Credit Access and Housing Quality

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Abstract

Would widespread credit access solve housing quality issues? Using data from Mexico, we find a huge effect of credit access - access to mortgage loans for households in the lowest-income decile is equivalent to raising their income to the middle-income decile in terms of improvement in housing quality. This correlation falls for high-income households. We present a heterogeneous-agent model with a discrete housing choice and borrowing constraint to match our empirical facts. In this model, low-income households are differentially affected by limited access to credit as they are more financially constrained. We use this model to study the effect of credit provision and find that housing quality can be improved by 22 percent if all households in Mexico are given access to mortgage loans.

Keywords: Housing Quality, Heterogeneous Agents, Borrowing Constraint

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1 Introduction

Housing quality has been a focus of governments in developing countries. Even though the homeownership rate is often much higher in developing countries than in developed countries, many households live in dwellings with poor conditions **(cite something here)**. One possible explanation is that households in developing countries have limited access to mortgage finance, effectively barring low-liquidity households from acquiring more expensive homes with adequate quality.

In this paper, we study the housing market in Mexico to understand what providing credit access might do to improve housing quality. Despite a high homeownership of nearly 80%, Mexico has a major housing quality problem. Most households in Mexico do not have access to any mortgage loan facilities. Access to government funding is available for formal workers, who make up less than half of the working population.

We argue that providing mortgage loan opportunities can have a huge impact on the housing quality in Mexico. Using survey data, we construct an index to measure the quality of dwellings in Mexico. We find that credit access and income are positively correlated to the housing quality index. In particular, for households in the lowest-income decile without credit access, providing credit access brings an improvement in housing quality comparable to providing income up to the middle-income deciles. The effect of credit access vanishes for high-income households. These findings are robust to alternative definitions of housing quality index and characteristics of households. The finding suggests that households are potentially bound by financial constraints at home purchases.

We used a model with borrowing constraints to rationalize our empirical findings. Low-income households are discouraged from purchasing high-quality homes because the downpayment is too large that the household finds it infeasible, or may have to sacrifice large non-housing consumption to afford it. We extend this idea to a quantitative heterogenous-agent model with discrete housing choices to analyze the potential effect of relaxing mortgage credit conditions. Households in the model face an exogenous borrowing constraint, which allows our model to match our empirical findings. We compute a policy counterfactual where all households have equal access to mortgage loans with the same Loan-to-value constraint. We found an overall 22% increase in the share of households living in high-quality housing. The improvement is mostly concentrated in the mid-income households. This is because, under the current calibration, mid-income households are the marginal households that are close to being able to purchase a high-quality home. The additional relaxation of credit allows them to upgrade from their original home.

Literature Our paper is related to the literature on financial constraints in developing countries. Many papers have shown that financial constraints can lead to a misallocation of resources and thus losses in productivity (Moll (2014)). Our paper is similar to Manysheva which emphasizes using micro-data to discipline a heterogeneous agents model to answer development economics questions. On the technical side, we applied techniques in discrete choices Iskhakov *et al.* (2017) to study the housing market with potentially rich heterogeneity on the household side.

The paper proceeds as follows. Section 2 and 3 discusses housing data in Mexico and empirical findings. Section 4 presents a simple model to explain how financial constraints may explain our findings. Section 5 describes our quantitative model and counterfactual exercise. Section 6 concludes.

2 Data

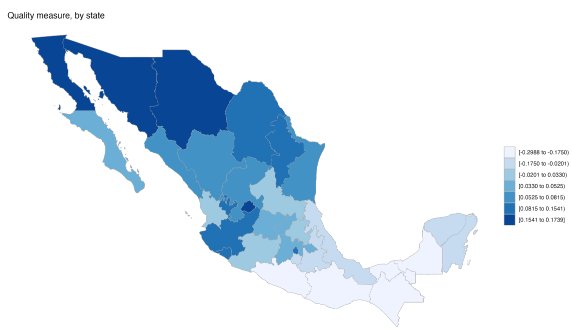
Our main source for empirical work is Mexico's 2020 National Housing Survey (ENVI), a public dataset put together by the Mexican National Institute of Statistics. The survey includes sections on housing, financial and sociodemographic characteristics at the housing, household and individual level from 55,147 representative housing units.

For each housing unit, we obtain housing information including quality, value, rental value, and sociodemographic information of the head of the unit (type of ownership, formal or informal type of income, access to credit, age, education level) and unit inhabitants.

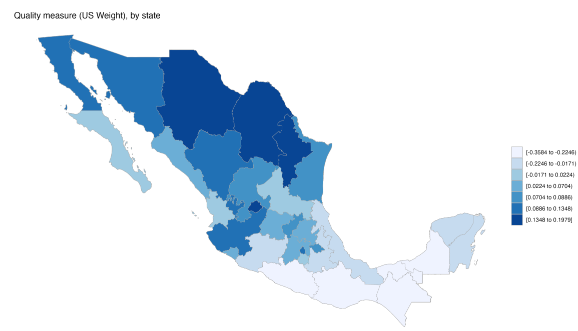
To complement the household credit access information from the ENVI, we incorporate the National Banking and Securities Commission (CNBV) regulatory data on banking access and usage at the state level.

Based on the ENVI 2020 section on housing issues, we present a quality index to measure housing quality. The index is based on the American Housing Survey (AHS) 2013 Housing Quality Index methodology, incorporating additional quality dimensions not considered for the US housing market but relevant for the Mexican housing market.

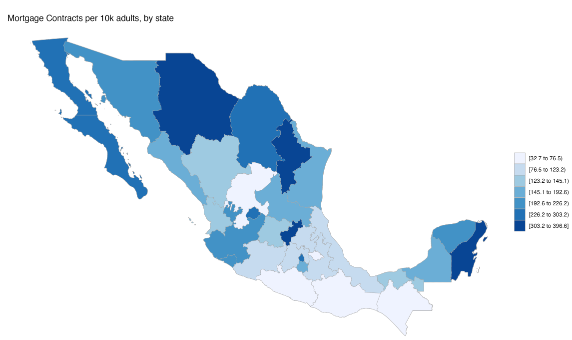
Figure 1 displays the three main variables of our study as a state level heat map. Figure 1a and Figure 1b display two measures of housing quality: the average unweighted aggregate of all quality issues a unit presents (full list of quality issues considered is available in APPENDIX) and our AHS index equivalent of housing quality issues. Both indices are highly correlated at the state level, but throughout the paper we mainly refer to the AHS equivalent index. Figure 1c and Figure 1d display the banking useage and access variables we consider: total mortgage contracts and banking branches at the state level. We note that, while banking useage and quality seem to have a stronger link, the relationship between ((banking access / access to credit)) is not as evident. We study the ((non-linear / particular / disproportionate)) effects access to credit has on housing quality outcomes, incoporating sociodemographic information as well as state level controls.



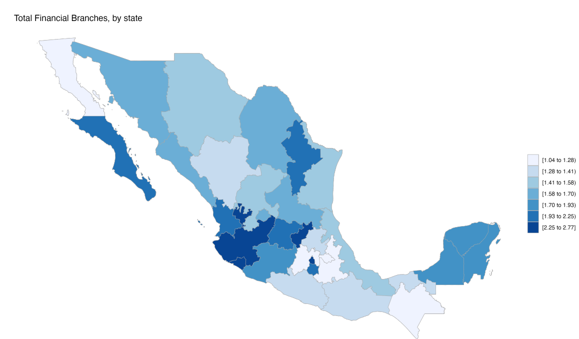
(a) Average unweighted quality index



(b) Average weighted quality index



(c) Mortgage contracts per 10k adults



(d) Total financial branches

Figure 1: State level aggregates of quality index, number of mortgages and banking access

3 Credit and Housing Quality in Data

We present three facts regarding credit access and housing quality, 1) the quality of dwellings is increasing in income, 2) the quality of dwellings is positively correlated to credit access, and 3) the correlation of quality and credit access dissipates for high-income households. This confirms our hypothesis that low-income households encounter credit constraints which limits them from purchasing high-quality housing.

