determine the probability that a default (DF) belongs to a particular category, also known as log odds (Brooks, 2008). The log odds can be given as:

$$\Pr(DF = 1|X_i) = \frac{1}{1 + e^{-\beta_i}} = \frac{e^{\beta_i}}{1 + e^{\beta_i}} \quad (5)$$

where the variables retain their origination designations. Thus, from the values in Panel B of Table 7, we can evaluate

$$\Pr(DF = 1|\text{Zone 3}, \text{Zone 4}, \text{Plot size}, \text{Floor area}) = \frac{1}{1 + e^{-[-1.034653*\text{Zone 3} - 1.033111*\text{Zone 4} - 0.000680*\text{Plot size} - 0.011626*\text{Floor area}]}} \approx 0.0000$$

There is almost a zero probability that the mortgages will default. This can be evaluated for any specific property for lenders to determine the level of risk involved. This confirms the assertion that many lenders approve mortgages for Gated community houses because they are seen as premium markets and hence with perceived lower risks (Soyeh et al., 2021). The result also corroborates the opinion by Sarfoh et al. (2017) that, despite the claim by the largest mortgage lender in Ghana to extend facilities to workers, their high mortgages are the reserve of 'low-risk' borrowers, hence pricing out their intended customer base. It is also not surprising, given that only 66 out of 1465 properties meet the high-risk threshold of 85% LTV ratio in the dataset. Nonetheless, we should be wary of the Lucas Critique (Smith & Yezer, 2023) on models where they perform well but fail seldomly because mortgage applicants are both able and willing to act strategically.

5. Conclusion

We examine the role residential property attributes play in loan origination (i.e., loan values and LTV ratios). Despite the limitations on transaction data in terms of availability, currency, borrowers' and property characteristics, the literature needs a nuanced understanding of emerging real estate market dynamics like Ghana's. The study reveals that neighbourhood characteristics play a crucial role in the origination of mortgages. Precisely in Ghana, the Emerging, Upmarket and Middle-income property markets attract lower loan values. The number of bedrooms and plot size correspond to higher mortgages, but a bigger floor area tends to reduce house value marginally.

We also find that the probability of default is negligible in the Ghanaian market, as judged by the LTV ratio. As a fledgling mortgage and real estate market in Ghana, transaction data is mostly for new properties rather than old ones, where the repeat sales approach could be used to establish property price indices, as in other countries. Thus, control variables such as loan conditions, borrower characteristics, as well as age of property, which can influence the loan amounts and LTV, are missing. These could lead to the models suffering from omitted variable bias. But their unavailability in the market mitigates the problem.

From a policy perspective, the study's findings can be leveraged to inform policymakers and financial institutions in their decision-making regarding access to affordable housing. Policies can be formulated not only to address the provision of affordable housing but also infrastructure financing to improve the quality of neighbourhoods in cities and towns across the country. These actions can expand the bracket for beneficiaries of state-provided affordable housing, which has mainly focused on civil servants (Asante et al., 2022). With the availability of data and the expansion of the residential real estate market, further studies can be done to track the differences across major cities in Ghana or across the regional capitals, as in Parnes (2023), to foster more policy action and investment insights.

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Appendix: Residential sub-market or location classification

Market Classification	Neighbourhood Characteristics
Upmarket (Zone 1): Airport Residential, Cantonments, East Legon, Labone, Ridge, Roman Ridge, Switchback Road	Low density buildings; predominantly of detached types; plot sizes of no less than 600 square metres; spacious environment free from intrusion by incompatible land uses; community facilities such as schools, clinics and corner shops adequately provided; roads and concrete drains; public utility services adequately provided; state owns freehold interest in land.
Gated Market (Zone 2): East Airport (Golden gate), East Legon Extension (Trasacco Villas)	Gated community with high density buildings; spacious environment free from intrusion by incompatible land uses, access roads and concrete drains available; and public utility services adequately provided; customary freehold interest in land.
Emerging Upmarket (Zone 3) Abelemkpe, Dzorwulo, East Legon Extension, North Legon, West Legon	Predominantly detached with varied plot sizes; spacious environment, no intrusion by incompatible land uses; adequate community facilities such as schools; clinics and corner shops adequately provided; surfaced roads and concrete drains with basic public utility services; both state and customary freehold interest in land.
Middle-income market (Zone 4): Achimota, Adenta, Baatsona, Dansoman, Dome, Okpoigono, Kaneshie, Teshie/Nungua Estates	Variety of buildings at net site densities of between 15 and 45 units per hectare, a mixture of house types (detached, semi- detached, etc.); small-scale retail development in selected areas; adequate level of infrastructural and social amenities; both state and customary freeholder interest in land.

Source: Ministry of Local Government (1990).