Geographic disparities of interest rate in housing loans and local financial markets concentration*

Barbara Castillo Rico†

June 9, 2022

Abstract

Interest rates are a major channel of monetary policy to households. However, although important disparities in credit conditions across European countries are well known, almost nothing is known about geographic inequalities within countries. Here,I study the geographic disparities of housing interest rates due to the existence of local market structures in France. I then assess the heterogeneous pass-through of monetary policy to the housing credit system. In particular, I estimate the hedonic reduced form of housing credit interest rates, assuming some degree of imperfect competition, which depends on the geographic area. The study uses Bank of France data on new housing loans and banks' credit volumes to households to create a single extensive data set of regional housing credit activity. This paper documents two main results. First, banks set interest rates, on average, 0.32 basis points higher in areas of high credit market concentration compared with areas of low concentration. Second, in periods of expansionary monetary policy, banks reduce interest rates less in concentrated markets than they do in more competitive markets. Nevertheless, the latter result is sensitive to a certain number of robustness checks.

Keywords: Housing credit, Interest rates, Market structure, Geographic inequalities, Monetary policy.

JEL Codes: E43, G21, L11, E52.

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*I would like to thank my PhD director, Alain Trannoy (Aix-Marseille Université, CNRS, EHESS, Centrale Marseille, AMSE) for unconditional support and guidance, as well as my Banque de France colleagues, together with participants of the Banque de France Seminars (Paris, France) and AMSE Seminars (Marseille, France) for a number of helpful comments and suggestions. I would also like to thank Meilleurs Agents for selflessly providing me with their rich house price data. This paper reflects the opinions of the author and does not necessarily express the views of the Banque de France. This work is also supported by a public grant overseen by the French National Research Agency (ANR) as part of the "Investissements d'avenir" programme (reference: ANR-10-EQPX-17 – Centre d'accès sécurisés aux donnés – CASD). I also acknowledge support from ANR-17-CE41-0008 (ECHOPPE).

†Aix-Marseille University, CNRS, EHESS, Centrale Marseille, AMSE and Banque de France. barbara.castillorico@etu.univ-amu.fr

The distributional effects of monetary policy have recently gained attention both among the public and academia. Interest rates are an important channel of monetary policy to households, transmitting it directly through its impact on households' interest payments for outstanding debts and on their financial income from short-maturity assets (Ampudia et al. (2018)). The incomes of households with outstanding debt will rise upon a reduction in policy rates, if loans follow an adjustable interest rate schedule. Nevertheless, only 7% of the stock of ongoing housing loans in France are adjustable rate loans (ACPR (2017)). Additionally, the ability to refinance loans at a lower rate and reduce interest payments has been shown to be unequally distributed across households[1] (Eggertsson and Krugman (2012); Mian, Rao, and Sufi (2013)). Hence, the direct transmission of monetary policy action to housing finance mainly takes place in France through the agreement of new loans. This is important because housing assets are the primary source of wealth for households in the euro area (81% of total net wealth in 2015, according to Garbinti, Savignac, et al. (2018)), and their importance in households' portfolios increases in the middle of the distribution. Moreover, housing debt is the largest expense in a household's monthly budget.

This paper builds on the argument that monetary policy pass-through to a household's housing debt may be heterogeneous. The transmission channel takes place at loan origination and may experience substantial inequalities across the French territory due to local credit markets. Thus, the functioning of local credit markets may have important consequences for households' finances and purchasing power. In this paper, I first study the existence of housing loan pricing inequalities across the French territory due to market structures. Second, I test the existence of market frictions in the transmission channel of monetary policy to new housing loans during the period 2012–2018.

I address two main questions related to housing finance conditions in the household sector: Are there geographic inequalities in interest rates due to disparities in credit market concentration? And does market concentration hamper the transmission of monetary policy into new housing loans? To answer these, I use two complementary sources of credit data to French households between 2012 and 2018 from the Bank of France. I create a disaggregated database that links bank total volumes of housing credit to households by French administrative department with a sample of new housing loans to households granted in this precise geographic area every quarter. Since I observe banks that operate in different departments, I exploit within-bank heterogeneity in the identification strategy. I use Wu and Xia (2017) shadow rates as an indicator of conventional and unconventional monetary policy changes. Additionally, in a first step, I treat loan geographic heterogeneity in a hedonic framework thanks to the exhaustive information about loan characteristics. Then, I estimate the impact of credit market concentration on equilibrium hedonic interest rates over the period 2012–2018.

[1] Highly indebted households are unable to renegotiate due to their vulnerable financial situation. This prevents them taking advantage of the favourable credit market conditions.

The paper relates to the literature on the pass-through of monetary policy to household borrowing interest and deposit rates. Three main findings are of interest to this paper. First, that the transmission is lower in markets that are more concentrated because producers use their market power to capture larger profits. Thus, when policy rates fall, interest rates decline less in less competitive markets (Gropp, Kok, and Lichtenberger (2014), Van Leuvensteijn et al. (2013), Kahn, Pennacchi, and Sopranzetti (2005), Mojon (2000), Borio and Fritz (1995), Cottarelli and Kourelis (1994), Neumark and Sharpe (1992), Hannan and Berger (1991)). Second, interest rates respond asymmetrically to changes in policy rates, depending on whether they rise or fall (Levieuge, Sahuc, et al. (2020), Gropp, Kok, and Lichtenberger (2014), Driscoll and Judson (2013), Neumark and Sharpe (1992), Scholnick (1996)). The main findings highlight the stickiness of rates variation in periods of unfavourable trends for financial institutions. When the central bank increases policy rates, lending institutions rapidly follow the trend. Nevertheless, they adjust loan rates slowly in periods of expansionary monetary policy[2]. This mismatch in the timing of adjustment has important consequences for household finance in favour of bank revenues. Furthermore, these studies provide evidence that this adjustment is slower and more asymmetric in concentrated markets. Finally, papers assessing the role of industrial organization in financial markets find that market concentration has a positive impact on the level of loan rates, whether the estimation is static (comparing markets) or dynamic (following a merger) (Van Leuvensteijn et al. (2013), Kahn, Pennacchi, and Sopranzetti (2005), Maudos and De Guevara (2004), Corvoisier and Gropp (2002), Demirgüç-Kunt and Huizinga (1999), Berger, Demsetz, and Strahan (1999) Prager and Hannan (1998)).

Most of the previous research has a macro perspective, using bank-level data on interest rates, combined with measures of banking structure at country level, to assess monetary policy transmission to household new loans. Hence, within-country analysis of this issue is scarce. Only a few studies go beyond cross-country analysis and assess within-country local markets. Drechsler, Savov, and Schnabl (2017) exploit US bank branch-level data to argue that the existent asymmetry is explained by industrial organization in local deposit markets, such as deposit spreads increasing more in concentrated markets, even across branches of the same bank[3]. Scharfstein and Sunderam (2016) explore the idea of mortgage lending in a county-level panel analysis. They find that when the Federal Reserve lowers interest rates (production costs fall), mortgage rates fall less in concentrated markets than they do in competitive ones because banks (producers) use their market power to capture larger profits. In particular, 1 standard deviation more concentrated counties are 17% less sensitive to

[2] This is the opposite case for deposit interest rates.

[3] Their identification strategy is based on bank-time fixed effects to compare branches of the same bank, which operate in different counties, and get rid of bank specificities and lending opportunities effects. The same identification strategy is employed in the present paper.

changes in mortgage-backed securities in the United States between 2000 and 2011[4]. As it happens, the scarce microeconomic literature on interest rates, concentration and monetary policy uses entirely US data, which leaves a gap for related research on European countries. Hence, to the best of the author's knowledge, this question has not been fully evaluated in France.

The present paper makes multiple contributions to the literature. First, this empirical work is the first to provide evidence using a within-country perspective in France, as well as in Europe. The existence of important disparities in credit conditions across countries are well known in Europe. Nevertheless, almost nothing is known about geographic inequalities within countries. Second, this is the first study to apply the identification strategy of Drechsler, Savov, and Schnabl (2017) in the housing loan context. The rich database I exploit allows comparison of loan pricing across bank branches operating in different markets, which is a genuine feature of the data. This represents a substantial contribution. The best empirical attempt provided in the literature conducts county-level panel regressions (Scharfstein and Sunderam (2016)), ignoring bank heterogeneity within counties. Third, I propose a preliminary treatment of housing loans in a hedonic model to ensure constant loan quality across banks, markets and time. This guarantees comparison of equivalent products across geographic areas. Hence, I can convincingly conclude that credit characteristics heterogeneity does not drive my results. The sequential use of these two techniques represents an interesting improvement on previous literature. Fourth, unlike previous work, I focus my analysis on a period dominated by a conventional monetary policy that is tied down, and non-conventional tools come into play. The use of classic indicators of monetary policy would create substantial computational problems. Thus, I propose shadow rates as an alternative proxy that is gaining importance in the monetary policy literature.

First, like Scharfstein and Sunderam (ibid.), I find that banks set interest rates 32 basis points (bps) higher, on average, in geographic markets with a high level of concentration (bottom 10% of competition) compared with markets with low concentration (top 10% of competition). This is true for branches of the same bank, and when comparing identical loans granted to the same borrower profile. This proves the existence of significant inequalities in terms of capital cost for households' housing purchases between French departments. In particular, we know that higher banking competition is often concentrated in departments with large urban areas and further economic activity. This result raises important concerns about affordability inequalities, housing access and subsequent wealth accumulation over the life cycle, which would be particularly detrimental for disadvantaged geographic areas. Second, global changes in monetary policy during 2012 and 2018 are only lightly reflected in new housing loan rates in the household sector, particularly due to the restricted action of conventional tools. A change in monetary policy equivalent to a 100 bps decrease in policy

[4] A recent theoretical working paper by Wang et al. (2018) suggests that several transmission channels interact at the same time, and the importance of deposits versus lending depends on the level of the policy rate. Nevertheless, there is no empirical evidence on this issue, due to substantial difficulties disentangling both channels.

rates is associated with only a 5 bps fall, on average, in housing loan rates during the period 2012–2018. Third, the transmission of monetary policy is 10% lower in areas with 1 standard deviation higher concentration. This can be translated to a 38% lower transmission in highly concentrated departments compared with highly competitive ones. This result may be considered notable for policy makers, since it suggests a heterogeneous transmission of monetary policy into households, which implies important distributional effects. In expansionary periods, households in competitive geographic areas benefit more from decreasing capital costs than do those in more concentrated departments, which are often rural areas. Finally, I document the existence of important heterogeneity in loan features, such as type of interest rate, maturity or renegotiation rate. This is important for other studies that do not take into account loan characteristics and may suffer important bias in their results.

The remainder of this paper is structured as follows. Section 1 briefly reviews the housing finance system in France. In section 2, I provide the main hypothesis tested in this paper through the classic theoretical model of Monti et al. (1972). Data and descriptive statistics are presented in section 3. In section 4, I develop the hedonic model of new housing loan interest rates. Estimates and results of loan price differentials and the transmission of monetary policy are given in section 5. Finally, sections 6 and 7 provide robustness tests and concluding remarks, respectively.

1 Housing credit system in France

Housing finance represents a major part of banking and has grown in importance during recent decades. In 2017, loans to households for housing purchases represented 28% of total loans to non-credit institutions in France. Furthermore, 99% of all outstanding loans in France were granted by domestic banks, such that the presence of foreign banks in the housing credit market remains limited (ACPR (2017)).

To protect themselves against credit default, French banks require a financial guarantee for every housing loan. Mortgages represent a small part of housing finance compared with other countries. In 2017, only 30% of outstanding loans in France were guaranteed by a mortgage (ACPR (ibid.)). Most housing loans are secured by a guarantee granted by French insurance or credit institutions such as Crédit Logement. This is different from other countries such as Spain or the Netherlands, which instead agree most housing loans using the house value as collateral (mortgage). As a result of the selection criteria of the guarantee system, accepted applicants will represent, on the whole, a less risky segment of the population. Moreover, all housing credits are agreed by financial institutions under conditions of engagement to particular default and death insurances. Thus, the use of insurance as a payment guarantee speeds up the refund process, avoids complicated legal processes and reduces the default risk of lenders. All of this makes the French housing credit system to be considered as particularly safe.

Despite the context of competition and relatively deregulated financial markets, the French government still imposes some regulations. Usury rates are set every trimester to avoid abusive practices and ensure a smooth evolution of housing loan rates. Thus, charged interest rates cannot deviate more than one third from the average rate of the previous trimester. There also exists a rigorous framework of compensation ceilings for early repayments (3% of the outstanding debt or 6 months' interest, if any). And since 1989, French law has given banks part of the responsibility for preventing household over-indebtedness. Additionally, since Basel III, even if there are no formal restrictions for loan-to-value ratios, banks are required to hold more capital against housing loans if the loan-to-value ratio exceeds a particular limit.

Several subsidized credit schemes are still offered by the French government. The PC, PAS[5] and PTZ[6] are the main tools of government financial aid in housing finance, and they offer an advantageous interest rate. It is common in France for households to use several loans to finance their housing purchases. They often combine aided loans with traditional ones from the private credit sector.

This combined system of insurance and a substantial framework of government regulation results in a very limited default rate among households with housing loans (less than 1.5% in 2017) (ACPR (2017)). Only solvent households are accepted for a housing loan, excluding high default risk families from the housing market (they are not eligible for the required guarantee and insurance and subsequent housing loan). Moreover, the independence of the house value from the housing loan reduces the risk exposure of households in periods of important house price falls. This partly explains the limited impact of the 2007–2008 financial crisis in France, in which affected households were outside the housing market (Tutin and Vorms (2014)). Moreover, a substantial effort to recover house prices was made by the government through increasing the support to subsidiary loans during the subsequent years of the crisis.

[5] The PC (Prêt Conventionné) and PAS (Prêt Accession Sociale) allow the entirety of a real estate transaction to be financed over a period of 5 to a maximum of 35 years. The rate depends on the duration of the loan, but also on the bank that offers it. However, maximum rates are set by the government in both cases. The PC is granted without condition of resources, in contrast to the PAS. These subsidized loans can be obtained from any bank or financial institution that has concluded an agreement with the State.

[6] The PTZ (Prêt à Taux Zéro) makes it possible to finance part of the amount of the purchase of the future principal residence. To be eligible, you must not have owned your home for the 2 years preceding the loan. However, there are special cases. The ceiling of resources to be respected and the amount of the PTZ granted depend on the area where the future housing is located. It is possible to complete it with one or more other loans. The PTZ replaced the former PAS in 1995.

2 Theoretical framework

The banking competition may naturally be argued to be a question of interest rates (*à la* Bertrand) rather than quantities (*à la* Cournot). This is particularly true since the objective of this paper is to identify interest rate geographic asymmetries within banks. Nevertheless, there exists evidence in favour of using Cournot modelling in the banking industry. First, Kreps and Scheinkman (1983) show that Bertrand competition with capacity constraints gives a unique equilibrium equivalent to the Cournot outcome[7]. Second, hybrid models that allow price and quantity competition, or Bertrand–Cournot-type models, are shown to end up with both firms naturally competing in output when products are substitutes (Singh and Vives (1984)). Subsequently, in this section, I present a housing credit market competition model that is assumed to be oligopolistic and follows standard Cournot features *à la* Monti–Klein (1972)[8]. The main purpose of this section is to illustrate the underlying mechanisms between European Central Bank (ECB) monetary policy and geographic disparities of interest rates in a framework of heterogeneous market structures in France. Nevertheless, I make clear that no contribution is made to the theoretical literature in this paper.

Suppose the following classic demand function:

$$L(r_L) = a - br_L$$

which can be equivalently expressed as

$$r_L(L) = \alpha - \beta L$$

where $\alpha = a/b$ and $\beta = 1/b$; and $r_L(L)$ represents the interest rate of housing loans associated with demand L.

The total supply of credit is given by a symmetric set of N banks operating in a local market,

$$L = \sum_{n=1}^{N} l_n = Nl$$

with the following production costs function:

$$C(d, l) = r_D d - rM + \Gamma(d, l)$$

$$M = (1 - \theta)d - l$$

$$\Gamma(d, l) = \gamma_D d + \gamma_L l$$

[7]Given capacities for the producers, equilibrium behaviour in the second, Bertrand-like, stage will not always lead to a price that exhausts capacity. But when those given capacities correspond to the Cournot output levels, in the second stage, each firm names the Cournot price. And importantly, for the entire game, fixing capacities at the Cournot output levels is the unique equilibrium outcome, being the result of alternative capacities and imperfect equilibrium.

[8]See Scharfstein and Sunderam (2016) and Corvoisier and Gropp (2002) for similar applications.

which depends on the cost of funding from deposits r_D and the exogenous inter-bank market rate r,[9] plus the existence of transaction and management costs $\Gamma(d, l)$. M represents the inter-bank market net position, determined by the volume of deposits d, loans l and the reserve coefficient θ. We impose the management costs to be additive to simplify the bank's decision problem, which is assumed to be separable[10]. Hence, the marginal cost of producing an extra loan is given by $r + \gamma_L$. Since monetary policy impacts the overnight inter-bank interest rate through the marginal lending and deposit facilities corridor, we can interpret changes in the funding cost r as changes due to conventional monetary policy tools. This is crucial for understanding the transmission to interest rates agreed to households.

The solution for the symmetric Nash equilibrium result from the profits maximization problem,

$$Max_{d,l}\Pi = r_L(L)l - C(d, l)$$

The resulting interest rate and total production of loans at equilibrium are given by

$$l^* = \frac{\alpha - \gamma_L - r}{(N+1)\beta}$$

$$L^* = \frac{(\alpha - \gamma_L - r)N}{(N+1)\beta}$$

$$r_L^* = \alpha - \frac{(\alpha - \gamma_L - r)N}{(N+1)}$$

The equilibrium solution depends on the inter-bank funding cost r and the number of competitors N in the local housing credit market. Then, we can easily assess the sensitiveness of market equilibrium to changes in funding costs and the role of market concentration N.

A shift in the supply function due to a fall in production costs (for example, a decrease in the overnight inter-bank rate r) results in a new market equilibrium. Housing loan interest rates r_L^* decrease with a fall in funding costs r, and total housing credit L^* rises.

Subsequently, we can evaluate how the relationship between r_L and r reacts to different levels of market concentration N. By computing the cross partial derivative with respect to r and N, we obtain

$$\frac{\partial r_L / \partial r}{\partial N} = \frac{1}{(N+1)^2} > 0$$

The impact on equilibrium interest rates of a given change in funding costs is larger in markets characterized by a higher number of competitors, which completely pass through the production cost variation to borrowers. This is illustrated in figure 1. MR_l represents the marginal revenue curve in a market with low concentration. Conversely, MR_h refers to

[9] This is considered as given since it is determined at equilibrium on the international capital market.