To uncover the relationship between credit access and housing quality, we regress the quality of the housing y_i to the individual credit access

$$\text{quality}_i = \beta_0 + \beta_1 \log(\text{income})_i + \beta_2 \times \text{credit access}_i + z_i'\gamma + \epsilon_i \tag{1}$$

quality_i is the quality index of the dwelling occupied by individual i. credit access_i is a binary variable of whether the household is eligible for INFONAVIT or FOVISSSTE, which are two government programs that offer housing credit. β_1 captures the correlation between credit access and the quality of housing. z_i' is a collection of control variables which includes age, education level, and whether the household is in an urban area. We also included state fixed effect to account for potential unobservable geographical factors.

Table 1: Quality Index and Credit Access

	Quality Index	
	baseline	with state controls
	(1)	(2)
log(Income)	0.067*** (0.001)	0.049*** (0.001)
Age	0.001*** (0.0001)	0.001*** (0.0001)
Credit Access	0.091*** (0.002)	0.043*** (0.002)
College Educ	0.144*** (0.003)	0.148*** (0.002)
Urban		0.109*** (0.002)
Observations	73,167	73,167
R^2	0.228	0.353
Note:		*p<0.1; **p<0.05; ***p<0.01

The effect of income is captured by β_1 and the effect of credit access is captured by β_2. Table (1) shows a positive correlation between credit access and income to housing quality. Access to credit is associated with a 0.043 points increase in the quality index. To gauge the potential importance of this channel, we can compare it with the correlation between income and quality. For a 100 percent increase in income, it is associated with a 0.049 points increase in the quality index. Therefore, giving access to credit is comparable to an 87 percent increase in income at improving the quality of the dwellings.

To uncover the heterogeneous effect of credit access for different income groups, we regress the quality of the dwellings to the interaction between income quantiles and credit access.

$$\begin{aligned}\text{quality}_i =& \beta_0 + \sum_{g=1}^{10} \beta_{1g} \times I(i \in \text{Income Quantile g}) \\ &+ \sum_{g=1}^{10} \beta_{2g} \times I(i \in \text{Income Quantile g}) \times \text{credit access}_i + m_i'\gamma + \epsilon_i \end{aligned} \tag{2}$$

β_{2g} captures the effect of credit for households in the income quantile g. m_i is the collection of control variables, which includes age, education level and whether the household is in an urban area.

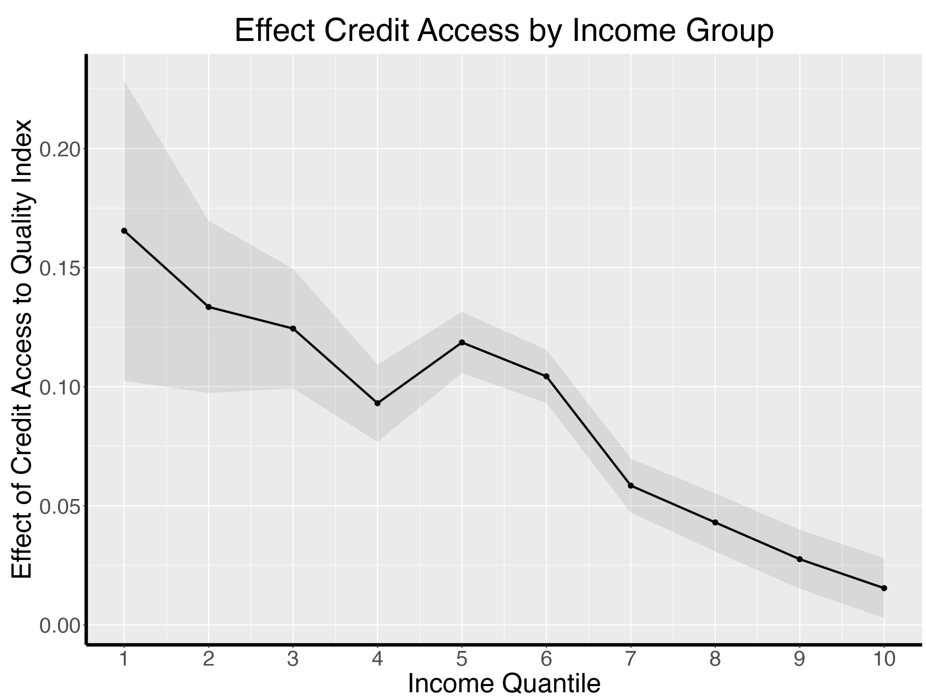


Figure 2: Effect of Credit Access by Income Group

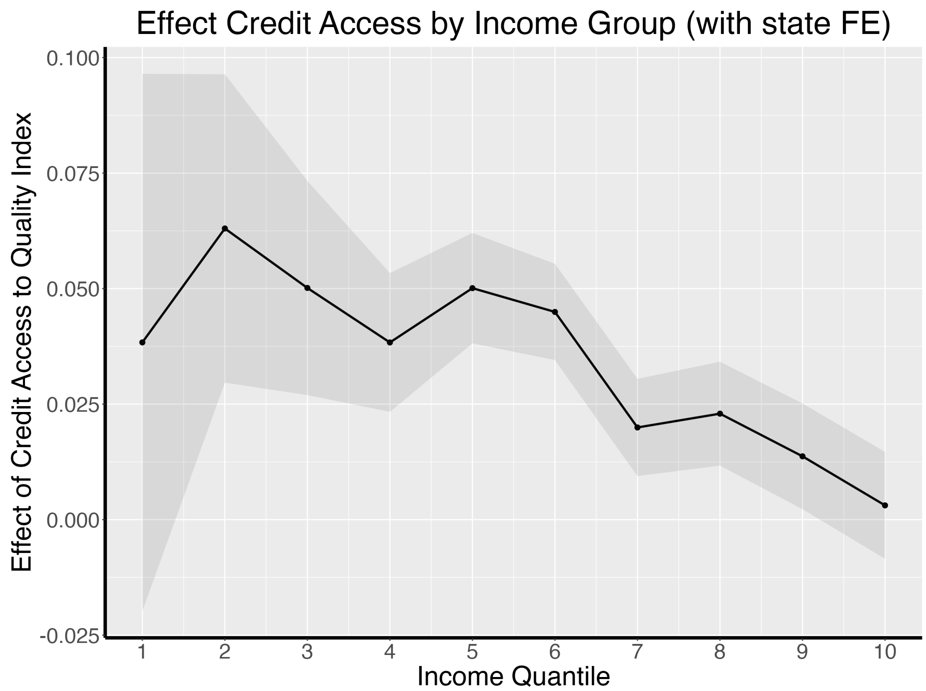


Figure 3: Effect of Credit Access by Income Group with state fixed effects

Figure (2) and (3) show that the effect of credit access decreases with income. In both specifications, the highest income group benefitted very little from the access to credit while the low-middle income groups mostly benefitted from the credit access. Credit access largely varies by state. The additional fixed effects in Figure (3) potentially adsorb some variations in the credit access, making the error bands wider.

These three facts support the idea that many low-income households are constrained by limited access to credit. This suggests that a model of credit constraint may explain the pattern in the data.

4 Simple Model

We consider a two-period consumption-saving problem with a housing choice. This model highlights why limited credit access might deter households from acquiring high-quality housing.

At the beginning of period 1, they have to choose whether to purchase a low-quality house (L) or a high-quality house (H). The latter is more expensive, provides a higher utility and is more capable of being mortgaged.

