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Are government and bank loans substitutes or complements? Evidence from spatial discontinuity in equity loans.

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Abstract: *This paper studies the impact of an increase in the limit of a direct equity loan provided by the UK government to finance mortgage deposits on aggregate mortgage lending by banks. It uses the spatial discontinuity methodology and takes advantage of the natural experiment which occurred when the limit of equity loans increased in London after the reform of the Help-to-Buy (HTB) scheme. By comparing postcode sectors on the opposite sides of the London boundary, we measure the impact of the new policy on very similar housing markets. The results show that higher equity loans increase aggregate mortgage lending by banks.*

Keywords: Housing finance, mortgages, credit markets, government loans

JEL codes: G21, D14, R28, H31

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Introduction

The critical role of mortgage lending in the last financial crisis prompted many governments to rethink their housing finance polices in the context of the effect they have on the financial system. While supporting origination of private mortgages through secondary market guarantees used to be a popular method of supporting housing finance, after the financial crisis other instruments are receiving renewed attention. In particular, many countries are considering lending directly to households as a way of providing mortgage support without exposing the financial sector to additional risk (Blommestein et al. 2011; Aron et al. 2012; Duca et al. 2010). This trend revives the interest in the longstanding academic debate on the impact of government lending on the credit market.

Since house purchases are not only a fundamental determinant of location choices but also the most important financial decision most households make, restricted access to mortgage finance can have adverse economic consequences. On the other hand, making private loans too easy to access can expose the financial system to additional risk. In this light, an ideal housing finance policy would simply address any frictions in credit provision. However, while many government-sponsored programs aimed at improving access to mortgages are based on a controversial economic argument that this may be a good way to reduce credit rationing (Duca et al. 2011), increasingly there are also political reasons for improving access to mortgages. In many countries where housing is unaffordable, access to housing is becoming a very sensitive social issue and mortgage access programs are motivated by both economic and political incentives. The political context makes measuring their impact difficult as it is often unclear what objective a particular program may pursue (Gerardi et al. 2013). Therefore, while numerous studies considered the impact of direct government lending on credit markets theoretically, there is very little empirical evidence of its effect (Gale 1991; Williamson 1994; Ono et al. 2013).

In this study we provide this evidence by focusing on the impact of a government equity loan scheme on mortgage lending. While the theory that making mortgages more accessible may affect the pecking order of financing decisions is well-established (Meltzer 1974, Amromin et al. 2007, Quigley & Van

Order 1991), the challenge of measuring how a particular scheme affects them lies in disentangling the impact of the scheme from other drives of demand for mortgages. We take advantage of a natural experiment provided by a change in the UK government's Help To Buy equity loan scheme (HTB) introduced in London in February 2016. In particular, we exploit the boundary discontinuity effect that occurs between postcodes on the opposite sides of the London boundary. The program is based on providing equity loans to mortgage borrowers who meet the program's eligibility criteria. In London, the maximum amount available under this scheme to any single household was changed in February 2016 from 20% to 40% of the value of the purchased house. Controversially, the geographical limit of the increased threshold was set at the border of the Greater London Authority (GLA).

Most scholars focus on the impact the government programs of increasing mortgage accessibility have on the wider economy (Shin 2012 and 2009), stability of the financial sector (Lucas & McDonald 2006, Meek et al. 2017, Beck et al. 2007) or housing markets (MacDonald 1996) but relatively little is known about the effect they have on the supply and demand for private credit. The question is especially important in the context of other government initiatives related to retail lending. Since the financial crisis, banks have been forced by regulators to limit their exposure to risk. Amongst other measures, regulated lenders have to increase their risk screening standards, which makes mortgages less accessible (Dagher & Fu 2017, Beck et al. 2007). Since this works against the political goal of increasing access to housing, contemporary housing finance polices have to be designed carefully to provide mortgages without exposing banks to excessive risk. We study a program which helps households access the mortgage market by offering equity loans. On the one hand, adding a tranche of cheap junior debt makes it easier to take out a mortgage with a low deposit which should increase lending. On the other, offering an equity loan could, at least partially, crowd out private lending (Gabriel & Rosenthal 2010).

The substitution or complementarity question of non-traditional borrowing is also important in the context of the increasing importance of the shadow banking sector. As government lending programs

are an excellent example of loans that are not regulated by the central bank, their impact on traditional lending can provide insight into the relationship between traditional and shadow lending.

We measure if the government's decision to provide larger equity loans affects the total value of mortgage borrowing. We do not focus on whether the loans are taken out by households that have an option to use other sources of finance or not. Instead, we examine the impact of providing public mezzanine financing on the aggregate level of mortgage debt. The natural experiment allows identifying the impact of local mortgage borrowing on very small areas and provides us with a control group which creates an opportunity to disentangle the impact of higher government lending on mortgage lending. Our methodology focuses on spatial discontinuity which is a spatial adaptation of the popular regression discontinuity design in which the treatment is assigned to selected geographical locations. The fact that mortgages are tied to specific addresses makes them an excellent candidate for this type of analysis. Nevertheless, there are very few studies that apply this methodology to analyse mortgage credit markets. Notable exceptions include Pence (2006) and (Huang 2008) but focus solely on the spatial dimension of discontinuity. The present study exploits a combination of a difference-in-differences design with the spatial discontinuity approach. Since this method is commonly used in many branches of economics, our study contributes to the banking and real estate literature also by demonstrating how it can be applied in this field.

Our results show that, after controlling for confounding factors, providing government loans to mortgage borrowers increases the total amount of funds borrowed. Although we do not distinguish between the additional borrowing by households who in absence of the treatment would borrow smaller amounts and loans given to households who would not be able to borrow at all, we find that their combined level of borrowing is higher when equity loans of higher values are provided. Although in this paper we do not focus on housing market outcomes, we report that higher equity loans have

surprisingly little impact on the average number and value of transactions[2]. This leads to an important conclusion as it shows that in our sample the impact of higher equity loans on aggregate outcomes in the credit market does not appear to be driven by corresponding changes in the housing market[3].

Our main contribution is to the literature that discusses the impact of government lending on mortgage credit markets. Gale (1991) develops a theoretical model of public lending under credit rationing and redlining based on the Stigliz-Weiss approach with asymmetric information. He finds that the effects on lending will depend on the details of any new program as subsidies from the government may support some borrowers but crowd-out others. He concludes that the net impact on aggregate borrowing is therefore difficult to establish a priori without knowing the extent of credit rationing and interactions between the subsidized group and other borrowers. Williamson (1994) develops a model of the impact of government loans from which he concludes that they are perfect substitutes for private lending and therefore should crowd it out. In fact, he claims that such policy may make credit rationing more severe. More recent works suggest that when the government is making mortgages more accessible by providing guarantees or reducing risk to lenders, banks have an incentive to relax their risk screening polices and provide credit to riskier borrowers (Karlan & Zinman 2009; Jiménez et al. 2013). This increases the supply of credit and may lead to higher aggregate lending. Since theoretical studies do not provide a clear answer, the impact of government's equity loans on bank lending is essentially an empirical issue.

To date, studies that examined the impact of government support on mortgage borrowing empirically, focused largely on US mortgage securitization and Government-Sponsored-Entities (GSEs) that guarantee some loans in this market (Loutskina & Strahan 2009, Loutskina 2011). Most studies found

[2] We do not measure the impact of the scheme on house prices as due to data limitations we cannot control for the characteristics of the transacted houses. This means that we would not be able to distinguish between changing prices and changing characteristics of the transacted properties. Instead, we focus on average transaction prices which are the key variable driving mortgages.

[3] While this does not mean that the HTB scheme has no effect on the housing market, it shows that these effects warrant a study that goes beyond the present paper.

that providing government guarantees increased mortgage lending. However, the increase is attributed mainly to lenders taking excessive risk by issuing subprime mortgages and little is known about how borrowing decisions of low risk households were affected. There is also evidence that shows that GSEs may lead to lower risk screening standards (Keys et al. 2010), increase prices (Duca et al. 2011) and do not increase housing outcomes for low-income households (Bostic & Gabriel 2006). Other US studies include research on mortgage insurance issued by the Federal Housing Administration (FHA) and show that governmental mortgage guarantees can stimulate mortgage borrowing during a credit crunch (Duca et al. 2016) but have little impact on long term home ownership rates (Goodman & Nichols 1997). We are not aware of any studies of the impact of providing equity loans directly in the primary market: our goal is to provide first empirical evidence on this topic.

