Does location matter?

Evidence on differential mortgage pricing in Israel

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Abstract

This paper explores the contribution of various factors to determining mortgage interest rates in Israel. We use a unique database combining loan-level data on mortgage loans originated by Israeli banking system during 2010-2013 with the proprietary data on assets underlying mortgage origination and several additional variables designed to capture risk associated with regional real estate markets and extent of competition prevailing in the banking system. We show that there exist significant differences in real mortgages interest rates among different locations and neighborhood qualities. While homebuyers purchasing assets in the prosperous central neighborhoods are paying the lowest interest rates, those purchasing assets in the peripheral and economically weak neighborhoods are paying the highest ones. Observable characteristics of the borrower, the mortgage and the underlying asset risk, and banking competition explain up to two thirds of the regional and socioeconomic differences in mortgages interest rates found in the raw data.

* The views expressed in the paper are those of the authors and do not necessarily reflect those of the Bank of Israel.

1. Introduction

Investment in housing is the main share of households' investment portfolio, especially among households in the lowest income deciles. Balance sheet data of Israeli households sector for 2017 shows that the value of real estate constitutes for 51 percent of all households' wealth (real and financial assets altogether).[1] According to the Israeli Central Bureau of Statistics data, in 2017, 71.8 percent of households owned at least one housing unit.[2]

Since housing investment usually cannot be financed solely by equity,[3] availability of mortgage credit (in the sense of mortgage approval) and its affordability (in the sense of the cost of credit, i.e. interest rate) are crucial for the ability of households to accumulate wealth. Given large scale and extremely long duration of mortgage loans, even small differences in interest rates may sum up in large amounts of money "overpaid" to the lender. Although differences in the interest rates are supposed to reflect differences in the risk stemming from borrowers and their investment and financing decisions, they may also incorporate some element of prejudice towards certain types of borrowers – racial and religious minorities, women, immigrants, residents of specific regions, etc.

Despite public and political importance of the issue, empirical research of differential treatment in mortgage lending is difficult to implement. This is mainly due to the lack of suitable databases which combine all the information needed for such research, including detailed loan conditions, borrower demographic and occupational characteristics and credit history, and also influential characteristics of the underlying asset. The scarcity of the data is the main reason that the issue of discrimination in mortgage lending was explored mainly in the US, where collection of the data became mandatory in the early nineties, but for much lesser extent in Europe, where such data was not collected due to non-existence of anti-discriminatory legislation.

We do not focus on discrimination issue but instead we explore the contribution of various factors to determining mortgage interest rates, paying special attention to the

[1] For details see Financial Stability Report for the first half of 2019, Bank of Israel.
[2] More specific, 61.8 percent owned one housing unit and 10 percent owned two or more housing units.
[3] In Israel, approximately 85 percent of home purchases are been financed using a mortgage.

role of the distance from the business center of the country (Tel Aviv) and socioeconomic status of the neighborhood where purchased housing asset is situated. In other words, we examine if Israeli lenders price differently similar mortgage products offered to comparable households purchasing homes in different locations. We use a unique database combining loan-level data on mortgage loans originated by Israeli banking system during 2010-2013 with the proprietary data on assets underlying mortgage origination and several additional variables designed to capture risk associated with regional real estate markets and extent of competition prevailing in the banking system. These data provide an opportunity to conduct a large scale and relatively complete study of the potential differential treatment of mortgage borrowers. The uniqueness of the data means that, for the best of our knowledge, no previous research has considered the questions addressed in this paper.

Controlling for multiple factors that might affect interest rate pricing, we show that there exist significant differences in real mortgage interest rates among different locations and neighborhood qualities. While homebuyers purchasing assets in the prosperous central neighborhoods are paying the lowest interest rates, those purchasing assets in the peripheral and economically weak neighborhoods are paying the highest ones. Observable characteristics of the borrower, the mortgage and the underlying asset risk, and banking competition explain up to two thirds of the regional and socioeconomic differences in mortgages interest rates found in the raw data. Additional factors that may explain these differences – borrower's credit history, wealth, employment characteristics (in terms of occupation, seniority, tenure, stability and employment contract duration), financial literacy and bargaining ability – are unobservable in our data. We also assume that lenders incorporate the risk of asset foreclosure in the cost of credit, while the costs of foreclosure seem to be higher in the regions with lower housing demand and lower prospective house price growth (or higher possibility of price depreciation). It also seems reasonable that lenders consider past experience concerning the incidence of loans in arrears of similar borrowers.[4]

The rest of the paper is organized as follows. Section 2 surveys relevant literature. Section 3 explains the data. Section 4 presents the stylized facts. Section 5 outlines

[4] Partly due to the absence of Public Credit Registry in Israel in this period. Such Registry was founded and began to operate in 2019.

basic empirical framework. Section 6 reports the results. Section 7 presents some robustness checks. Finally, Section 8 concludes.

2. **Related Literature**

Historically, the research on differential mortgage pricing is mostly dealing with discrimination issues. As was mentioned above, we are not focusing on discrimination, but we refer to this research in the construction of our empirical framework.

Despite the existence of a great deal of work concerning discrimination in the mortgage lending in the US, mainly against Afro-American and Hispanic borrowers, very little research has been done dealing directly with *pricing inequality*. Conventional explanation for the scarcity of such studies is lack of appropriate data on interest rates.[5] Studies that succeeded to overcome this issue are essentially case studies focusing on data from a single particular lending institution; the immediate and obvious disadvantage of such studies is that their findings cannot be generalized to the market level.

The majority of such case studies document significant differences in the lending terms between minority borrowers and whites, but in most cases they cannot attribute these differences to solely racial issues. For example, researchers who analyzed the incidence of paying overages[6] and their size were not convinced that it was exactly minority status that shaped the differences. Courchane and Nickerson (1997) suggest that differences in bargaining and negotiating power of whites and minorities may have caused the observed racial differences. Similarly, Black et al. (2003) conclude that the differences in overages have more to do with the market power of lending institution and

[5] Under credit rationing regime, discrimination of minorities could take place at the approval/denial stage; the US mortgage market was considered as a highly competitive one where lenders have little room for differential rate manipulations in the sense that long-term loans were made at a very thin spread over lenders' cost of funds (Holmes and Horvitz, 1994). Even in the 1990s, after the transition to risk-based pricing regime (due to improvement of statistical models of individual risk assessment and substantial reductions in the data storage costs), the lenders were not required to report their lending terms for all individual loans, but only to indicate high-interest ones.

[6] An "overage" is a kind of premium, the difference between the price at which a loan closes and the minimum price acceptable to the lending institution for specific loan products and for borrowers with particular credit attributes. Since the borrower is usually unaware of how the loan is priced, lack of financial information, severe liquidity constraint, risk aversion, or unwillingness to bargain could lead to an overage.

differential bargaining skills of borrowers and less to do with the borrower's race. Moreover, Crawford and Rosenblatt (1999) who document significant price differences between individual borrowers found these differences largely race-neutral, controlling for various borrower demographic and financial characteristics, differences in market rates, and rate-lock protection periods. Likewise, Courchane (2007) concludes that after controlling for individual and market characteristics, relatively little of the differences in the annual percentage rates (APR)[7] paid by minority compared to non-minority borrowers are attributable to the differential treatment of borrowers. Some studies used explicit data on mortgage interest rates of subprime mortgages, but their results are also inconclusive: Ghent et al. (2014) document evidence of adverse pricing for Afro-American and Hispanic borrowers in subprime mortgage market in metropolitan areas of California and Florida during 2005, while Haughwout et al. (2009) find no evidence of pricing discrimination against minority borrowers (possibly due to missing data on mortgage origination costs).

In France, Gary-Bobo and Larribeau (2004) show that lender exercise "social discrimination" against workers vs. professionals due to the differences in elasticities of demand (to buy a home as opposed to rent) and in perceived default risks. In Spain, controlling for a large set of household, mortgage and market characteristics and using Oaxaca-Blinder decomposition, Diaz-Serrano and Raya (2011) find that between two-thirds to three-fourths of the gap in average mortgage interest rates between immigrant and native borrowers can be attributed to discrimination.

The only one study that treats *interregional* disparities in the mortgage rates is Eichengreen (1984). He aims to explain lower mortgage rates for agricultural land in the North and South Atlantic states (Eastern states) compared to the rest of the country. In a simple framework of mortgage interest rate determination, he finds that once mortgage interest rates have been adjusted for risk (expressed in the price of the land, build on the fact that the market prices risk, and types of agricultural crops) and for the effects of statutory interest rate ceilings, varying widely among the states, there remains no evidence of a significant interregional differentials.

[7] The APR is based on the full cost of the loan, including both the interest or note rate on the loan and additional charges and fees, amortized over the full loan term.

One of the drawbacks of all studies dealing with discrimination is an omitted variable bias caused by unobservable features, such as financial literacy and bargaining ability of a borrower, and leading to biased estimates of discrimination variable coefficients. This issue is essentially insoluble, because banks do not collect data which can be used as a proxy. Even an income of a borrower is not a perfect proxy, because it is not necessarily correlated with her financial skills. Scarce are studies which try to overcome this issue. Cheng et al. (2015) use data from the Survey of Consumer Finance (SCF), instead of administrative data provided by lending institutions, exploiting the advantages of more detailed households' information[8] and a unique variable of shopping behavior.[9] They document persistent statistically and economically significant racial differences in mortgage rates, but while individual risk factors affect differential pricing of mortgages, shopping behavior appears as a weak explanatory factor. More accurate analysis (using residual analysis and quantile regressions) reveals that racial discrimination is concentrated in the most vulnerable demographic subgroups as younger and lower-educated minority borrowers. These results are quite opposite to their previous findings concerning gender gap in mortgage pricing.[10] In the earlier study, Cheng et al. (2011) find that the traditional explanatory variables (mortgage features, borrower characteristics, market conditions, etc.) can only partially explain such gender disparity, while a behavioral variable that captures how men and women differ in shopping for mortgages can completely explain the rest of the gap; in particular they claim that men are likely to pay lower rates on mortgages because they simply tend to search more for the lowest rates.[11,12]

Much more severe critique is directed to modelling the functional relationship between mortgage outcome (rejection/interest rate/default rate) and the discriminatory feature (race in most cases). As Yezer (2010) states, there is no fully developed *theoretical*

[8] The SCF collects both detailed loan information, including type of mortgage, loan amount, term, interest rate, time of origination, etc. and borrower's characteristics, including age, race, education level, information on wealth and debts, past bankruptcy and credit applications that were rejected in the past five years.