[10] The optimal loan rate is independent of the deposit market characteristics, and vice versa.

the marginal revenue curve for a highly concentrated market (low number of competitors N). As market structure approaches perfect competition D, the market price approaches marginal cost, reducing banks' markup. Thus, a larger part of the funding cost reduction is passed to households. A fall in funding costs would be perfectly transferred to prices in a competitive market. The higher the market power, the larger the effective markup and the lower the pass-through of monetary policy into the household sector.

Using this simple theoretical framework, this paper aims to shed light on the transmission mechanism from monetary policy to interest rates. More importantly, it provides some intuitive evidence about the role of market competition in this process. As we have seen, changes in funding costs are imperfectly transferred to loan prices in areas with higher market concentration (low number of competitors). Depending on whether there exist heterogeneous levels of market concentration across counties in France, we would expect to find important inequalities in interest rates across the territory. Furthermore, we would expect an unequal pass-through of monetary policy into the housing credit market due to competition structures. These are the main hypotheses tested in the current paper.

3 Data

In order to asses this question, we use two data sets from the Bank of France.

New housing loans to households: This source lists, line by line, new credit transactions with customers concluded during the period 2012 to 2018 in France by commercial banks operating in the French territory. Each new transaction is reported individually, and they are classified according to the customer category: households, non-financial institutions, entrepreneurs or public administrations. Registered credit transactions take place during a reduced time window in each quarter[11] such that this database represents a sample of the whole production of credit. As a consequence, it does not allow the computation of aggregated figures of credit volume granted in a given quarter. This is important because we are not able to measure credit inflows at bank-location level, which impedes the analysis of quantities as a variable of interest. Nevertheless, the data is representative of the entire quarter in terms of loan characteristics, which is valuable for our analysis of interest rates[12].

The register includes exhaustive loan-level characteristics such as interest rate, loan size, type of interest rate, maturity and purpose of the loan. Moreover, banks declare the annual income of the household as part of the criteria to agreeing the loan. Subsidized loans are not included in the data. Interestingly, the data is provided by *guichet*[13], which allows iden-

[11] It is generally around one week, but this time window varies from quarter to quarter.

[12] This data set is used by the central bank to compute quarterly usury rates in the country. This reinforces the belief of the good representativeness of the data in terms of loan characteristics.

[13] French *guichet* are equivalent to agencies.

tification of the French department where the agencies are located. This feature enables the analysis to take a geographic perspective. Importantly, we do not distinguish between bank location and household's department of residence. We concentrate on the bank's geographic location because we want to identify supply disparities, and we assume that the majority of the demand has a local origin.

Total volumes of housing credit to households: Financial institutions provide the Bank of France with the outstanding amount of deposits and loans of the agencies in their network every month. Subsequently, the central bank statistics bureau aggregates this information by parent bank and department, and makes it available to researchers. Hence, we obtain a bank–department database with information on total volumes of outstanding housing credit to households[14]. This information will be used to measure local market structure.

Both sources of data are merged by bank and department, such that all *guichet* of a bank in a given geographic area are assigned the total credit volume of the bank in this department. Thus, we observe banks that operate in several departments in the same period. This data structure allows exploitation of cross-county heterogeneity within banks, which is a clear advantage of this database. This represents a contribution compared with Scharfstein and Sunderam (2016). Although information about new loans is available at the municipality level, the quantity of data by bank and municipality is not statistically sufficient to provide this level of analysis. Much more exhaustive data would be needed for this level of detailed evaluation[15]. Moreover, total volumes of housing credit are uniquely available at the level of department. Hence, this study focuses on the bank–department level, which is the most disaggregated geographic stratum at which we can measure market structure and interest rates. This is a limit of the analysis and provides a path of improvement for future research.

For the purpose of this paper, we restrict the sample to generalist bank[16] transactions agreed to households for housing purchases in the French metropolitan territory. The Banque Postale group is excluded from the analysis due to the bad reporting of geographic refer-

[14]It is important to distinguish between outstanding credit (*encours totaux*) and volumes of new housing credit by quarter. The latter would represent quarterly inflows of credit, which is not an information we observe in our data set. Computing differences in outstanding volumes over time may be considered an alternative for the lack of quarterly volume production. Nevertheless, this is given by the sum of inflows and outflows of the quarter, which results from loans reaching their natural end, being partially or totally repaid and refinanced (outflows), versus new loan relationships (inflows). Since we know that renegotiation behaviour and wealth distribution is importantly heterogeneous across the territory, this cannot be viewed as a measure of quarterly production of loans, and using it as such is not considered an adequate exercise.

[15]In particular, a full daily register of new loans would be required, avoiding the limits resulting from the reduced sampling period established by the Bank of France.

[16]Specialist banks cannot be included, because they are not obliged to declare the geographic location of the agency of the credit agreement. As a result, very few of them reveal this information. Generalist banks represent 70% of the initial total sample of housing loans.

ences[17]. Groupe BPCE is underrepresented in this study[18]. This may be an important shortcoming of our analysis since this group holds 27% of all housing loans in France according to the ACPR (2017), and importantly, it is a mutualist bank (setting regional strategies), contributing to the mechanism of interest rate differentials assessed in this paper. Excluding this bank may hide part of the current mechanism[19].

Finally, banks are treated at CIB (*code interbancaire* or bank ID) level during the entire analysis. For example, Credit du Nord Ile-de-France, Banque Tarneaud and Societé Marseillaise de Crédit have their own bank ID (CIB) and are exploited separately in this paper; nevertheless, they all belong to the same single group[20]. Under these criteria, we obtain a total sample of almost 200,000 observations for the period 2012–2018.

Monetary policy action: In normal times, the policy rate estimated in term structure models coincides with the overnight rate of the inter-bank market, the Euro Overnight Index Average (EONIA). For this reason, EONIA is widely used as an indicator of monetary policy action. This paper uses shadow policy rates from Wu and Xia (2017)[21] as an indicator of monetary policy activity. The shadow rate is the shortest maturity rate, extracted from a term structure model, that would generate the observed yield curve[22] if the effective lower bound were not binding (Kim and Singleton (2012); Christensen and Rudebusch (2016)). It accounts for the effect of direct and indirect market intervention on all maturity rates. This indicator coincides with the policy rate in normal times, and deviates into negative territory when the policy rate is trapped at its lower bound, and unconventional tools are implemented[23]. As a result, shadow policy rates are widely used as convenient indicators of the array of both conventional and unconventional policies (Krippner (2013); Wu and Xia (2017)).

For our purpose, shadow rates will be interpreted and used in the same way as classic indicators of monetary policy are in normal periods. Additionally, using shadow rates is very important for us, since classic policy rates in our period of study are predominantly stuck in the lower bound. This would, importantly, limit the time variation of the indicator, generating significant computational problems for traditional estimation techniques. Moreover, substantial unconventional accommodation takes place during the same period.

[17] This bank represents only 1.7% of the total housing credit market and declares all loans in a single *guichet* in Paris.

[18] We observe only 10% of their agency locations.

[19] Although Groupe BPCE is mostly missing in the first data source (new housing loans to households), it is fully included in the second one (total volumes of housing credit to households). Subsequently, there is no bias in the measure of concentration.

[20] Robustness tests are presented at group level in section 6.

[21] Updated data is made available on their website (https://sites.google.com/view/jingcynthiawu/shadow-rates?authuser=0).

[22] The yield curve is the curve that relates each maturity to corresponding bank rates or bond yields.

[23] See Claus, Claus, and Krippner (2014), Francis, Jackson, and Owyang (2020) and Van Zandweghe (2015) for evidence.

Other data: Importantly, we need information on other housing demand factors, which subsequently are considered housing credit shifters. This is important for estimation of the reduced form of housing credit. Data on population structure and unemployment rates comes from the INSEE[24]. Information on temporary contracts is retrieved from the Bank of France registers. Additionally, we use information about the timing of implementation of DMTO (*Droits de Mutation à Titre Onéreux*) tax reform for each department, which is obtained from the Direction Générale des Finances Publiques. The DMTO is the tax that a buyer must pay when acquiring an old house or apartment. Each department applies a rate that must be lower or equal to a certain ceiling rate. Reform of the ceiling rate took place in 2014, and departments implemented the tax reform heterogeneously after this date Bérard and Trannoy (2018). We use the timing of its implementation as a control of the expected change in housing demand around the date of implementation, as it is observed in Bérard and Trannoy (ibid.). This is important because it certainly drove changes in credit demand behaviour.

3.1 Geographic inequalities in interest rates

Financial institutions act as intermediaries between consumers and suppliers of funds. As intermediary institutions, they face time-asymmetric demands for loans and supplies of deposits. Thus, they may be in a position of having a deposits surplus, which is invested in the inter-bank market. In contrast, they may ask for funding on the money market when they face an excess of loan demand. An additional instrument of funding to cover credit needs is the issuance of corporate bonds and funding from the ECB. Hence, banks' interest rates depend on the funding costs environment, other production costs and the spread charged to their customers. Other important business costs are operational costs and the number of agencies in the field. Importantly, the interest rate margin of banks depends on the state of competition (as explained in section 2) and other factors such as business strategy. Both elements, importantly, vary by geographic area, which partly explains the existence of interest rate inequalities across the country.

The housing credit system in France is formed by two types of financial institution: mutual banks, such as Crédit Agricole and Crédit Mutuelle, and the so-called national banks, such as BNP Paribas and Societé Generale. The latter are characterized by a corporate strategy agreed at the national level and applied equally to all partner agencies. Mutualist banks, in contrast, decide their objectives and take action at the regional level, even if they all belong to a consolidated banking group. This has important consequences for the way financial institutions deal with local credit market structures. While mutual banks are autonomous in setting their interest rates and can aggressively adapt their rates to competition exposure, national banks must follow common guidelines. In practice, we expect

[24]French national bureau of statistics.

to find important geographic disparities in interest rates within mutual banks, but slight differences among national financial institutions. This is important since the French mutual groups (Crédit Agricole, Groupe BPCE and Crédit Mutuelle) held around 75% of outstanding housing loans in 2017 (ACPR (2017)).

Furthermore, local commercial objectives fixed by banks have important consequences for setting interest rates. For example, a regional bank that does not reach its budget for housing credit by the end of the year will be tempted to reduce its margin to accelerate the production of loans. Conversely, in geographic areas where demand remains strong, banks will rarely carry out such an adjustment. This is particularly true in the case of housing credit, since it remains a major way to capture long-term clients.

In 2012, the median interest rate for new housing loans in France was close to 4%[25]. A continuous decrease occurred in subsequent years, until 2017, when the ECB expansionary issued its monetary policy. Then, in 2018, it stabilized at around 1.6% (figure 2). This trend is similar for all departments in France. Nevertheless, important heterogeneity is observed in levels across geographic areas during the entire period, as shown in figure 2. Figure 3 shows the mean interest rate of all new housing loans granted to French households in the last quarter of 2018 by department. We observe heterogeneous levels of interest rates across the French territory, with a department standard deviation[26] of 0.07, and a within-department standard deviation[27] of 0.32. This suggests that there exists an important within-department heterogeneity that is higher than between-department differences on average. Nevertheless, differences across geographic areas are substantial and significant, as shown in figure 4. The minimum level is found in the Cantal department, with a mean interest rate of 1.07%. In contrast, the Gers department presents the highest mean rate, at 1.84%. Hence, there is a 77 bps of difference between the two. These values are computed using loan-level data, and no differentiation is made by type of loan. Hence, these values partly capture differences in loan characteristics in our sample within and across geographic areas. This probably explains the existence of outliers, which may be driven by particularly short maturities or other loan characteristics.

In light of this evidence, I attempt to understand and identify the underlying forces explaining geographic inequalities of interest rates for housing loans in France in the period in question. In particular, I consider the role played by market competition.

[25] All loans together. Interest rate net of fees.

[26] First, we compute the mean interest rate of all new housing loans for each department using loan-level disaggregated rates. Then, we compute the standard deviation of the departments sample.

[27] First, we compute the standard deviation for each department using loan-level rates. This is then averaged across departments

3.2 Housing credit market concentration

As predicted by the standard theory of market equilibrium under imperfect competition, presented in section 2, we expect the degree of concentration in the credit market to which a certain bank is exposed to be an important determinant of interest rates (Demirgüç-Kunt and Huizinga (1999); Maudos and De Guevara (2004); Dietrich, Wanzenried, and Cole (2015)). Banks may be forced to reduce their spreads in very competitive markets to capture clients, whereas banks in highly concentrated markets may have no incentive to reduce their margins to keep their position. Hence, we expect a bank operating in different markets to charge different interest rates on housing loans, depending on the level of concentration to which the bank is exposed. This may imply the existence of local markets and may create important inequalities across the territory in terms of loan pricing.

Thanks to the disaggregated structure of the data, we can compute the market share of each bank in each department, followed by a credit concentration index for the given geographic area. In particular, we compute the market-structure measure of competition Herfindahl–Hirschman Index (HHI):

$$HHI_{dt} = \sum_{j=1}^{J} s_{jdt}^2$$

where market share s refers to the volume of housing loans of bank j over the total volume of housing loans in department d in period t. This is between 0 and 10,000,[28] where 0 is a situation of perfect competition (low concentration) and 10,000 a perfect monopoly with a single bank operating in the market (high concentration).

We observe an important heterogeneity in competition across the territory and over time[29]. Concentration in the housing credit market changed substantially between 2012 and today; 77% of French departments have seen their situation evolve towards a more concentrated credit market (figures 5 and 6). Remarkably, 25% of them increased by more than 15% during this period. For example, Haute-Vienne county increased its housing credit concentration by 35% during the period of study, while the Drôme and Loiret departments remained stable. Geographic areas enjoying an evolution towards competition are those with important economic and demographic development, for which we observe important growth in house prices in recent years. For instance, Bas-Rhin became more than 15% more competitive, probably driven by the evolution in economic activity around Strasbourg. This evidence is in line with the general disappearance and absorption of less competitive banks in the context of extremely low monetary policy rates.

[28] This is normalized in the empirical section 5.1 to be interpreted in terms of standard deviations.

[29] Detailed figures on ranking and growth are presented in (appendix) figure **??**.

In terms of ranking, Paris is the most competitive county in France, while Cantal shows the highest concentration index according to the HHI. As may be expected, departments with large cities, such as Lyon (Rhône), Toulouse (Haute-Garonne), Lille (Nord) and Bordeaux (Gironde), which are economically attractive, are those with high levels of credit competition.

Figure 7 shows a plot of within-bank time deviations from the mean rate and concentration (HHI) for a reference loan type (less than 100,000, 15–19 years of maturity fixed-rate loan). This suggests the existence of a positive correlation between concentration and interest rates, raising important questions about interest rate inequalities and the transmission of monetary policy to households.

3.3 Loan characteristics heterogeneity

An important issue to account for in this study is that loans are differentiated goods. They are priced according to their attributes. This represents a particular difficulty in this paper since we expect to find substantial differences in terms of loan characteristics across France.

The average interest rate of new housing loans varies by loan maturity and type of loan, among others. Loans of 25 years maturity or more have, on average, 0.5 percentage points (pp) higher interest rates than those of 10–14 years (figure 8). Banks allocate higher rates to longer loans to protect themselves from future uncertainty, since their visibility of long-term events decreases with loan length. Similarly, fixed-rate loans have more expensive interest rates than adjustable-rate loans, the latter having a mean rate 0.25 pp lower than the former (figure 9). For the same reason, adjustable rates are designed to vary with economic changes such as monetary policy, so that there is no need to compensate in advance for future changes that may affect interest rates. However, fixed-rate loans need to cover for discounted future rates, which depend on future events and become more uncertain as the loan period lengthens.

The decreasing trend of interest rates, along with the persistence of low interest rates in recent years, greatly increased the purchasing power of French households. The latter substantially encouraged housing demand and resulted in a record of more than 1 million housing transactions in 2019. Hence, we observe a rise in the volume of total housing credit during the period of study. The stock of outstanding loans to individuals increased continuously in the last years (figure 10). It grew by 6% in 2017, compared with 4% in 2016. The attractiveness of lending conditions in recent years have supported a sharp upturn in real estate prices. In particular, we observe an increase of 9% between 2014 and 2019, according to the Notaires de France (Notaries of France). This certainly explains why the average loan amount in France continued to rise during this period, reaching an average size of €160,000 by the end of 2017. However, there exist important disparities in house price trends across geographic areas. According to the Notaires de France, in 2019, Paris and Lyon showed growth of 6.1% and 10%, respectively, compared with 4% on average in France. Thus, the increase in the average loan amount is particularly concentrated in large cities areas and Ile-de-France (where house prices show the highest levels), which account for 25% of total new loans in the country (ACPR, 2018). Because of the heterogeneous panorama of house prices over the French territory (figure 11), we can expect important differences in terms of loan size too.

Even though adjustable and fixed-rate loans[30] are granted in the credit market, France has one of the highest shares of fixed rates on housing loans in the euro area: 97.9% of new housing loans were fixed-rate during the period of study. This pattern was fairly heterogeneous across French departments before 2015 (figure 12). As shown in figure 13, at this time, a substantial wave of loans were renegotiated, and importantly, floating rates decreased in favour of more advantageous fixed rates. Thus, outstanding loans make up 93.2% of all loans, a legacy of the pre-crisis trend towards adjustable rates (ACPR, 2018). In France, the typical initial period of fixation is greater than 10 years, with more than 77% of new housing loans belonging to this category. This means that borrower and lender agree to contract a loan in which the interest rate is fixed for at least 10 years, followed by a period of variable rates until the end of the loan maturity. The most common reference index for variable-rate loans is the EURIBOR (70% of them between 2012 and 2018), and more than 70% are capped-rate loans (ACPR (2017)).

The average maturity decreased between 2008 and 2015, being 20 years by the beginning of the financial crisis, and 18 years by the end of 2015. It then started increasing to 19 years by the end of 2018. In contrast to the pre-crisis period, the rise in house prices has been reflected in loan size rather than in maturity, and seems today to have reached an upper bound. Banks rarely declare loans with maturities over 25 years, which seem to be specifically offered to young first-time buyers. Furthermore, we observe important discrepancies across French departments (figure 14).

In view of these substantial geographic heterogeneities in loan characteristics, we need to be sure about the equivalence of products across local markets. We look at this issue in the next section.

4 Hedonic interest rate

Rosen (1974) examined an empirical methodology to estimate demand and supply functions in an environment of differentiated goods. The model is based on the hypothesis that products are valued for their utility-bearing attributes, which is the base hypothesis of hedonic theory. This seems a suitable frame for the analysis of credit markets and was first theorized in this context by Baltensperger (1976). Baltensperger questioned the assumption of price taking previously assumed in credit models, and concluded that every borrower,

[30]Loans with adjustable interest rates have a maximum fixed period of one year. Loans with a fixed period greater than one year are considered fixed-rate loans.

however small and insignificant relative to the market as a whole, knows that a change in his/her creditworthiness and loan features will change his/her risk of default and therefore the "quality" of the loan. Thus, loans are priced according to the borrower's profile and the loan's characteristics, agreed simultaneously between lender and borrower. As a result, hedonic interest rates are represented as

$$r(z) = r(z_1, z_2, ..., z_k)$$

where z represents the vector of k objectively measured loan characteristics. The function $r(z)$ is determined at market equilibrium, where the amount of commodities offered by sellers equals the amount of commodities demanded by buyers in a given credit market. According to Baltensperger's model, market clearing interest rates are determined by the distributions of consumer tastes and producer costs.