The study is structured as follows. Section 2 provides a general overview of the Help-To-Buy program, outlies its key features and compares it with similar programs implemented elsewhere. It also presents some descriptive statistics that show the significance of the scheme for the UK and London mortgage lending. Section 3 describes our methodology and data. Results are presented in section 4 and section 5 concludes by offering final remarks.

The Help to Buy scheme and the mortgage lending market.

In April 2013 the UK government introduced its biggest housing market intervention since 1980. Although the program involved several different types of support for house buyers[4], this study focuses on the Equity Loan scheme (EL) in which the government provides loans intended to help mortgage

[4] Initially HTB was introduced as a combination of new and existing housing programs. The new initiatives included: a mortgage guarantee in which the government guaranteed a bank mortgage for buyers with 5% deposits (discontinued in December 2016), a HTB ISA which was a savings account designated to be used for a mortgage deposit and offered a cash bonus at the time of purchase and the equity loan scheme. The HTB ISA is the only program that has eventually been changed in London. The change occurred in December 2015 but since the account is designed so that buyers save money over time before they buy a house its effect is unlikely to materialize in any one time period. More details on all schemes can be found on the government's website: helptobuy.gov.uk

buyers finance deposits. Initially the government offered 20% of the value of a new house and required a minimum own deposit of 5%, with up to 75% of the price being financed by a bank mortgage. The equity loan was free from interest (except for monthly £1 service charges) for the first five years after which the cost increased to 1.75% and raised with inflation (the increase is calculated as the retail price index plus 1%). Only new houses up to £600,000 were eligible in England.

The loan could be repaid at any time (at the sale of the property if the house was sold before the loan was repaid) without additional charges. In default, the bank had the first claim to the borrower's assets and the government would only recover its funds after the mortgage principle is repaid. Critically, if the property appreciated in value and the owner chose to sell it before the equity loan was fully repaid, the principal owed to the government was a share of the new price based on the initial equity loan[5]. This was intended to reduce speculation amongst the scheme's participants. As all loans were full recourse loans strategic defaults were unlikely, which further limited opportunistic behaviour.

In the UK, mortgages are priced mainly based on their LTVs and maturity and prices usually do not vary across space. The borrower's characteristics are usually only used for a decision to grant or refuse a loan, therefore the price varies with characteristics of the loan rather than of the borrower. This means that the same borrower could be approved for a 75% loan but not for a 90% one of the same duration for the same house. In practice, this means that mortgages are not available to those who cannot afford high deposits but can afford to repay a mortgage with a low LTV ratio.

The scheme was restricted to buyers who purchase their only property and did not allow interest only or offsetting mortgages. While initially there was no restriction on income, terms of the new loans were determined not only by HTB regulations but also by mortgage market regulations that came into effect at the same time. In 2013 the Bank of England made mortgage lending ineligible for its loan

[5] If a property bought for £100,000 with a 20% equity loan is sold for £110,000 before any repayments are made the required repayment amount is £22,000.

subsidy scheme[6], which increased the cost of an average mortgage to the lending bank. In April 2014, a requirement for stricter borrower affordability tests were introduced[7] and since October of the same year only 15% of new mortgages can be higher than 4.5 multiple of the borrower's income. Similar changes were made to the HTB program. The maximum loan value was capped at 4.5 times income of the purchasing household and the debt to income ratio at 45%. It is easy to see how the UK's government measures to increase mortgage affordability through HTB, are simultaneous with efforts of the Bank of England to reduce the risk to the financial sector associated with too much lending.

In practice, HTB meant that households with good credit scores who had savings sufficient only for a 5% deposit could apply for a 75% LTV loan. This meant not only that more households were eligible for bank loans but also that average bank loans could potentially be lower, safer and cheaper (if average LTV values decreased). However, the scheme could also have made mortgages accessible to a more risky group of borrowers. Those who did not have sufficient income to borrow 95% of the value of a house or save for a deposit could purchase properties by qualifying for a 75% LTV mortgage if they were able to produce a 5% deposit[8]. In this light, it is difficult to formulate a priori expectations of the effect this should have on the mortgage credit market. On the one hand, average loans could be lower as government loans crowd out private lending (Gabriel & Rosenthal 2010), on the other, more loans could be made as credit becomes more accessible and cheaper (Duca et al. 2011). In addition, only selected house buyers and properties qualified for the scheme which means that interaction between qualifying and non-qualifying groups can also affect the overall demand for mortgage lending (Gale 1991).

[6] The Funding for lending scheme introduced in August of 2012 by the Bank of England made cheap funding available to commercial banks under the condition that they will use these funds to originate loans to small business and mortgages.

[7] Lenders were required to evaluate if with base rates three percentage points above their levels at origination the borrowers would still be able to afford the mortgage. After including the bank's margin this meant that the test was using a 5 percentage point change in mortgage rates.

[8] Note that the risk of those borrowers not repaying the equity loan is borne entirely by the government. Since the equity loan can be repaid at any time, this risk does not affect the delinquency risk of the bank mortgage significantly.

In some ways the HTB equity loan scheme is similar to the main mortgage insurance program administered by the US Federal Housing Administration (FHA). Under this scheme qualifying lenders can take mortgages to purchase properties with only 3-3.5% deposits and FHA guarantees lenders against any losses on loans given under this program. This insurance costs less than mortgage insurance from private providers for high-risk borrowers but more for those with good credit history and low payment and value ratios. Critically, it offers lower underwriting standards for both types of customers. The qualifying criteria are focused on payment-to-income and LTV ratios, consumer debt levels and the credit history of the borrower. By design they are less stringent than requirements of conventional lenders but the segment of the population qualifying for FHA but not traditional insurance is relatively small (Goodman & Nichols 1997). Nevertheless, FHA insurance is relatively popular which suggests that there are many borrowers who prefer to use this scheme over cheaper private mortgage insurance. This is interesting in the context of the present study as it suggests that when offered access to riskier loans through a governmental scheme, some borrowers prefer riskier mortgages even when they are more expensive. Indeed, Gabriel and Rosenthal (1991) and Hendershott et al. (1997) show that borrowers prefer FHA insurance when it is cheaper or when they are constrained by conventional lending standards. Pennington-Cross and Nichols (2000) show that borrowers may be constrained by income or value ratios as well as by poor credit history. This suggests that HTB equity loans may have an effect not only on buyers who would not have access to mortgages without it, but also allow buyers who could only qualify for safer loans to increase their loan to value ratios.

Additional evidence on the influence of LTV requirements on mortgage lending is provided by studies of the increase in the maximum size of FHA-guaranteed mortgages during the financial crisis. In order to counteract the rise in credit standard required for non-FHA mortgages the US government increased the maximum loan amount eligible for FHA guarantees. The intention of the policy was to stimulate mortgage lending during a credit crunch. Indeed, Blinder and Zandi (2016) as well as Duca, Muellbauer and Murphy (2016) show that the policy was successful in achieving this objective.

Critically, they show that the effect occurs not only at the extensive margin by allowing more customers to take mortgages but also at the intensive margin by allowing borrowers to borrow more than they would without governmental support. While HTB mortgage guarantees were a very similar instrument that reduced LTV restrictions on borrowing, equity loans work differently as they also allow borrowers to choose between equity and mortgage loans. Therefore, the question of the overall impact of equity loans on mortgage borrowing still remains open.

Another interesting lesson from FHA research is the impact of the program on tenure choice. Several papers show that the alternative to taking advantage of FHA insurance is not to never become a house owner but to purchase the first house at a later date (Goodman & Nichols 1997). Effectively, the program is simply accelerating the transition from renting to owning. It is possible that the overall effect of the HTB scheme could be similar and results in a higher rate of home ownership in the short term but have little long term impact. If this is the case, then in places where the HTB scheme is not limited by qualifying criteria, total housing demand may be inelastic to changes in lowering these standards.

Given the evidence from FHA studies, the impact of any changes in the HTB scheme on mortgage and housing markets depends on whether borrowers are constrained in their overall access to mortgage and in their choice of preferred financing structure. Granting access to mortgages to more customers would increase mortgage lending at the extensive margin and increase housing demand. On the other hand, allowing existing buyers to borrow more would do so through the intensive margin. Therefore, the final effect of the change in HTB policy is determined not only by its parameters but also by characteristics of the real estate market it is applied to (Coulson et al. 2016, Strobel et al. 2017).