Conditional on choosing home type $i \in \{L, H\}$, each household solves

$$V^i(\bar{\theta}) = \max_{c_1, c_2, a} \log(c_1) + \beta \log(c_2) + \psi \log(h^i)$$

subject to

$$c_1 + a + P^i = y$$

$$c_2 = y + (1+r)a$$

$$a \geq -\theta(h^i)P^i$$

$\theta(h^i)$ represents the LTV constraint that depends on the housing types. Low-quality houses are not eligible for mortgage financing ($\theta(h^L) = 0$). This is consistent with the observation that low-quality housing is often non-standardized, making valuation challenging. For the high-quality housing

$$\theta(h^H) = \bar{\theta}$$

Households can relax their borrowing constraint when they purchase a high-quality house. Our interest is on how changing $\bar{\theta}$ may affect the housing decision.

For simplicity, we further assume $1/\beta = 1 + r$. If $\bar{\theta} < \frac{\beta}{1+\beta}$, the borrowing constraint is binding and the household would like to borrow up to the limit.

The value of choosing high-quality housing ($i = H$) is given by

$$V^H(\bar{\theta}) = \begin{cases} \log(y - (1-\bar{\theta})P^H) + \beta \log(y - \frac{1}{\beta}\bar{\theta}P^H) + \psi \log(h^H) & \text{if} \quad \bar{\theta} \leq \frac{\beta}{1+\beta} \\ (1+\beta)\log(y - P^H/(1+\beta)) + \psi \log(h^H) & \text{if} \quad \bar{\theta} > \frac{\beta}{1+\beta} \end{cases}$$

The value of choosing low-quality housing is given by

$$V^L(\bar{\theta}) = \log(y - P^L) + \beta \log(y) + \psi \log(h^L)$$

4.1 How does credit affect housing choices?

How does the provision of credit affect the housing choice? We model the credit access using $\bar{\theta}$. In particular, we want to understand how changing $\bar{\theta}$ affects the decision between choosing $i = L$ or $i = H$. In this model, households pick the housing type to maximize their final value $V(\bar{\theta}) = \max\{V^H(\bar{\theta}), V^L(\bar{\theta})\}$.

As the borrowing constraint is binding for $\bar{\theta} \leq \frac{\beta}{1+\beta}$, it can be shown that $\frac{dV^H(\bar{\theta})}{d\bar{\theta}} > 0$ if $\bar{\theta} < \frac{\beta}{1+\beta}$. But as $\bar{\theta}$ increases, the borrowing constraint ceases to be binding. Thus, an additional relaxation of credit does not affect the housing choice. $\frac{dV^H(\bar{\theta})}{d\bar{\theta}} = 0$ if $\bar{\theta} > \frac{\beta}{1+\beta}$. This means that households are more likely to choose high-quality housing when $\bar{\theta}$ increases.

Intuitively, relaxing the borrowing constraint encourages households to purchase high-quality homes for two reasons. First, increasing $\bar{\theta}$ makes high-quality housing more feasible. Households may not be able to afford the full price P^H in the first period. Second, increasing $\bar{\theta}$ makes consumption smoothing possible. As households receive a constant stream of income and have to pay for the home purchase in the first period, it would require them to borrow in the first period to achieve consumption smoothing.

We perform a comparative statics to understand how the effect of $\bar{\theta}$ depends on the parameters. Three possible outcomes may happen when $\bar{\theta}$ increases.

4.1.1 Case 1: Always Low-quality

If $(1+\beta)\log(y - P^H/(1+\beta)) + \psi \log(h^H) < \log(y - P^L) + \beta \log(y) + \psi \log(h^L)$, regardless of what $\bar{\theta}$ is, households would always pick the low-quality housing. This may happen if the price of high-quality housing is too high compared to the additional utility benefit. This also likely happens when income is low since the marginal utility consumption is high for low-income households, the marginal cost of buying a high-quality house is therefore higher.

4.1.2 Case 2: Always high-quality

If $\log(y - P^H) + \psi \log(h^H) > \log(y - P^L) + \psi \log(h^L)$, households would always pick the high-quality housing. The first term is the value of buying a high-quality house with the least generous credit condition. This inequality means that households are willing to purchase a high-quality home even when there is no mortgage loan available. This happens when y is high because the utility cost of paying more for housing is lower if the marginal utility of consumption is low.

4.1.3 Case 3: High-quality housing if $\bar{\theta}$ is high enough

If $\log(y-P^H)+\beta\log(y)+\psi\log(h^H) \leq \log(y-P^L)+\beta\log(y)+\psi\log(h^L) \leq (1+\beta)\log(y-P^H/(1+\beta))+\psi\log(h^H)$, by intermediate value theorem, there exists a θ^* such that if $\bar{\theta} > \theta^*$, the households would choose high-quality housing over the low-quality one. Those households are the marginal households that are primarily benefitted under a policy of credit relaxation. Households in this category have relatively high marginal utility of non-housing consumption so even though they can afford to purchase a high-quality house, they have to sacrifice a lot of non-housing consumption to do so. The additional relaxation of credit allows them to purchase a high-quality house without sacrificing too much non-housing consumption in the first period.

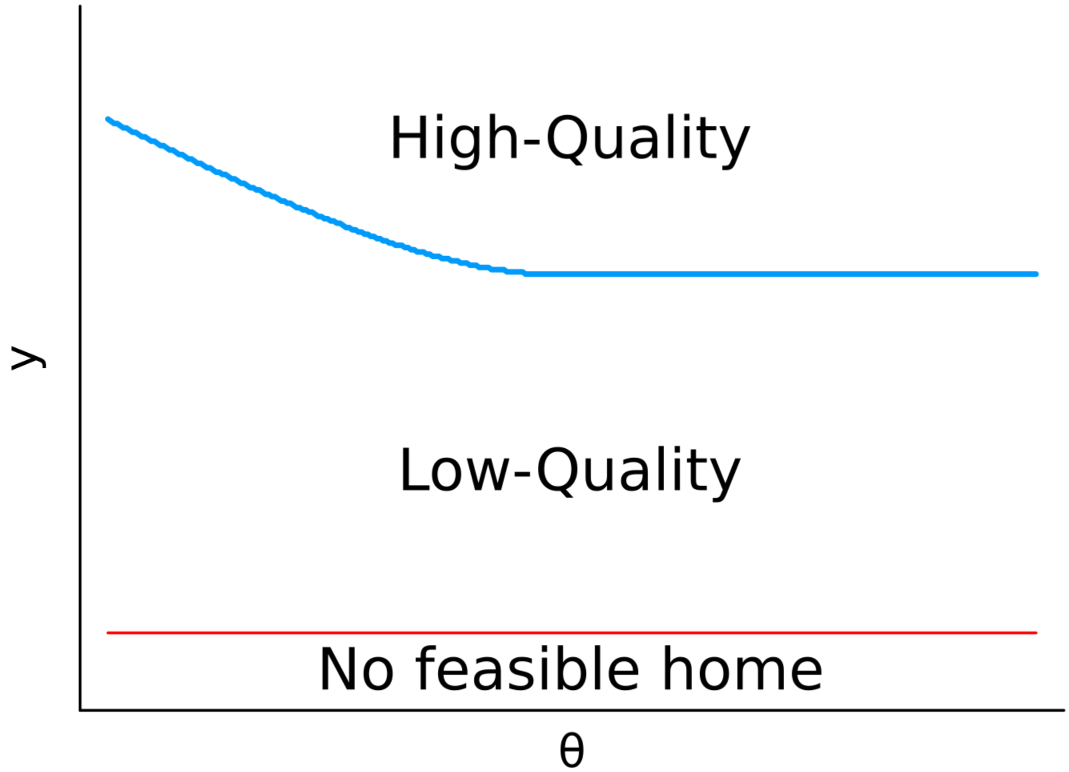


Figure 4: Optimal housing choice depending on y and $\bar{\theta}$

Figure (4) summarizes the theoretical results. Consistent with our empirical findings, high-income households opt for high-quality housing regardless of the credit condition. Low- and middle-income households choose high-quality housing only when the credit condition is sufficiently generous.

5 Quantitative Exercise

Consumers can choose two types of housing: low and high quality, i.e. $h \in \{h^L, h^H\}$ every period. They get an exogenous income $y(s)$ following an AR(1) process with persistence ρ and standard deviation σ. Additionally, people with high quality housing can borrow an exogenous fraction θ of their house value.