The first aim of applying hedonic models in this paper is to determine how interest rates vary with the set of loan attributes. Secondly, we predict the price of a constant-quality loan type for each bank, French department and quarter in the sample. Thus, we can evaluate interest rate disparities that are not driven by loan attributes. This strategy allows us to treat loan characteristics heterogeneity across departments and be able to compare twin loans.

4.1 Estimation and prediction

Following the standard hedonic literature, we first estimate the loan price function $r(z)$. The loan price or interest rate r is defined as the interest rate net of fees (*TESE, Taux Effectif Sens Etroit*) for loan i agreed by bank j in department d at quarter t. It is used as the main indicator throughout this paper. The price function estimation consists of the loan interest rate regressed on intrinsic characteristics z as follows:

$$log(r_{ijdt}) = \gamma_0 + \gamma_1 z_{ijdt} + \gamma_{jdt} + \upsilon_{ijdt} \tag{1}$$

where z includes the following explanatory variables: loan size, maturity, the type of interest rate, a dummy indicator for renegotiated loans, the type of loan project (investment or occupancy) and a binary indicator for the age of the dwelling. We additionally include the level of annual income of the household and assume that all families have a stable work profile as they have been granted a loan[31]. All characteristics are observed at the origination of the loan i, which is known to be agreed by bank j, in a county d, at quarter t. The vector of coefficients γ_1 represent what hedonic theory calls implicit marginal prices. Since all explanatory variables are specified as categorical variables, the constant term γ_0 is interpreted as the mean interest rate of the reference loan in the bank, department and quarter

[31] Having a permanent contract is a major requirement to be accepted by insurance companies. This is a mandatory requirement to be granted a housing loan, whether you are secured by an insurance guarantee or mortgage.

of reference. Finally, γ_{jdt} are bank–department–time fixed effects. This vector of coefficients represent the deviations of each bank–department–quarter mean from the reference group γ_0. Additionally, standard errors are clustered at bank level.

Following general hedonic literature, we specify a semi-logarithmic functional form. This allows interpretation of the estimation coefficients in a standard way, in contrast to the alternative Box–Cox model used in hedonic studies[32].

Subsequently, we predict the hedonic interest rate $\overline{r}_{jdt}$. This is the expected value of the loan price evaluated at the amounts of loan characteristics z of the reference loan:

$$\mathbb{E}(r_{ijdt}/z_{ijdt}) = e^{\hat{\gamma_0}+\hat{\gamma_1}z_{ijdt}+\hat{\gamma_{jdt}}}$$
$$\mathbb{E}(r_{ijdt}/z_{ijdt}=0) = e^{\hat{\gamma_0}+\hat{\gamma_{jdt}}} = \overline{r}_{jdt}$$

The reference loan is defined to be valued at the most frequent category in the distribution of each explanatory variable, presented in the last column of table 1. Hence, we choose a loan size lower than €100,000, between 15 and 19 years of maturity, fixed rate, non-renegotiated loan, granted to a household with an annual income between €30,000 and €100,000, allocating the housing credit to the purchase of an old dwelling as residence. This strategy provides us with a predicted interest rate $\overline{r}_{jdt}$, for a constant-attributes loan ($z_{ijdt}=0$), which varies according to the lender, location and time, which we commonly refer to as hedonic price. In other words, we obtain twin loans in terms of characteristics that differ only by bank, geography and the time they were granted. This is very important for the identification of loan price differentials due to factors other than loan attributes and borrower risk profile, since we know that loan characteristics are heterogeneous across France. The remaining disparities in interest rates across bank–department–time will be the heterogeneity source of the identification strategy in section 5.

Nevertheless, some of the loan characteristics are established simultaneously to interest rates, such that they are endogenously determined. Banks offer different combinations of rate, loan size, maturity and type of adjustment regime (adjustable or fixed) as a sort of package. Then, the borrower may negotiate the conditions and accept the preferred combination. Hence, the equilibrium package results from a simultaneous decision between several

[32] Since theory does not offer any particular guidance about the functional form of the equation defining $r(z)$, several studies allow the model to endogenously determine it, to fit the data properly. Hence, they first apply a Box and Cox (1964) transformation on the dependent variable r such that

$$r_{ijdt}(\rho) = \begin{cases} \frac{r_{ijdt}^{\rho}-1}{\rho} & if \quad \rho \neq 0 \\ ln(r_{ijdt}) & otherwisee \end{cases}$$

This method enables us to improve the explanatory power of the model dealing with heteroscedasticity and error distribution concerns. Nevertheless, the generalized version as a log transformation gives equivalent results and allows simpler interpretation. Thus, log estimations are applied extensively in hedonic models (see Cropper, Deck, and McConnell (1988) and Rasmussen and Zuehlke (1990) for further discussion on this issue).

attributes. Estimating the interest rate using these characteristics may create important bias problems, which would affect the predicted rate and be difficult to solve. The traditional method of solving endogeneity issues is to use instrumental variables. This method requires access to a variable (called an instrument) that is correlated with the endogenous variable, but uncorrelated with any other determinants of the dependent variable. Several instruments may be considered adequate instrumental variable candidates in our analysis, according to the general processes determining our variables of interest. In particular, house prices, savings, risk aversion or expectations about future interest rates do play a role in explaining loan size, maturity and the type of adjustment schedule of a loan. Nevertheless, most of these variables are unobserved in our data, and furthermore, they may not respect the exclusion restriction necessary for a good independent variable strategy. House price results from an endogenous formation process, along with credit conditions. Macroeconomic models proved this issue to be particularly difficult to solve (Cloyne et al. (2019)), and therefore, house prices cannot be considered adequate instrumental variables for loan size and maturity, since house prices are not independent of interest rate outcomes. Expectations, risk aversion and savings are not observed in our data. Moreover, the exogeneity of savings at credit origination may be questionable since its level may be, and probably is, dependent on the previously made tenure choice, which, importantly, depends on credit conditions.

Since no adequate available instrumental variable candidate has been found, and to account for this issue, I propose to compare the estimation of equation 1 (hereafter, the "benchmark") with a consistent alternative. This alternative restricts the sample to the most common loan package: a fixed-rate loan of less than 100,000 with a maturity of 15–19 years, which coincides with the reference categories of the benchmark estimation. Subsequently, we estimate the standard price function equation with the remaining regressors. This strategy avoids the endogeneity problem and estimates an unbiased hedonic interest rate for the loan of reference. Then, we can evaluate the importance of the bias in the benchmark estimation by running some significance tests. If the benchmark hedonic rate prediction results as being unbiased, it will be treated as the preferred model. This will boost inference power in our subsequent analysis, since the consistent estimator is restricted to a particular type of loan, which greatly reduces the estimation sample. This would result in a significantly lower number of bank–department–quarters with predicted hedonic interest rates compared with the benchmark estimator.

4.2 Results

Results of the loan price function estimation are presented in table 1. The first column shows an estimation of equation 1 with only fixed effects. The second column shows results for the benchmark estimation, and the consistent alternative is presented in column 3. The fourth and last columns show the distributions of each explanatory variable. Importantly, fixed effects do explain a major part of interest rates heterogeneity when they are the unique regressors (73% of the total variability). This suggests that most of the loan price heterogeneity comes from the lender-geography perspective, as well as the evolution of interest rates over time. However, due to important disparities in the housing market, particularly in house prices, we expect fixed effects to capture differences in credit characteristics across the French geography. Moreover, we expect to explain within-bank–department–time heterogeneity by loan-type diversity. Unsurprisingly, including the entire set of loan attributes increases the explanatory power up to 85%, which is similar in both benchmark and consistent estimators. The remaining unexplained variance may be related to agency level features, or other borrower unobserved information such as total wealth, or other ongoing debts. This can be seen as a weakness of our interest rate measure since the general literature uses interest rates from banks' official schedules. While this has clear advantages for interest rates analysis because it avoids all noise related to unobserved household features, it also obviates the existence of bargaining markups.

Regarding estimated marginal prices, we find a significant gradient of interest rates in loan maturity. For instance, loans with 25 years or longer maturity present, on average, 22% higher interest rates than loans between 15 and 19 years, once we control for bank, department and time differences. Similarly, adjustable rates are priced with 16% lower rates on average compared with fixed-rate loans. As expected, financial institutions protect themselves from future uncertainty, which increases with loan length; they also compensate for their exposure to economic changes that do not affect fixed-rate loans. According to economic intuition, we would expect the loan price to increase with the amount of exposure to exogenous risks (loan size). However, larger loans seem to be cheaper than smaller loans, on average. The difference is small but significant at 1%. Interestingly, we find evidence that renegotiated loans are priced with 25% higher rates than regular new loans during the period of study. Starting a relationship with another bank leads to associated searching and moving costs for ongoing borrowers. Banks are aware of this fact and take advantage of it in the renegotiation process. As our evidence suggests, the expected transaction costs of joining a new bank seem to be, at least partly, compensated by the foster financial institution, which charges higher interest rates to their current clients.

Moreover, we observe a significant small difference in interest rates between purchases of new and old housing. One explanation may be that financial institutions anticipate a household's access to subsidized loans offered by the government to complement former housing credit. One of the most popular French housing policies consists of zero interest loans for new housing purchases under some income conditions. Moreover, housing loans devoted to investment projects do seem to be perceived as riskier projects by the lender, such that they present slightly higher interest rates on average. Finally, the borrower risk profile plays a marginal role in loan pricing. The differential is significant, but the magnitude remains minor. Households with the highest income present interest rates only 6% lower than those in the middle income category. This may be because, once households have passed the insurance requirements, financial institutions consider them sufficiently safe, and the level of income is not considered a major determinant of their risk profile.

The consistent estimation in column 3 leads to similar interpretations. Moreover, the hedonic interest rate estimated by the two models have a correlation of 0.98. Their distributions are presented in figure 15. A comparative test is run in which the null hypothesis states that the hedonic interest rate predicted by the benchmark model is equivalent to the one predicted by the consistent estimation ($H_0 : \bar{r}^B_{jdt} = \bar{r}^C_{jdt}$). No evidence is found to reject the null hypotheses. This suggests that the potential endogeneity problem due to the simultaneous determination of price, loan size, maturity and type of rate is a minor issue in this analysis. We therefore continue the analysis, using the benchmark prediction of the hedonic interest rate $\bar{r}^B_{jdt}$, which provides a substantially larger number of observations. This is important to ensure higher inference power in subsequent steps. Estimations are presented with the alternative hedonic price for robustness.

Lastly, the benchmark model assumes a temporal and geographic homogeneity in estimated marginal prices. The existence of significant differences in marginal prices between groups could mislead the model's estimation of hedonic interest rates. Creating different models for each department and quarter is not possible, given the number of observations, and including interactions would be too statistically demanding. Nevertheless, year and regional evidence is provided in appendix B. The evidence shows that differences are minor in magnitude and often not significant. Moreover, adding these features does not improve the explanatory power of the model. In light of this evidence, it is not necessary to include interaction terms in the benchmark model used in the main analysis.

Hedonic interest rates are presented in figures 16 and 17. We still observe important variation over time and between French departments, regardless of the period of time. This is important for the identification strategy of the subsequent analysis, which relies on within-bank–time variation across departments.

5 Demand and supply of housing credit: reduced form

This section attempts to estimate a general reduced form equation resulting from the standard supply and demand problem applied to an oligopolistic market following Bresnahan (1982). The system of market equations to be estimated is

$$r = D(Q, X^D)$$
$$r = C(Q, X^S) - \lambda h(Q, X^D)$$

where r and Q are jointly determined dependent variables. D represents the typical reverse demand function, C the marginal cost function and λh a markup element resulting from imperfect market competition. In particular, λ is a parameter indexing the degree of market power and $r + \lambda h$ the marginal revenue function from the oligopoly solution[33]. In the case

[33] We can interpret $r + \lambda h$ as the marginal revenue as internalized by the banks in a market with some degree of market concentration.

of $\lambda = 0$, the system of structural equations is equivalent to a perfect competition problem, and $\lambda = 1$ is equivalent to the case of perfect cartel or monopoly (see appendix A for detailed derivation of the supply structural equations). X^D and X^S are vectors of credit demand and supply exogenous shift variables, respectively.

Estimation of the supply and demand equations presents largely known simultaneity problems. This, importantly, makes it more difficult to identify the system. To avoid this issue, we follow previous literature and estimate the classic reduced form, assuming some degree of market competition (Scharfstein and Sunderam (2016)). Thus, we do not face any simultaneity problem, and we can apply classic panel estimation techniques.

5.1 Panel estimation

Geographic differential in pricing loans

We estimate a standard reduced form equation through the following panel regression:

$$\bar{r}_{jdt} = \beta_0 + \beta_1 HHI_{dt-1} + \beta_2 R_{t-1} + \beta_3 X^D_{dt-1} + \alpha_{jt} + \alpha_d + e_{jdt} \tag{2}$$

where $\bar{r}_{jdt}$ is the hedonic interest rate estimated in section 4, which varies across bank j, department d and time t.[34]. The reduced form equation contains several credit supply and demand factors, as specified in the original system of market equations[35] Demand shifters X^D are the exogenous variables: unemployment rate, percentage of contracts that are temporary, percentage of population that is 20–39 years old, and a dummy variable equal to 1 from the quarter in which the DMTO tax regime changed. These variables represent the exogenous demand sources of variation in our analysis, and we expect them to explain changes in housing credit demand. They are all specified at county level d with time variation.

R_{t-1} represents the classic supply shifter, presented in the theoretical section 2 as the funding cost of an extra euro in the inter-bank market. As proxy, we use the previously presented monetary policy rate indicator called the shadow rate, which varies quarterly. We recall that this variable represents the level at which the interest rate in the inter-bank market should have been in order to have the same effect on the economy as the array of monetary policies carried out by the ECB. Thus, it represents both conventional and non-conventional tools that play a role in the cost of funding of banks at different maturities. This is important because the present study covers a period of time in which the overnight rate (EONIA) does not significantly vary. The ECB action is mainly dependent on non-conventional tools that principally affect the cost of longer-term financing sources. Hence, this is a key variable for identification of the link between current monetary policy action and loan price changes.

[34]Recall that this is the interest rate predicted for a standard loan: an amount less than €100,000, between 15 and 19 years of maturity, fixed rate, non-renegotiated loan, granted to a household with an annual income between €30,000 and €100,000, allocating the housing credit to the purchase of an old dwelling as residence.

[35]Implicitly, the credit volume is the variable used to constitute the single equation from the initial equilibrium system.

Notably, it is a national level series with no geographic variability. This is important for the specification of fixed effects in the reduced form model, since we need to allow enough time variation within our specification to be able to estimate its coefficient.

HHI_{dt-1} is the concentration level at which banks are exposed in department d in a given quarter, and represents the markup element displayed in classic oligopoly models (market power structure). This is the main variable of interest in the estimation of equation 2. It allows identification of the housing loans pricing differential (β_1) practised by banks due to local market structure disparities. As defined earlier, this indicator refers to the classic HHI[36], which is between 0 and 10,000. Likewise, we recall that a high HHI means low competition in the local market. For the sake of interpretation, we normalize it in terms of standard deviations[37]. Thus, one additional unit of HHI in our estimation represents 1 standard deviation, which is, on average, 525 units of the original HHI value. Even though this measure of concentration is probably not a perfect indicator of the local competition structure, it is our most disaggregated available measure. Intrinsically, we assume that department credit activity is independent and that market formation is formed locally within departments. This statement may be called into question in geographic areas such as Île-de-France, where Paris and border departments are, in practice, geographically non-differentiated. This may imply that credit information crosses the lines and that households from neighbouring departments may be tempted to cross the border to borrow. In that case, the independence hypothesis would be violated. This issue is further discussed in section 6, where some robustness tests are proposed and other alternative proxies of concentration are presented.

Additionally, we include department fixed effects α_d to control for all latent department particularities that may play a role in interest rates. All variables are defined in levels at $t-1$ to avoid reverse-causality issues. Equation 2 is specified at bank–department level (hereafter referred to as branch) over 25 quarters, which allows a panel estimation exploiting branch heterogeneity (between) and temporal variability (within). Descriptive statistics of the model variables are presented in table 2.

Identification strategy: Equation 2 includes year–bank fixed effects α_{jt}, to account for bank specificities over time that impact the setting of interest rates (for example, operational costs, corporate strategy or lending opportunities). Thanks to year–bank fixed effects

[36] In particular, we compute the market-structure measure of competition, the HHI:

$$HHI_{dt} = \sum_{j=1}^{J} s_{jdt}^2$$

where the market share s refers to the volume of housing loans of bank j over the total volume of housing loans in department d in period t. The HHI is between 0 and 10,000, where 0 is a situation of perfect competition (low concentration) and 10,000 is a perfect monopoly with a single bank operating in the market (high concentration).

[37] The normalization is carried out within-quarter, to account for the concentration structure changes over the period.

α_{jt}, we exploit within-bank–time heterogeneity across departments. Thus, we are able to isolate the local market structure effect on housing loan interest rates within banks. This is possible since we can observe banks operating in several geographic areas at the same time[38]. We restrict the sample to banks operating in at least two geographic areas, to identify the coefficient of interest, β_1. This identification strategy is also employed in Drechsler, Savov, and Schnabl (2017).

Heterogeneous transmission of monetary policy

According to standard oligopoly theory, interest rates should be more sensitive to monetary policy changes in less concentrated markets, where competition is higher. This mechanism is tested in our specification by estimating the classic reduced form equation in differences (Δ) and, importantly, including an interaction term as follows:

$$\Delta\overline{r}_{jdt} = \delta_0 + \delta_1 \Delta R_{t-1} * HHI_{dt-1} + \delta_2 \Delta R_{t-1} + \delta_3 HHI_{dt-1} + \delta_4 \Delta X^D_{dt} + \alpha_{jt} + \alpha_d + u_{jdt} \quad (3)$$

where $\Delta\overline{r}_{jdt}$ refers to the difference of the hedonic interest rate of branch jd from $t-1$ to t. All variables in differences in $t-1$ refer to the difference between $t-1$ and $t-2$. Here, δ_2 represents the average transmission of changes in monetary policy to the household housing sector, and δ_1 the average pass-through difference between local market competition levels. As previously, since we include bank–time specific fixed effects, we identify an effect that is exogenous to time-varying factors at bank level. Intuitively, we compare branches of the same bank at the same time and assess whether, after a change in the ECB monetary policy action, the bank's branches in more competitive departments adjust their housing loan rates more than the bank's branches in less competitive areas.