Initially, £12bn were dedicated to the Help-to-Buy project which was supposed to end in 2017 but was extended to 2020 with an additional funding of £10bn. The participation rate in the scheme was relatively high across the country with around 20% of all new homes being purchased using HTB in the first year of its operation and the figure increasing to 33% if only properties outside of London were

considered[9]. The overwhelming majority of those loans chose the maximum equity loan of 20% of the purchase price. Although, the government reports document no impact of the scheme on the number of transactions and note that mortgage approval rates went down after it has been introduced[10], the biggest political concern was the fact that only 6% of new houses in London were bought using the scheme. The key difference was that London's buyers faced much higher price-to-income ratios than the rest of the country which meant that fewer borrowers qualified for 75% mortgages under the new affordability limits. To address this issue in November 2015 the government announced that since February 2016 the maximum level of the purchase price offered as the equity loan would be changed to 40%. Controversially, the increase would only apply to properties within the boundary of the Greater London Authority. Although average house prices in central London and their ratio to the income of local workers (including inward commuters) are much higher than in the rest of the UK, house prices do not change significantly at the border of the GLA (see table 1).

The overall effect of the change in the scheme on the value of loans given by the government in London can be seen in Figure 1 which demonstrates that HTB became significantly more popular after Q1 2016. Before the change in policy HTB loans constituted only around 10% of all new housing lending[11]. However, out of around £345m of net new lending in Q4 2016 as much as £58m (16.8%) were HTB loans. This suggests that the volume of the program is significant and that the potential effect on the volume of mortgages can be profound. This however, does not show how this figure would develop in the absence of higher equity loans. It is also difficult to assess if the popularity of the new London scheme is due to the city's high price to income ratios or the overall attractiveness of the higher loan. Until Q4 2016 only two loans in the most unaffordable area of the UK (Kensington and Chelsea located in central London) have used HTB while as many as 501 equity loans have been

[9] According to data provided by the Department for Communities and Local Government in September 2017.
[10] A detailed report of the government's evolution of the initial scheme is available in the Annual report of the Department for Communities and Local Government for years 2014-2015.
[11] This is calculated by adding the total value of new HTB loans per quarter with the change in aggregate mortgage lending reported by UK banks.

granted in much more affordable Barnet (adjacent to London's northern boundary). This suggests that the increase in popularity of the scheme could have been driven by higher equity loans rather than removing an obstacle to use HTB in unaffordable areas. However, the obvious limitation of this preliminary analysis is the fact that no counterfactual scenario is presented thus the causal impact of the HTB scheme cannot be assessed.

Figure 1. Help to buy loans and the mortgage credit market.

Methodology and data

The main aim of this paper is to establish the causal impact of the increase in the equity loan scheme on aggregate mortgage lending. The critical empirical challenge is to disentangle the impact of the program from all other determinants of aggregate lending. For example the government argues that the London version of HTB was introduced since London is distinctively different from the rest of the country. If that is the case, then it may be difficult to compare the impact of the equity loan in central London with its effect elsewhere. To solve the identification problem we focus our analysis on the boundary of the Greater London Authority as neither house prices (Table 1) nor socio-economic characteristics (Figure 3) change significantly at the border. This means that locations that are close to the boundary and within London are very similar to area located nearby but immediately outside of the GLA boundary. We do not suggest that the administrative boundary makes no difference as local taxes and public services may differ. However, the different factors that affect mortgage and housing markets on both sides of the boundary do not change systematically over time (we confirm this assumption below). This allows us to exploit the boundary discontinuity effect that occurs between postcodes on both sides of the London boundary when the limit of equity loans is changed. This natural experiment also allows us to identify the impact of HTB on very small areas at the postcode sector level, and provides a comparable control group that allows to disentangle the impact of higher government lending on mortgage lending. Our spatial discontinuity analysis relies on a regression discontinuity design (RDD) in which the treatment is assigned to geographical locations.

The fact that mortgages are tied to specific locations makes them ideal for this approach. By comparing observations lying closely on either side of the border, it is possible to estimate the average treatment effect even when randomization is unfeasible. Following the RDD in a difference-in-differences fashion, the general empirical model is formulated as follows:

$$Y_{it} = \alpha_i + \gamma(L_i \times H_t) + \beta X_{it} + \varepsilon_{it}$$

In the above equation Y_{it} is aggregate mortgage lending for the postcode sector *i* in quarter *t*. The main parameter of interest is γ, which captures the different impact of the HTB policy change for postcode sectors within the GLA boundary if $L_i = 1$ (and $L_i = 0$ otherwise) after the HTB policy reform has taken place in the first quarter of 2016 when $H_t = 1$ (and $H_t = 0$ otherwise). In addition, we include X_{it}, a vector of area-specific time-variant factors that affect mortgage lending, such as the total number of transactions per value band, the average transaction price and postcode and quarter fixed-effects.

The data on mortgage lending by banks comes from UK Finance. It is an aggregation of the biggest mortgage lenders and accounts for 73% of all UK mortgages. The quarterly aggregate mortgage lending includes new loans and borrowing agreements carried forward from the previous period less the amount repaid or written off. This means that the quarterly change in the figure reflects new mortgages minus the amount repaid on existing loans.

The mortgage data is available at postcode sector level. The UK is divided into 10,000 postcode sectors (lending occurs only in 9,247) with an average size of around 1,000 addresses in each sector (but with high standard deviation). Table 1 shows that in our sample the average lending per sector was around £200m. This is much larger than the national average of £100m but similar to the average for London. Overall, mortgage lending in the capital and the three layers of postcodes around the GLA boundary account respectively for around 24.7% and 4.66% of all UK lending. This demonstrates that although the sample of postcodes may seem small, it represents a meaningful proportion of the UK's mortgage credit market. The earliest time period available in this data is Q2 2013 and the latest is Q1 2017.

Table 1. Descriptive statistics of postcode lending data.

Data on Help To Buy mortgages comes from the Department for Communities and Local Government. It is available quarterly since the beginning of the program but only at Local Authority District level. It includes the number and value of HTB loans made in each quarter.

Data on housing comes from the Land Registry and includes all transactions of residential dwellings in England. This dataset provides information on prices and indicates if the sold property is newly built or existing. Table 1 shows that neither average house prices nor the number of new transactions differed significantly between sectors located next to the boundary. In fact, as shown in the appendix, we find that after controlling for location and period fixed effects there is no significant difference in house prices and the number of transactions between postcodes even after the change in HTB is introduced. Note, that we do not control for the characteristics of the transacted houses, thus we do not make inference about prices of individual properties.

To precisely identify the postcode sectors on both sides of the GLA boundary we first employ information about the administrative boundaries of the Greater London Authority provided by the Office for National Statistics Open Geography Portal as shown in Figure 2. Specifically, bordering postcode sectors are identified using the ONS postcode centroids shapefile, determining their adjacency to the border of GLA using ArcGIS proximity toolbox. The first layer comprises all postcode sectors which include at least one full postcode which is tangent to the boundary, while the second layer includes postcodes adjacent to the first layer and the third layer includes sectors tangent to the second layer. Once we identify the three different layers, we keep in our sample all postcode sectors with centroids within 2 kilometres from the boundary, precisely identifying similar and comparable sectors inside and outside of the Greater London Authority.

Figure 2. Administrative Boundary of the Greater London Authority

The regression discontinuity design, combined with the difference-in-differences methodology, allows us to precisely estimate the different impact of the HTB policy reform on the aggregate mortgage lending for postcode sectors within the GLA boundary versus the non-affected sectors immediately outside of the administrative boundary, before and after the policy change in February 2016. In this way, we are able to control for possible pre-treatment trends and structural differences between postcodes on the two sides of the GLA border, which would violate the conditional independence assumption.

We start our empirical analysis by implementing a simple fixed effects OLS panel regressions where the treatment variable is a dummy variable that equals 1 for postcodes sectors inside the GLA boundary in periods after Q4 2015 and zero otherwise. Secondly, to control for the presence of parallel trends between postcode sectors on both sides of the GLA boundary before the HTB policy reform, we interact the "London" dummy L_i with each of the quarters in our time period H_t from Q3 2013 to Q1 in 2017. In this way we are be able to explicitly assess the change in aggregate lending that occurred after Q1 2016 when the HTB policy in London has been changed, while controlling for potential pre-treatment differences in trends between postcode sectors within and outside the GLA boundary.

A potential concern for our analysis regards the possible spillover effect the HTB policy reform could have on the postcode sectors located immediately outside of the GLA boundary. It is possible that the reform of the HTB policy for the Greater London area could trigger a negative spillover effect on the first layer of postcodes located immediately outside London, since agents might decide to stop buying houses in these sectors and to relocate within the GLA boundary to take advantage of the new HTB policy. This could affect our analysis by overestimating the impact on mortgage lending within the GLA if we do not take appropriately into account the potential negative impact on the first outside layer. To address this issue, we estimate two separate models: in the first in which we consider only the two first layers immediately inside and outside of the GLA boundary; in the second one we remove the

first layer immediately outside the GLA area, thus comparing the HTB policy impact on aggregate mortgage lending GLA areas versus the second outside layer only, which should be less prone to potential negative spillover effects.