Agents choose consumption c, savings a' and housing h' to solve the following problem:

$$
\begin{aligned}
V(s, a, \theta, h) = \max_{c, a', h'} u(c) + v(h') + \beta \mathbb{E}[V(s', a', \theta', h') | s, \theta] \\
\text{s.t. } a' + c + \chi p(h') + I(h, h') = (1 + r)a + y(s) + T \\
a' \geq -\theta p(h') \mathbf{1}\{h' = h^H\}
\end{aligned}
$$

Where $v(h')$ is some flow consumption function from housing. χ is a maintenance cost for housing and T are government transfers. Agents lose a fraction ℓ of the previous housing price $p(h)$ when switching to h', reflecting some market illiquidity. Additionally $p(h^H) > p(h^L)$. The total cost of adjusting housing is:

$$
I(h, h') \equiv \begin{cases} p(h') - (1 - \ell)p(h) & h' \neq h \\ 0 & h' = h \end{cases}
$$

This is a discrete-continuous choice model, which can be hard to solve computationally. If we use the endogenous grid method as in Carroll (2006), there could potentially be kinks in the value function, resulting in discontinuities in the policy functions.

Following Iskhakov *et al.* (2017), we can solve this class of models including taste shocks. These are additive choice-specific independent and identically distributed extreme value taste shocks that can be thought of as *unobserved state variables* or *random noise*. This is sufficient to smooth the value functions and eliminate any potential kinks, removing any discontinuities in the value functions.

Each housing option has its own taste shock $\sigma_\epsilon \epsilon_i$, and the problem becomes:

$$V(s,a,\theta,h,\epsilon) = \max_{c,a',h'} u(c) + v(h') + \left(\sigma_\epsilon \sum_i 1(h' = h_i)\epsilon_i\right) + \beta\mathbb{E}[V(s',a',\theta',h',\epsilon')|s,\theta]$$

$$\text{s.t. } a' + c + \chi p(h') + I(h,h') = (1+r)a + y(s)$$

$$a' \geq -\theta p(h')\mathbf{1}\{h' = h^H\}$$

We are not be able to derive a policy function for the discrete choice of housing but only the probability of choosing each of the potential options. This probability is most likely between 0 and 1, i.e. $P \in (0,1)$ instead of jumping from 0 to 1 or vice versa.

5.1 Access to Credit

Access to credit is reflected through θ, which is the (exogenous) share of housing that can be borrowed against. Borrowing is only available for people that buy high quality houses. We assume $\theta \in \{0, \bar{\theta}\}$, where $\bar{\theta} > 0$. Additionally, θ is updated according to transition matrix:

$$\pi_\theta = \begin{pmatrix} p_1 & 1-p_1 \\ 1-p_2 & p_2 \end{pmatrix}$$

With stationary distribution Π_θ such that $\pi_\theta \Pi_\theta = \pi_\theta$. Moreover, p_1 is the probability of $\theta = 0$ remaining constant and p_2 is the same for $\theta = \bar{\theta}$. Note that p_1 and p_2 need not be the same.

The reason why θ does not remain constant is that access to credit in Mexico is usually related to having a formal or informal job. Informal jobs represent a large share of total jobs in Mexico. In that sense, we can think of p_1 and p_2 as the probability of staying in an informal or formal job, respectively.

Access to credit is not a completely exogenous variable and is highly (and positively) correlated with income. In the data we see that lower income people tend to have less access to credit. Following the idea of informality in Mexico, lower income people are more likely to have informal jobs than high income people. However, we decided to include θ as an exogenous variable, independent of income and wealth in order to identify the role of credit. By making θ completely exogenous, we can see the specific role of credit for people across different income and wealth levels.

5.2 Calibration

We do the model calibration in two steps. First, we calibrate certain standard parameters consistent with the literature, such as the discount factor β. Secondly, we calibrate some parameters in order to replicate some moments in the data.

We assume that $u(c) = \log(c)$ and $v(h) = \psi \log(h)$ where, $\psi > 0$. On the other hand, parameters such as the discount factor β, interest rates r and income process y were calibrated using standard values in the literature. In particular, income process y was calibrated to have a mean of 1 with three potential states $n_s = 3$ by using Rouwenhorst method of approximating stationary AR(1), following Kopecky and Suen (2010).

We set $\bar{\theta} = 0.8$ to replicate the typical LTV constraint of mortgage loans. Additionally, we calibrate p_1 and p_2 so we can match the stationary distribution Π_θ to the data. In particular, we want to target people with access to credit $D_{\bar{\theta}} = 13.75\%$. This way, we do reverse engineering to get the exact values of p_1 and p_2 so that $\Pi_\theta = [0.8625, 0.1375]$.

The rest of the parameters are related to housing and are used so that the steady state distribution replicates the main findings described in section 3:

- Housing quality is positively related with income
- Housing quality is positively related with access to credit
- Credit becomes less relevant for housing quality as income becomes larger

Our calibration is done in the following way:

Figure 5 shows the share of people that own high quality housing for different wealth groups (5 in total) in steady state. Each group contains the same mass of people over the asset space. It shows that the three facts mentioned above are satisfied under our calibration. This figure. As a first point, both curves have a positive slope. This implies that the share of people with high quality housing increases as wealth increases, regardless of their access to credit situation. Secondly, people with access to credit (orange curve) have a higher share of high quality housing

Parameter	Name	Value
β	Discount factor	0.98
r	Interest rate	0.01
$\mathbb{E}(y)$	Expected income	1
ρ	Income process persistance	0.975
σ	Income process variance	0.7
ϕ	Housing utility parameter	0.1
h^H	Utility of high quality housing	25
h^L	Utility of low quality housing	1
$p(h^H)$	Price of high quality housing	2
$p(h^L)$	Price of low quality housing	1
$\bar{\theta}$	Loan-to-value constraint	0.8
p_1	Probability of remaining at $\theta = 0$	0.93
p_2	Probability of remaining at $\theta = \bar{\theta}$	0.56
χ	Maintenance cost	0.5
ℓ	Liquidity cost of selling a house	0.1
T	Government transfers	1

Table 2: Calibration of the quantitative model

than people without access to credit (blue curve) regardless of their wealth level. Finally, the gap between both curves decreases as wealth increases.

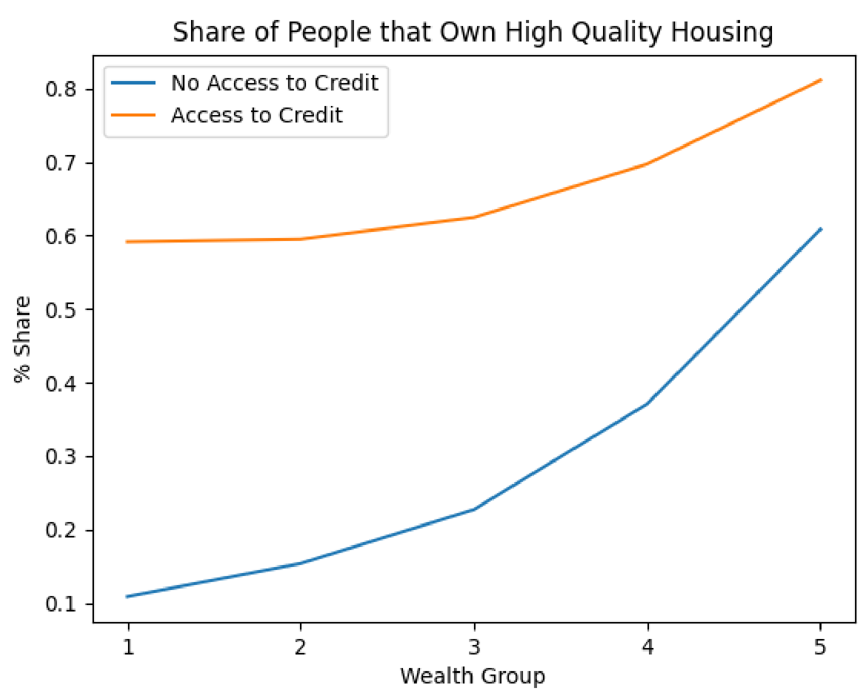


Figure 5: Steady State Share of People that Own High Quality Housing

5.3 Results

The main goal of the model is to study housing choice probabilities and do some counterfactuals. Figure 6 shows the discrete choice probability in the housing market. The model gives us the probability of choosing $h' \in \{h^L, h^H\}$, where this probability does not jump from zero to one or vice-versa as a result of including taste shocks. This figure shows this probability of choosing $h' = h^H$ across the asset space for people with mid-level income (people with low or high level income have the same behavior) given that they start with either low or high quality housing. The behavior is quite similar in both cases, where people with access to credit most likely buy a high quality house, regardless of their initial housing situation. The main difference between both graphs comes for people without access to credit. Although the behavior is the same for both levels of h, the probability of buying a high quality house is higher for people that start with $h = h^H$.