[9] This information distinguishes between those who primarily rely on recommendations by people they trust and those who make effort in searching and comparing among multiple loan offers.

[10] There is some empirical evidence that women are more likely than man of the same race to be subprime mortgage borrowers (Fishbein and Woodall, 2006).

[11] In their sample, 42.1% of men selected their lenders based on the search for the lowest rate offer, whereas only 20.5% of women behaved in the same way.

[12] Moreover, the results suggest that searching for the lowest rates is much more beneficial for borrowers who choose adjustable rate mortgages, compared to those who choose fixed rate mortgages, supporting the hypothesis that the impact of search is greater for more complex mortgage products.

model of mortgage lending process. Single-equation *empirical models* of mortgage outcomes all relate mortgage outcomes to a variety of "casual" variables which include various loan terms: loan amount, loan-to-value ratio (LTV), payment-to-income ratio (PTI), term-to-maturity, cosigner, etc., financial characteristics of the applicant, characteristics of the real property collateral, and variables reflecting demographic factors, including minority status of the applicant or borrower. The assumption lying beyond such single-equation model is that the mortgage outcome variables have no role in causing the loan terms. In other words, applicants have no knowledge of the relation between the loan terms that they request and loan outcomes. As those, they never behave strategically and mortgage terms are selected by lender. But much more reasonable assumption is that loan applicants recognize that mortgage interest rate[13] is a function of the mortgage terms, such as loan amount, down payment/LTV, monthly PTI, term-to-maturity, etc. and that they may influence these variables to lower interest rate. Furthermore, sometimes lenders do not allow the initial terms required by the applicants; instead they demand to increase equity, to change loan maturity or to underwrite a cosigner.

From the econometric point of view, the "independent" right-hand side variables are jointly determined with the dependent variable leading to endogeneity and identification problem, causing estimates obtained using single-equation techniques to be biased and inconsistent. For example, as Yezer (2010) claims, higher-risk applicants can self-select into loan programs with higher mortgage rates and higher rejection and default rates. These outcomes are due to applicants' self-selection into particular loan programs, not to differential treatment by lenders. As a result, discrimination tests tend to produce false positive indicators of discrimination when none exists.

But even without such opportunistic behavior the problem of simultaneous equations bias occurs when applicants increase their down payment, i.e. lower the LTV, to gain more favorable interest rates. Households with more resources are better able to avoid high interest rates, supplying additional equity. The conventional solution of the identification problem is utilization of some instrumented variable which can explain the LTV but is not associated with the interest rate. Unfortunately, the standard set of

[13] Although the reasoning is equally implemented on rejection and default rates, from now on we will refer to only interest rate as this is the focus of our research.

variables in mortgage files does not include such variables. The econometric issue is even more complicated since not only LTV is simultaneously determined with the interest rate, but also other variables which can be used to influence the loan terms, as PTI and term-to-maturity. This means that each of these variables is to be modelled separately to obtain unbiased estimates.

We are aware of econometrical problems with single-equation estimation of mortgage interest rate, but we have no suitable data to overcome these problems. Anyway, we assert that in the Israeli case the severity of the endogeneity problem is much weaker than in the US. We state that in Israel self-selection problem resulting from borrowers' opportunistic behavior and moral hazard is not an issue because of the recourse nature of mortgage loans, i.e. loans which allow the lender to take action above and beyond the foreclosure of housing asset securing the mortgage. In Israel, mortgages are mostly originated by banks: 94 percent of mortgages stock is at the banking system, while only 4 percent of the mortgage stock is at the non-banking financial institutions such as pension funds, with savings as a lien. Mortgage origination at banking institutions is possible only in person at the bank branches and operated only by bank employees; requirements of employment documentation are uniform (wage sheets for three last months for all employed members of the household); lock-in period is uniform for all banks and is defined by the Supervisor of Banks; interest rates do not incorporate ex-ante prepayment penalty, such penalty is charged from borrowers only at the time of actual prepayment, mostly due to switching to improved mortgage contract[14]. Furthermore, there is no sub-prime market for mortgages in Israel.

Even if we had some data to attempt to model LTV, PTI or time-to-maturity, we were facing additional econometric issue; we don't know what the functional form of the relationship between the interest rate and other loan terms is. Anyway, it doesn't seem to be linear and continuous. It makes sense that there are some levels of these risk variables which signal that the risk associated with a loan climbed to another, higher level. Such significant change has to cause the interest rate to jump. To extract such signals we can utilize macro prudential policy tools which were implemented in Israel and their timing. We consider those macro prudential tools which raise the cost of

[14] This is different from the US experience, where the cost of future prepayment is embodied in the mortgage interest rate as an option while a borrower pays for the option at loan origination.

lending for homebuyers. Probably, these signals are commonly recognized to be the main risk-increasing factors and they were always considered by the banks in their decision-making in housing credit. Several macro prudential tools were implemented during our research period. First, banks were required to make additional provisions for housing loans with LTV higher than 60 percent in May 2010. Later that year, in October 2010, banks were required to make higher capital provision for loans above 800 thousand NIS, LTV higher than 60 percent and share of variable loans higher than 25 percent. In May 2011 the share of the loan with variable rate based on Bank of Israel interest rate was limited to one third. In February 2013, risk weights for capital adequacy requirements rose for loans with LTV higher than 45 percent and for loans with LTV higher than 60 percent. In August 2013, PTI ratio was limited to 50 percent while risk weights for capital adequacy requirements on loans with PTI more than 40 percent were raised to 100 percent, and loan duration was limited to 30 years.

To weaken the endogeneity problem, we will not use the loan terms in their continuous form; instead, we will divide the mortgages to less risky and more risky ones with the special levels of these variables which we regard as risk-increasing: LTV more than 60 percent, PTI above 30 percent and duration above 20 years.

3. Data

For the purposes of the macro prudential policy, mainly in order to perform stress tests, during 2015, Banking Supervision Department at the Bank of Israel required all banking corporations to report retroactively on all approved mortgage originations during each calendar year, beginning from 2010. These reports contain diverse data on loan characteristics, including approved loan amount and duration, loan-to-value ratio, mortgage monthly payment-to-net income ratio, purpose of the purchase (first home, upgrading or investment), interest rates set at mortgage origination, type of the interest rate (fixed or variable, adjusted or not adjusted), type of the benchmark for adjustable rates, etc. Also, the data contains indication of the bank branch where the mortgage was originated.

In Israel, mortgage borrowers often decide to take out combined loans which consist of number of types of interest rates, including fixed and variable rates, real and nominal

rates and adjusted rates with different benchmarks.[15] This makes the procedure of transformation of the reported interest rates to uniform ones somehow tricky. We start with transforming all interest rates to the real terms by subtracting the inflation expectations rate at mortgage origination (with data on banks' expectations[16] for 1, 2, 5 and 10 years, according to mortgage duration[17]) from all CPI non-adjusted rates in our sample. Then we calculate weighted average of the real interest rates on all parts of each mortgage, weighted by the shares of all parts. Although the final price of a mortgage includes also two other components in addition to the interest rate – the mortgage opening fee and obligatory purchase of property appraisal – we don't have information on the extent of these expenses. The lack of these data is not crucial for our analysis due to uniformity of these costs and their fixed nature (not dependent on loan amount).

The banks also report some features of the borrowers, including after-tax monthly household income and fixed monthly expenses, number of borrowers (single or couple), age of all borrowers, if there was a guarantor (bank's requirement for more risky borrowers), and if borrower manages current (wage) account at the same banking institution.

The data on mortgage originations includes accurate property location, date of purchase and location of the bank branch where the loan was originated. Mortgage database was merged with home-sale transactions database hold by the Israeli Tax Authority, containing information on housing unit characteristics (CARMEN). This procedure left us with approximately one third of the observations from the mortgage database, because of omitted and partial information issues,[18] but it enabled us to locate the neighborhood where purchased property is situated and to account for the distance from

[15] For example, one of the most popular combinations in the recent years is a mortgage that is one-third based on adjustment to the Bank of Israel Rate, one-third fixed rate (CPI adjusted or not) and one-third variable rate changing every 2 or 5 years. This composition resulted from the restriction to at most one-third of the share of mortgage bearing interest rate adjusted to the Bank of Israel Rate, effective from May 2011 (as a measure of the macro prudential policy).
[16] We use the series of bank's inflation expectations, calculated by the Bank of Israel out of data on banks' interest rates on CPI adjusted and not adjusted loans and deposits.
[17] Since there are no data on longer ranges of inflation expectations, we use data on inflation expectations for 10 years also for more prolonged mortgages.
[18] For detailed explanation of the combined database construction see Tzur-Ilan (2017).

the neighborhood to the center of Tel Aviv and for the neighborhood socioeconomic status.[19] Socioeconomic index serves as a proxy for neighborhood risk.

Unfortunately, we do not have information on borrowers' credit history, employment characteristics and net wealth. Additionally, some important factors influencing mortgage interest rates are unobservable, for example, borrowers' financial literacy, bargaining skills and shopping behavior.