Figure 3. Postcode Sectors Layers 1 and 2 on both sides of the Greater London Authority and their socio-economic characteristics.

Another possible concern for our estimation is that the aggregate lending data at the postcode sector-level is influenced by borrowing contracts made in previous periods, thus introducing a new source of bias linked to the autocorrelation of our dependant variable. As a robustness test, we estimate the above equation by employing models robust to autocorrelation. First we employ a GMM Arellano-Bond (1991) estimator including lags of the dependent variable up to three quarters before the change in the HTB policy in Q1 2016. By implementing a dynamic system GMM with lags of the dependent variable we take into consideration the potential autocorrelation with the predetermined aggregate lending. System GMM has been found to be more efficient compared with difference GMM, particularly in the presence of heteroscedasticity (Arellano and Bond, 1991). To evaluate the overall goodness of fit of the GMM models we report the Sargan tests for over-identifying restrictions and we test for the presence of first and second order serial autocorrelation (Windmeijer, 2006). Finally, as a further robustness test, we estimate a first difference model in which the dependent variable is the growth of net lending in each quarter. Note that when previous lending contracts are controlled for, the estimated coefficients can also be interpreted as the impact of independent variables on net lending per quarter rather than on its aggregate levels. This is explicit in the first difference model but applies to all specifications that control for autocorrelation.

Results

Table 2 presents results of a regression of aggregate mortgage lending on time and postcode fixed effects. The second column, shows that the first layer of postcodes within London has a higher level of aggregate borrowing compared to postcodes outside of London after the equity loan limit is

changed. This suggests that the change in HTB increased aggregate mortgage lending. This result remains significant after controls for different values of transactions are included in the regression. It appears that increasing government lending had an overall positive effect on the volume of bank mortgage lending.

Table 2. Regression results for aggregate mortgage lending in layer 1.

Table 3 shows explicitly that the change in aggregate lending occurred in Q1 2016 when the HTB scheme was introduced. It also presents evidence that trends in mortgage lending on the opposite sides of the GLA boundary before the new level of equity loans was introduced were parallel. This is most clearly visible in column 3 in which none of the controls for the difference between quarterly mortgage lending in the treatment group before Q1 2016 are significant. This changes after the new rules of HTB are introduced which is consistent with the expectation that the higher equity loans has a significant impact on mortgage lending. Aggregate mortgage lending appears to increase by an average of around £3m in the treated postcodes. Although estimates vary between models and over time, this represents an increase of around 1.5% in the average outstanding mortgage lending per postcode. It also appears that the shift in lending occurred as a step change at the time of policy change. The treated sample does not appear to be following a different trend after it adjusts to the new policy.

Table 3. Regression results for trends in aggregate mortgage lending in layer 1.

Figure 4 shows the relative differences in aggregate mortgage lending across space and time. It appears that while the change in mortgage lending from layer 2 to layer 1 on both sides of the GLA boundary remained similar after HTB rules are changed, the difference between the first layers increases. This confirms that the change reported in tables 2 and 3 occurs at the border of GLA. It also suggests that the spillover effect across the boundary is relatively small. If the change in HTB affected only the first layers, the relation between layer 1 and layer 2 (on each side of the boundary) would change after higher equity loans are introduced. Further evidence of the fact that the effect is not

limited to spillovers across adjacent postcodes on different sides of the GLA boundary is provided in table 4. The results clearly show that even after the sample is expanded to include all 295 postcodes in the first two layers, the magnitude of the boundary discontinuity effect remains unchanged. The conclusions do not change even after the first layer of postcodes outside of London is removed from the estimation sample[12].

Figure 4. Mortgage lending relative to different layers.

Net change in lending

As already noted, one of the possible concerns for the estimated results is that aggregate lending data is influenced by borrowing contracts made in the past, thus making the dependant variable highly auto-correlated. To show that our conclusions are not affected by this issue, table 4 presents results for models robust to auto-correlation. Columns 1 and 2 show estimates based on the GMM Arellano-Bond (1991) estimator and show that lags of the dependent variable are significantly affecting its contemporary values. Note that even after controlling for a lag of three quarters the change in Q1 2016 remains significant and positive. This is also true when the sample is extended to include all layers and the sample size is increased to 295 postcodes. Column 3 presents results for a fixed-effects model that assumes first-order autocorrelation following the method suggested by Baltagi and Wu (1999). The results are consistent with earlier estimations. Note that the goodness of fit statistic decreases significantly as a much lower proportion of variance is now explained by the model. Nevertheless, there is a clear positive effect of introducing HTB in Q1 2016. The final column uses a first difference model in which the dependent variable is net lending in each quarter. The results show that the value increases in Q1 2016 in London postcodes by around £0.664m compared to areas located outside of the GLA boundary. This difference stays constant afterwards suggesting that the change occurred as a step increase in lending in London postcodes.

[12] Results are available from the authors upon request.

Table 4. Additional regression results for trends in aggregate mortgage lending.

Table 4 offers estimates of the HTB effect that are much lower than previously estimated. It appears that after controlling for momentum in mortgage lending, the impact of the change in the equity loan decreases. However, these results need to be interpreted in the context of the average net change in lending per postcode, which in Q4 2015 is around £2.5m. The estimate of the HTB effect of £1m means that net lending in Q1 2016 increased by around 40% more in the treated locations than in the control group. After the step change in Q1 2016 all subsequent changes were parallel on both sides of the boundary.

It is possible that the results are driven by the fact that our data does not cover all mortgage lending in the UK. In principle is possible that after the change in the HTB equity loan scheme borrowers would switch from lenders that are not in our sample to lenders who are. This would translate into an increase in mortgage lending in our sample but not in the population. In practice, it is difficult to imagine that such a 'lender substitution' effect really takes place. First, in London the concentration of the mortgage market is higher than in the rest of the country (BBA 2014) so our sample covers a higher proportion of total lending than the UK average of 73%. Second, it is unclear why in a market with very high customer loyalty borrowers would switch to another bank due to a government policy which affects all lenders equally. While lenders had to opt into participating in the HTB scheme, 15 biggest lenders (covering over 95% of the lending market) took part in the program. Finally, switching banks would have to occur instantly after the policy changed, persist over time at the same level and not spill over across the boundary. Losing customers to other banks would probably elicit an attempt to attract new customers so it is unlikely that the effect of lender switching would remain constant over time. If customers were attracted to bigger lenders (for example by intensifying marketing

efforts) at the time of the change in policy, then the effect should be similar across the boundary of London[13].

Placebo test

To provide further evidence that it is the change in the Help-To-Buy scheme that affects mortgage lending in London postcodes we provide a test of its impact on Small and Medium Enterprise lending using the same methodology. If the change found in mortgage lending is driven not by higher equity loans but by a structural change in local credit markets (for example more intense advertising, change in consumer attitude towards credit or opening/closing of bank branches) then the effect should be noticeable in SME lending as well as in mortgages.

Table 5 replicates the results presented in table 2 and in the first column of table 3 and shows that the change in HTB had no impact on SME lending. We find no evidence that introducing higher equity loans affected lending to small businesses.

Table 5. Regression results for aggregate SME lending in layer 1.

Other effects and interpretation

Although it goes beyond the scope of this study, in the appendix we present a summary of the estimations considering the impact of the change in HTB on housing market variables. We find that the change in the rules of the scheme had virtually no impact on any variable other than mortgage lending. The total number of transactions did not change after higher equity loans were offered in London nor did the ratio of existing to new houses. This suggests that neither the size nor the composition of the transacted stock is sensitive to the amount offered as government loans for newly

[13] Note that the results of the SME placebo test are consistent with the expectation that higher equity loans lead to more mortgage lending but not with the claim that the results of tables 3 and 4 are driven by a lender switching effect being caused by a characteristic of the mortgage market that changed at the same time as the HTB policy. Although not reported in this study, a similar placebo test performed on personal loans rather than SME lending gives the same results (no effect of HTB). These tests show that HTB changes did not affect customer preference for borrowing from a particular bank in SME and personal loan markets. If customers were really switching mortgage lenders due to the HTB scheme changes it is likely that some effect could be noticeable in the other two credit markets due to cross selling.

built houses. In fact, we find no evidence that the scheme affects housing demand at all as total value of transactions as well as the average value per transaction remain unchanged after the limit of equity loans is changed. By focusing on total and average values of transactions, we show that the increase in mortgage lending is not related to a higher trading volume. Instead, it appears that higher equity loans increase demand for mortgage debt not only as an aggregate volume of loans but also as a percentage of transaction volume.