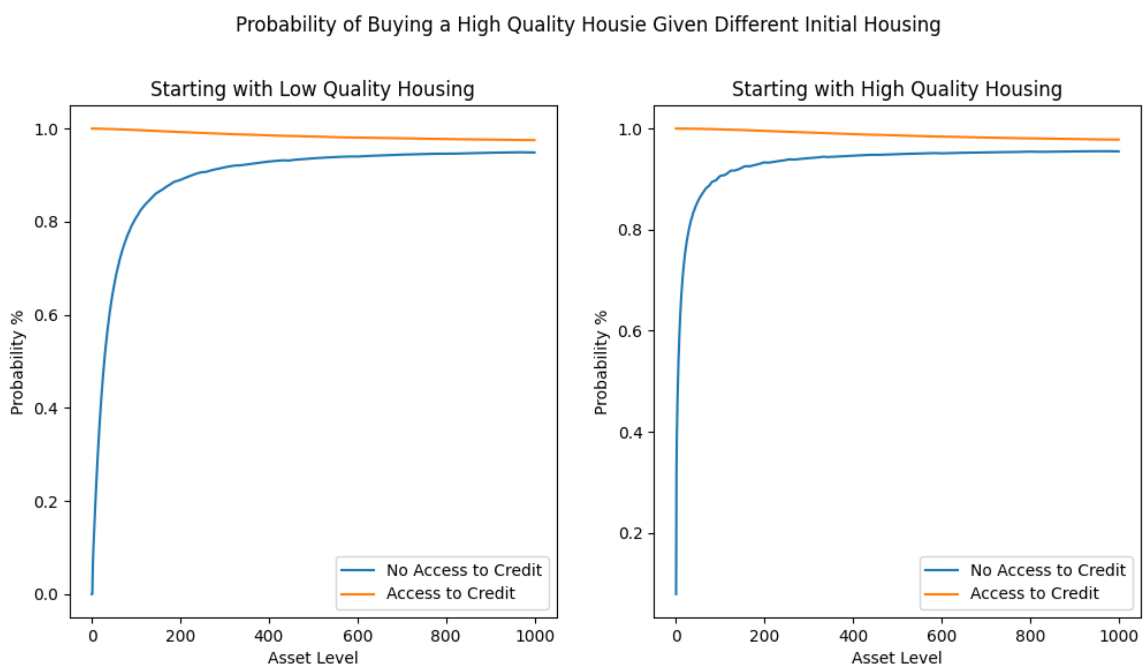


Figure 6: Probability of Buying High Quality Housing

Buying a high quality house gives people higher utility and potential access to credit. On the other hand, it costs more money and represents a higher maintenance cost. People with no access to credit only benefit from higher utility but not from potential debt. Moreover, they need to buy everything with 100% equity, which makes it costlier. It represents a potentially large opportunity cost in terms of consumption, especially for people with low levels of income and wealth. Given this, people at the lower end of the asset space have a low probability of buying a high quality house. This is close to zero if people own a low quality house and need to buy it, whereas it is somewhat larger if they start with a high quality house. It might seem counterintuitive that people with no access to credit, low wealth and $h = h^H$ decide to switch to low quality housing. However, these people only benefit from high quality housing in terms of utility, so they prefer selling their houses and getting liquid wealth. This allows them to consume a larger amount and potentially save in liquid wealth. Moreover, the calibration of the model is such that people with no access to credit are most likely to stay in the same state $\theta = 0$. This further reduces the incentives to own a high quality house as the probability of gaining access to credit is low.

Turning now to people with access to credit (i.e. $\theta = \bar{\theta}$), the probability of them owning a high quality house in the next period is close to 1. Not only do they have a higher utility from this house, but they potentially get access to credit. Owning a high quality house might be seen as some sort of precautionary saving or safety net in two senses: i) people can sell it at any moment if needed; ii) they can issue debt using the house as collateral when needed. Even those with $h = h^L$ and low liquid wealth decide to purchase a high quality house using leverage and still have liquidity to consume that period, as opposed to people with $\theta = 0$. In particular, the possibility of switching from $\theta = \bar{\theta}$ to $\theta = 0$ makes buying a high quality house more valuable whenever $\theta = \bar{\theta}$. Written in other words, since the probability of switching from $\theta = 0$ to $\theta = \bar{\theta}$ is small, being in $\theta = \bar{\theta}$ makes it a *unique* opportunity to buy a high quality house. If they remain in the same state next period they get the benefits listed before. If they lose access to credit, they can always sell the house if needed. This last point will be fundamental when comparing the baseline case against the counterfactual economy.

5.4 Counterfactual Economy

For the counterfactual economy, we assume that $\theta = \bar{\theta}$ for everyone. That is, everyone has equal access to credit with probability one. The share of people that own a high quality house in steady state goes from 34% in the baseline case to 56% in the counterfactual economy. Moreover, Figure

7 shows that the share of people that own a high quality house increases across wealth groups in the new steady state. The share of high quality housing increases the most for people who can marginally own a house. These are the mid-level wealth households under this calibration. Owning a house becomes a wealth - rather than wealth and credit access - story. In the baseline economy, people with low wealth and access to credit had a lot of incentives to own a high quality house by the possibility of losing access to credit next period. This made the probability of buying a high quality house close to 1 regardless of the wealth level to seize the opportunity of having access to credit. However, that incentive does not appear anymore in the counterfactual economy where owning a high quality house always comes with the option of getting a loan. So, people with low wealth levels potentially choose $h' = h^L$ in order to save liquid wealth and wait to buy a high quality house. Moreover, those who can afford a high quality house have more incentives to buy it.

Another important point is that the curve in Figure 7 for the baseline economy (blue) is convex while the one in the counterfactual economy (orange) is concave. Housing in the counterfactual economy becomes directly related to wealth and not wealth and credit in the counterfactual economy. People in the counterfactual economy probably buy a high quality house if they can afford it. That is why we see the largest increase of share of people with high quality housing for the first wealth groups as opposed to the last ones. There is a point where people can afford a high quality house and having more wealth doesn't change their incentives a lot, decreasing the slope of the curve.

Now turning into the baseline economy, access to credit is an important factor in choosing h'. People with no access to credit don't have as many incentives to choose $h' = h^H$ as those with high quality housing unless their wealth level is sufficiently high. That means that credit becomes less relevant to buy a high quality house as wealth increases and thus more people choose $h' = h^H$ the higher their wealth. Since credit becomes less relevant as wealth increases, the share of people with high quality house increases at an increasing rate as wealth increases.