4. Stylized facts

Our data includes 88,914 mortgage originations set between January 1, 2010 and December 31, 2013. Figure 1 presents the distribution of average real mortgage interest rates by distance from the center of Tel Aviv (the business center of Israel), divided to three groups: less than 40 km, 40 to 80 km, and 80 km and above. Figure 1 shows that as the distance from the center increases, the entire distribution moves to the right, meaning that the incidence of higher-priced mortgages in the peripheral neighborhoods is higher than in the central ones. According to Kolmogorov-Smirnov test, differences between the three distributions are significant. However, not only distance matters. We add a socioeconomic status dimension by defining three classes – low, middle and high, approximately one third of observations in each class. Figure 2 shows the distribution of average real interest rates by socioeconomic status for each group of distance from the center of Tel Aviv. The distributions for high socioeconomic class are shifted left for all groups of distance from the center, but most obviously for the most distant group. Generally, in the group of the most peripheral neighborhoods the differences between socioeconomic classes are the most striking. Kolmogorov-Smirnov test shows significant differences between the distributions.

Since differences in the mortgage interest rates have two-dimensional nature (location and neighborhoods quality), for further analysis we use nine combinations of distance

[19] The Israeli Central Bureau of Statistics constructs a socioeconomic index of neighborhoods, consisting of 16 different variables, including demography, education, employment, income, and standard of living. The 16 variables are combined into a single index, and all neighborhoods in Israel are classified into one of twenty clusters, 1 being the lowest socioeconomic status and 20 being the highest.

and socioeconomic status (interactions). Table 1 presents median values of weighted average real interest rates, LTV, weighted average duration (different parts of the mortgage may have different durations), PTI, size of the loan, monthly net (after taxes) income of household, age of the borrower (average age for couple of borrowers), loan-to-income ratio (LTI, loan size divided by yearly net income), weighted average real interest rates for investors and first-time home buyers along with investors' share in mortgages, percentage of borrowers who took out a mortgage outside the locality of purchased property and number of observations (mortgages), for nine interactions of distance and socioeconomic status. It is obvious that there exist non negligible differences in the real interest rates, while interest rates vary by both dimensions: they rise with the distance from the center and with deterioration of socioeconomic status. As a result, the lowest median real interest rate is found in the prosperous neighborhoods near the center of Tel Aviv, while the highest median real interest rate is found in the economically week peripheral neighborhoods. The data also shows that households purchasing housing assets close to the center, independently of the socioeconomic class of the neighborhood, have lower LTV ratios and higher incomes, but take out larger mortgages with longer durations and higher PTI and LTI ratios. Also, investors' share is higher in the distant locations, especially in the distant and weak neighborhoods, where properties are relatively low-priced. Investors receive consistently more favorable mortgage rates than first-time homebuyers. The share of those taking out mortgages outside the locality of purchased property is high in all regions, but it is lower in the remote regions compared to the central ones. Taking the size of locality into consideration, it makes clear that borrowers negotiating for mortgages outside the locality of purchased property are those purchasing assets in smaller localities, where the competition among banking institutions is anticipated to be lower. Higher percentage of mortgages that were originated outside the locality of purchased property in the central regions is possibly explained by the geographical proximity and territorial continuity between cities in Gush Dan (Tel Aviv metropolis).

5. Basic empirical framework

A simple competitive loan-pricing model is based on the hypothesis that financial institution's lending decisions are a function of risk and return factors that affect the

expected net present value of the loan. To maximize profits, financial institutions are assumed to accept those loan applications which generate net present value that exceeds zero.

The model assumes that the rate of interest charged on any loan includes four components: (1) cost of funds incurred by the bank to raise funds to lend, while such funds are obtained either through customer deposits or through money markets; (2) operating costs associated with servicing the loan, including application processing, monitoring, personnel remuneration and other current expenses; (3) a profit margin on capital; and (4) a risk premium to compensate the bank for the degree of default risk inherent in the loan.

The first three components may vary among lending institutions and over time. The risk for the lender arises mainly from the possibility that the borrower might remain in arrears, forcing the lender to foreclosure. In the countries where the extent of the liability is limited to the value of collateral, for example in the US, the lender can suffer from losses if sales proceeds are insufficient to cover the principal, interest, legal fees, and transaction costs of reselling the property. In Israel, this risk is minimized because borrower’s liability is not limited to the value of collateral and lenders can pursue other borrower’s assets to mitigate default-related losses.

According to the risk-based pricing theory, risk premium is determined personally for each borrower and is influenced by a variety of factors linked to borrower characteristics, loan characteristics, and collateral characteristics.

A number of financial and nonfinancial characteristics of individual borrowers are systematically related to creditworthiness. Higher wages of family members and higher household's income tend to reduce the chance of missed payments or default. However, higher obligations-to-income (for example, repayment of other loans or other fixed family expenses, some of which grow with family size) leaves less money available to service the mortgage. Financial stability and wealth, including liquid asset holdings, tend to increase with age, reducing the probability of loan delinquency. Higher education level of borrower guarantees not only higher present wage but also better employment stability and prospects. It also indicates higher financial sophistication. Borrowers buying homes for investment purposes are usually older and wealthier than

first-time homebuyers, and probably have other assets to back the loan. Upgraders have a history of repayment a mortgage.

Given all above mentioned features, one have to admit that borrower's bargaining skills definitely affect interest rate determination. Some individuals might be better at bargaining than others and they may obtain better terms than would similar borrowers who lack these skills. Bargaining skills could not be measured directly but they are probably correlated with other borrower's characteristics, including education, age, prior property ownership (in the case of upgraders and investors), i.e. those characteristics that increase expertise, experience, confidence and reasoning ability.

But even taking under consideration various objective borrower characteristics, predicting future loan delinquency, from the perspective of the lender, is problematic since many credit problems arise from events that are difficult to foresee, such as illness or disability, divorce, and job loss. Concerning the latter, lenders may believe that higher unemployment rates in the peripheral regions make the income of periphery residents more volatile, on average, over the economic cycle, compared to that of residents of the central regions, even controlling for the type of job, and hence increasing the probability of delinquency of borrowers in the periphery.

Concerning loan characteristics, there are several factors that can obviously increase the risk of default. A higher LTV ratio means that less collateral backs the loan, which implies greater risk for a lender. Longer maturities imply increased probability of default, since it increases a chance that a borrower will encounter a situation affecting her ability to repay a loan. Variable-rate mortgages have higher default risk if interest rates move upward. Higher loan amount subject to approved LTV[20] means better property in upscale neighborhoods and also higher extent of down payment; as such it may be less risky for lender since borrower will work harder to keep the property. Higher PTI increases the risk of default, especially for low-income households; in Israel, the PTI is constrained to 50 percent since August 2013. As discussed earlier, there is an econometrical difficulty to include mortgage characteristics such as LTV, PTI and duration in the regression explaining the interest rate because of endogeneity problem. Therefore, to weaken the severity of this problem, we do not include these

[20] It is crucial to examine the effect of loan amount when also LTV ratio is in the regression, to ensure that higher loan amount does not suggest higher LTV.

variables as continuous, but we only define more risky mortgages as those with LTV higher than 60 percent, PTI higher than 30 percent and time to maturity above 20 years.

Some not negligible risk stems from the collateral itself. This risk originates mainly from future price movements and assets turnover since these factors affect the potential of selling the property (by the borrower himself or by the lender) to settle a loan in the case of personal financial distress. Lender expectations of home price appreciation affect the assessment of mortgage risk; it can be assumed that the quality of neighborhood and a socioeconomic level of its residents are interlinked with home prices and potential price appreciation. Neighborhoods with low turnover will tend to have more uncertain housing values (independent of housing prices) and, hence, represent greater risk for a lender (Ling and Wachter, 1998; Lang and Nakamura, 1993; Calem, 1996). As an additional factor of risk we consider substantial at-once increase of housing supply in the way of building great number of housing units (building starts, by year and by municipality).

Using this simple model requires caution, since mortgage markets may not be fully competitive. Despite substantial competition on the supply side, mortgages are rather complex products and most of the consumers lack information about mortgage pricing, so regional disparities may reflect the limited ability of consumers to shop for the best products available in the marketplace. In our case, it may appear that there is a specialization by size of the lender, since larger banks have more branches and are represented in more localities including small and remote ones; they could be a main provider of financial services, including mortgages, in these locations. In this case, some lenders may have more market power than others, in the peripheral regions.

Our empirical model exploits measures of borrower and location characteristics that are supposed to affect the loan's risk through their expected impact on the probability of default. We estimate the following reduced form linear regression:

$$R_i = \alpha + \beta_1 A_{1i} + \beta_2 A_{2i} + \beta_3 A_{3i} + \beta_4 Competition_i + \beta_5 LenderID_i + \beta_6 Time_i + \varepsilon \quad (1)$$

where R_i is a real weighted average interest rate on a mortgage of borrower i, A_{1i} is a vector of borrower i characteristics, A_{2i} is a vector of borrower's i mortgage characteristics, A_{3i} is a vector of borrower's i collateral characteristics, $Competition_i$ is a vector of variables measuring the extent of banking competition which meets

borrower i, $LenderID_i$ is a vector of bank fixed effects, $Time_i$ is a month and a year of borrower's i mortgage origination, and ε is an error term. The variables are introduced in Table 2.

We expect that single borrower, younger age, lower family net income, high LTV ratio, high PTI ratio, long duration, lower socioeconomic index of the neighborhood, lower housing market turnover and fast expansion of housing supply are associated with higher risk and therefore higher interest rates. We expect that higher distance from the center is also associated with higher interest rates but we enable nonlinear relationship between interest rates and distance. Realizing that there may be several regions that are quite independent from Tel Aviv, we add *Potential Accessibility Index*[21] to our regression; we expect that higher accessibility is associated with low mortgage risk and thus lower interest rate. On the other hand, we expect that upgraders and those who manage current account at the same bank are supposed to gain more favorable terms of credit. Upgraders have not only had loans originated in the past but have been paying them for a period of time. Banks also have more prolonged acquaintance with customers who manage their salary account within the bank, receiving higher precision signals of their creditworthiness.