To better interpret the results, it is worth noting the specific conditions of the housing market we analyse. While prices in central London are notoriously unaffordable, the problem is less severe at the edge of the city. Around the boundary, prices are still relatively high which is attributable mainly to the fact that housing supply in this part of the country is heavily constrained by very strict planning policies. This translates into new supply being price inelastic. Although our sample is too short for supply to be able to adjust to demand shocks, it is worth noting that the supply of (new) houses eligible for the HTB scheme is predetermined. At the same time, demand can fluctuate according to economic conditions and credit accessibility (Braakmann 2016). While increasing the limit of equity loans was intended to have a strong impact on housing demand in central London where high prices made it difficult for many to qualify for the HTB scheme with 20% equity loans, it is less clear that the impact at the edge of the city would be the same. The response in housing demand depends on how many additional buyers qualify for mortgages and how many buyers who previously qualified are willing to purchase more expensive houses. However, in places where the supply had never been able to satisfy the demand for HTB-supported houses due to planning restrictions, changing the scheme could have little effect on the housing market. With a predetermined quantity and quality of houses that qualify for the HTB scheme and a limit on the maximum price, it is possible that average numbers and values of transactions may not change even if demand increases because they are limited by housing supply and price limits rather than mortgage accessibility.

As discussed in section 2, the impact on mortgage demand is less clear and can occur either through changes in the number of loans or through changes in LTV ratios. As we do not have borrower-level data we are unable to tell if the households that use HTB after the change have the same level of income and LTV ratios as before. Therefore, it is not possible to show what drives the change in demand for mortgages. One possibility is that buyers with specific debt preferences are crowding out other groups. This would be consistent with the prediction of Gale (1991). To an extent, if the dominant group are first-time buyers with low incomes, it would also mean that HTB is meeting the government's target. However, it is also possible that households who would otherwise use less mortgage debt are choosing to increase their LTVs due to the change in the equity loan program. Indeed, the results from FHA studies suggest that the effect of changing the equity loan allowance is more likely to be on the intensive margin through allowing buyers who are able to purchase homes with higher equity loans to change their financing structure.

The latter explanation is consistent with the fact that we do not see any changes in housing demand. We find no evidence of an increase in the number of transactions even after examining transactions at different price levels. Although the scheme is limited to assets worth up to £600,000, there is no change in the number of transactions around this value. We also examine the average transaction value and find that a higher equity loan has no statistically significant impact on the average value of a sold property. However, this does not mean that house prices are not affected. As we do not control for housing characteristics, the houses sold after Q1 2016 could be different so the constant average transaction price does not necessarily reflect housing demand. While focusing on transaction values and volumes is sufficient for an analysis of credit markets, we offer no firm conclusions of the impact of HTB on the housing market. While is possible that our results are limited to places where supply is

restricted[14], it is worth noting that these are the areas where housing is unaffordable and housing finance interventions are mostly required.

Conclusions

This paper provides empirical evidence on the impact of government equity loans on private mortgage lending. Although it builds on a long history of theoretical research in banking and public economics, it is the first study to document a direct causal link. The results suggest that providing higher government loans increases overall mortgage lending. This effect is consistent with the expectation that government loans alleviate credit rationing limitations and increase the size of the mortgage credit market. However, an important feature of our findings is that we test the impact of a very specific mortgage loan program which helps qualifying buyers purchase qualifying properties in a market where housing supply is restricted and cannot identify the process through which the policy affects mortgage lending. As predicted by Gale (1991), changing the parameters of the scheme could potentially alter its outcome. Nevertheless, our results clearly show that providing additional funding positively affects mortgage lending.

Housing finance schemes often have political and economic consequences. While we do not examine whether introducing higher equity loans achieves the government's political objectives, it appears that it stimulates mortgage borrowing. This finding is important in the context of the debate on substitutability between government and bank loans as well as between debt and other forms of financing. While this issue has been studied in firms, there is no evidence on how households make those decisions. We show that government and bank mortgages do not seem to be perfect substitutes and that a targeted program may increase overall lending.

The key economic concern for modern housing finance schemes is if the expansion of mortgage lending comes with an increase in the risk to the financial sector. One of the downsides of secondary

[14] If equity loans stimulate demand and supply is price elastic it could be possible that higher equity loans stimulate demand, increase prices and consequently stimulate development activity.

market guarantees is their negative impact on screening standards (Keys et al. 2010; Duca et al. 2011) which leads to higher credit accessibility but induces higher risk into the financial system. With direct equity loans the government assumes most of the housing market risk and partially shields banks from excessive exposure to volatility in house prices. While this is different from mortgage guarantees where the government assumes all losses when the borrower defaults, the effect of the two programs on mortgage borrowing is similar. For the government, the critical differences is that equity loans require less capital to be exposed to risk (full value of the equity loan) than mortgage guarantees (full value of the mortgage). Although the percentage loss in default is higher for equity loans, the nominal amount lost in default is the same or lower than for mortgage guarantees. Because banks also assume some risk, choosing equity loans over mortgage guarantees shifts some of the risk of extreme events to lenders. This suggests that if the government is willing to bear the risk of lending to borrowers who are not served by banks, equity loans may be able to achieve this objective without significantly affecting the stability of the financial system. This approach appears to be an improvement on polices focused on providing secondary market guarantees which allow lenders to give higher volumes of more of risky loans and mortgage guarantees which shield lenders from all losses.

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Appendix

Table A1 shows that the change in the equity loan scheme did not impact the difference between postcodes on the opposite sides of the GLA boundary in any of the key housing market variables presented. While the coefficient for the number of transactions in London in Q1 2016 is significant it needs to be noted that the number of houses bought and sold in London is higher in a number of periods and it is difficult to attribute this effect to any particular phenomenon. Critically, for this study there is no systematic change in the difference between treatment and control groups that occurs in Q1 2016. Replicating the analysis of housing markets using the simple approach applied in table 2 also shows no impact of HTB and yields the same conclusion.

Table A1. Regression results of spatial discontinuity in the Help-to-Buy scheme on housing market variables.

VARIABLES	(1) New houses transaction number	(2) Number of house transactions	(3) Total transaction value	(4) Average price of a transaction	(5) Number of transaction £500k-£600k	(6) Number of transaction £600k-£700k
lon_q3_2013	-2.932**	0.0278	-128.2	6,840	0.805	0.187
	(1.213)	(0.480)	(1,372)	(58,507)	(0.531)	(0.376)
lon_q4_2013	-3.015**	-0.118	-988.6	-18,902	0.220	0.404
	(1.212)	(0.479)	(1371)	(58,450)	(0.531)	(0.376)
lon_q1_2014	-0.978	0.116	-32.7	-7,794	0.541	-0.0307
	(1.212)	(0.479)	(1,371)	(58,434)	(0.531)	(0.376)
lon_q2_2014	-1.516	0.0240	71.6	16,250	1.110**	0.505
	(1.213)	(0.480)	(1,372)	(58,495)	(0.531)	(0.376)
lon_q3_2014	-0.252	1.170**	-745.8	-37,181	1.474***	0.257
	(1.214)	(0.480)	(1,374)	(58,559)	(0.531)	(0.376)
lon_q4_2014	-0.992	0.942*	593.2	-7,379	0.126	0.0279
	(1.215)	(0.481)	(1,375)	(58,613)	(0.531)	(0.376)
lon_q1_2015	-0.404	0.252	914.9	70,742	0.375	0.143
	(1.212)	(0.479)	(1,371)	(58,450)	(0.531)	(0.376)
lon_q2_2015	0.247	0.499	1379.0	43,329	0.640	0.139
	(1.212)	(0.479)	(1,371)	(58,471)	(0.531)	(0.376)
lon_q3_2015	-0.443	1.056**	1119.0	52,800	0.695	0.438
	(1.214)	(0.480)	(1,373)	(58,549)	(0.531)	(0.376)
lon_q4_2015	-1.153	1.179**	1365.0	46,390	0.550	0.357
	(1.214)	(0.480)	(1,374)	(58,563)	(0.531)	(0.376)
lon_q1_2016	**-0.318**	**0.947****	**1015.0**	**9,651**	**0.0862**	**0.263**
	(1.214)	**(0.480)**	**(1,374)**	**(58,561)**	**(0.531)**	**(0.376)**
lon_q2_2016	**0.117**	**0.605**	**-117.3**	**-39,864**	**0.564**	**0.430**
	(1.213)	**(0.480)**	**(1,372)**	**(58,482)**	**(0.531)**	**(0.376)**
lon_q3_2016	**1.988**	**0.531**	**898.3**	**-1,472**	**0.364**	**0.119**
	(1.211)	**(0.479)**	**(1,370)**	**(58,420)**	**(0.531)**	**(0.376)**
lon_q4_2016	**1.516**	**0.967****	**2541.0****	**88,471**	**0.795**	**0.245**
	(1.212)	**(0.479)**	**(1,371)**	**(58,441)**	**(0.531)**	**(0.376)**
lon_q1_2017	**0.120**	**0.857***	**1169.0**	**30,498**	**0.780**	**0.759****
	(1.214)	**(0.480)**	**(1,373)**	**(58,524)**	**(0.531)**	**(0.376)**
Constant	-12.15***	1.022***	1327.00**	380,584***	1.151***	0.751***
	(0.520)	(0.205)	(587.771)	(25,059)	(0.187)	(0.132)
Values	Units	Units	£000s	£s	Units	Units
Observations	2,001	2,001	2,001	2,001	2,001	2,001
R-squared	0.599	0.974	0.438	0.085	0.149	0.098
Number of PCs	126	126	126	126	126	126
Quarter FE	YES	YES	YES	YES	YES	YES
Postcode FE	YES	YES	YES	YES	YES	YES
Transaction controls	YES	YES	YES	YES		