5.2 Results

Table 3 presents alternative estimations of equation 2. Column 1 includes only the main variables of interest. Column 2 additionally includes the fixed effects. Column 3 contains our preferred specification with the full set of controls and fixed effects. Priority is given to bank–year rather than bank–quarter fixed effects, to provide a minimum time variability in the model. This is necessary to estimate the coefficient of the shadow rates, which is time-varying at the national level. Including very restrictive time fixed effects would eliminate the time variability, avoiding estimation of this parameter due to multicollinearity. As a comparison, columns 4 and 5 provide versions with more restrictive time fixed effects, such that the remaining time variability is extremely reduced or non-existent, and the shadow rate coefficient cannot be estimated.

The results confirm the existence of significant interest rate inequalities across local markets due to concentration, even within branches of the same name. In particular, housing

[38]Some 90% of the sample of banks operate in at least two departments; 50% operate in four or more.

loans are 8.6 bps[39] more expensive in local markets with 1 standard deviation greater concentration. Hence, the interest rate is, on average, 32 bps lower in less concentrated departments (HHI in the bottom 10th percentile) than in highly concentrated departments (HHI above the 90th percentile). This result is important and highlights the existence of substantial inequalities in loan pricing in the housing financial system in France, explained by market frictions. Banks take advantage of their position of power in more concentrated markets by charging higher interest rates for identical loans and borrowers. This is particularly important since the most concentrated markets coincide with geographic regions with lower economic development and substantial depopulation. This finding raises questions about geographic financial inequalities in France and the direct implications for interest payments and borrowing capacity and, therefore, the indirect implications for housing purchasing power and consumption. How this is translated into wealth and consumption may be a major question of interest for future research[40].

This result is consistent with the theoretical intuition presented in section 2, and previous empirical evidence. Maudos and De Guevara (2004) found that market power, proxied by the Lerner index, affects the interest margin positively. In Corvoisier and Gropp (2002), the authors found that moving from a country with a moderately concentrated banking market (for example, Belgium) to a highly concentrated one (for example, the Netherlands) increases interest rates by 240 bps for mortgage loans. They estimate that increasing concentration in European countries has increased banks' margins by 100 to 200 bps.

Including controls, department and bank–year fixed effects in the estimation slightly decreases the magnitude of the differential from 10 to 8.6 bps. This suggests the existence of differences in banks' distribution over the French territory, as well as heterogeneity in terms of demand characteristics, which are correlated with the credit market structure. Nevertheless, including more restrictive bank–time fixed effects at quarter level importantly reduces the magnitude of the coefficient, even though it is still significant at 1%. This may be expected since we cancel out the remaining variability, and we would need a more disaggregated level of data to boost statistical power.

Additionally, interest rates rise significantly in the share of the population under 39 years old. This is explained by the expected higher housing demand in this age range, who are often first-time buyers. Furthermore, we expect them to finance the housing project through higher ratios of housing debt than older households, who may have accumulated wealth during their life cycle. Therefore, we expect higher credit need in areas and periods with more inhabitants in the age range of most first-time buyers. By contrast, the share of temporary contracts, and the unemployment rate, significantly decrease interest rates through the opposite reasoning. The higher the instability and precariousness of the population employ-

[39] All results are expressed in basis points, where 100 bps = 1 pp.

[40] This is in line with existing literature about the heterogeneous marginal propensity of households to consume, which seems to be higher for hand-to-mouth households (households with large spending commitments relative to their regular income and liquid assets).

ment situation, the lower the self-selection into home ownership and the greater the refusal of housing loans by banks. As expected, implementation of the housing purchase tax reform decreased interest rates on average, probably through a reduction of housing demand in subsequent quarters, as indicated by Bérard and Trannoy (2018), who estimated a drop in transactions of 4.6% over a period of ten months following the implementation date. Most of the controls lose their significance under the restrictive version of column 5 of table 3, which indicates that most of the variability in these variables comes from a temporal perspective rather than across geography.

Table 4 shows the results of equation 3. Column differences are equivalent to those of table 3. The third column shows that a 100 bps decrease in the shadow rate is associated with a 5 bps fall on average in housing loan rates during the period 2012–2018. This coefficient may seem small compared with previous literature[41]. Recall that other studies used direct measures of funding costs, such as overnight rates or mortgage-backed securities yields, which have direct effects on banks' funding costs and therefore on housing loan rates. Nevertheless, we exploit a proxy that accounts for the whole ECB monetary policy action (conventional and non-conventional tools), which hampers identification of direct effects (see Ampudia et al. (2018) for a discussion).

While the transmission channels remain the same, the strength of the pass-through may vary since unconventional monetary policy mainly impacts the long-term rates of banks' funding costs[42]. Additionally, we know from previous evidence that the transmission of monetary policy to loan rates is lower during periods of expansionary action (Gropp, Kok, and Lichtenberger (2014) and Levieuge, Sahuc, et al. (2020)). In particular, the ECB needs to decrease its policy rate further by 50% to 75% to obtain a comparable transmission to a positive shock. Furthermore, downward rigidity is even stronger when policy rates are stuck at their effective lower bound. Hence, a small coefficient may be expected and is in line with evidence of a mitigated direct impact of non-conventional tools during periods of small variation in marginal lending facility and deposit facility rates. Nevertheless, our result is significant at 0.1%. The period of study represents an important difficulty in this work, and further efforts should be made to quantify the direct transmission of conventional tools to the household housing sector in France, where we expect to find a substantial direct pass-through. However, our period of study does not allow further exploration of the issue in this paper.

Interestingly, the coefficient of the interaction implies that high concentration reduces the transmission of monetary policy to the household housing credit sector within banks. One standard deviation higher concentration reduces the pass-through of a 100 bps fall in the shadow rates on housing loan rates by 10% ($-0.005/0.05$). Intrinsically, the transmission of a 100 bps decline in monetary policy rates is 38% lower in highly concentrated French

[41] Drechsler, Savov, and Schnabl (2017) and Scharfstein and Sunderam (2016).

[42] The general literature shows that the indirect channel of non-conventional tools is relatively more powerful than the direct effect (Ampudia et al. (2018)).

departments (in the top 10% of HHI) than in highly competitive ones (in the bottom 10% of HHI). This result is significant at 5%. This implies that banks not only set higher interest rates depending on the competition structure of the local market in which they operate, but also, they decrease less the price charged to housing borrowers in periods of expansionary monetary policy in departments with higher concentration. This leads to a transmission gap of almost 40% between opposing market structure cases within the same bank. Even though the magnitude of this result in absolute terms is small, the relative difference in the pass-through of monetary policy action between departments is not negligible. Thus, further research must be conducted to prove the applicability of this result in periods of exclusive conventional ECB action. This result may be important for policy makers, since it suggests a heterogeneous transmission of monetary policy to households according to their location and may have redistributive income and wealth effects. In expansionary periods, households located in competitive geographic areas benefit more from decreasing capital costs than do households located in more concentrated departments, which are often rural areas with weaker economic activity. These results are in line with evidence from Gambacorta and Mistrulli (2014), who found that the lower the number of banks that have a business relationship with a given firm, the lower the increase in the firm's interest rate during a period of crisis. According to Scharfstein and Sunderam (2016), between 2000 and 2011 in the United States, 1 standard deviation more concentrated counties were 17% less sensitive to changes in mortgage-backed securities.

The results are robust to controlling for demand characteristics and implicit department specificities such as house price levels. Nevertheless, significance was lost when the most restrictive fixed effects were used in column 5 of table 3. This may be expected since the geographic disaggregation proposed in this analysis does not offer sufficient variability for inference power. To successfully estimate column 5 in tables 3 and 4, we need more disaggregated measures of market structure that enforce cross-section variability and, therefore, identification. Ideally, the possibility of computing concentration measures at municipality level would boost the within-bank–time heterogeneity. This remains an open research question for the future.

6 Robustness

6.1 Consolidated credit sector

As explained in section 2, the housing credit system is formed by two types of financial institution: mutual banks, such as Crédit Agricole and Crédit Mutuelle, and the so-called national banks, such as BNP Paribas and Societé Generale. The latter are characterized by a corporate strategy agreed at the national level and applied equally to all partner agencies. Mutual banks, in contrast, decide their objectives and their action at the regional level, even if they all belong to a consolidated banking group. This has important consequences for the way financial institutions deal with local credit market structures. While mutual banks are autonomous in setting their interest rates and can aggressively adapt their rates to competition exposure, national banks must follow common guidelines. In practice, we expect to find important geographic inequality in interest rates within mutual banks, but slight differences among national financial institutions.

The concentration measure exploited in our analysis is based on market shares at the bank level, assuming a strict independence between banks. Nevertheless, there exists important within-group coordination that cannot be ignored. Importantly, we expect banks to reduce their offensive action regarding interest rates if, along with surrounding financial institutions, they all belong to the same group. Hence, banks' perception of market competition can be different at a consolidated-banking level. Hence, it is important to check the robustness of our results to a market environment in which within-group interactions may impact local competition.

For this purpose, the empirical analysis presented in section 5 is replicated using consolidated measures instead of bank-level measures. In particular, market shares and concentration indicators are computed using aggregated volumes of credit at the banking group level. Consolidated values of HHI are presented in figures 26 and 27 of appendix C. As expected, the levels of market competition across geographic areas are substantially lower when we account for group relationships, and they importantly evolved during the period of study towards a more concentrated banking system. This suggests that large banking groups increased their market share in the last few years. The remaining explanatory variables are unchanged. This takes into account the possible within-group synergies and common strategies that could drive the setting of interest rates and local market structures.

The results shown in table 5 are significant and equivalent to our benchmark analysis, both in terms of interest rate geographic inequalities and the heterogeneous transmission of monetary policy to the household housing sector. In terms of magnitudes, the loans price differential due to market concentration structure is slightly lower when we measure competition at banking group level. The gap between departments in the top and bottom 10% of the concentration distribution is around 24.5 bps (versus 32 bps at non-consolidated banking level). This reinforces our benchmark specification and confirms that there are significant differences in interest rates between banks in the same group. Subsequently, the difference between the magnitude of the two estimations is in line with the existence of diverse within-group interest rate setting strategies, which are highlighted with more disaggregated controls, as in our benchmark specification.

6.2 Local credit markets

An important hypothesis of this paper is the formation of local credit markets within geographic areas that are independent of neighbouring markets. We assume that borrowers consider banking agencies in only a small geographic area around their location. The main reason for this assumption is the high information, communication and transactions costs associated with entering a new agency relationship conducted at a distance. Often, borrowers are not aware that they may be able to agree a cheaper loan in another geographic area. Moreover, travelling expenses and time required may be highly discouraging. Likewise, if a potential client looking for funding for an apartment in Limoges contacts a bank in the Bouches-du-Rhône department, the bank may invite the client to see a partner agency in the corresponding Haute-Vienne department. This is commonly known in the French banking system as the principle of territoriality. The only way to break this rule is through the contract of a third party, called a *courtier*, or broker. Nevertheless, this practice is limited and mainly exists in cases of bordering geographic areas.

We hold that the principle of territoriality applies to the country as a whole, except for Paris and the neighbouring departments of Seine-Saint-Denis, Val-de-Marne and Hauts-de-Seine. These are relatively small departments in terms of geographic extension compared with the rest of France. Moreover, these departments are bound to Paris, and in practice, the geographic separation between them and the capital is reduced to a street. In particular, daily life for the population is not limited by theoretical borders, and so household activity can take place around the many cities (and therefore departments) that surround their residence and work location. This is particularly true for households located close to several department borders, such as Saint Mandé in the Val-de-Marne department and Clichy in the Hauts-de-Seine department. In this case, we can assume that information asymmetries are reduced and transaction costs due to distance are non-existent due to the public transport network and proximity. For this reason, the geographic independence assumed in this exercise may be considered at risk.

To test the validity of our estimations, we propose a simple exercise in which we exclude Paris and neighbouring departments[43] from our estimation of the benchmark equations. The results for equations 2 and 3 are summarized in table 6. They are robust to previous evidence, both in terms of loan pricing differentials and monetary policy transmission. In both cases, magnitudes are equivalent, and we observe the same significance. This suggests that our main results were not biased by hypothesis inconsistency, and even if the Paris region can be considered a single credit market, the rest of the French territory is formed by multiple local independent markets that depend on their local competition structure. Ideally, this hypothesis should be tested among more disaggregated measures of market formation, such as city-level measures. However, current data sources do not allow this, and it remains an issue for future research.

[43] Seine-Saint-Denis, Val-de-Marne and Hauts-de-Seine.

6.3 Alternative concentration measure

The results presented in the previous sections were obtained using the classic measure of concentration, the HHI, following Drechsler, Savov, and Schnabl (2017). The pertinence of using the HHI indicator has been discussed in the literature due to its endogeneity to the economic development of the local market and its inability to capture complex structures of competition. In a recent paper, Cerasi, Chizzolini, and Ivaldi (2019) showed that the HHI is inadequate for analyses of banking mergers in a variety of situations. For example, increasing concentration as defined by the HHI may imply increasing competition in the case in which a single bank leads the local market with an important market share and other banks adapt residually to the leader. Here, the merger of two smaller banks increases competition by creating a sizeable rival in the market. The researchers proposed an interesting alternative measure of competition based on estimation of the elasticity of bank profits to branching size from a structural model of the banking industry. The tougher the competition, the smaller the expected gain from a network of a given number of branches. Thus, the elasticity of profits (called the cci[44]) with respect to an additional branch, all other things being equal, must be inversely correlated with the intensity of competition in that specific market (Cerasi, Chizzolini and Ivaldi, 2019). This measure represents a novel opportunity to improve the measurement of concentration since it accounts for entry and expected operating costs, as well as long-term profitability in a given market.

Unfortunately, whereas Cerasi, Chizzolini and Ivaldi make available the estimation of this indicator (cci) for every French department, I consider it to be inadequate for the present analysis. Their competition indicator is computed using 2007 banking data, whereas the present analysis studies the period 2012–2018. The changes taking place after the 2007–2008 financial crisis are particularly important for the housing finance system in Europe. Bank lending to households became more guarded, driven by the regulatory measures that took place during the following years. The approval of Basel III by Europe in 2010 substantially changed the structure of banks by establishing new rules of capital requirements. All the same, the main estimations of section 5.1 have been replicated using the data of Cerasi, Chizzolini, and Ivaldi (ibid.), but the results are not significant, as expected.

Ideally, a cci would be computed for our period of study using the number of branches of each bank in each local market over time. Nevertheless, this is not information that we observe in our data. To compute our concentration measure (HHI), we use total volumes of housing credit to households from the Bank of France, which covers regional activity in France. This data set does not have information on banks' branching networks. Computing the latter by bank and geographic area is not possible using the source of new loans granted by banks, since specialist branches, La Poste and Groupe BPCE are partially or totally missing their locations[45]. This remains an important limitation of this paper and opens the door to future improvements when recent data on banks' branching is made available for

[44] Comprehensive Concentration Index

[45] See section 3 for more details.

future research.

Nevertheless, other indicators are used in the literature to define market structure. Scharfstein and Sunderam (2016) used the sum of the market share of the four largest lenders in a geographic area as benchmark. In table 7, we test the robustness of our results to using this alternative concentration indicator. The results regarding inequalities of interest rates due to the existence of different local market structures are confirmed. Loans are priced with 10 bps higher rates in departments with 1 standard deviation higher concentration, as measured by the share of the four largest lenders. This implies a difference of 31 bps between departments in the bottom 10% and top 10% by concentration. This is consistent with our previous estimates of a 32 bps differential using the HHI. The results regarding the transmission of monetary policy are also in line with previous evidence. Nevertheless, we can observe a substantial loss of significance as controls and fixed effects are included, such that the heterogeneous pass-through is no longer identified. Increasing the period of study to have higher time variability in monetary policy indicators, and working with more disaggregated measures of competition, may be helpful for inference power. Unfortunately, this is not possible in the present work, and it remains an important axis to explore in future research.

6.4 Hedonic interest rate: consistency

Two important issues need to be tested concerning our measure of hedonic interest rates: first, the robustness of the results using the alternative consistent estimator in column 2 of table 1; second, the existence of possible inconsistencies regarding the use of the selected reference loan defined in section 4, which is treated in the next robustness section 6.5.

As previously discussed, there is a potential endogeneity bias in the prediction of hedonic interest rates when using the benchmark estimation. Even if robustness tests are reassuring in terms of the validity of the predicted term $\overline{r}^{B}_{jdt}$, I propose making an additional check. Equations 2 and 3 are estimated using the consistent prediction of hedonic interest rates $\overline{r}^{C}_{jdt}$, which results from the alternative estimation in column 2 of table 1. This indicator is exempt of endogeneity bias, since the estimation is restricted to a specific group of loans. Nevertheless, by restricting the sample, we substantially reduce the resulting number of predicted hedonic interest rates, which can, importantly, weaken the identification power. The results are presented in table 8, columns 1 and 2, and 5 and 6. As expected, inference power drops substantially due to the massive loss of observations in computing the consistent estimator, and results on the transmission of monetary policy, which are the most statistically demanding, are not identified. A more exhaustive data set is needed to apply this strategy and to ensure sufficient variability in the model. Nevertheless, the results on the existence of a significant gap in interest rates across departments with different local market structures are robust.

6.5 Hedonic interest rate: representation

Finally, one of the important contributions of this paper is the treatment of geographic heterogeneity in terms of loan features. Working with differentiated products can present important difficulties for identification if heterogeneity is not taken into account. The use of a hedonic approach has allowed us to overcome this obstacle by providing a price for an equivalent product in different areas and times and with different lenders. Subsequently, comparing how equivalent loans are priced across geographic areas allowed the identification of interest rate differentials in France. Nevertheless, the choice of this "equivalent loan" is particularly important. Although we selected the most common loan combination among our sample, some geographic areas may be underrepresented by this choice. In particular, we expect regions with high house prices to be concentrated in higher categories of loan size and maturity. For example, buying a 45 m^2 apartment in Paris requires around €530,000 on average (all transaction fees included)[46]. Assuming a generous 20% down-payment, Parisian borrowers still need a housing credit of more than €420,000. Thus, assuming a reference loan of around €100,000 could bias the hedonic rate predicted in these expensive areas.

We assess the distribution of each variable by department. The chosen reference categories represent the most frequent group for all departments in the following cases: type of rate (ref. fixed rate), type of loan (ref. non-renegotiated loan), type of dwelling (ref. old), type of project (ref. residence) and household income (ref. €30,000–100,000). As expected, we find important heterogeneity between geographic areas in terms of loan size and maturity of the loan, both variables being highly linked to house prices level.

Regarding the loan size, "lower than €100,000" is the largest category for 60% of the geographic areas, while for 40% of the departments, the most frequent loan is between €100,000 and €200,000. The largest group for each department represents between 30% and 80% of the within-department spectrum of loans, with an average share of 50%. In cases in which the reference loan (lower than €100,000) is not the most frequent type for a geographic area, the difference between the share of the two groups is lower than 15 bps in 75% of the departments. The relationship between the reference category and the largest group is shown in figure 18. Importantly, the share of the reference category (lower than €100,000) is considered to be substantial enough even in cases in which this group is not the most typical one. Nevertheless, the few cases in which it represents less than 25% of the loans could be considered low compared with the distribution[47]. This issue concerns the following three geographic areas: Paris (23%), Yvelines (24%) and Hauts-de-Seine (23%). This is particularly important for Hauts-de-Seine since the difference with the largest group share (€100,000–200,000) is 25 bps.