Larger number of all banking institutions providing mortgage services in the area is supposed to be associated with higher competition and therefore lower interest rates. We don't have clear expectations as for *Investor* variable; although investors are usually more financially mature, standard approach ascribes higher property risk to non-owner occupied properties, since those buying secondary homes for investment purposes are less eager to invest money in property maintenance. Sometimes banks demand guarantors to underwrite more risky mortgages, but it is hard to assume if this procedure neutralizes completely the extra risk. *Log of loan amount*, given LTV ratio, may signal better property with higher prospects of price appreciation, but on the other hand, it means higher total loss for a lender in case of default. The sign of *Bank in the same location* dummy is also ambiguous, because we don't know what considerations are

[21] The index is calculated by the Central Bureau of Statistics according to the gravity model and reflects the proximity of the given locality to each of the localities in Israel, weighted by the size of their populations, with the size of the population indicating the intensity of the opportunities, activities, and assets in each locality. The value of the index ranges from -1.487 (the most remote and least accessible town) to 6.318 (the most central and accessible town). Potential Accessibility Index is a part of the Peripheriality Index, which also includes the distance from the boundary of the Tel Aviv district.

standing behind such choice. For example, investors are likely to negotiate with lenders close to the place of residence and not close to purchased property which may be located in another locality; commuters may choose to negotiate with lenders located close to their workplace; upgraders may change place of residence moving to larger homes outside central cities while negotiating for mortgages at their current locations. This variable may also proxy shopping behavior.

The use of the time dummies is supposed to control for macroeconomic factors (changes in the basic price of credit) and the effect of macro prudential policies concerning mortgage lending (LTV limits and higher capital requirements for more risky loans). Bank fixed effects control for the differences in the cost of funds, operating costs and business strategies among lending institutions.

The main variables of interest are the interactions of distance and socioeconomic status. Holding constant all available measures of household, loan and neighborhood risk and accounting for degree of banking competition in the area, the econometric analysis is aimed to examine the role of purchased property location in the mortgage interest rate determination.

6. Results

We estimate regression model (1) by OLS in three variations to control for the impact of inclusion of some explanatory variables on the effects of interactions between distance and socioeconomic status on the real interest rate. Regression (1) includes the main measures of borrower, mortgage and property risk, and banking competition, according to equation (1). Although we examine the influence of the distance from the business center of the country, utilizing the monocentric model, there are several large urban centers which can be more relevant for small peripheral towns.[22] Following this consideration, we add the Potential Accessibility Index to get Regression (2), along with the number of building starts in the locality as a percentage of existing housing units to control for supply expansion. Regression (3) adds control for the number of banking institutions in the location of purchased housing asset. All three versions

[22] Generally speaking, there are 4 metropolis centers in Israel: Tel Aviv, Jerusalem, Haifa in the north and Beer Sheba in the south.

include banks fixed effects and month and year fixed effects (coefficients are not reported,[23] but they are mostly statistically significant). Despite relatively large number of explanatory variables and very large number of observations, the explanatory power of the model seems to be disappointing low with R^2 of only 28 percent.

As Table 3 shows, most of the coefficients are statistically significant and have the expected signs. Other things equal, households with higher incomes pay lower interest rates on mortgages; ten percent increase in the net income is associated with 0.02 percentage points decrease in the mortgage interest rate. Those who take out mortgages from the banks where they manage their current account pay, on average, 0.13 percentage points less than similar borrowers managing their current account at another bank. Upgraders pay interest rates that are lower, on average, by almost 0.03 percentage points compared to similar situated first-time home buyers, while investors pay 0.07 percentage points less. Those borrowers who face guarantor requirements pay, on average almost 0.06 percentage points higher interest rates. Higher loan amount is indeed associated with lower interest rate, as predicted by literature. Other things equal, mortgages with LTV above 60 percent bear interest rate higher by almost 0.06 percentage points. The effect of higher than 30 percent PTI ratio is not statistically significant, while longer than 20 years duration increases the interest rate by 0.22 percentage points on average, other things equal. Households buying assets in neighborhoods with higher socioeconomic status pay lower interest rates, while the effect of the distance from Tel Aviv alone, not in the interaction with socioeconomic status, depends on regression specification. Further on, higher real estate market turnover operates in favor of mortgage borrowers; other things equal, 10 percentage points increase in the turnover is associated with 0.08 percentage points decrease in the interest rate. Fast expansion of housing supply contributes to rising the interest rate, but its influence is statistically significant only in specification (2). Other things equal, households taking out mortgages from bank affiliates located in the purchased asset's town, pay, on average, 0.04 to almost 0.08 percentage points more, depending on regression specification; the effect strengthens after inclusion of the control for bank competition in the property location town. It can be argued that those who exhibit shopping behavior and exert effort looking for better deals can obtain lower interest rates. Such type of behavior can be beneficial since higher competition among mortgage

[23] Banks fixed effects are not reported because of confidentiality issues.

lending institutions both in the town of mortgage origination and purchased property location is associated with lower interest rates; in specification (3), each additional corporate bank in the property location is supposed to lower the average interest rate by 0.016 percentage points and each additional corporate bank in the town of mortgage origination is supposed to lower the average interest rate by another 0.009 percentage points, other things equal.

Only three variables have unexpected signs. Contrary to our expectations the *number of borrowers* variable has a positive sign, meaning that couples pay higher interest rates than singles, other things equal. Single borrowers are relatively rare (only 12 percent of all mortgage borrowers in our data), and perhaps have solid enough economic background[24] to gain favorable mortgage terms. The sign on *age* variable is positive meaning that older borrowers pay higher interest rates. However, age variable is apparently correlated with several other variables including *upgrader* and *investor* dummies and with *net income*, so that it catches only partly effect. The influence of the *Potential Accessibility Index* is positive, meaning that those purchasing assets in the central and accessible towns pay higher interest rates, but, anyway, it is not economically significant.

Now we turn to understanding the effects of interactions of distance and socioeconomic status on mortgage pricing. Inspection of estimation results in Table 3 shows that all coefficients on interaction terms are highly statistically significant and all have expected positive sign, since the omitted category is prosperous and close to the center neighborhoods. One can also notice that except for two coefficients (*Dmid_SElow, Dmid_SEmid*) the order of coefficients' magnitude varies in the expected way: keeping the distance category the same, the coefficients decrease with the improvement of the socioeconomic status, while keeping the socioeconomic status the same, the coefficients increase with the distance from the center.

Table 4 shows the unconditional means of the calculated real interest rates by nine interactions of distance and socioeconomic status (Panel A), the differences between the means in each group relative to the group of the shortest distance and the highest

[24] In our data, average net monthly income of single borrowers is 71 percent of the average net monthly income of couples (approximately 11.4 and 16 thousand NIS, respectively).

socioeconomic status – category omitted in the regression analysis (Panel B) and the estimated coefficients (Panel C).

Comparison of unconditional and conditional differences reveals that, on average, above one half of the unconditional differences in means are explained by the characteristics of borrower, mortgage and underlying asset risk, along with banking competition, included in the regression. Interestingly, the extent of explanation varies from only 40 percent in the most distant regions to as much as two thirds in the rest. The rest of the differences probably may be explained by unobservable regional and borrower's characteristics, asset risk that is not captured by included variables and/or differential treatment of borrowers.

7. Robustness checks

7.1 Inclusion of mortgaged asset price

It is possible that inter-regional interest rate differentials reflect the risk premium charged by a competitive market for the greater uncertainties associated with lending to borrowers purchasing assets in peripheral and poor neighborhoods. Under the assumption that market prices such risk we would like to include, say, rates of return on housing assets (calculated as rent divided by price of the asset), but we don't have such data neither for neighborhoods nor for cities. We run regression model (3) with addition of *log of price* variable (regression model 4) and rerun it without *loan amount* variable, because of relation between these two variables (regression model 5). Table 5 presents estimation results, relative to regression (3). The influence of *log of price* variable is statistically significant and has expected sign, imposing that higher-priced assets are regarded as less risky, and therefore mortgages originated to finance purchasing such assets are cheaper. Inclusion of the variable does not influence the most of estimation results, and the explanatory power of the regression does not really increase. But the coefficients of the interactions of distance and socioeconomic status decrease in magnitude (except one, *DmidSEhigh*). In other words, these interaction terms are supposed to incorporate some share of housing asset risk which is not expressed in the rest of the variables. However, the distance-socioeconomic status differentials remain.

7.2 Restriction on the share of "prime"-adjusted interest rate

In May 2011, the Banking Supervision department at the Bank of Israel imposed a restriction on the share of variable interest rate adjusted to the BOI interest rate ("prime"[25]) and set this share to one third of the mortgage at the most. "Prime" adjustment was quite popular before the restriction became effective (Figure 3). "Prime"-adjusted rate is in fact the lowest rate of interest that a borrower can get (it is also not CPI adjusted) since it is thought of as the riskiest one, especially when BOI interest rate is at the rising path, because it can change every month. Therefore we divide all observations to two sub-samples, according to the incidence of the restriction.[26]

We can hypothesize that, since the choice of a larger share of "prime"-adjusted rate demands better awareness of mortgage market, more intensive shopping and maybe stronger negotiation ability, we expect that in the period before the restriction these borrower's qualities could be beneficial to attain the most convenient mortgage setting. Table 6 confirms this hypothesis. In the pre-restriction period (regression model (6)), the effect of distance-socioeconomic status interactions has dissolved for only high socioeconomic status groups, which is also consistent with relatively high share of "prime"-adjusted rate in the mortgage within these groups (Figure 3). Furthermore, the influence of banking competition after the restriction (regression model (7)) weakened both for the locality of mortgage origination and of mortgaged asset. The effect of the *bank in the same location* variable weakened, meaning the decrease of return to shopping behavior after the restriction. On the other hand, the influence of high LTV and PTI ratios and local housing market situation (*turnover* variable) strengthened after the restriction. We can also mention differences in the distance from the center and the socioeconomic status of neighborhood influence before and after the restriction, with

[25] "Prime" is a Bank of Israel interest rate + 1.5 percentage points. Banks lend mortgages adjusted to this rate, usually with negative increment.