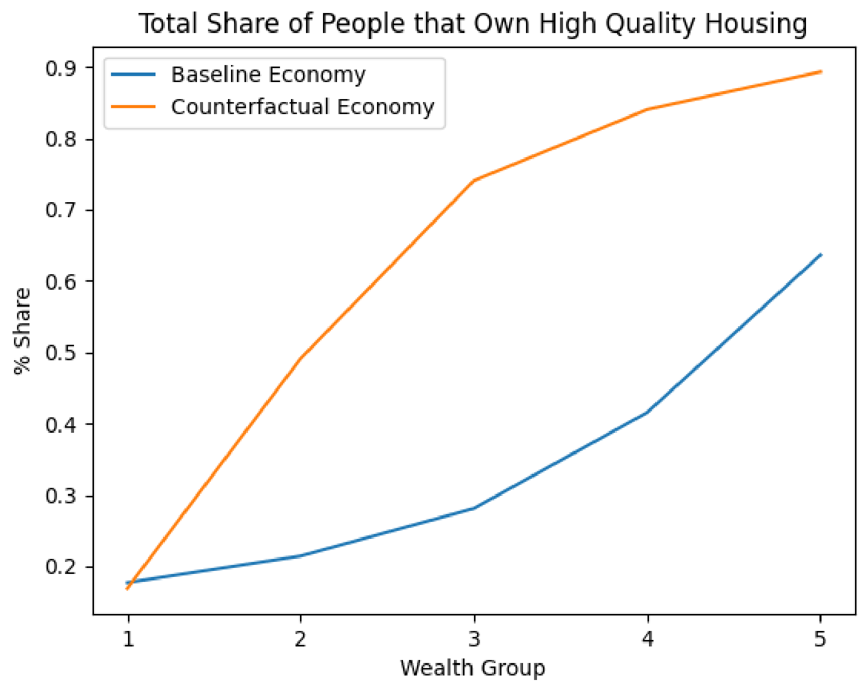


Figure 7: Total Share of People that Own High Quality Housing for Baseline and Counterfactual Economies

To better understand the lower end of the wealth distribution, it is useful to study discrete housing choice probabilities. As shown in Figure 8, the probability of buying a high quality house approaches to 1 as assets increase regardless of the starting housing quality. However, people with high quality house always have a higher probability of choosing $h' = h^H$ than people with low quality housing.

The main difference between these dynamics and the ones in the baseline model is that people at the lower end of wealth distribution have a low probability of buying a high quality house, whereas people with access to credit in the baseline case and same wealth level chose $h = h^H$ with probability close to 1. The reason behind this is that people with access to credit in the baseline economy saw it as a *unique* opportunity and decided to buy a high quality house to seize this opportunity. The potential threat of losing access to credit in the following periods made people choose $h' = h^H$ even if they would have low liquid wealth for consumption. However, in the counterfactual economy everyone gets access to credit at any moment, so people don't have a lot of incentives to choose $h' = h^H$ when their wealth level is low. They prefer to pause the possibility of owning a high quality house to increase their liquid wealth while maintaining a somewhat constant level of consumption. This way they wait some periods to increase their liquid wealth and buy $h' = h^H$ when they have enough liquidity to do it, without the necessity of issuing debt.

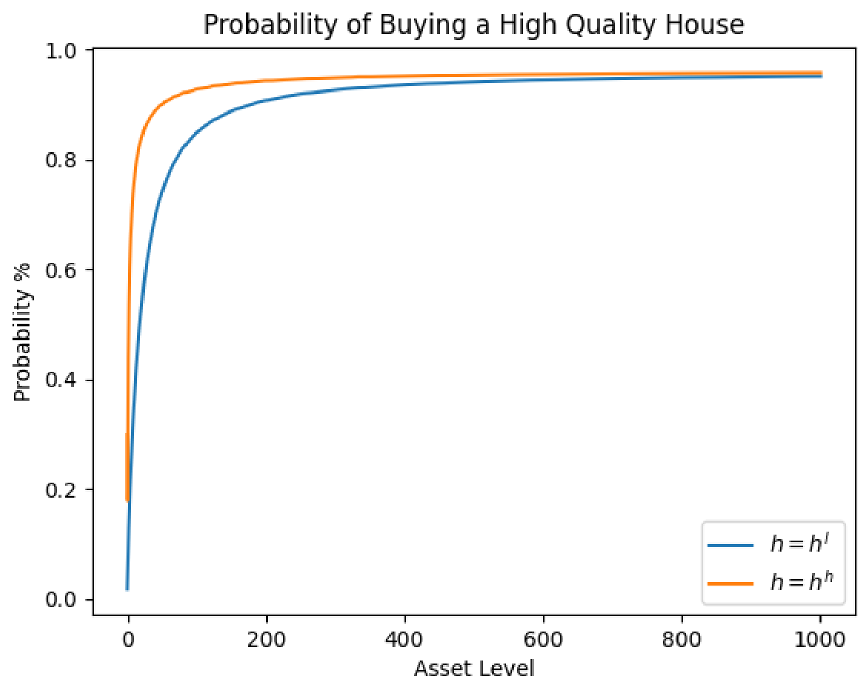


Figure 8: Transitional Dynamics in Counterfactual Economy

6 Conclusion

We study the effect of credit access on housing quality in Mexico. We argue that this effect is potentially huge. Empirically, we find that access to mortgage loans to associated with residing in higher-quality homes and its effect diminishes along the income levels. We show that a model with borrowing constraint can explain such a pattern and expand it to a quantitative heterogeneous-agent model with discrete housing choices. We find that providing mortgage loans to all households in Mexico can massively improve housing quality, especially for middle-income households.

Is providing widespread credit access a good policy? While our paper shows that the borrowing constraint is binding for many households in Mexico, we do not consider the full ramifications of credit relaxation. Home prices may increase as a result of the policy, which may offset the improvement in housing quality. We leave this question for future research.

A Solving the Simple Model

We will solve the model from section 4. Recall that the problem is

$$V^i(\bar{\theta}) = \max_{c_1,c_2,a} \log(c_1) + \beta \log(c_2) + \psi \log(h^i)$$

$$\text{s.t } c_1 + a + P(h^i) = y$$

$$c_2 = y + (1+r)a$$

$$a \geq -\theta(h^i)P(h^i)$$

Taking FOC we get:

$$c_1^{-1} = \lambda_1$$

$$\beta c_2^{-1} = \lambda_2$$

$$\lambda_1 = (1+r)\lambda_2 + \mu$$

Where λ_i represents the lagrange multiplier of the budget constraint in period $i \in \{1,2\}$ and μ is the multiplier for the liquidity constraint such that $\mu \geq 0$. Since we assume that $\beta(1+r) = 1$, using the three equations above we get the Euler Equation specified below:

$$c_1^{-1} = c_2^{-1} + \mu$$

Note that since income is constant and consumers need to pay for housing in the first period $P(h^i) > 0$ then they will always want to borrow. To see this, let's assume that there is no liquidity constraint for now and thus the intertemporal budget constraint is:

$$c_1 + \beta c_2 = (1+\beta)y - P(h^i)$$

On the other hand, the optimal is $c_1 = c_2 = c$. Then we get $c = y - P(h^i)/(1+\beta)$. This implies that:

$$a' = \beta(c-y) = -\frac{\beta}{1+\beta}P(h^i) < 0$$

This way we can get the optimal consumption of the original problem depending on whether the liquidity constraint is binding or not. Since credit depends on the choice of housing, we can take a look into both problems separately.

Choosing $h = h^H$. In this case $\theta(h^H) = \bar{\theta} \geq 0$. The liquidity constraint will be binding depending on the value of $\bar{\theta}$. In particular, it will be binding iff:

$$a' = \beta(c - y) = -\frac{\beta}{1+\beta} P(h^i) < -\bar{\theta} P(h^i) \quad \Leftrightarrow \quad \frac{\beta}{1+\beta} > \bar{\theta}$$

Then, if the constraint is not binding we get $c_1 = c_2 = c = y - P(h^H)/(1+\beta)$. However, if it's binding then $a' = -\bar{\theta} P(h^H)$ and thus $c_1 = y - (1-\bar{\theta})P(h^H)$ and $c_2 = y - \frac{1}{\beta}\bar{\theta}P(h^H)$. Substituting in the value function we get

$$V^H(\bar{\theta}) = \begin{cases} \log(y - (1-\bar{\theta})P(h^H)) + \beta \log(y - \frac{1}{\beta}\bar{\theta}P(h^H)) + \psi \log(h^H) & \text{if} \quad \bar{\theta} \leq \frac{\beta}{1+\beta} \\ (1+\beta)\log(y - P(h^H)/(1+\beta)) + \psi \log(h^H) & \text{if} \quad \bar{\theta} > \frac{\beta}{1+\beta} \end{cases}$$

Note that both cases are the same if $\bar{\theta} = \frac{\beta}{1+\beta}$.