Similarly, we find differences between departments in terms of maturity representation. "15–19 years" is the largest group in 59% of the departments, followed by "25 years or more"

[46]In 2020, Paris has a mean square-metre price of €10,500, according to MeilleursAgents.

[47]The minimum department share is 30%.

and "10–14 years" for 35% and 6% of the geographic areas, respectively. The length of the loan is less concentrated among a single group, and the share of loans in the largest category is between 20% and 35%. In cases in which the reference loan (15–19 years) is not the most frequent type for a geographic area, the difference between the share of the two groups is always lower than 10.5 bps. Moreover, the share of the reference group (15–19 years) never represents less than 20% of the loans within a department (see figure 19).

To support this with evidence, I propose estimating the benchmark model while excluding departments with average house prices over €4,000, according to the house price per-square-metre data from MeilleursAgents[48]. This concerns the following French departments: Alpes-Maritimes, Paris, Yvelines, Hauts-de-Seine and Val-de-Marne. Results are presented in columns 3, 4, 7 and 8 of table 8 and are robust and consistent with previous evidence in terms of magnitude and significance. Excluding expensive departments does not lead to different conclusions.

7 Conclusion

Interest rates are a major channel of the direct transmission of monetary policy to households. Nevertheless, there are important transmission frictions in ongoing housing loans due to the predominance of fixed-rate loan schedules and highly indebted households' inability to refinance. Therefore, the main transmission of monetary policy action takes place at the origination of new housing loans. This paper studies inequalities of interest rates at origin through the identification of pricing differentials across the French territory at department level during the period 2012–2018. Moreover, I evaluate the existence of a heterogeneous pass-through of monetary policy to the housing sector for French households.

The results confirm the existence of significant interest rate inequalities across geographic areas due to local market concentration, even within banks. Banks are forced to reduce their spreads in very competitive markets to capture clients, but they have no incentive to reduce their margins to keep their position in concentrated ones. As a consequence, they charge higher interest rates in less competitive areas. This gap can reach 32 bps between French administrative departments in the top and bottom 10% of the concentration distribution. This is true after accounting for loan characteristics disparities and borrower profile heterogeneity across France. This result is robust to all of the alternative tests described in the paper.

Furthermore, I find evidence that high concentration (low competition) reduces the transmission of monetary policy to the household housing credit sector within banks. Banks de-

[48] This data set is constructed from French institution sources such as the INSEE and the Notaires de France, combined with additional rich information directly provided by housing transaction agencies in France.

crease less the price charged to borrowers during periods of expansionary monetary policy in departments with higher market concentration. The higher the market power structure, the larger the effective markup of the bank relative to the funding cost and the lower the pass-through of monetary policy rates to the household sector. Nevertheless, results on the heterogeneous pass-through of monetary policy action are very sensitive to the different robustness tests, and further research is needed.

The presented evidence is crucial because interest rates at origin drive households' budget constraints through the entire loan life cycle. Subsequently, the existence of interest rate inequalities in housing loans may imply regional asymmetries in budget constraints for peer households (and loans), which may have consequences on consumption and savings. Additionally, this impacts borrowing capacity and, therefore, housing purchasing power and wealth accumulation. Since credit concentration is negatively linked to the economic development of a geographic area, we may expect departments with lower attractiveness to be those with the more expensive loans. This is particularly important in the context of growing wealth inequalities, documented in the literature (Alvaredo et al. (2017) and Piketty and Saez (2014)). In addition, an expansionary monetary policy seems to accentuate the situation by widening the interest rate gap across departments due to the heterogeneous transmission of monetary policy action.

Finally, I find only a marginal transmission of conventional and unconventional monetary policy tools during the period of study (2012–2018). This is not surprising since, today, the scope of action of conventional monetary policy has reached its limits, and the ECB is concentrating its efforts on boosting the economy through unconventional monetary policy, which has direct limited effects. In addition, the majority of housing loans follow fixed schedules, and highly indebted households encounter difficulties in refinancing their debt at a lower rate and reducing their interest payments. This evidence calls into question the direct effects of ECB monetary policy action and highlights the importance of reducing inequalities in renegotiation in times when the policy action relies on non-conventional tools with limited direct impact on ongoing housing debt.

These results are in line with standard oligopoly theory on credit markets and with previously published evidence in other countries. Nevertheless, the modest geographic disaggregation in the definition of local markets remains the main limitation of this paper. The reduced variability of policy rates during the period of study may also contribute to the sensitivity of some of the results. Additional geographic detail at municipality level would, importantly, boost the inference power, and the identification strategy would be more finely tuned. Including information from the pre-crisis period would certainly be an advantage. This remains a challenge for future research.

In an ongoing working paper, Wang et al. (2018) suggest that several transmission channels interact at the same time, and the importance of deposits versus lending depends on the level of the policy rate. Assessing how lending and deposit channels interact between these and with other monetary policy transmission mechanisms would be an important topic of future research.

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Figure 1: Interest rate sensitiveness to funding cost changes in Cournot theory

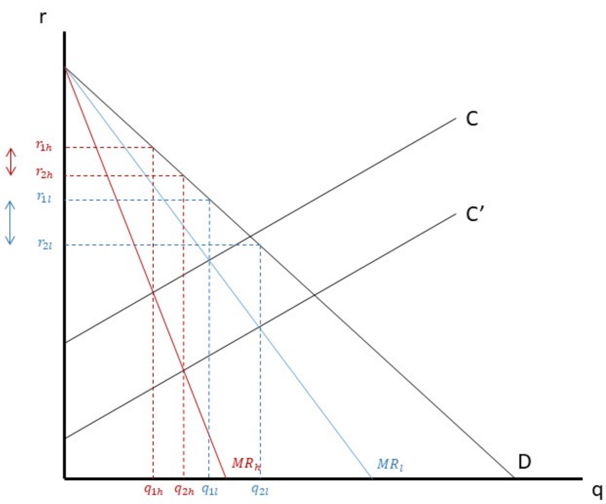


Figure 2: Median interest rate of new housing loans by department, 2012-2018

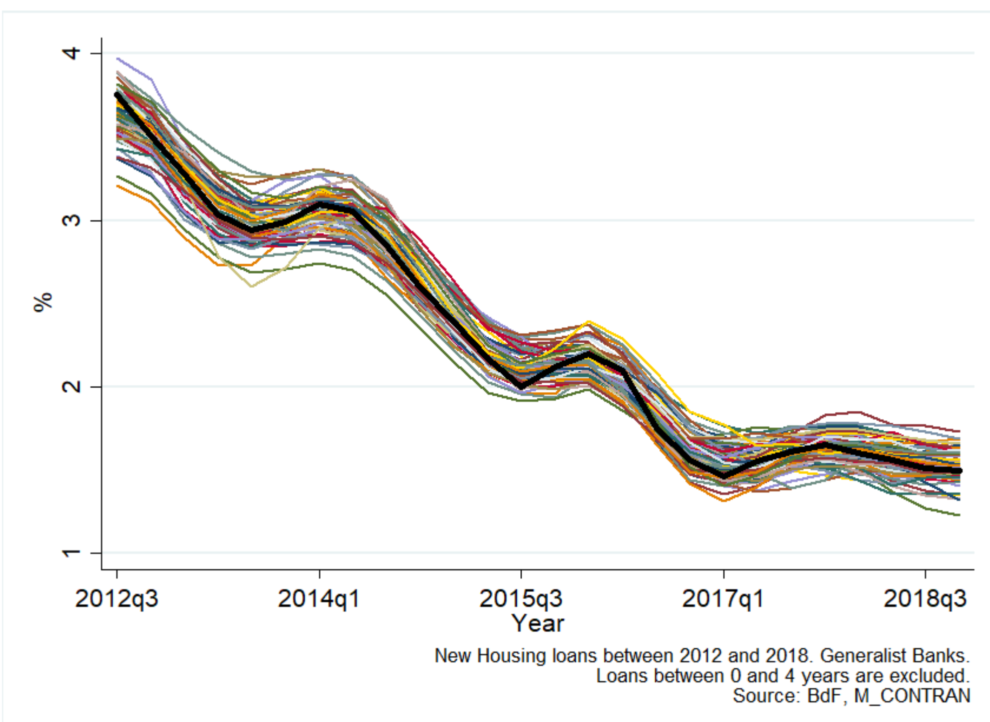
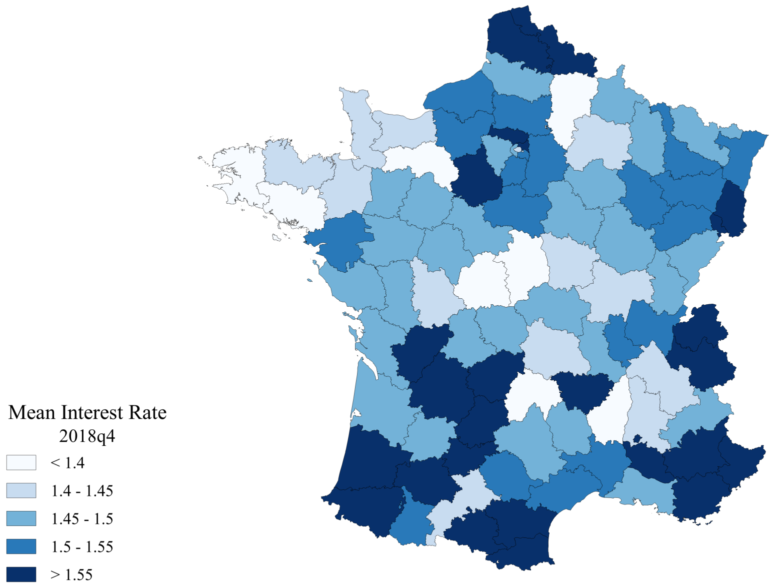


Figure 3: Map of average interest rate of new housing loans by department, 2018q4



New housing loans in 2018q4. Loans between 0 and 4 years maturity are excluded. Generalist banks.

Figure 4: Average interest rate of new housing loans by department, 2018q4

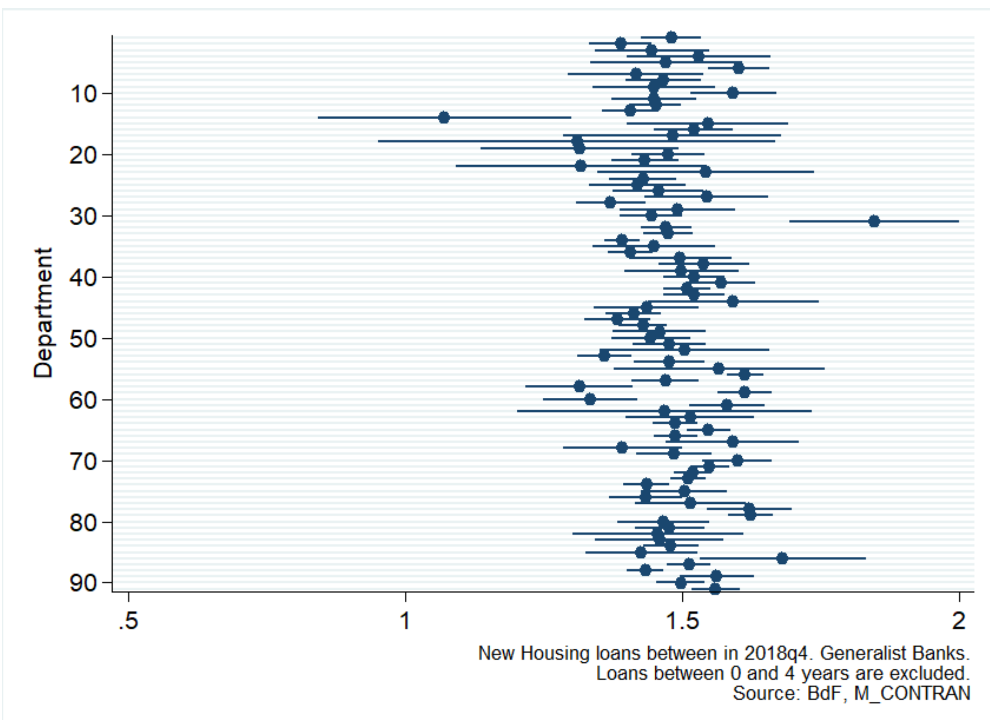


Figure 5: HHI housing loans concentration by department, 2011q4

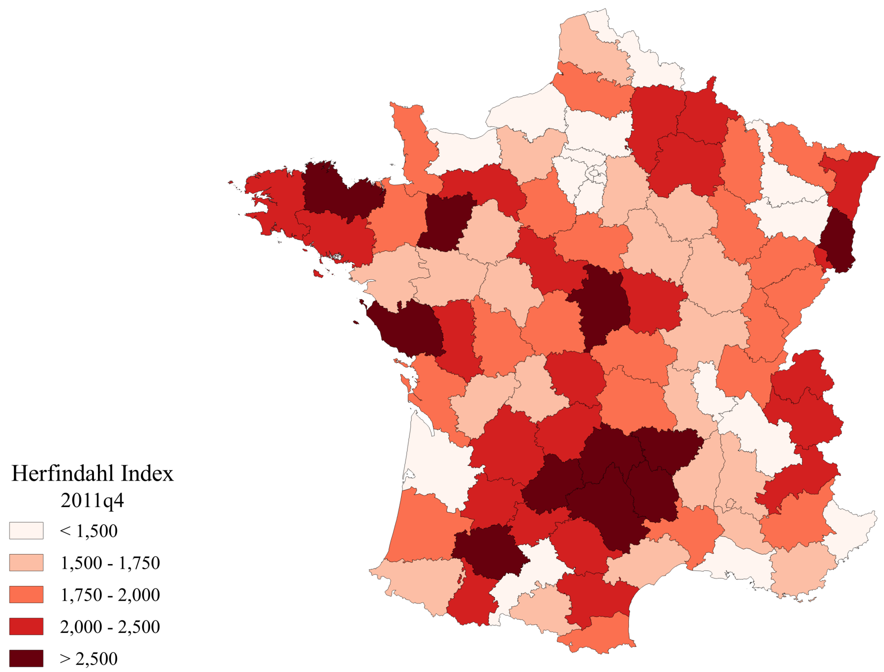


Figure 6: HHI housing loans concentration by department, 2018q4

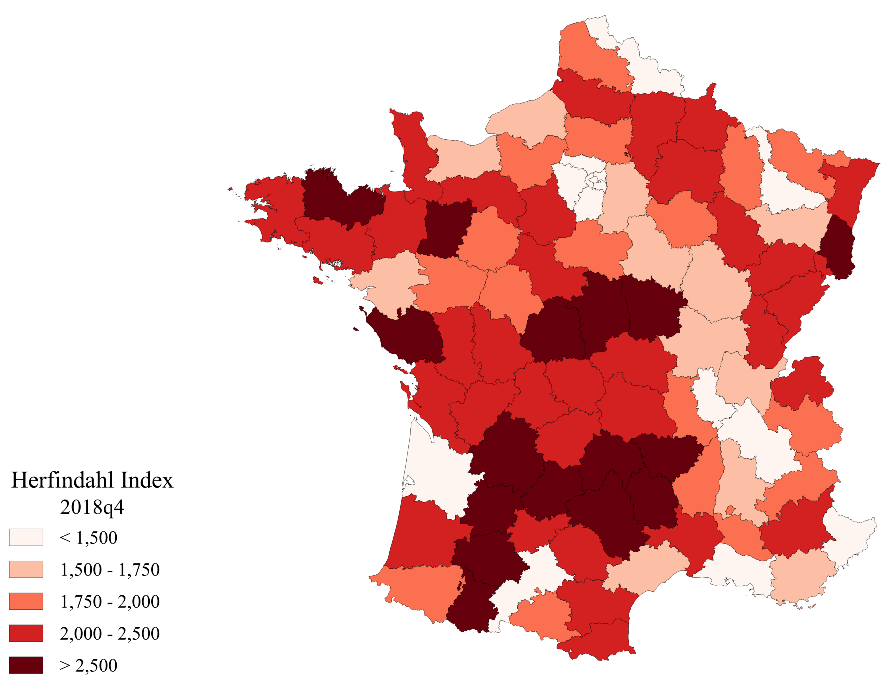


Figure 7: Interest rate vs market concentration (HHI)