Notes: Dependant variables are given in the first row, Standard errors clustered at sector level are in parentheses, *** p<0.01, ** p<0.05, * p<0.1, all results are for a fixed effects panel regressions, transaction controls include the number of new transactions and 8 variables that include the number of transactions in 8 price brackets from zero to £800,000 with £100,000 intervals, the series of variables denoted as lon_qX_20XX is a series of dummy variables which are a time fixed effect for postcodes located in London, they are included in addition to a general time trend and represent the divergence of the trend in London form the overall time-fixed effect.

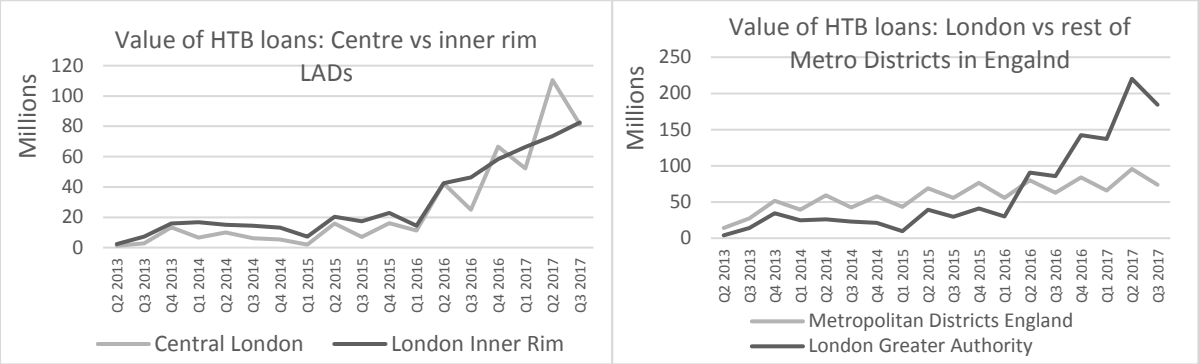
Tables and Figures

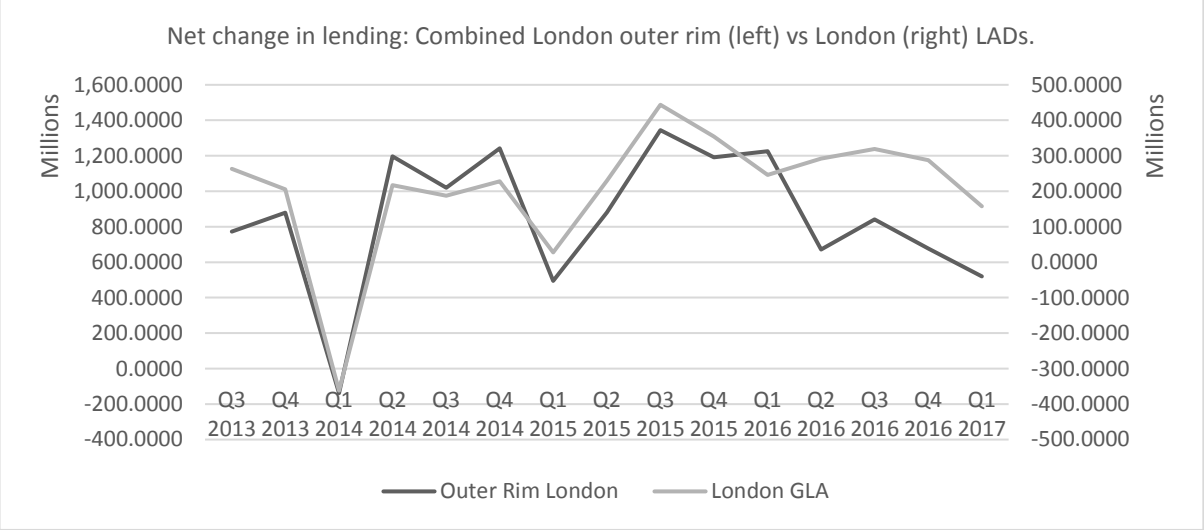
Table 1. Descriptive statistics of mortgage lending per postcode sector.

Postcode sectors adjacent to the GLA boundary (within London)					
	Sectors	Mean	Std. Dev.	Min	Max
Aggregate mortgage lending	68	£219m	£86.6m	£23.1m	£541m
Total number of transactions	68	37.25	18.89	1	172
Total value of transactions	68	£15.8m	£9.1m	£0.2m	£93.5m
Average transaction price	68	£464,278	£288,095	£156,673	£3,956,111
Transactions of new houses	68	2.80	8.11	0	119
Postcode sectors adjacent to the GLA boundary (outside London)					
Aggregate mortgage lending	57	£179m	£69.3m	£41.6m	£373m
Total number of transactions	57	33.62	21.57	2	210
Total value of transactions	57	£14m	£9.4m	£0.5m	£98.8m
Average transaction price	57	£460,688	£325,007	£119,477	£4,489,245
Transactions of new houses	57	3.88	11.28	0	124
All postcode sectors within the GLA boundary (all of London)					
Aggregate mortgage lending	1,183	£190.7m	£105.5m	£2.05m	£492.6m
All postcode sectors in the UK					
Aggregate mortgage lending	9,247	£103m	£78.56m	£0.37m	£697.5m

Notes: Data used to calculate summary statistics covers all years before Q1 2016 (before the change in HTB policy). Within this sample period, the mean and standard deviation are calculated across all sectors. GLA stand for Greater London Authority, m denotes millions.

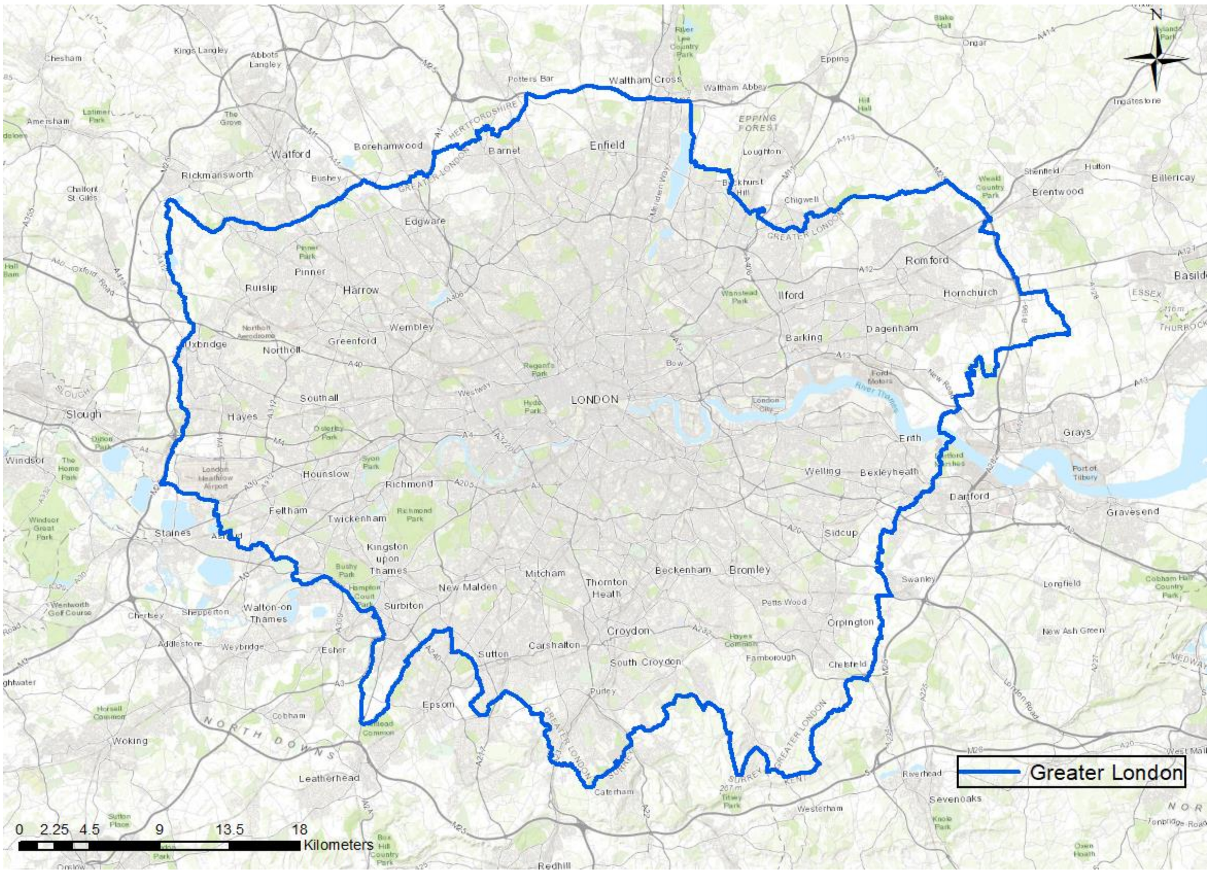
Figure 1. Help to buy loans and the mortgage credit market.