[26] We also included the share of "prime"-adjusted interest rate into our basic regressions (see Table A1 in the Appendix), but we don't think that its inclusion has economically reasonable results. Regression results show that it decreases the average interest rate both statistically significant and economically sizable. However, while in the period before the restriction we can hypothesize that the share of "prime"-adjusted rate is correlated with borrower's financial sophistication, it will not be true in the period after the restriction. We also claim that large effect of inclusion of the share of "prime"-adjusted interest rate into the regression is generally technical and stems mainly from its large magnitude. In the before-restriction period, 63.5 percent of mortgages included one-third and more "prime"-adjusted interest rate share; after the restriction, 57 percent of mortgages included at least one-third "prime"-adjusted interest rate share.

former influencing in the pre-restriction period and later influencing in the post-restriction one.

We also find the evidence of substantial weakening of the role of net income, being upgrader or investor (all of them signaling better negotiation ability) in the interest rate determination in the post-restriction period, as the composition of mortgage interest rate became more uniform and less risky.

7.3 Propensity-score matching approach application

While the OLS approach is completely valid, there are a few concerns about its implementation, the major one being that by using OLS, we make strong assumptions about normality or the linear relationship between the covariates of interest. By contrast, equivalent non-parametric statistical methods make no assumptions about the population distribution from which the data are sampled. In addition, the OLS approach allows for extreme outliers in the estimation, which can bias the interest rate estimates substantially.

Therefore, we use Propensity Score-Matching (PSM) estimation strategy. The PSM is less parametric and more closely related to the notion of a randomized[27] that deals with the self-selectivity problem that may bias the estimates of interest rate gaps. The PSM was developed as part of the selection on observables approach (Rubin, 1973; Rosenbaum and Rubin, 1983; and Heckman et al., 1998). The propensity score is the probability of treatment assignment conditional on observed baseline characteristics. The propensity score is a balancing score: conditional on the propensity score, the distribution of observed baseline covariates will be similar between treated and untreated subjects.

In the following set of tests, we use the PSM method, and examine the difference in the average mortgage interest rates between three types of borrowers: those who purchase assets within 40 kilometers from the center of Tel Aviv, those who purchase assets within the distance of 40 to 80 kilometers from the center of Tel Aviv and those who purchase remote assets situated 80 kilometers and more from the center of Tel Aviv.

[27] See Angrist and Lang (2004) for a review.

The matching procedure uses a logistic model to predict each borrower propensity score using covariates *Number of borrowers*, *Age*, *Age squared*, *Log of net income*, *Wage account*, *Upgrader*, *Investor*, *Guarantor*, *Log of loan amount*, *LTV*[28], *PTI30*, *Dur20*, *Socioeconomic* and *Turnover* as well as bank identity and date (month and year).

The results are presented in Table 7. On average, borrowers purchasing assets within 40 to 80 kilometers from the center of Tel Aviv pay mortgage interest rates which are higher by 0.1 percentage points than similar borrowers purchasing assets within 40 kilometers from the center of Tel Aviv, while borrowers purchasing assets situated 80 kilometers and more from the center of Tel Aviv pay mortgage interest rates which are higher by 0.2 percentage points than similar borrowers purchasing assets within 40 kilometers from the center of Tel Aviv. There is also statistically significant gap of approximately 0.1 percentage points between two "peripheral" groups of borrowers. The magnitude of these gaps is in line with our OLS estimates.

8. Discussion

In this paper, we explore the contribution of various factors of risk to the mortgage interest rate determination, paying special attention to location-based differentials, including two dimensions – distance from the center and socioeconomic status of the neighborhood where the mortgaged asset is situated. Empirical evidence based on more than 80 thousand mortgage loans originated during 2010-2013 indicates that location does matter. It looks like borrowers purchasing housing assets in the central prosperous regions are perceived by lenders as preferred customers gaining the best interest rate terms, while borrowers purchasing assets in the peripheral poor neighborhoods are compelled to pay the highest interest rates. The ranking remains unchanged and statistically significant after controlling for various factors of borrower, mortgage and asset risk and also for the extent of banking competition.

However, we can't attribute these location-based interest rate differentials to discrimination against poorly situated borrowers. Some crucial factors of interest rate determination that are unobservable are likely to be correlated to some degree with the location of the purchased asset, including borrower's credit history, wealth,

[28] The exact value of the LTV ratio.

employment characteristics (in terms of occupation, seniority, tenure, stability, contract duration), financial literacy and bargaining ability. For example, Haran Rosen and Sade (2018) find that individuals living in central locations with a higher socioeconomic index demonstrated more active beneficial financial behavior.

Canner (1981), Stiglitz and Weiss (1981) and Williamson (1986, 1987) argued that creditors may apply binding credit constraints to loan applicants due either their ability to repay a loan, or because of factors that may adversely affect the collateral value of the property. In other words, lenders are supposed to apply tighter credit conditions (including higher down payment requirements, shorter terms to loan maturity, and higher interest rate) to more risky loan applicants, irrespective of whether that risk is related to the attributes of the borrower or to those of the neighborhood where the property is located. It is reasonable that lenders incorporate the risk of asset foreclosure in the interest rates, while the costs of foreclosure seem to be higher in the regions with lower housing demand (at least partly captured by *turnover* variable) and lower prospective house price growth (or higher possibility of price depreciation). Since in Israel most demanded for living regions are central ones, where land reserves for residential building are limited, the prospects of price growth there are much more promising than in the periphery where abundance of land suitable for residential building keeps its price low.

Even when discrimination occurs, it is not feasible to test whether it is prejudice-driven or statistical one. However, we assume that discrimination in mortgage pricing, at least against those purchasing assets in the peripheral regions (but not necessarily those buying assets in poor but close to the center neighborhoods), is unlikely to be a *prejudiced discrimination*. Peripheral borrowers approaching local banks' affiliations meet there loan officers who are also local residents, such that we should not expect them to have personal prejudices against their neighbors. Several studies examined group identity effect on the credit market outcomes. For example, Beck et al. (2012) tested the influence of shared gender identity and showed that in Albania, borrowers assigned to opposite-sex officers received lower loan amounts and paid higher interest rates, although, ex post, they did not experience higher arrears. Fishman et al. (2017) report that shared ethnicity and religion between borrowers and loan officers in India increased access to credit and loan size dispersion and reduced collateral requirements, while improving future repayment.

Statistical discrimination occurs when individual members of a particular group are treated differently based on the use of empirical (statistical) correlations of this group's distinctive observable characteristics with its economic performance or outcomes. In the context of our study, statistical discrimination would occur if peripheral residents *as a group* have a higher average statistical risk of default or being in arrears (say, because of less favorable conditions in the local labor markets), and a lender uses this past experience to charge a higher interest rate from all loan applicants living in the periphery, independent of their individual characteristics, while *particular applicants* belonging to this group may or may not cause higher risk. Since lender has imperfect information about potential customers, she only uses available statistical data as a kind of screening device to assess a risk premium for potential borrower based on the assumption that her group affiliation is correlated with socioeconomically relevant characteristics and likelihood of repayment/default (or being in arrears). As a result, an individual borrower could be adversely affected because of his group affiliation.

Unfortunately, we have no information on default rates by locality of residence or long run statistics on regional distribution of loans in arrears. However, since our data was collected retroactively and not at the mortgage origination we know the status of the mortgages originated in 2010-2013 (regularly repaid or in arrears) in the year 2015. The share of the mortgages in arrears is generally low, but there are some differences among distance-socioeconomic status groups (Table 8), suggesting that there is some economic rationality for differential treatment of certain groups of borrowers.

Given large loan amount and long duration, even relatively small interest rate increment may cause substantial increase in the total repayments upon mortgage life span. Our findings indicate that interest rate differentials hurt mostly the weakest borrowers; higher mortgage prices increase the economic burden on borrowers purchasing housing assets in inferior locations, possibly raising their probability of default, and even contribute to exacerbating inequality at the economy-wide level.

One of the causes of getting less convenient interest rates is an inadequate financial literacy and shopping behavior. In the last years, provision of private mortgage counselling services becomes more and more common and perhaps it is successful in obtaining more favorable mortgage terms for those lacking financial knowledge and bargaining ability. However, we can't examine this hypothesis.

Commercial banks are profit maximizing firms. Their lending decision is based on prediction of the probability that borrower will repay the loan successfully. However, defaults generally happen as a result of some unexpected negative life event. To minimize expected mortgage loss, lending institution must, ex ante, predict whether the future value of the underlying property will exceed the outstanding debt. Naturally, properties situated in more demanded neighborhoods have better prospects of price stability and growth.[29] If policymakers care for more disadvantaged populations they may consider provision of government guarantees for first-time homebuyers purchasing housing assets in the geographic and socioeconomic peripheral neighborhoods to ensure lower mortgage interest rates.

Further research has to focus on enriching the list of independent variables to include dimensions of risk that are unavailable at this point of time. Central Credit Register at the Bank of Israel, which began to operate in April, 2019, will provide in the foreseeable future households' credit history data and measures of non-housing indebtedness which could be incorporated in the model of mortgage interest rate determination.

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[29] For example, Haughwout et al. (2009) find that mortgage rates are lower in locations that experienced higher past rates of house price appreciation, probably because lenders have expectations for such trend continuation.