Choosing $h = h^L$. This problem is simpler since choosing low-quality housing implies that there is no access to credit. The liquidity constraint will be binding and thus $a' = 0$. This will imply that $c_1 = y - P(h^L)$ and $c_2 = y$ and that the value of choosing low-quality housing is given by

$$V^L(\bar{\theta}) = \log(y - P^L) + \beta \log(y) + \psi \log(h^L)$$

Now we want to show that $\frac{dV^H(\bar{\theta})}{d\bar{\theta}} > 0$ if $\bar{\theta} < \frac{\beta}{1+\beta}$ as described in section 4.1. Recall that if $\bar{\theta} < \frac{\beta}{1+\beta}$ then

$$V^H(\bar{\theta}) = \log(y - (1-\bar{\theta})P(h^H)) + \beta \log(y - \frac{1}{\beta}\bar{\theta}P(h^H)) + \psi \log(h^H)$$

Then, taking derivative with respect to $\bar{\theta}$ we get:

$$\frac{dV^H(\bar{\theta})}{d\bar{\theta}} = \frac{P(h^H)}{y-(1-\bar{\theta})P^(h^H)} + \frac{P(h^H)}{y-\frac{1}{\beta}\bar{\theta}P(h^H)} = \frac{P(h^H)}{c_1} + \frac{P(h^H)}{c_2} > 0$$

Where the inequality follows from the fact that

$$\begin{aligned} c_1 = y-(1-\bar{\theta})P(h^H) < y - \frac{1}{\beta}\bar{\theta}P(h^H) = c_2 \quad &\Leftrightarrow \\ \frac{1}{\beta}\bar{\theta} < (1-\bar{\theta}) \quad &\Leftrightarrow \\ \bar{\theta} < \frac{\beta}{1+\beta} \end{aligned}$$

Which is true by assumption.

B Quantitative Model Derivations

B.1 Solving the Model

We will solve the model backwards in three recursive steps. These steps follow the methodology described in Iskhakov *et al.* (2017).

- Step 3: Solve the consumer model after choosing h'. That is, solve the model for each $h' \in \{h^L, h^H\}$, assuming it is a state variable.
- Step 2: Choose h' optimally. Given the type of taste shocks, we will only get the probability of choosing each h'.
- Step 1: Get the continuation value.

Step 3: Solving the model after choosing h'. If we assume h' has already been chosen, we get the following problem:

$$\mathcal{V}(s,a,\theta,h,h') = \max_{c,a'} u(c) + v(h') + W(s,b',\theta,h') \tag{3}$$

$$\text{s.t. } a' + c + \chi p(h') + I(h,h') = (1+r)a + y(s)$$

$$a' \geq -\theta p(h')\mathbf{1}\{h' = h^H\}$$

Where $W(s,a',\theta,h') \equiv \beta\mathbb{E}[V(s',a',\theta',h',\epsilon')|s,\theta]$ is the continuation value, which is computed in step 1. We can easily solve this model as it is a simple continuous choice model. We can use the endogenous grid method as in Carroll (2006) to solve the model. By solving the model we get value function $\mathcal{V}$, marginal value function $\mathcal{V}_a$ and policy functions $\hat{c}$ and $\hat{a}$ in the state space (s,a,θ,h,h').

Step 2: Choosing h' optimally. We follow the methodology described in Iskhakov *et al.* (2017). The problem of choosing h' is then simply to choose $h_i \in \{h^L, h^H\}$ from among the discrete set of choices to maximize:

$$V(s,a,\theta,h) = \mathbb{E}_\epsilon\left[\max_{h'\in\{h_i\}} \mathcal{V}(s,a,\theta,h,h') + v(h') + \left(\sigma_\epsilon \sum_i 1(h'=h_i)\epsilon_i\right)\right]$$

That is, to maximize our post-choice value function plus the value of housing itself and the taste shocks. This gives us logit choice probabilities $p(s,b,\theta,h,h')$ of each h'. Furthermore V can be obtained using the logsum formula, so that we have

$$V(s,a,\theta,h) = \sigma_\epsilon \log\left(\sum_i \exp\left(\frac{\mathcal{V}(s,a,\theta,h,h_i)+v(h_i)}{\sigma_\epsilon}\right)\right) \tag{4}$$

$$p(s,a,\theta,h,h_i) = \frac{\exp\left(\frac{\mathcal{V}(s,a,\theta,h,h_i)+v(h_i)}{\sigma_\epsilon}\right)}{\sum_j \exp\left(\frac{\mathcal{V}(s,a,\theta,h,h_j)+v(h_j))}{\sigma_\epsilon}\right)} \tag{5}$$

Additionally, for the endogenous grid point method, we'll also need to keep track of the marginal value function with respect to assets, V_a. This is given by simply taking the expectation of the marginal value function with respect to the probabilities. We can do exactly the same to get the policy functions in the original state space (s,a,θ,h).

$$V_a(s,a,\theta,h) = \sum_i p(s,a,\theta,h,h_i)\cdot\mathcal{V}_a(s,a,\theta,h,h_i)$$

$$c(s,a,\theta,h) = \sum_i p(s,a,\theta,h,h_i)\cdot\hat{c}(s,a,\theta,h,h_i)$$

$$a(s,a,\theta,h) = \sum_i p(s,a,\theta,h,h_i)\cdot\hat{a}(s,a,\theta,h,h_i)$$

Step 1: Get the continuation value. Now, we define the continuation value, the discounted expected utility $W(s, a', \theta, h')$ that enters into (3). We also need the discounted expected marginal utility $W_a(s, a', \theta, h')$ which is necessary to solve the problem via the endogenous grid method. This is simply given by taking the discounted expectation of utility V and marginal utility V_a. It is worth noting that this expectation is taken over two state variables: s and θ.

$$W(s, a', \theta, h') = \beta \mathbb{E}_{s,\theta}[V(s', a', \theta', h')|s, \theta]$$
$$W_b(s, a', \theta, h') = \beta \mathbb{E}_{s,\theta}[V_b(s', a', \theta', h')|s, \theta]$$

Putting it all together. Now we can solve the problem recursively following these three steps. By making an educated guess of the value and marginal value functions, we implement steps 1 to 3 repeatedly until the policy and value functions converge.