Notes: The data used in these figures is described in section 4. Central London is a group of boroughs located closest tot eh centre of the city defined by the Greater London Authority. The 'Inner Rim' is a group of London boroughs adjacent to the boundary of GLA. Metropolitan districts are defined by the Office for National Statistics. The 'outer rim' are local authority districts adjacent to the GLA boundary but not located outside of London.

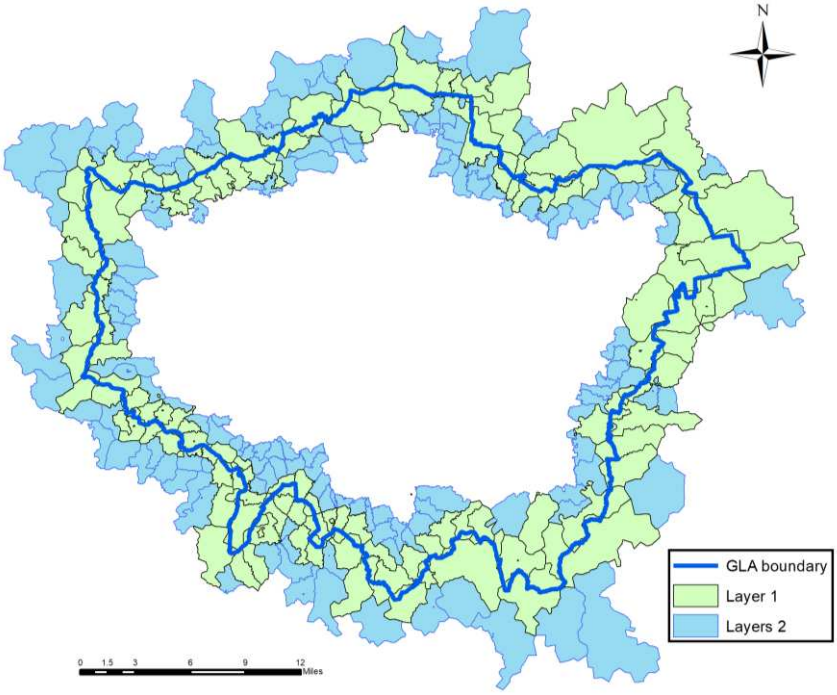
Figure 2. Administrative Boundary of the Greater London Authority



Sources: Elaboration of the Office for National Statistics Open Geography Portal shapefile for the GLA using ArcGIS

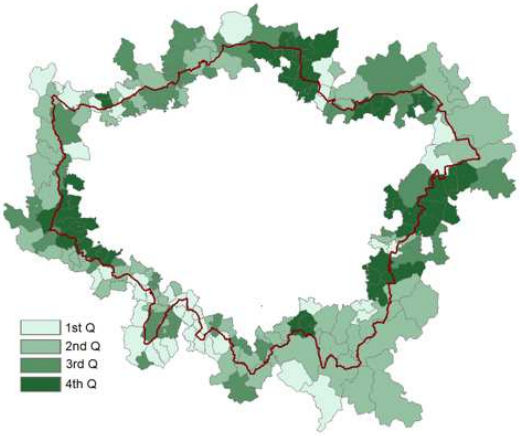
Figure 3. Postcode Sectors Layers 1 and 2 on both sides of the Greater London Authority

Sources: Elaboration of the ONS postcode centroids shapefile using ArcGIS

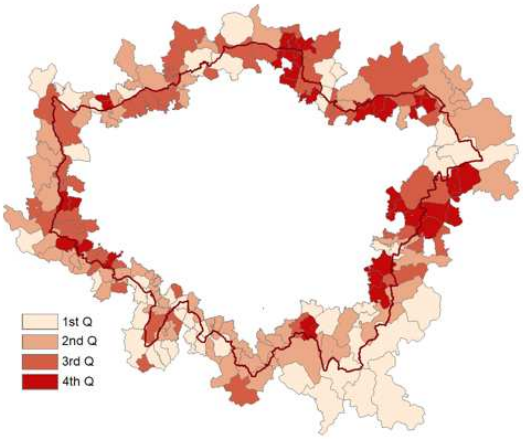


Source: The English index of multiple deprivation (sectors are divided into four equal groups).

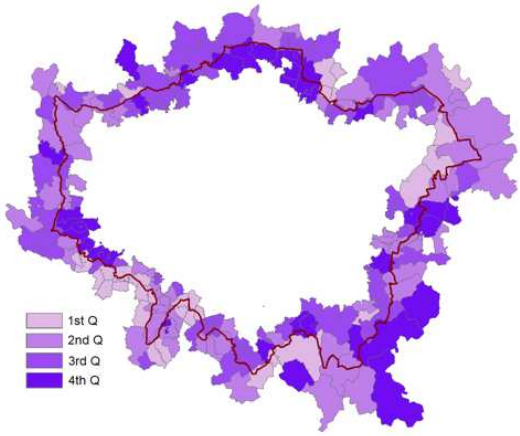
(a) Deprivation Index



(b) Income Deprivation Index



(c) Housing Deprivation Index



(d) Av. Transaction Value

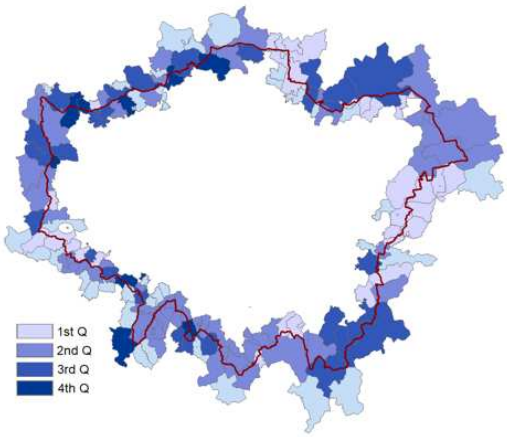


Table 2. Regression results for aggregate mortgage lending in layer 1.