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Figure 1

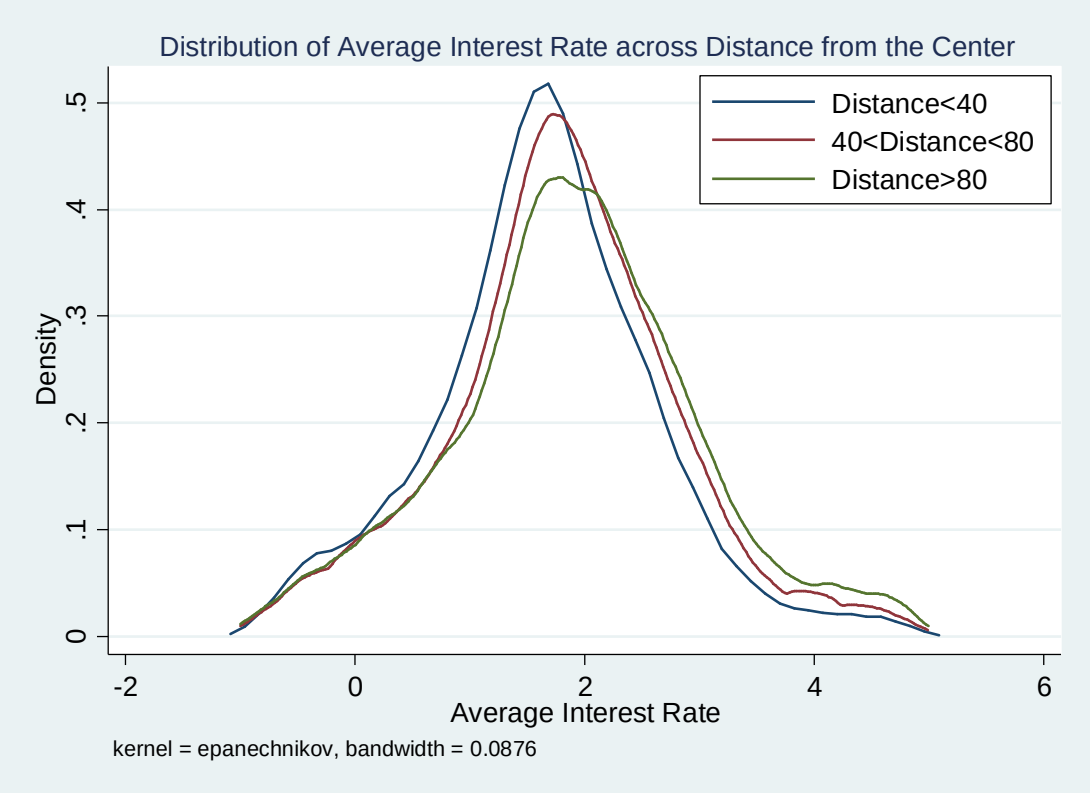
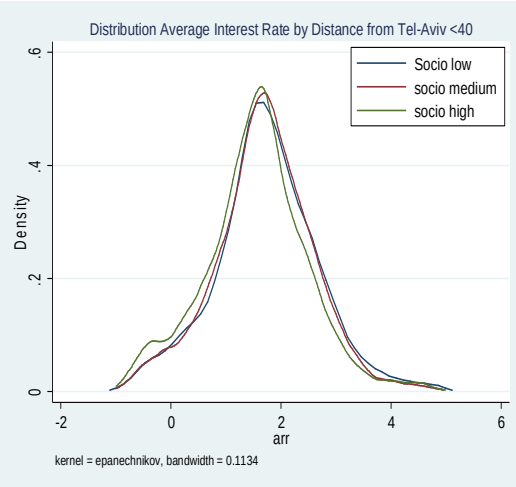
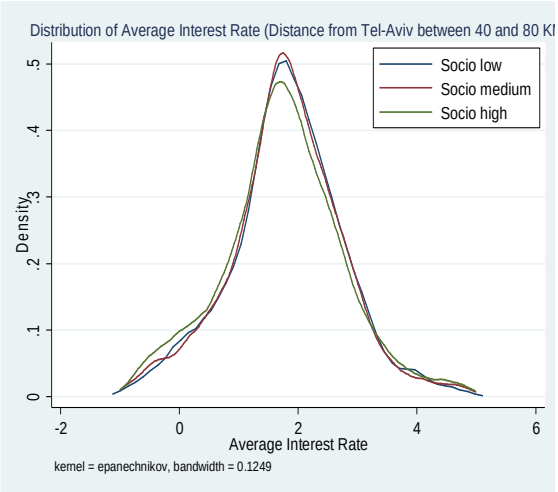
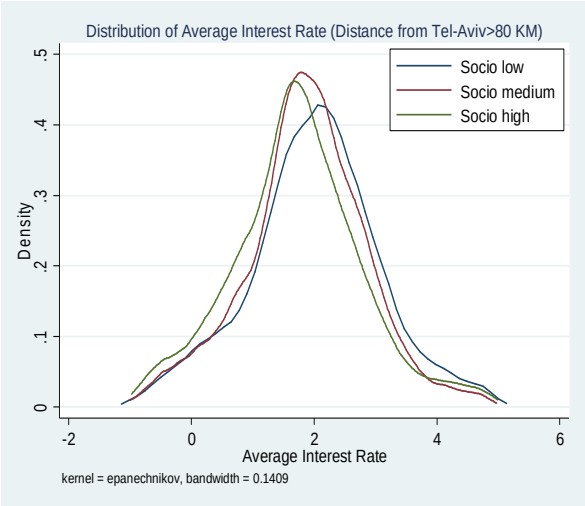

Distribution of Average Interest Rate across Distance from the Center
Distance<40
40<Distance<80
Distance>80
Density
0
.1
.2
.3
.4
.5
-2
0
2
4
6
Average Interest Rate
kernel = epanechnikov, bandwidth = 0.0876

Figure 2


Distribution Average Interest Rate by Distance from Tel-Aviv <40
Socio low
socio medium
socio high
Density
0
.2
.4
.6
-2
0
2
4
6
arr
kernel = epanechnikov, bandwidth = 0.1134


Distribution of Average Interest Rate (Distance from Tel-Aviv between 40 and 80 KI
Socio low
Socio medium
Socio high
Density
0
.1
.2
.3
.4
.5
-2
0
2
4
6
Average Interest Rate
kernel = epanechnikov, bandwidth = 0.1249


Distribution of Average Interest Rate (Distance from Tel-Aviv>80 KM)
Socio low
Socio medium
Socio high
Density
0
.1
.2
.3
.4
.5
-2
0
2
4
6
Average Interest Rate
kernel = epanechnikov, bandwidth = 0.1409

Fugure 3. Mean share of "prime"-adjusted interest rate before and after the restriction

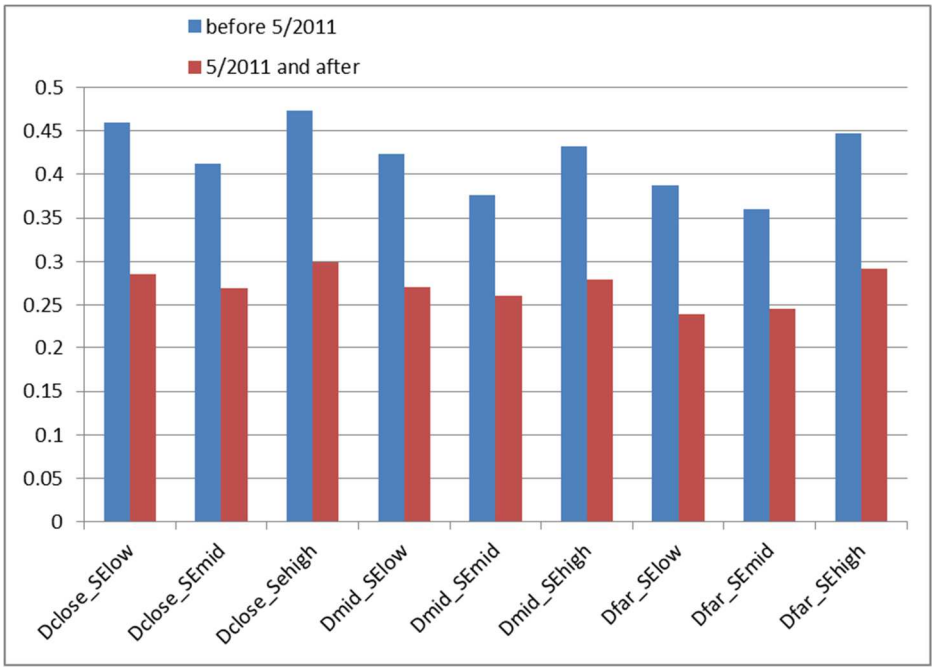


Table 1. Median values of main mortgage and borrower characteristics, broken by combinations of distance and socioeconomic status of neighborhood

	Distance<40			40<=Distance<80			Distance>=80		
socioeconomic	**low**	**medium**	**high**	**low**	**medium**	**high**	**low**	**medium**	**high**
interest rate (%)	**1.72**	**1.70**	**1.57**	**1.83**	**1.80**	**1.75**	**2.04**	**1.89**	**1.71**
LTV (%)	58.3	59.0	51.9	60.0	59.8	55.0	60.0	60.9	57.0
duration (months)	260	274	251	253	264	245	240	240	240
PTI (%)	27.9	27.5	28.0	26.0	27.0	27.0	23.1	24.4	24.5
loan size (000' NIS)	480	582	700	417	500	530	260	370	450
net monthly income (NIS)	12,000	13,200	16,500	11,800	12,706	14,805	11,900	12,380	14,900
age	36.3	38.5	40.1	35.2	38.6	40.3	38.6	39.4	41.0
LTI	3.4	3.7	3.5	3.2	3.3	3.1	2.0	2.7	2.6
investors' share (%)	15	13	15	15	13	14	29	17	16
investors' interest rate (%)	1.61	1.55	1.50	1.76	1.79	1.73	1.93	1.90	1.68
first-time home buyers' interest rate (%)	1.90	1.85	1.69	1.96	1.91	1.92	2.26	2.00	1.88
mortgage outside asset location	55.7	51.9	58.7	57.6	43.8	68.4	50.2	37.5	46.1
mortgage outside asset location for investors	59.7	55.5	59.1	60.0	51.0	62.5	59.2	49.6	47.6
mortgage outside asset location for first-time home buyers	56.4	52.9	62.3	59.5	45.2	73.4	49.5	38.7	47.3
mortgage outside asset location for upgraders	53.2	49.6	55.7	54.0	40.2	66.0	42.2	31.5	44.7
mortgage outside asset location in localities 100,000+ residents (%)	45.5	41.2	48.6	27.9	23.2	26.4	36.7	22.1	16.4
number of observations	11,833	13,366	20,608	7,507	7,984	5,380	8,201	9,022	5,013