B.2 Euler Equation

We derive the Euler equation now. Recall the original problem:

$$V(s, a, \theta, h, \epsilon) = \max_{c,a',h'} u(c) + v(h') + \left(\sigma_\epsilon \sum_i 1(h' = h_i)\epsilon_i\right) + \beta \mathbb{E}[V(s', a', \theta', h', \epsilon')|s, \theta] \tag{6}$$
$$\text{s.t. } a' + c + \chi p(h') + I(h, h') = (1 + r)a + y(s)$$
$$a' \geq -\theta p(h')\mathbf{1}\{h' = H\}$$

Recall that we in step 2 of solving the model we found V in terms of $\mathcal{V}$. Then we can replace 4 in 3 and get the following expression.

$$\mathcal{V}(s, a, \theta, h, h'|h') = \max_{c,b'} u(c) + \beta \mathbb{E}\left[\sigma_\epsilon \log\left(\sum_i \exp\left(\frac{\mathcal{V}(s', a', \theta', h', h_i) + v(h_i))}{\sigma_\epsilon}\right)\right) |s, \theta, h'\right] \tag{7}$$
$$\text{s.t. } a' + c + \chi p(h') + I(h, h') = (1 + r)a + y(s)$$
$$a' \geq -\theta p(h')\mathbf{1}\{h' = h^H\}$$

Now let's take FOC for (6).

$$u'(c) = \lambda$$

$$\beta\mathbb{E}[V_b(s', a', \theta', h')|s, \theta, h'] = \lambda$$

Then we get

$$u'(c) = \beta\mathbb{E}[V_a(s', a', \theta', h')|s, \theta, h']$$

Now taking envelope condition for (6):

$$V_a(s, a, \theta, h, h'|h') = (1 + r)\lambda$$

Together with the FOC for consumption we get:

$$V_a(s, a, \theta, h, h'|h') = (1 + r)u'(c)$$

Now, if we take FOC with respect to (7) we get

$$u'(c) = \lambda$$

$$\beta\mathbb{E}\Bigg[\left(\sum_i \exp\left(\frac{\mathcal{V}(s', a', \theta', h', h_i|h_i) + v(h_i)}{\sigma_\epsilon}\right)\right)^{-1}$$

$$\cdot\left(\sum_i \exp\left(\frac{\mathcal{V}(s', a', \theta', h', h_i|h_i) + v(h_i)}{\sigma_\epsilon}\mathcal{V}_b(s', a', \theta', h', h_i|h_i)\right)\right)|s, \theta, h'\Bigg] = \lambda$$

We can simplify and get

$$\beta(1 + r)\mathbb{E}\left[\left(\sum_i p(s', a', \theta', h', h_i)u'(c')\right)|s, \theta, h'\right] = u'(c)$$

	Average	Std. Dev	Median	Min	Max
Issues	15.696	4.733	19.5	1	37
Issues HQ	16.143	2.281	16.5	1	19
Issues LQ	23.902	3.169	23.5	20	37
Income	3625.663	6147.54	1491	0	98000
Issues LI	21.793	4.47	22.5	4	37
Issues HI	17.938	4.003	17.5	1	35
Price to Income	552.99	1623.349	249.1135	0.222	Inf
Price	860067.1	1805670	495000	4	45000000
Issues LP	22.509	7.012	22.5	6	37
Issues HP	17.297	3.805	17.5	1	34

Table 3: Housing quality issues, select descriptive statistics for housing characterstics

Assuming $c \equiv c(s, b, \theta, h, h')$ then the Euler equation becomes:

$$\beta(1+r)\mathbb{E}\left[\left(\sum_i p(s', a', \theta', h', h_i)u'(c(s', a', \theta', h', h_i))\right)|s, \theta\right] = u'(c(s, a, \theta, h, h'))$$

C Additional Information about the Data

C.1 Summary Statistics

C.2 Survey Questions

C.3 Weights on each question

Mnemonic	Variable	Question
P4_4	Good Wall	4.4 What material are most of the walls of this dwelling m
P4_5	Good Roof	4.5 What material is most of the roof of this dwelling mad
P4_6	Good Floor	4.6 What material is most of the floor of this dwelling mac
P4_7_1	Roof Thermal Insulation	4.7 To avoid excess heat or cold, does this dwelling have a
P4_7_2	Wall Thermal Insulation	4.7 To avoid excess heat or cold, does this dwelling have a
P4_7_3	Window Thermal Insulation	4.7 To avoid excess heat or cold, does this dwelling have a
P4_8_1	Roof Noise Insulation	4.8 To reduce excess noise, does this dwelling have any ty
P4_8_2	Wall Noise Insulation	4.8 To reduce excess noise, does this dwelling have any ty
P4_8_3	Window Noise Insulation	4.8 To reduce excess noise, does this dwelling have any ty
P4_8_4	Door Noise Insulation	4.8 To reduce excess noise, does this dwelling have any ty
P4_9	Kitchen	4.9 Does this dwelling have a room for cooking?
P4_11	Toilet	4.11 Does this dwelling have an outhouse, toilet or sanitar
P4_12	Flushing Water	4.12 Does the sanitary service. . .
P4_13	Inhouse Water Supply	4.13 Do they get water from faucets or hoses that are...
P4_14	Safe Water	4.14 Does the piped water coming into your home come f
P4_15	Public Drainage	4.15 Does this dwelling have drainage or sewage connecte
P4_16	Electric Light	4.16 Is there electricity in this dwelling?
P4_17	Gas or Electric Cooking	4.17 In this household, the fuel they use most often to coo
P4_22_1	Washbowl	4.22 Is this dwelling equipped with a laundry room?
P4_22_2	Sink	4.22 Is this dwelling equipped with a sink or sink unit?
P4_22_3	Water Tank	4.22 Is this dwelling equipped with a water tank?
P4_22_4	Cistern	4.22 Is this dwelling equipped with a cistern?
P4_22_5	Boiler	4.22 Is this dwelling equipped with a water heater or boile
P4_22_6	Solar Heater	4.22 Is this dwelling equipped with a solar water heater?
P4_22_7	Stationary Gas Tank	4.22 Is this dwelling equipped with a stationary gas tank?
P4_22_8	AC	4.22 Is this dwelling equipped with air conditioning?
P4_22_9	Heater	4.22 Is this dwelling equipped with heating?
P4_23_1	Dining Room	4.23 Does this dwelling have a living/dining room?
P4_23_2	Garden	4.23 Does this dwelling have a garden?
P4_23_3	Patio	4.23 Does this dwelling have a patio?
P4_23_4	Laundry	4.23 Does this dwelling have a laundry room?
P4_23_5	TV Room	4.23 Does this dwelling have a television room or study?
P4_23_6	Garage	4.23 Does this dwelling have a garage or parking space?
P4_25_1	Cracks	4.25 Does this dwelling have problems with cracks or craz
P4_25_2	Window Damage	4.25 Does this dwelling have problems with buckling or w
P4_25_3	Floor Problems	4.25 Does this dwelling have problems with floor heaving
P4_25_4	Leaking Problems	4.25 Does this dwelling have problems with dampness or
P4_25_5	Column Fractures	4.25 Does this dwelling have problems with cracking, buc
P4_25_6	Electric Problems	4.25 Does this dwelling have problems with the electrical
P4_25_7	Drainage Problems	4.25 Does this dwelling have problems with the water or s
P4_26_1	Corridor Crackings	4.26 Does your building have problems such as cracks, fra
P4_26_2	Stair Crackings	4.26 Does your building have problems such as cracks, fra
P4_26_3	Elevator Crackings	4.26 Does your building have problems such as cracks, fra

Table 4: ENIGH survey questions for our housing quality index

PQI Component
Housing materials*

Electricity problems
1 Unit does not have electricity
2 Unit has exposed wiring
3 Unit does not have electric plugs in every room
4 Each occurrence of a blown fuse or thrown circuit breakera
Amenities*

Heating problems
5 Unit was uncomfortably cold for 24+ hours
6 Each heating equipment breakdownb
7 Unit cold due to utility interruption
8 Unit cold due to inadequate heating capacity
9 Unit cold due to inadequate insulation
10 Unit cold due to other reason
11 Main heating equipment is unvented kerosene heater(s)

Inside structural or other problems
12 Water leak in roof
13 Water leak in wall or closed door/window
14 Water leak in basement
15 Water leak from other source
16 Inside leak from leaking pipes
17 Inside leak from plumbing fixtures
18 Inside leak from other or unknown source
19 Holes in the floor
20 Open cracks wider than a dime
21 Peeling paint larger than 8 by 11 inches
22 Evidence of rodents
Bathroom problems
23 Unit does not have hot and cold running water OR Unit does not have a bathtub or shower OR Un
24 Each breakdown leaving unit without a toilet for 6+ hoursc

Kitchen problems
25 Unit does not have a refrigerator OR Unit does not have a kitchen sink OR Unit does not have a co

Outside structural problems
26 Windows broken
27 Holes/cracks or crumbling in foundation

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