VARIABLES	(1)	(2)	(3)
Treatment		**3,024*** **	**3,102*** **
		(720.4)	**(676.3)**
Constant	188,300***	188,300***	188,300***
	(668.2)	(665.3)	(758.5)
Values	£000s	£000s	£000s
Observations	2,001	2,001	2,001
R-squared	0.604	0.607	0.658
Number of PCs	126	126	126
Quarter FE	YES	YES	YES
Postcode FE	YES	YES	YES
Transaction control			YES

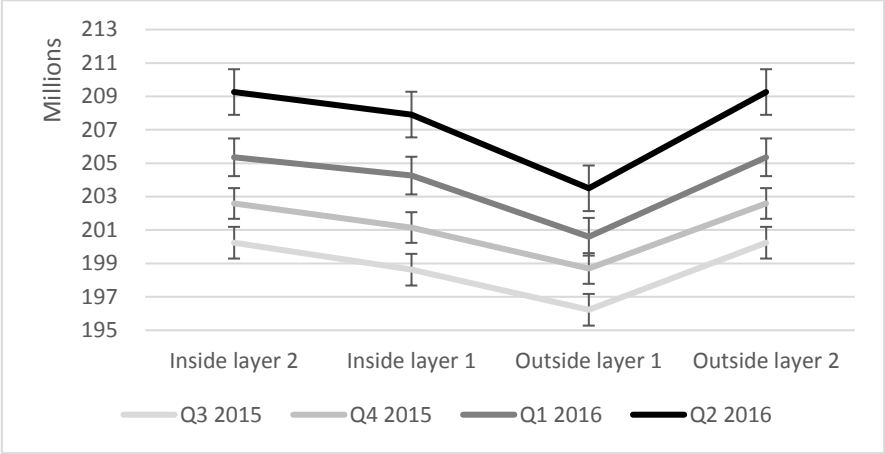
Notes: The dependent variable is aggregate mortgage lending, standard errors clustered at sector level are in parentheses, *** p<0.01, ** p<0.05, * p<0.1, all results are for a fixed effects panel regressions, the treatment variable is a dummy variable that equals 1 in periods after Q4 2015 and zero otherwise, transaction controls include the number of new transactions and 8 variables that include the number of transactions in 8 price brackets from zero to £800,000 with £100,000 intervals.

Table 3. Regression results for trends in aggregate mortgage lending in layer 1.

VARIABLES	(1)	(2)	(3)	(4)
lon_q3_2013			111.7	
			(1,776)	
lon_q4_2013			-112.5	
			(1,774)	
lon_q1_2014			561.9	
			(1,774)	
lon_q2_2014			-445.4	
			(1,776)	
lon_q3_2014			954.2	
			(1,778)	
lon_q4_2014			894.9	
			(1,779)	
lon_q1_2015			1,409	
			(1,774)	
lon_q2_2015			1,991	
			(1,775)	
lon_q3_2015			2,400	804.5
			(1,777)	(849.5)
lon_q4_2015		1,666	2,452	890.6
		(1,315)	(1,778)	(851.5)
lon_q1_2016	**2,716****	**2,874****	**3,660****	**1,776****
	(1,310)	**(1,316)**	**(1,778)**	**(851.7)**
lon_q2_2016	**3,483*****	**3,638*****	**4,413****	**2,331*****
	(1,309)	**(1,315)**	**(1,775)**	**(851.8)**
lon_q3_2016	**3,586*****	**3,738*****	**4,511****	
	(1,308)	**(1,313)**	**(1,773)**	
lon_q4_2016	**2,865****	**3,017****	**3,789****	
	(1,308)	**(1,314)**	**(1,774)**	
lon_q1_2017	**2,859****	**3,013****	**3,793****	
	(1,310)	**(1,316)**	**(1,777)**	
Constant	186,800***	186,800***	186,808***	206,200***
	(759,315)	(759,257)	(760,688)	(685,400)
Values	£000s	£000s	£000s	£000s
Observations	2,001	2,001	2,001	626
R-squared	0.658	0.658	0.659	0.628
Number of PCs	126	126	126	126
Postcode FE	YES	YES	YES	YES
Quarter FE	YES	YES	YES	YES
Transaction control	YES	YES	YES	YES

Notes: The dependent variable is aggregate mortgage lending, standard errors clustered at sector level are in parentheses, *** p<0.01, ** p<0.05, * p<0.1, all results are for a fixed effects panel regressions, transaction controls include the number of new transactions and 8 variables that include the number of transactions in 8 price brackets from zero to £800,000 with £100,000 intervals, the series of variables denoted as lon_qX_20XX is a series of dummy variables which are a time fixed effect for postcodes located in London, they are included in addition to a general time trend and represent the divergence of the trend in London form the overall time-fixed effect. Column 1 shows that postcodes in London were on a different trend than the rest of the sample since Q1 2016, column 2 shows that in Q4 2015 there was no difference between the two groups, column 3 shows that there was no difference between the two groups at any point in the sample before Q1 2016 when it became significant, column 4 shows that there was a clear change between the second half of 2015 and the first half of 2016 in the difference between the treatment and control groups.

Figure 4. Mortgage lending relative to different layers.



Notes: The boundary of GLA is between 'inside layer 1' and 'outside layer1', the average distance of layer 1 and layer 2 postcodes to the boundary is 0.95km (0.59m) and 1.05km (0.65m) respectively, the figure is meant to represent the change in the difference in mortgage lending in layers relative to other layers.

Table 4. Regression results for dynamic panel models of aggregate mortgage lending.

VARIABLES	(1) Levels	(2) Levels	(3) First difference
l.mort	0.992***	0.869***	
	(0.0195)	(0.0897)	
l2.mort		0.128	
		(0.0915)	
ld.mort			-0.131
			(0.0896)
lon_q3_2014	36,080	-105,575	-104,259
	(536,892)	(494,293)	(494,012)
lon_q4_2014	-246,702	-260,160	-254,031
	(553,896)	(501,670)	(500,274)
lon_q1_2015	-714,977	-831,685	-835,317
	(525,821)	(480,740)	(480,092)
lon_q3_2015	757,823	711,496	709,274
	(491,487)	(460,690)	(460,312)
lon_q1_2016	**1,129,300****	**953,216***	**939,903***
	(575,148)	**(556,332)**	**(551,096)**
lon_q2_2016	845,351	745,800	733,569
	(587,255)	(559,990)	(555,560)
lon_q3_2016	375,717	260,899	242,351
	(583,148)	(556,631)	(546,673)
lon_q4_2016	-681,287	-823,698	-843,751
	(587,739)	(563,543)	(552,069)
lon_q1_2017	394,298	106,254	85,509
	(592,391)	(594,464)	(582,816)
Observations	1,750	1,625	1,625
Number of PCs	125	125	125
Postcode FE	YES	YES	NO
Quarter FE	YES	YES	YES
Transaction	YES	YES	YES

Notes: The dependent variable for columns 1 and 2 is aggregate mortgage lending, for column 3 it is the first difference (new lending), standard errors clustered at sector level are in parentheses, *** p<0.01, ** p<0.05, * p<0.1, transaction controls include the number of new transactions and 8 variables that include the number of transactions in 8 price brackets from zero to £800,000 with £100,000 intervals, the series of variables denoted as lon_qX_20XX is a series of dummy variables which are a time fixed effect for postcodes located in London, they are included in addition to a general time trend and represent the divergence of the trend in London form the overall time-fixed effect, the lx.mort variable is a time lag of the dependent variable where x represents the number of lagged periods, ld refers to the frist lag of the first diffrence. Column 1 shows that a one period lag is strongly influencing the current level of borrowing the p value of the Arellano-Bond test for first and second order autocorrelation is 0.0 and 0.04 respectively, the p value of the Sargan test is 0.21, Column 2 shows that including a two period lag addresses the problem of second order autocorrelation shown in column 1 as the p value of the Arellano-Bond test for first and second order autocorrelation in column 2 is 0.0 and 0.856 respectively, while the p value of the Sargan test is 0.43. Column 3 also passes these specification tests with p values of 0.0, 0.81 and 0.35 respectively.

Table 5. Regression results for aggregate SME lending in layer 1.

VARIABLES	(1)	(2)	(4)	(5)
lon_q1_2016				**773.9**
				(766.3)
lon_q2_2016				**309.9**
				(765.9)
lon_q3_2016				**-1,014**
				(764.9)
lon_q4_2016				**-970.9**
				(765.3)
lon_q1_2017				**-1,554***
				(766.3)
treatment			**-492.4**	
			(396.3)	
Constant	14,980***	15,220***	15,230***	15,230***
	(364.9)	(444.3)	(444.5)	(444.1)
Values	£000s	£000s	£000s	£000s
Observations	2,001	2,001	2,001	2,001
R-squared	0.099	0.1014	0.1001	0.1015
Number of PCs	126	126	126	126
Quarter FE	YES	YES	YES	YES
Postcode FE	YES	YES	YES	YES
Transaction Controls	No	YES	YES	YES

Notes: The dependent variable is aggregate SME lending, standard errors clustered at sector level are in parentheses, *** p<0.01, ** p<0.05, * p<0.1, all results are for a fixed effects panel regressions, the treatment variable is a dummy variable that equals 1 in periods after Q4 2015 and zero otherwise, transaction controls include the number of new transactions and 8 variables that include the number of transactions in 8 price brackets from zero to £800,000 with £100,000 intervals, the series of variables denoted as lon_qX_20XX is a series of dummy variables which are a time fixed effect for postcodes located in London, they are included in addition to a general time trend and represent the divergence of the trend in London form the overall time-fixed effect.