Table 2. Variable names, definitions and expected relation to mortgage interest rate

Variable	Description	Expected sign
R	Dependent variable; weighted average of real interest rates on all parts of the mortgage	
Borrower risk		
Number of borrowers	1 for a single borrower, 2 for a couple	-
Age	For multiple borrowers – average age	-
Age squared	For multiple borrowers – average age squared	?
Log of net income	Log of family after-tax monthly income net of fixed monthly payments	-
Wage account	Dummy, 1 for household with current account within the bank, 0 otherwise	-
Upgrader	Dummy, 1 for upgrader, 0 otherwise	-
Investor	Dummy, 1 for investor, 0 otherwise	?
Guarantor	Dummy, 1 for loan with guarantor requirement, 0 otherwise	+
Loan risk		
Log of loan amount	Log of approved mortgage	-
LTV60	Dummy, 1 for mortgages with LTV>60%	+
PTI30	Dummy, 1 for mortgages with PTI>30%	+
Dur20	Dummy, 1 for mortgages with maturity of more than 20 years	+
Collateral risk		
Socioeconomic	Socioeconomic index of neighborhood, 1 (the lowest) to 20 (the highest)	-
Distance	Distance from the neighborhood to the center of Tel Aviv, in km	+
Distance squared	Square of distance from the neighborhood to the center of Tel Aviv	?
Dclose_SElow, Dclose_SEmid, Dclose_SEhigh, Dmid_SElow, Dmid_SEmid, Dmid_SEhigh, Dfar_SElow, Dfar_SEmid, Dfar_SEhigh	System of dummies for interactions of distance and socioeconomic status as described in section 4. Dclose_SEhigh variable is omitted in the regression analysis.	all +
Turnover, %	Number of transactions in the housing market divided by the number of existing housing units, by municipality[1]	-
Potential Accessibility Index	Continuous variable, by municipality, see footnote 21 in the text	-
Building starts, %	Number of housing units which construction had begun in the given year divided by the number of existing housing units, by municipality	+
Competitiveness		
Bank in the same location	Dummy, 1 if the loan was originated in the locality of purchased property, 0 otherwise	?
Number of banks in mortgage location	Number of different banking institutions providing mortgage services in the locality of loan origination[2]	-
Number of banks in property location	Number of different banking institutions providing mortgage services in the locality of purchased property[3]	-

Notes for Table 2

[1] To estimate turnover variable, we divide the number of transactions in each locality (not neighborhood) by the number of housing units in each municipality, officially reported by the Israeli Central Bureau of Statistics. For mortgage taken out in year *t* we use an average of turnover in years *t* and *t-1*. Since number of housing units in some small localities is not reported we lose 4.6% of observations due to use of the variable.

[2] Using the full list of bank affiliations, we count the number of banking institutions in the locality where the mortgage was originated. We also tried the number of different bank brances engaged in mortgage credit and the results of estimation were similar. Because of distortions in the data we were unable to identify correct location of mortgage origination in 4.1% of observations.

[3] The same as the previous variable, but for the locality where the mortgaged asset is situated.

Table 3. Basic regression estimation results

Variable	(1)		(2)		(3)	
number of borrowers	0.050***	(0.009)	0.049***	(0.009)	0.046***	(0.009)
age	0.030***	(0.002)	0.030***	(0.002)	0.029***	(0.002)
age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
log of net income	-0.223***	(0.008)	-0.225***	(0.009)	-0.225***	(0.009)
wage account	-0.126***	(0.008)	-0.125***	(0.008)	-0.126***	(0.008)
upgrader	-0.030***	(0.008)	-0.028***	(0.008)	-0.030***	(0.008)
investor	-0.075***	(0.010)	-0.072***	(0.010)	-0.069***	(0.010)
guarantor	0.059***	(0.012)	0.057***	(0.012)	0.058***	(0.012)
log of loan amount	-0.078***	(0.006)	-0.078***	(0.006)	-0.075***	(0.006)
LTV60	0.057***	(0.007)	0.058***	(0.007)	0.059***	(0.007)
PTI30	0.002	(0.007)	0.002	(0.007)	0.003	(0.007)
Dur20	0.221***	(0.008)	0.220***	(0.008)	0.219***	(0.008)
Dclose_SElow	**0.070*** **	(0.012)	**0.074*** **	(0.013)	**0.075*** **	(0.013)
Dclose_SEmid	**0.053*** **	(0.011)	**0.050*** **	(0.011)	**0.056*** **	(0.011)
Dmid_SElow	**0.068*** **	(0.018)	**0.063*** **	(0.019)	**0.089*** **	(0.019)
Dmid_SEmid	**0.080*** **	(0.017)	**0.081*** **	(0.017)	**0.109*** **	(0.017)
Dmid_SEhigh	**0.047** **	(0.020)	**0.041** **	(0.020)	**0.054*** **	(0.020)
Dfar_SElow	**0.179*** **	(0.025)	**0.200*** **	(0.026)	**0.248*** **	(0.026)
Dfar_SEmid	**0.105*** **	(0.025)	**0.123*** **	(0.025)	**0.175*** **	(0.026)
Dfar_SEhigh	**0.067*** **	(0.025)	**0.075*** **	(0.026)	**0.125*** **	(0.026)
distance	0.000	(0.000)	0.002***	(0.001)	0.001*	(0.001)
distance squared	0.000**	(0.000)	-0.000	(0.000)	0.000	(0.000)
socioeconomic	-0.005***	(0.001)	-0.004***	(0.001)	-0.003***	(0.001)
turnover	-0.008***	(0.002)	-0.011***	(0.002)	-0.007***	(0.002)
bank in the same location	0.044***	(0.006)	0.049***	(0.007)	0.076***	(0.007)
number of banks in mortgage location	-0.016***	(0.002)	-0.016***	(0.002)	-0.009***	(0.002)
potential accessibility index			0.001***	(0.000)	0.001***	(0.000)
building starts			0.007***	(0.002)	-0.002	(0.002)
number of banks in property location					-0.016***	(0.002)
Banks fixed effects	+		+		+	
Month & Year fixed effects	+		+		+	
Constant	3.580***	(0.101)	3.336***	(0.121)	3.343***	(0.120)
Observations	81,143		80,539		80,539	
R-squared	0.282		0.282		0.283	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4. Inter-regional interest differentials

Panel A. Unconditional means, standard deviations in parentheses

	distance<40	<=40distance<80	distance>80
socio high	1.536	1.741	1.719
	(1.022)	(1.121)	(1.168)
socio middle	1.684	1.800	1.866
	(0.961)	(1.074)	(1.091)
socio low	1.730	1.807	2.016
	(1.031)	(1.041)	(1.213)

Panel B. Differences in unconditional means, relative to basic category

	distance<40	40<=distance<80	distance>80
socio high	base	0.205	0.183
socio middle	0.148	0.263	0.330
socio low	0.194	0.271	0.480

Panel C. Estimated coefficients (conditional differences in means)

	distance<40	40<=distance<80	distance>80
socio high	omitted	0.054	0.125
socio middle	0.056	0.109	0.175
socio low	0.075	0.089	0.248

Table 5. Robustness check 1: Inclusion of *log of price* variable

Variable	basic regression (3)		(4)		(5)	
number of borrowers	0.046***	(0.009)	0.051***	(0.009)	0.051***	(0.009)
age	0.029***	(0.002)	0.029***	(0.002)	0.029***	(0.002)
age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
log of net income	-0.225***	(0.009)	-0.202***	(0.009)	-0.218***	(0.008)
wage account	-0.126***	(0.008)	-0.126***	(0.008)	-0.124***	(0.008)
upgrader	-0.030***	(0.008)	-0.012	(0.008)	-0.012	(0.008)
investor	-0.069***	(0.010)	-0.085***	(0.010)	-0.081***	(0.010)
guarantor	0.058***	(0.012)	0.060***	(0.012)	0.054***	(0.012)
log of loan amount	-0.075***	(0.006)	-0.047***	(0.006)		
LTV60	0.059***	(0.007)	0.038***	(0.008)	0.024***	(0.007)
PTI30	0.003	(0.007)	0.011	(0.007)	0.003	(0.007)
Dur20	0.219***	(0.008)	0.220***	(0.008)	0.204***	(0.007)
Dclose_SElow	**0.075*** **	(0.013)	**0.051*** **	(0.013)	**0.054*** **	(0.013)
Dclose_SEmid	**0.056*** **	(0.011)	**0.037*** **	(0.011)	**0.038*** **	(0.011)
Dmid_SElow	**0.089*** **	(0.019)	**0.067*** **	(0.019)	**0.073*** **	(0.019)
Dmid_SEmid	**0.109*** **	(0.017)	**0.090*** **	(0.017)	**0.096*** **	(0.017)
Dmid_SEhigh	**0.054*** **	(0.020)	**0.056*** **	(0.020)	**0.060*** **	(0.020)
Dfar_SElow	**0.248*** **	(0.026)	**0.189*** **	(0.026)	**0.197*** **	(0.026)
Dfar_SEmid	**0.175*** **	(0.026)	**0.143*** **	(0.026)	**0.150*** **	(0.026)
Dfar_SEhigh	**0.125*** **	(0.026)	**0.110*** **	(0.026)	**0.115*** **	(0.026)
distance	0.001*	(0.001)	0.001	(0.001)	0.001	(0.001)
distance squared	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
socioeconomic	-0.003***	(0.001)	-0.002***	(0.001)	-0.002***	(0.001)
turnover	-0.007***	(0.002)	-0.007***	(0.002)	-0.007***	(0.002)
bank in the same location	0.076***	(0.007)	0.080***	(0.007)	0.081***	(0.007)
number of banks in mortgage location	-0.009***	(0.002)	-0.009***	(0.002)	-0.009***	(0.002)
potential accessibility index	0.001***	(0.000)	0.001***	(0.000)	0.001***	(0.000)
building starts	-0.002	(0.002)	-0.001	(0.002)	-0.001	(0.002)
number of banks in property location	-0.016***	(0.002)	-0.016***	(0.002)	-0.016***	(0.002)
log of price			-0.107***	(0.007)	-0.122***	(0.006)
Banks fixed effects	+		+		+	
Month & Year fixed effects	+		+		+	
Constant	3.343***	(0.120)	3.505***	(0.121)	3.159***	(0.112)
Observations	80,539		80,539		80,539	
R-squared	0.283		0.285		0.284	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6. Robustness check 2: Estimation results before and after the restriction on "prime"-adjusted interest rate share