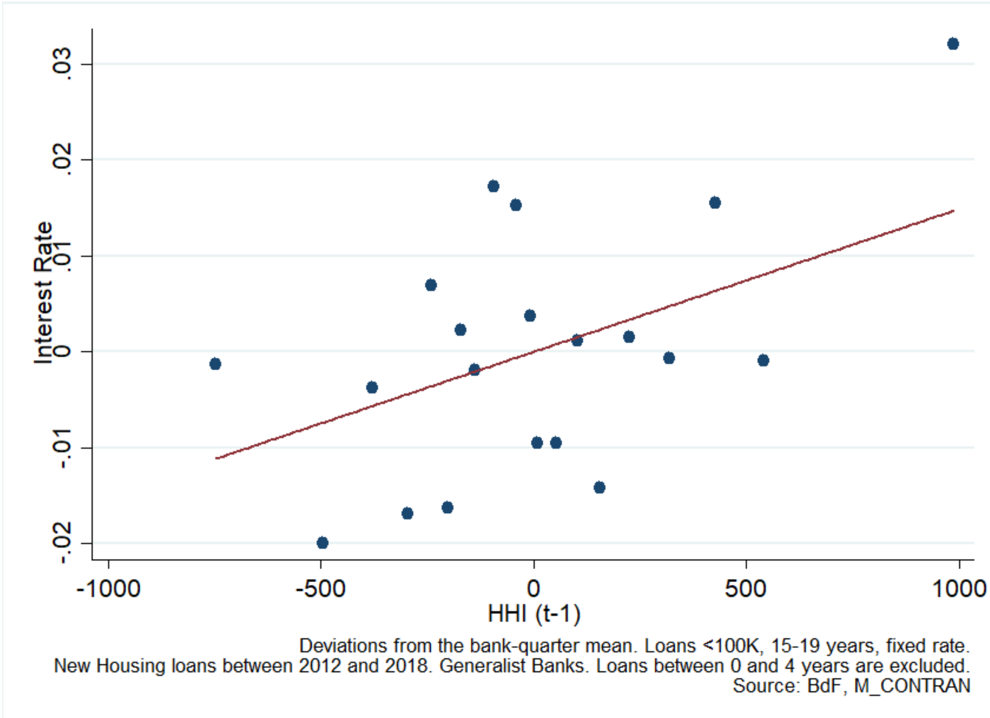


Figure 8: Average interest rate of new housing loans by maturity

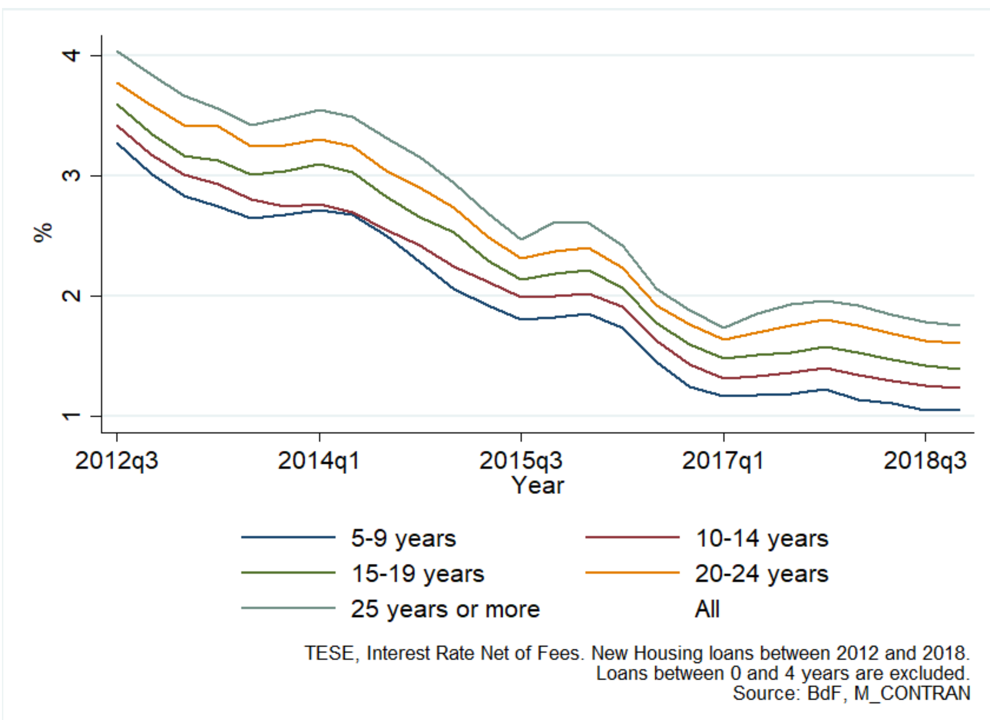


Figure 9: Average interest rate of new housing loans by type of loan

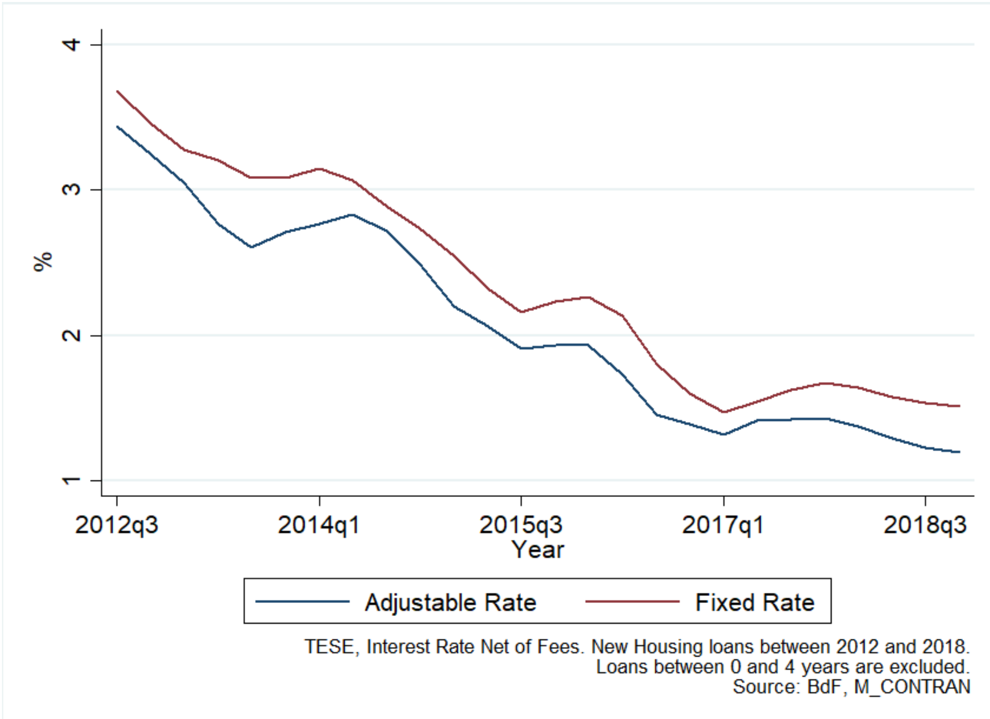


Figure 10: Total volume of outstanding housing loans to households in France

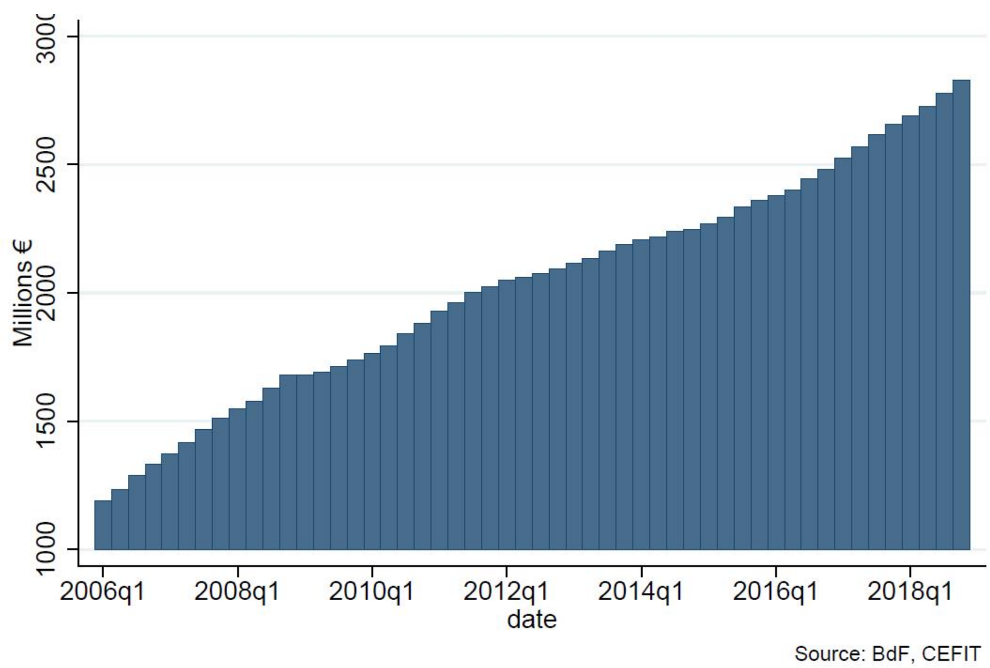
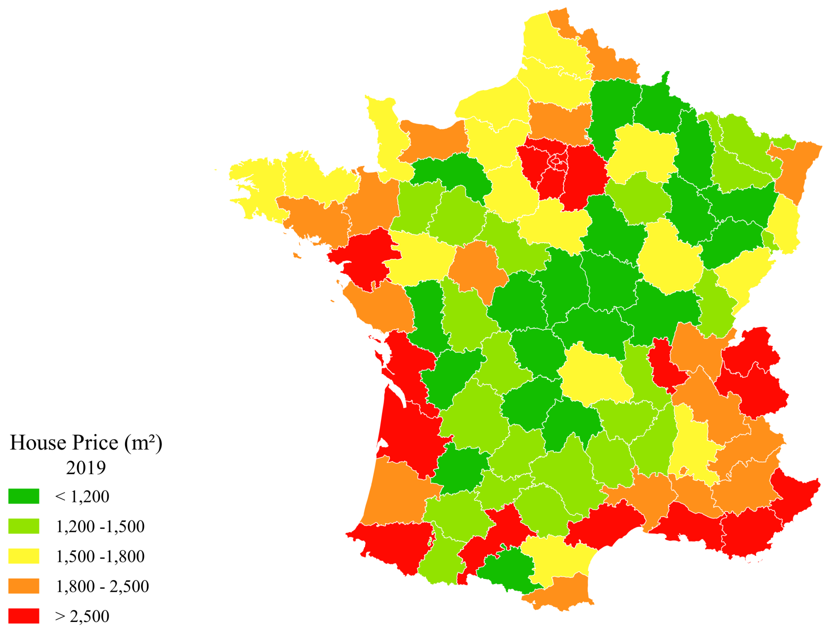


Figure 11: Average house price (m^2) by department, 2019



Source: *Meilleurs Agents (Notaires, Insee* and commercial agencies)

Figure 12: % of fixed rate loans by department, 2012-2018

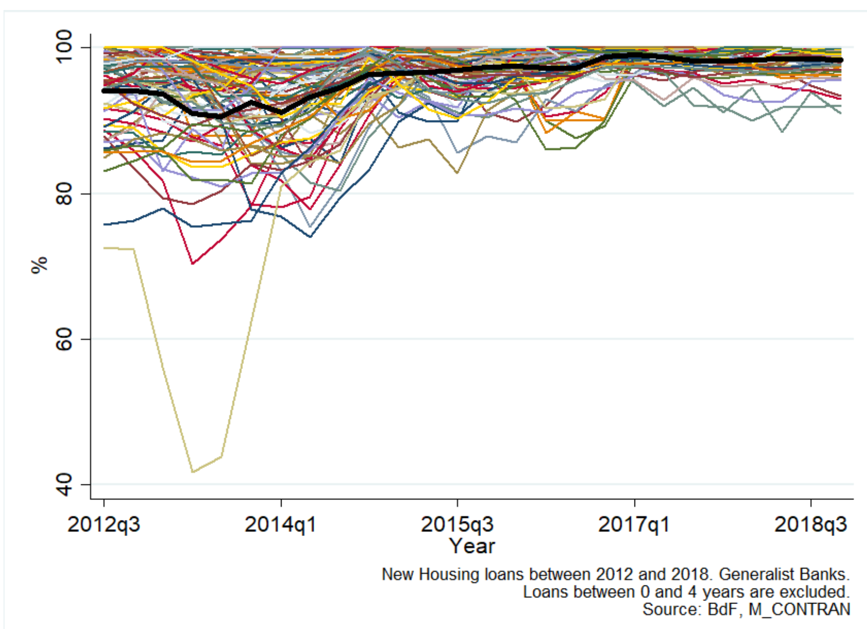


Figure 13: % of renegotiated loans over total new loans by department, 2012-2018

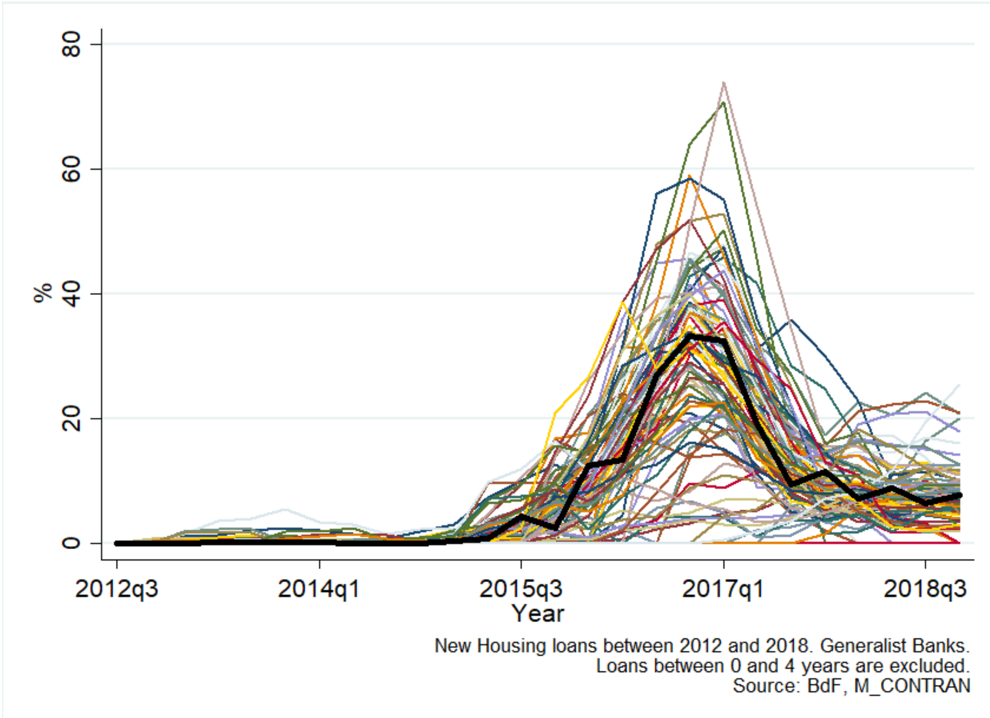


Figure 14: Average loan maturity by department, 2012-2018

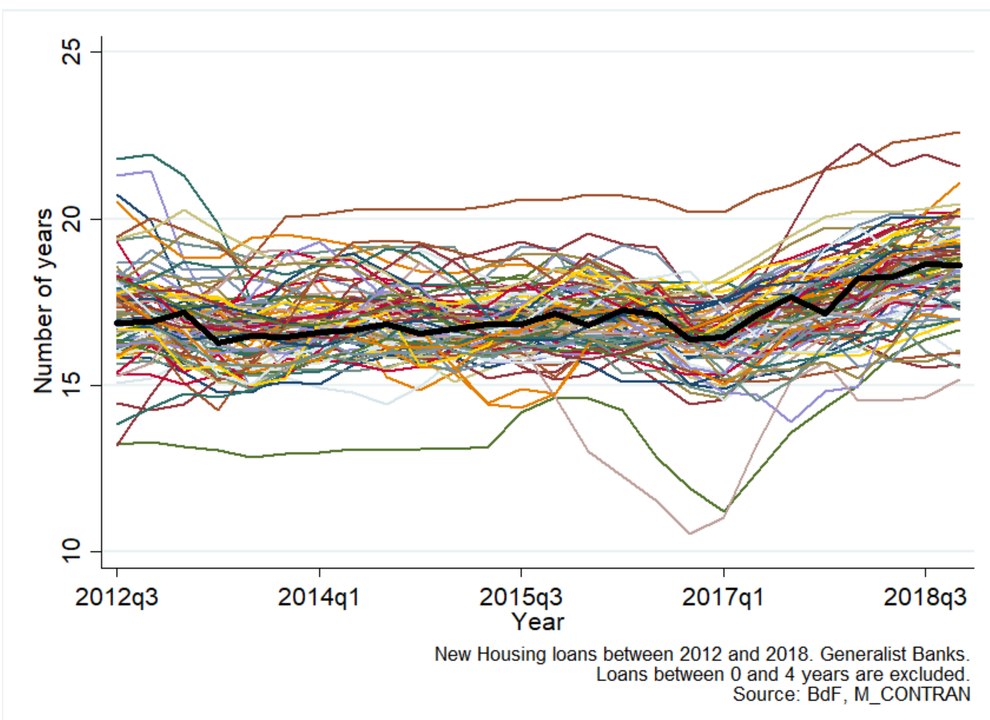
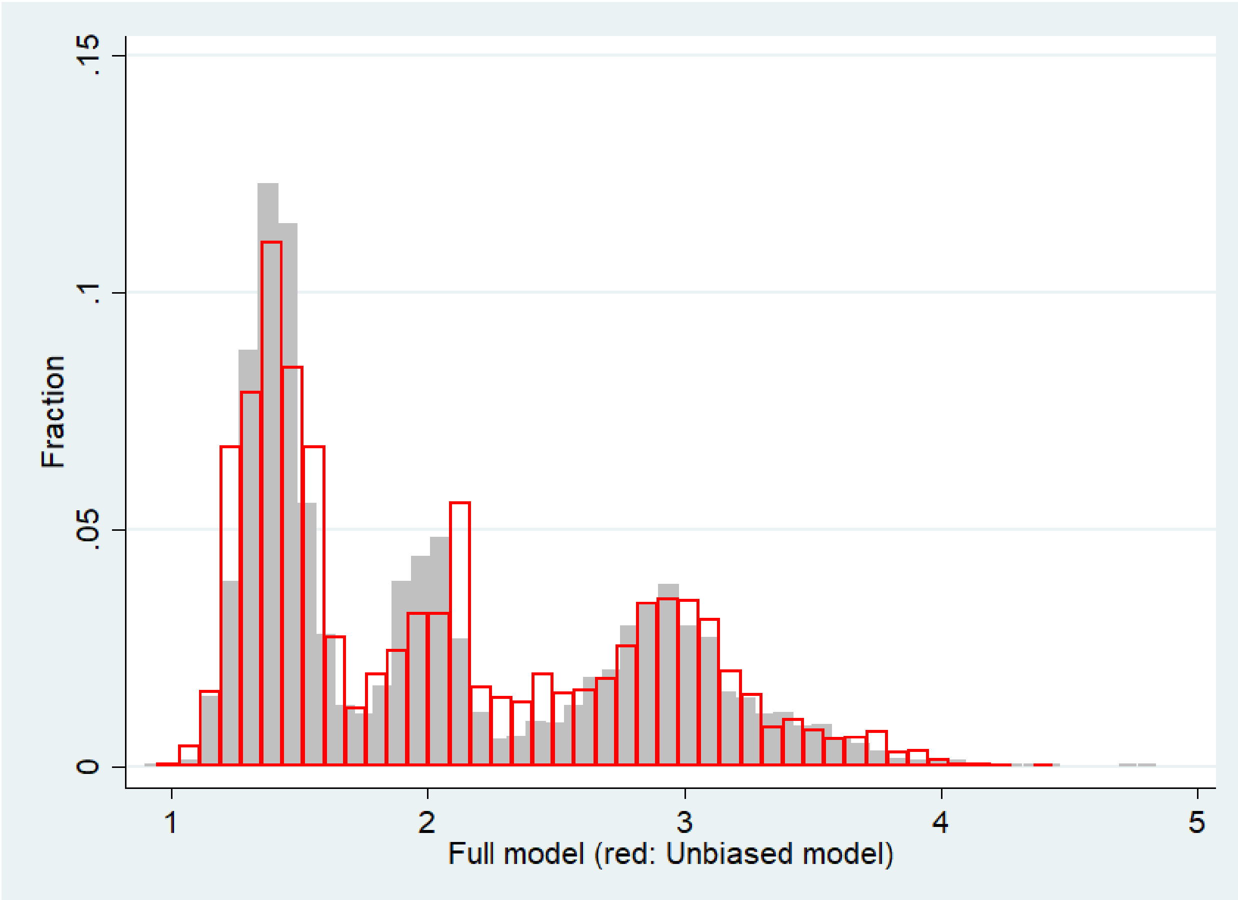


Figure 15: Hedonic interest rate, benchmark vs consistent estimator



Consistent estimator = <100K, 15-19 years, fixed rate loans. New housing loans between 2012-2018. Generalist banks. Loans between 0 and 4 years are excluded.