Variable	basic regression (3)		before restriction (6)		after restriction (7)	
number of borrowers	0.046***	(0.009)	0.069***	(0.018)	0.036***	(0.010)
age	0.029***	(0.002)	0.054***	(0.005)	0.018***	(0.003)
age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000***	(0.000)
log of net income	-0.225***	(0.009)	-0.365***	(0.017)	-0.165***	(0.010)
wage account	-0.126***	(0.008)	-0.113***	(0.015)	-0.095***	(0.009)
upgrader	-0.030***	(0.008)	-0.065***	(0.016)	-0.015*	(0.009)
investor	-0.069***	(0.010)	-0.196***	(0.020)	0.001	(0.012)
guarantor	0.058***	(0.012)	0.068***	(0.025)	0.053***	(0.014)
log of loan amount	-0.075***	(0.006)	0.019	(0.012)	-0.105***	(0.006)
LTV60	0.059***	(0.007)	0.056***	(0.014)	0.072***	(0.008)
PTI30	0.003	(0.007)	-0.055***	(0.014)	0.026***	(0.008)
Dur20	0.219***	(0.008)	0.233***	(0.015)	0.208***	(0.008)
Dclose_SElow	**0.075*** **	(0.013)	**0.100*** **	(0.026)	**0.069*** **	(0.014)
Dclose_SEmid	**0.056*** **	(0.011)	**0.103*** **	(0.021)	**0.029** **	(0.012)
Dmid_SElow	**0.089*** **	(0.019)	**0.077** **	(0.039)	**0.102*** **	(0.021)
Dmid_SEmid	**0.109*** **	(0.017)	**0.172*** **	(0.035)	**0.083*** **	(0.019)
Dmid_SEhigh	**0.054*** **	(0.020)	**-0.037**	(0.041)	**0.095*** **	(0.023)
Dfar_SElow	**0.248*** **	(0.026)	**0.265*** **	(0.054)	**0.234*** **	(0.029)
Dfar_SEmid	**0.175*** **	(0.026)	**0.182*** **	(0.052)	**0.169*** **	(0.028)
Dfar_SEhigh	**0.125*** **	(0.026)	**0.058**	(0.053)	**0.150*** **	(0.029)
distance	0.001*	(0.001)	0.003**	(0.002)	0.000	(0.001)
distance squared	0.000	(0.000)	-0.000	(0.000)	0.000	(0.000)
socioeconomic	-0.003***	(0.001)	0.001	(0.002)	-0.005***	(0.001)
turnover	-0.007***	(0.002)	0.001	(0.003)	-0.013***	(0.003)
bank in the same location	0.076***	(0.007)	0.114***	(0.014)	0.062***	(0.008)
number of banks in mortgage location	-0.009***	(0.002)	-0.020***	(0.004)	-0.005***	(0.002)
potential accessibility index	0.001***	(0.000)	0.001**	(0.001)	0.001***	(0.000)
building starts	-0.002	(0.002)	-0.006	(0.005)	0.000	(0.003)
number of banks in property location	-0.016***	(0.002)	-0.021***	(0.003)	-0.014***	(0.002)
Banks fixed effects	+		+		+	
Month & Year fixed effects	+		+		+	
Constant	3.343***	(0.120)	2.699***	(0.248)	3.939***	(0.132)
Observations	80,539		25,303		55,236	
R-squared	0.283		0.170		0.241	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7. Robustness check 3: Propensity-score matching estimation results

Comparison categories	Coefficient	Std. Err.	z	P>|z|	Number of obs.
40<=Distance<80 vs Distance<40	0.103	0.010	10.18	0.000	66,678
Distance>=80 vs Distance<40	0.202	0.012	16.42	0.000	68,043
Distance>=80 vs 40<=Distance<80	0.098	0.013	7.29	0.000	43,107

Table 8. Percentage of mortgages in arrears, by distance and socioeconomic status, for mortgages originated in 2010-2013 (%)

Distance<40			40<=Distance<80			Distance>=80		
SE low	SE middle	SE high	SE low	SE middle	SE high	SE low	SE middle	SE high
2.34	1.55	1.30	3.13	2.61	2.12	2.65	1.66	1.52

Appendix

Table 1A. Estimation results before and after the restriction on "prime"-adjusted interest rate share

Variable	before restriction (6)		after restriction (7)		before restriction (8)		after restriction (9)	
number of borrowers	0.069***	(0.018)	0.036***	(0.010)	0.057***	(0.012)	0.037***	(0.009)
age	0.054***	(0.005)	0.018***	(0.003)	0.015***	(0.003)	0.007***	(0.002)
age squared	-0.000***	(0.000)	-0.000***	(0.000)	-0.000**	(0.000)	-0.000	(0.000)
log of net income	-0.365***	(0.017)	-0.165***	(0.010)	-0.071***	(0.012)	0.010	(0.009)
wage account	-0.113***	(0.015)	-0.095***	(0.009)	-0.026***	(0.010)	-0.061***	(0.008)
upgrader	-0.065***	(0.016)	-0.015*	(0.009)	-0.039***	(0.011)	-0.002	(0.007)
investor	-0.196***	(0.020)	0.001	(0.012)	-0.090***	(0.014)	-0.027***	(0.010)
guarantor	0.068***	(0.025)	0.053***	(0.014)	0.057***	(0.017)	0.023*	(0.012)
log of loan amount	0.019	(0.012)	-0.105***	(0.006)	-0.139***	(0.008)	-0.285***	(0.006)
LTV60	0.056***	(0.014)	0.072***	(0.008)	0.049***	(0.010)	0.075***	(0.007)
PTI30	-0.055***	(0.014)	0.026***	(0.008)	0.046***	(0.010)	0.080***	(0.007)
Dur20	0.233***	(0.015)	0.208***	(0.008)	0.133***	(0.010)	0.248***	(0.007)
Dclose_SElow	**0.100*** **	(0.026)	**0.069*** **	(0.014)	**0.063*** **	(0.018)	**0.023***	(0.012)
Dclose_SEmid	**0.103*** **	(0.021)	**0.029** **	(0.012)	**0.023**	(0.014)	**-0.008**	(0.011)
Dmid_SElow	**0.077** **	(0.039)	**0.102*** **	(0.021)	**0.087*** **	(0.027)	**0.062*** **	(0.018)
Dmid_SEmid	**0.172*** **	(0.035)	**0.083*** **	(0.019)	**0.093*** **	(0.024)	**0.036** **	(0.017)
Dmid_SEhigh	**-0.037**	(0.041)	**0.095*** **	(0.023)	**0.014**	(0.028)	**0.090*** **	(0.020)
Dfar_SElow	**0.265*** **	(0.054)	**0.234*** **	(0.029)	**0.209*** **	(0.036)	**0.116*** **	(0.025)
Dfar_SEmid	**0.182*** **	(0.052)	**0.169*** **	(0.028)	**0.101*** **	(0.035)	**0.086*** **	(0.025)
Dfar_SEhigh	**0.058**	(0.053)	**0.150*** **	(0.029)	**0.100*** **	(0.036)	**0.128*** **	(0.025)
distance	0.003**	(0.002)	0.000	(0.001)	-0.001	(0.001)	-0.001	(0.001)
distance squared	-0.000	(0.000)	0.000	(0.000)	0.000**	(0.000)	0.000***	(0.000)
socioeconomic	0.001	(0.002)	-0.005***	(0.001)	-0.003***	(0.001)	-0.005***	(0.001)
turnover	0.001	(0.003)	-0.013***	(0.003)	-0.008***	(0.002)	-0.020***	(0.002)
bank in the same location	0.114***	(0.014)	0.062***	(0.008)	0.046***	(0.010)	0.044***	(0.007)
number of banks in mortgage location	-0.020***	(0.004)	-0.005***	(0.002)	-0.002	(0.002)	0.002	(0.002)
potential accessibility index	0.001**	(0.001)	0.001***	(0.000)	-0.000	(0.000)	0.001**	(0.000)
building starts	-0.006	(0.005)	0.000	(0.003)	-0.004	(0.003)	0.003	(0.002)
number of banks in property location	-0.021***	(0.003)	-0.014***	(0.002)	-0.012***	(0.002)	-0.009***	(0.002)
share of "prime"					-2.372***	(0.014)	-1.794***	(0.014)
Banks fixed effects	+		+		+		+	
Month & Year fixed effects	+		+		+		+	
Constant	2.699***	(0.248)	3.939***	(0.132)	4.362***	(0.168)	5.510***	(0.116)
Observations	25,303		55,236		25,303		55,236	
R-squared	0.170		0.241		0.619		0.422	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1