Figure 16: Hedonic interest rate by department, 2012q4

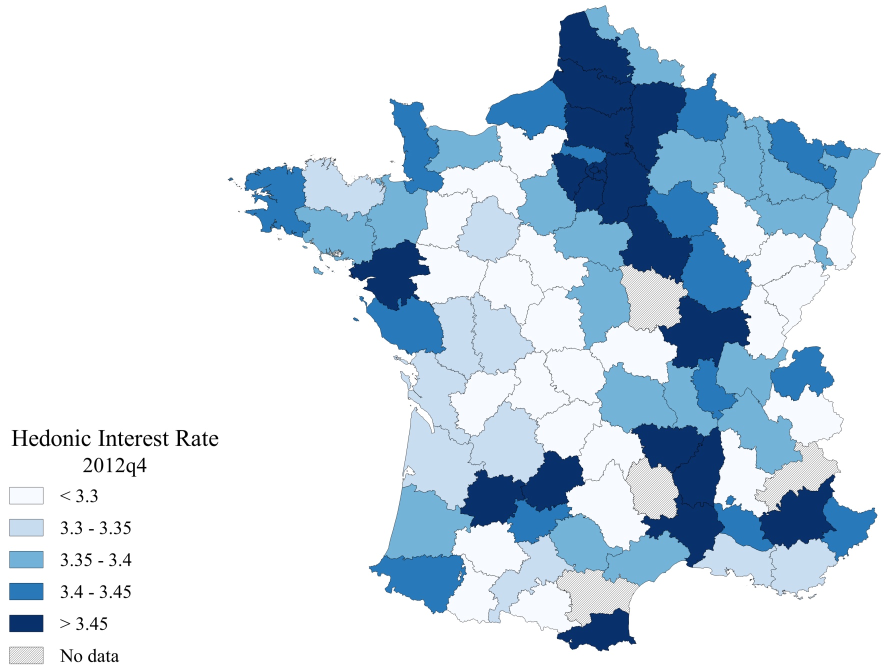


Figure 17: Hedonic interest rate by department, 2018q4

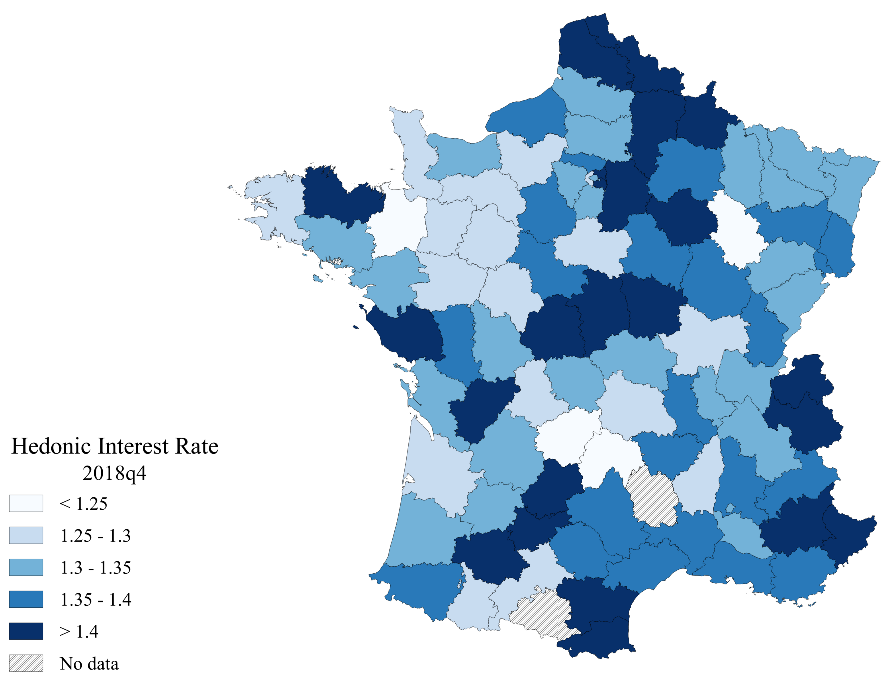


Figure 18: Reference category vs difference between the highest category and the reference category share, loan size groups within department

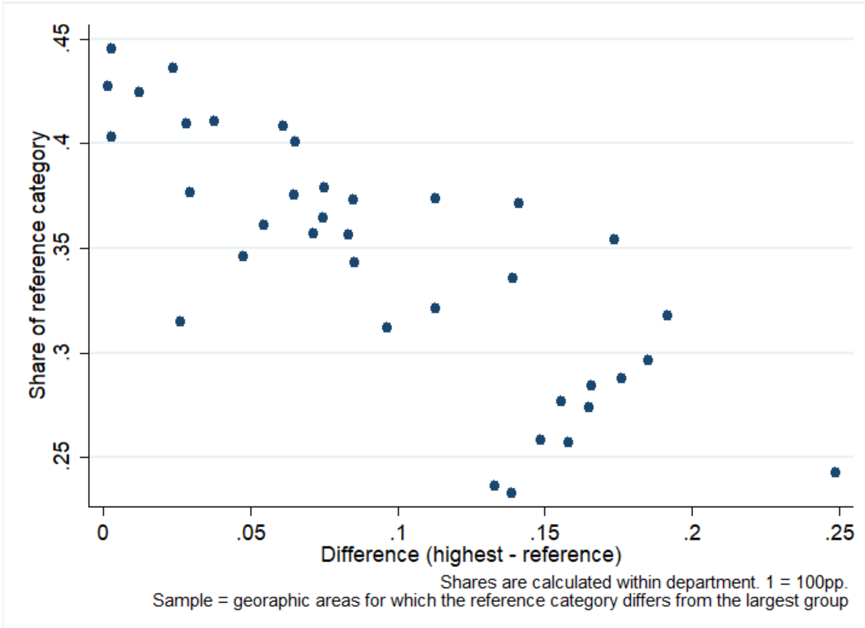


Figure 19: Reference category vs difference between the highest category and the reference category share, maturity groups within department

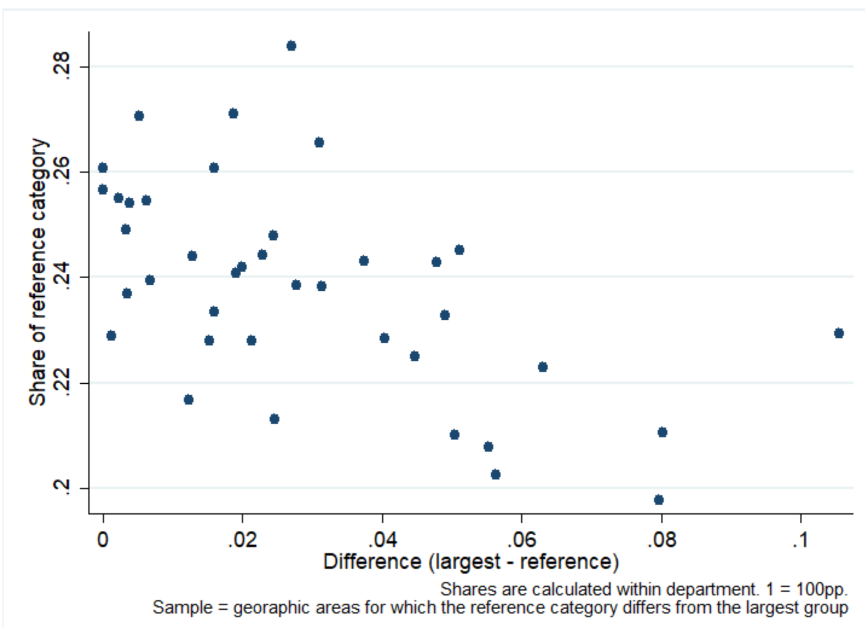


Table 1: Interest rate net of fees, loan level data

	log(IR)	log(IR)	log(IR)	N	%
Loan size:					
<100K		Ref.		98,099	43.10
100K-200K		0.00***		90,131	39.60
200K-300K		-0.01***		27,108	11.91
>300K		-0.03***		12,245	5.38
Loan maturity:					
5-9 years		-0.21***		18,756	8.24
10-14 years		-0.09***		45,735	20.10
15-19 years		Ref.		58,971	25.91
20-24 years		0.09***		53,969	23.71
25 years or more		0.22***		46,525	20.44
Missing		-0.05***		3,637	1.6
Type of rate:					
Adjustable Rate		-0.16***		8,278	3.64
Fixed Rate		Ref.		219,305	96.36
Type of loan:					
Standard		Ref.	Ref.	205,281	90.20
Negociated		0.25***	0.35***	22,302	9.80
Type of dwelling:					
New		0.01***	0.01**	59,632	26.20
Old		Ref.	Ref.	167,951	73.80
Type of project:					
Residence		Ref.	Ref.	200,198	87.97
Investment		0.01***	0.01**	27,385	12.03
Household annual income:					
<30K		0.02***	0.02***	56,967	25.03
30K-100K		Ref.	Ref.	111,294	48.90
>100K		-0.03***	-0.06***	17,487	7.68
Missing		0.01	-0.02	41,835	18.38
Constant	0.70***	0.65***	0.66***		
Bank-Department-Quarter FE	Yes	Yes	Yes		
Sample	All	All	Restricted		
R2	0.73	0.85	0.87		
Observations	227583	227583	22805	227583	100

* 0.1, ** 0.05, *** 0.01. Restricted = <100K, 15-19 years, fixed rate loan. New housing loans between 2012-2018. Generalist banks. Loans between 0 and 4 years are excluded.

Table 2: Summary of main variables

	Observations	Mean	sd	Min	Max
Hedonic Interest Rate_jdt	13148	2.26	0.76	1.02	4.53
HHI_dt-1	13148	1760	528	787	3775
Shadow Rate_t-1	13148	-2.71	2.03	-6.30	-0.11
Ln Market Share_jdt-1	13148	10.84	11.10	0.07	57.77
Share of Temporal Contracts_dt-1	13148	5.36	0.97	2.97	9.74
Unemployment Rate_dt-1	13148	9.60	1.81	5.30	15.70
Share of pop aged 20-39 years old_dt-1	13148	23.48	3.23	16.83	34.56

Branch-quarter aggregated data.

Table 3: Hedonic interest rate net of fees

	(1)	(2)	(3)	(4)	(5)
Shadow Rate_t-1	0.329***	0.147***	0.142***		
Normalised HHI_dt-1	0.102***	0.118***	0.086***	0.078***	0.026**
Ln Market Share_jdt-1			0.005	0.005*	0.004
Share of Temporal Contracts_dt-1			-0.008**	-0.003	0.001
Unemployment Rate_dt-1			-0.114***	-0.027***	0.005
Share of pop aged 20-39 years old_dt-1			0.216***	0.139***	0.011
Implemented DMTO Reform_dt-1			-0.048***	-0.008	0.004
Department Fixed Effect	No	Yes	Yes	Yes	Yes
Bank-Year Fixed Effect	No	Yes	Yes	No	No
Bank-Semester Fixed Effect	No	No	No	Yes	No
Bank-Quarter Fixed Effect	No	No	No	No	Yes
Sample	All	All	All	All	All
Period	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018
Overall R2	.83	0.96	0.96	0.97	0.98
Observations	13,148	13,148	13,148	13,148	13,148

Branch aggregated data. * 0.05, ** 0.01, *** 0.001.

Table 4: Δ Hedonic interest rate net of fees

	(1)	(2)	(3)	(4)	(5)
Δ Shadow Rate_(t-1, t-2)	0.054***	0.035***	0.050***		
Normalised HHI_dt-1	0.003*	0.136***	0.116***	0.006	-0.009
Δ Shadow Rate_(t-1, t-2) × Normalised HHI_dt-1	-0.005*	-0.003	-0.005*	-0.002***	0.002
Δ Market Share_jd(t-1, t-2)			0.017***	-0.004	0.003
Δ Share of Temporal Contracts_d(t-1, t-2)			-0.002	-0.008***	0.001
Δ Unemployment Rate_d(t-1, t-2)			-0.112***	-0.073***	-0.002
Δ Share of pop aged 20-39 years old_d(t-1, t-2)			0.067***	0.061***	0.013
Δ Implemented DMTO Reform_d(t-1, t-2)			0.030***	-0.020***	0.002
Department Fixed Effect	No	Yes	Yes	Yes	Yes
Bank-Year Fixed Effect	No	Yes	Yes	No	No
Bank-Semester Fixed Effect	No	No	No	Yes	No
Bank-Quarter Fixed Effect	No	No	No	No	Yes
Sample	All	All	All	All	All
Period	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018
Overall R2	.022	0.30	0.36	0.63	0.72
Observations	12,478	12,478	12,478	12,478	12,478

Branch aggregated data. * 0.05, ** 0.01, *** 0.001.

Table 5: Hedonic interest rate net of fees - Consolidated credit system

	HIR	HIR	HIR	Δ HIR	Δ HIR	Δ HIR
Shadow Rate_t-1	0.329***	0.148***	0.144***			
Normalised HHI_dt-1 (Consolidated)	0.148***	0.098***	0.066***	0.004***	0.136***	0.122***
Δ Shadow Rate_(t-1, t-2)				0.091***	0.052***	0.066***
Δ Shadow Rate_(t-1, t-2) × Normalised HHI_dt-1 (Consolidated)				-0.011***	-0.006**	-0.007***
Department Fixed Effect	No	Yes	Yes	No	Yes	Yes
Group-Year Fixed Effect	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
Sample	All	All	All	All	All	All
Period	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018
Overall R2	.81	0.95	0.95	.026	0.30	0.35
Observations	13,148	13,148	13,148	12,478	12,478	12,478

All market structure related indicators are measured at consolidated level (banking group) instead of bank level. Controls are market share, % temporary contracts, unemployment rate, % population 20-39 years old, dummy indicator of tax implementation. Branch aggregated data. * 0.05, ** 0.01, *** 0.001.

Table 6: Hedonic interest rate net of fees - local credit market formation

	HIR	HIR	HIR	Δ HIR	Δ HIR	Δ HIR
Shadow Rate_t-1	0.327***	0.147***	0.142***			
Normalised HHI_dt-1	0.112***	0.110***	0.076***	0.003*	0.141***	0.120***
Δ Shadow Rate_(t-1, t-2)				0.059***	0.036***	0.049***
Δ Shadow Rate_(t-1, t-2) × Normalised HHI_dt-1				-0.006*	-0.003	-0.004*
Department Fixed Effect	No	Yes	Yes	No	Yes	Yes
Bank-Year Fixed Effect	No	Yes	Yes	No	Yes	Yes
Controls	No	Yes	Yes	No	Yes	Yes
Sample	Restricted	Restricted	Restricted	Restricted	Restricted	Restricted
Period	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018
Overall R2	.83	0.96	0.96	.022	0.30	0.36
Observations	12,145	12,145	12,145	11,524	11,524	11,524

we exclude Paris, *Seine-Saint-Denis, Val-de-Marne* et *Hauts-de-Seine* from the estimation of benchmark equations. Controls are market share, % temporary contracts, unemployment rate, % population 20-39 years old, dummy indicator of tax implementation. Branch aggregated data. * 0.05, ** 0.01, *** 0.001.

Table 7: Hedonic interest rate net of fees - alternative measure of competition, top 4

	HIR	HIR	HIR	Δ HIR	Δ HIR	Δ HIR
Shadow Rate_t-1	0.317***	0.151***	0.144***			
(Normalised) Share of top 4 lenders_dt-1	0.205***	0.150***	0.100***	-0.003*	-0.085***	-0.102***
Δ Shadow Rate_(t-1, t-2)				0.080***	0.007	0.032*
Δ Shadow Rate_(t-1, t-2) × (Normalised) Share of top 4 lenders_dt-1				-0.006**	0.003	0.001
Department Fixed Effect	No	Yes	Yes	No	Yes	Yes
Bank-Year Fixed Effect	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
Sample	All	All	All	All	All	All
Period	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018
Overall R2	0.78	0.96	0.96	0.021	0.30	0.36
Observations	13,148	13,148	13,148	12,478	12,478	12,478

Concentration indicator refers to the sum of the market share of the four largest lenders in the geographic area. Controls are market share, % temporary contracts, unemployment rate, % population 20-39 years old, dummy indicator of tax implementation. Branch aggregated data. * 0.05, ** 0.01, *** 0.001.

Table 8: Hedonic interest rate net of fees - consistent estimator of hedonic interest rates

	HIR	HIR	HIR	HIR	Δ HIR	Δ HIR	Δ HIR	Δ HIR
Shadow Rate_t-1	0.332***	0.138***	0.327***	0.142***				
Normalised HHI_dt-1	0.067***	0.163***	0.111***	0.079***	0.004	0.230***	0.003*	0.119***
Δ Shadow Rate_(t-1, t-2)					-0.018	-0.057	0.060***	0.049***
Δ Shadow Rate_(t-1, t-2) × Normalised HHI_dt-1					-0.004	-0.012	-0.006*	-0.004*
Department Fixed Effect	No	Yes	No	Yes	No	Yes	No	Yes
Bank-Year Fixed Effect	No	Yes	No	Yes	No	Yes	No	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Sample	All	All	Restricted	Restricted	All	All	Restricted	Restricted
Period	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018	2012-2018
Overall R2	0.80	0.94	0.83	0.96	0.003	0.25	0.023	0.36
Observations	3,677	3,677	11,834	11,834	2,205	2,205	11,230	11,230

The dependent variable HIR in columns 1,2,5 and 6 corresponds to the consitent estimator presented in column 2 of table 1. The restricted sample excludes *Alpes-Maritimes, Paris, Yvelines, Hauts-de-Seine* and *Val-de-Marne*. Controls are market share, % temporary contracts, unemployment rate, % population 20-39 years old, dummy indicator of tax implementation. Branch aggregated data. * 0.05, ** 0.01, *** 0.001.

Appendices

A Appendix. From theory to structural equations

Given the Cournot symmetric model presented in section 2, we consider the standard reverse demand function:

$$r(Q) = a - bQ$$

or equivalently,

$$r(Q) = a - b(\sum_{n=1}^{N} q_n)$$

and a production cost function:

$$C(q) = cq$$

We solve the maximization problem for three different cases:

1. Monopoly:
   $Max_Q \Pi = r(Q)Q - C(Q)$
   FOC: $r(Q) = C'(Q) - r'(Q)Q$

2. Oligopoly:
   $Max_{q_n} \Pi = r(Q)q_n - C(q_n)$
   FOC: $r(Q) = C'(q_n) - r'(Q)q_n$

3. Perfect Competition:
   $Max_{q_n} \Pi = rq_n - C(q_n)$
   FOC: $r = C'(q_n)$

We observe the existence of a markup $r'(Q)q_n$ both in monopoly and oligopoly solution creating a deviation from perfect competition. Also, there is a divergence between monopoly and oligopoly as the number of competitors increases ($q = \frac{1}{N}Q$). Subsequently, all three expressions can be nested as

$$r(Q) = C'(Q) - \lambda r'(Q)Q$$

where $\lambda = \frac{1}{N}$, and N the total number of competitors.

Hence, for values of:
$\lambda = 1 \rightarrow$ Monopoly
$\lambda \in (0, 1) \rightarrow$ Oligopoly
$\lambda = 0 \rightarrow$ Perfect competition

and then, the supply structural equation can be expressed as:

$$r(Q) = C(Q) - \lambda h(Q)$$

B Appendix. Homogeneity of marginal prices across space and time

The benchmark model proposed in section 4 assumes temporal and geographic homogeneity in estimated marginal prices. The estimation of different hedonic models across geographic areas is a common practice in housing literature since it is evidenced that the value added of housing features can be different depending on the location. For example, having a balcony may be highly valued in a sunny county whereas its utility is importantly lower in places where the weather is less forgiving. Regarding interest rates, whether the setting of categories differentials is heterogeneous across geographic areas or over time remains uncertain. The existence of significant differences in marginal prices between groups could mislead the estimation of hedonic interest rates of our model. In what is to follow, we provide year and regional evidence about this issue.

Interaction terms with year and regional dummies are included in equation 1 and results are presented in table 9 and figures 20 to 25 of this appendix. Variables whose interactions does not have significant differences over time or across geography are not presented in the tables/figures. Marginal prices of loan maturity and type of rate show significant and substantial differences over time (Column 1 of table 9). We observe a clear gradient on the heterogeneity of interest rates by maturity and time. The penalty charged to longer loans where importantly lower at the beginning of the period, being this gap reduced as the time passes by. A possible explanation could be the recent trend towards riskier loans structures (longer maturity among others) which has been observed during last years (ACPR (2017)) in France. This would have changed the overall exposure of banks to default risk in their balance sheets, which implies higher capital requirements. This may have pushed banks to additionally compensate the risk by charging higher interest rates. Nevertheless, There is a possible methodological explanation. While hedonic models are generally specified in a logarithmic form, the determination of interest rates differentials by banks is in practice decided as an absolute delta. This means that a very similar marginal prices delta would be importantly higher in relative terms in an environment of very low interest rates, which is the case of later years. Column 2 of table 9 presents the results of the estimation of equation 1 in levels to assess this possibility. As foretold, the gradient of the results disappeared and some of the significant differences are lost. All the same, we notice lower gaps after 2017, which may be the result of the lost of downward flexibility since we approach the zero lower bound. The remaining significant effects does not follow any particular pattern and there are rarely significant differences among categories other than compared to the reference (figures 20 and 21). As a whole, differences remain small around 3 basis points in absolute terms.

With regard to geographic heterogeneity in marginal prices, disparities are less important than in the temporal case. While some variables present significant differences between the interacted terms and the reference region (*Ile-de-France*), we notice that the across regions differences are rarely significant. Figures 22 to 25 present the coefficients and confident intervals of the only 4 variables with significant results.

In light of this evidence, we do not consider necessary the inclusion of interaction terms in the benchmark model used in the main analysis. Evidence shows that differences are minor in magnitude and often not significant. Moreover, adding these features does not improve the explanatory power of the model. Additionally, we could only allow heterogeneous coefficients at region/year level, since department and quarter terms are too statistically demanding. Hence, this issue remains a limit of this paper and could represent an interesting question for future research.

Figure 20: Interest Rate Net of Fees - time heterogeneity in maturity marginal price

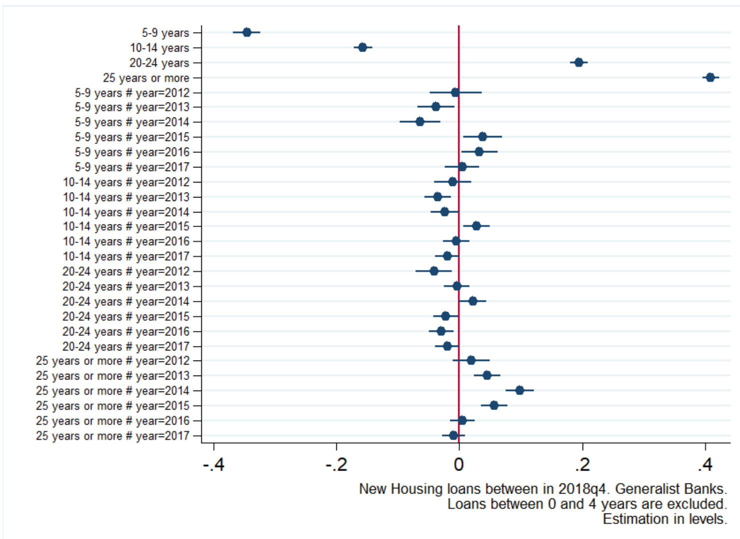


Figure 21: Interest Rate Net of Fees - time heterogeneity in type of rate marginal price

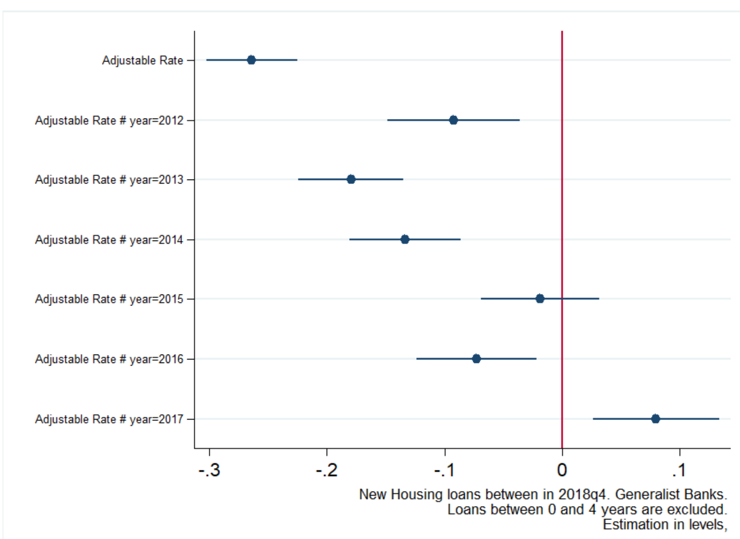


Figure 22: Interest Rate Net of Fees - geographic heterogeneity in loan size marginal price

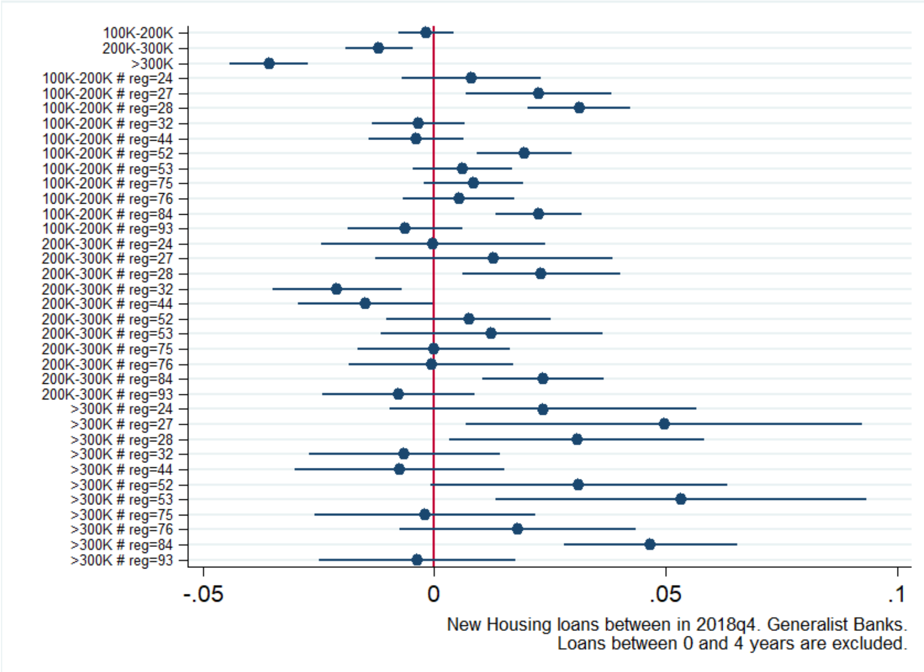


Figure 23: Interest Rate Net of Fees - geographic heterogeneity in maturity marginal price

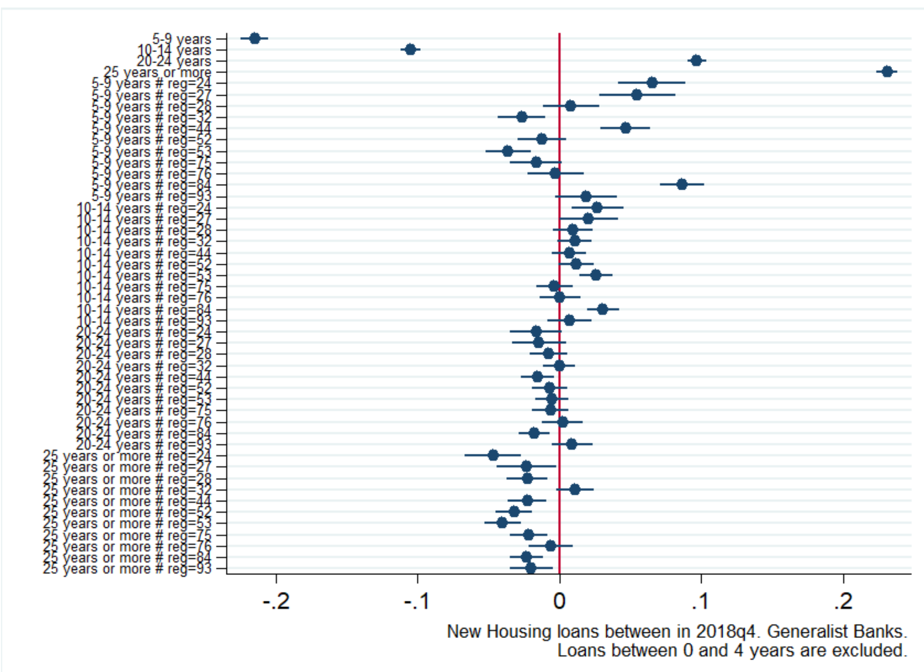


Figure 24: Interest Rate Net of Fees - geographic heterogeneity in type of loan marginal price

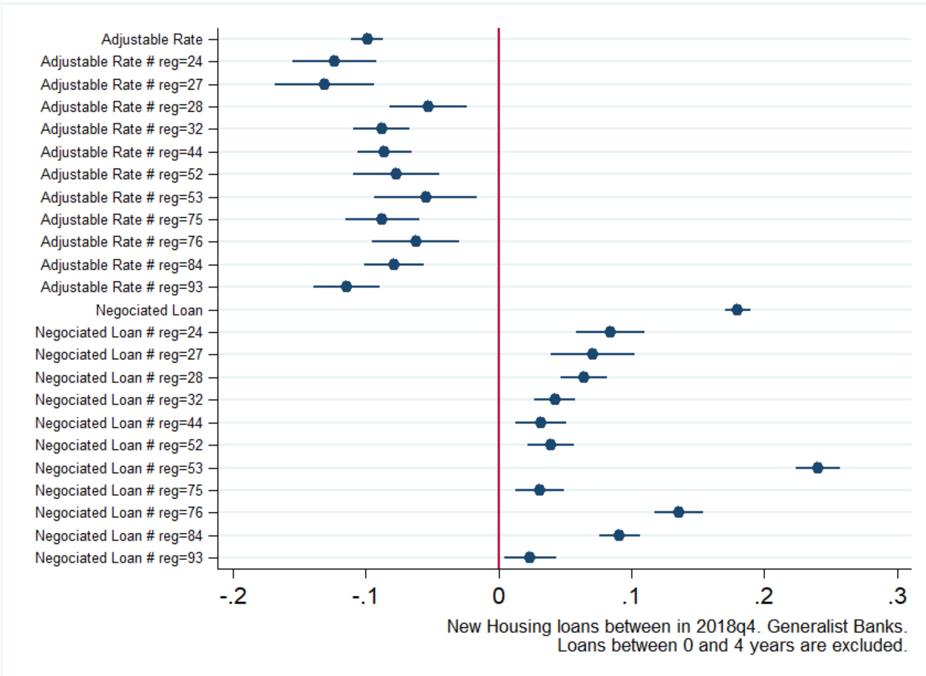


Figure 25: Interest Rate Net of Fees - geographic heterogeneity in household profile marginal price

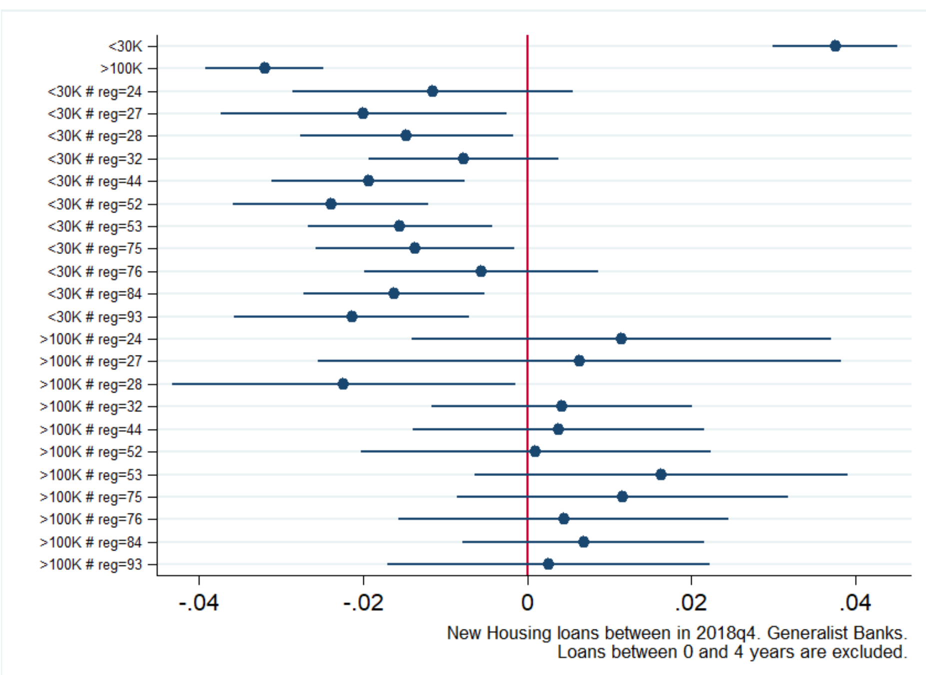


Table 9: Interest Rate Net of Fees, loan level data - time heterogeneity in marginal prices

	log(IR)	IR
Loan maturity:		
5-9 years	-0.30***	-0.35***
10-14 years	-0.13***	-0.16***
15-19 years	Ref.	Ref.
20-24 years	0.13***	0.19***
25 years or more	0.27***	0.41***
5-9 years × year=2012	0.19***	-0.01
5-9 years × year=2013	0.16***	-0.04***
5-9 years × year=2014	0.14***	-0.06***
5-9 years × year=2015	0.13***	0.04***
5-9 years × year=2016	0.09***	0.03***
5-9 years × year=2017	0.02***	0.00
5-9 years × year=2018	Ref.	Ref.
10-14 years × year=2012	0.08***	-0.01
10-14 years × year=2013	0.07***	-0.03***
10-14 years × year=2014	0.06***	-0.02**
10-14 years × year=2015	0.06***	0.03***
10-14 years × year=2016	0.03***	-0.00
10-14 years × year=2017	-0.01	-0.02**
10-14 years × year=2018	Ref.	Ref.
20-24 years × year=2012	-0.09***	-0.04***
20-24 years × year=2013	-0.07***	-0.00
20-24 years × year=2014	-0.06***	0.02**
20-24 years × year=2015	-0.05***	-0.02***
20-24 years × year=2016	-0.04***	-0.03***
20-24 years × year=2017	-0.02***	-0.02***
20-24 years × year=2018	Ref.	Ref.
25 years or more × year=2012	-0.15***	0.02*
25 years or more × year=2013	-0.12***	0.05***
25 years or more × year=2014	-0.10***	0.10***
25 years or more × year=2015	-0.06***	0.06***
25 years or more × year=2016	-0.04***	0.01
25 years or more × year=2017	-0.02***	-0.01
25 years or more × year=2018	Ref.	Ref.
Type of rate:		
Adjustable Rate	-0.21***	-0.26***
Fixed Rate	Ref.	Ref.
Adjustable Rate × year=2012	0.11***	-0.09***
Adjustable Rate × year=2013	0.05***	-0.18***
Adjustable Rate × year=2014	0.06***	-0.13***
Adjustable Rate × year=2015	0.06***	-0.02
Adjustable Rate × year=2016	0.01	-0.07***
Adjustable Rate × year=2017	0.08***	0.08***
Adjustable Rate × year=2018	Ref.	Ref.
Constant	0.65***	2.05***
Bank-Dep-Quarter FE	Yes	Yes
Loan characteristics	All	All
Sample	All	All
R2	0.86	0.88
Observations	227583	227583

* 0.05, ** 0.01, *** 0.001. Restricted = <100K, 15-19 years, fixed rate loan. New housing loans between 2012-2018. Generalist banks. Loans between 0 and 4 years are excluded.

C Appendix. Figures

Figure 26: HHI housing loans concentration (consolidated), 2011q4

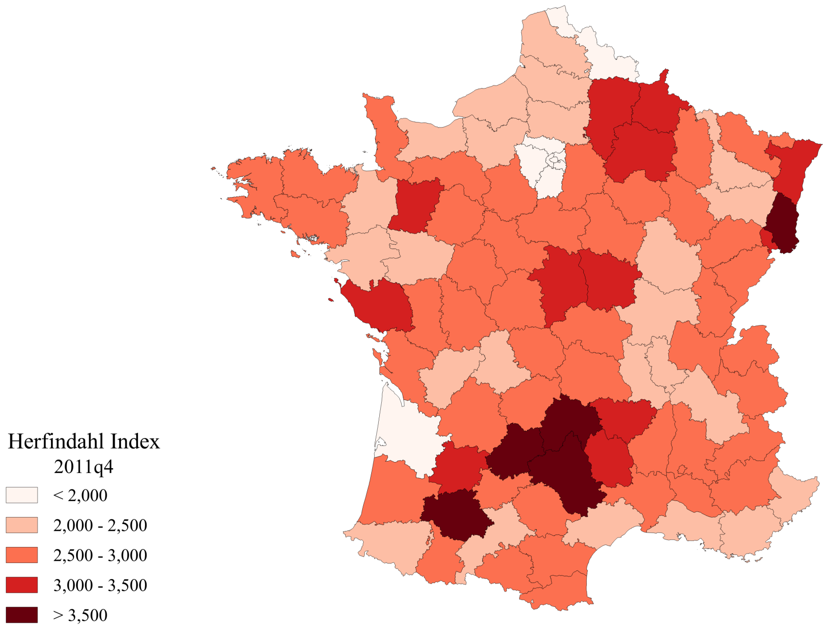


Figure 27: HHI housing loans concentration (consolidated), 2018q4