THE ECONOMIC IMPACTS OF HELP TO BUY*

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THE ECONOMIC IMPACTS OF HELP TO BUY

Abstract

The British government introduced its new flagship housing policy—Help to Buy (HtB)—in 2013. The policy aims to help households, especially first-time buyers, to overcome their credit and liquidity constraints, stimulate housing construction and increase housing affordability. To explore the economic impacts of HtB, we exploit a difference-in-discontinuities design, taking advantage of spatial discontinuities in the scheme that emerge at the Greater London Authority (GLA) boundary and the English/Welsh border post implementation. We find that HtB substantially increased house prices and had no discernible effect on construction volumes or aggregate private mortgage lending in the GLA, where housing supply is subject to severe long-run constraints and housing is already extremely unaffordable. HtB did increase construction numbers without affecting prices near the English/Welsh border, an area with less binding supply constraints and comparably affordable housing. HtB also led to bunching of newly built units below the price threshold, building of smaller new units and an improvement in the financial performance of developers. We conclude that HtB may be an ineffective policy in already unaffordable areas.

JEL classification: G28, H24, H81, R21, R28, R31, R38.

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1. Introduction

House prices in the UK have risen more in real terms between 1970 and 2015 than in any other OECD country.[1] During this period, housing has become increasingly unaffordable in large parts of the country, especially in London and the South East of England. This remarkable increase in house prices—especially relative to earnings—has led to a stark reduction in the number of first-time buyers. Homeownership attainment amongst those in their 20s decreased from 50% in 1993 to 20% in 2013. At the aggregate level, the homeownership rate in the UK decreased from nearly 70% in 2002 to about 61% in 2017.[2]

The worsening affordability crisis ultimately led the British government to announce a new flagship housing policy in 2013: Help to Buy (HtB). The policy was announced during the Budget Speech in March 2013 and was implemented in April of that same year. The program was initially only implemented in England, but Welsh and Scottish versions were put in place within a year. At time of implementation, HtB consisted of four different schemes: Equity Loans, Mortgage Guarantees, Shared Ownership, and Individual Savings Accounts (ISA).[3] All four schemes aim to help credit constrained households to buy a property.

In this paper, we set out to explore the causal impact of HtB on housing construction, house prices, the size of newly constructed units and the performance of residential developers. To do so, we focus on the Equity Loan scheme (ELS), which provides an equity loan for up to 20% of the housing unit's value (or 40% within the Greater London Authority, GLA) to buyers of new build properties. The ELS is by far the most salient and popular of the four schemes and the one requiring the biggest budget. The ELS is often referred to simply as "Help to Buy" and henceforth, unless we note otherwise, when we refer to HtB we mean the ELS.

The ELS expands housing credit and thus increases demand for housing. To explore how such a positive demand shock in the housing market affects construction and prices, we develop a simple theoretical framework with heterogeneous households and credit constraints. Our model predicts that the impact of the policy depends crucially on the supply price elasticity of housing. In a setting with elastic supply, HtB can be expected to mainly stimulate construction numbers as intended by the policy. However, when supply is price inelastic (i.e., regulatory constraints or physical barriers to residential development impede a supply-response), the effect of the policy may be mainly to increase house prices, with the unintended consequence of making housing less rather than more affordable.

In our empirical analysis, we exploit spatial discontinuities in the generosity of the ELS and the timing of implementation (pre vs. post) to identify the causal impact of HtB on housing construction and house prices.

[1] Based on the OECD Economic Outlook Database (last accessed: 29 April 2019). House prices in the UK appreciated by 337 percent in real terms during this period.

[2] The data is derived from the Survey of English Housing from 1993/4 to 2007/8 and from the English Housing Survey from 2008/9. For an in-depth analysis of the intergenerational links in homeownership attainment and its role for social mobility see Blanden and Machin (2017).

[3] The Mortgage Guarantees scheme ceased at the end of 2016. The HtB-ISA closes for new entrants in November 2019 and any bonus must be claimed by 2030. In April 2017, the British government introduced a new Lifetime ISA scheme. In contrast to HtB ISA, it is only open to individuals aged 18-39 and the money saved can also be used to fund a pension.

We implement a difference-in-discontinuity design to compare changes in house prices and construction activities across jurisdictional boundaries. We separately analyze properties sold on either side of the GLA boundary and on either side of the English/Welsh border. In both cases we only consider housing purchases close to the respective boundaries. As pointed out above, in Wales the scheme was put in place later and it only applied to a subset of the properties that were eligible in England. Likewise, the London scheme that was implemented in 2016, offered larger government equity loans (as a share of house values) for dwellings inside the GLA compared to those available for purchase outside the GLA. Our main estimates exploit these spatial discontinuities to study the effect of the ELS on house prices and construction activity. We also use this design to study the impact of the scheme on the size of newly constructed units and on total private mortgage lending.

We focus on the GLA boundary and the English/Welsh border for two reasons. First, our research design requires spatial discontinuities in the scheme's conditions, which can be found in these boundaries. Second, the two areas differ starkly in their regulatory land use restrictiveness and in barriers to physical development: While the GLA is the most supply constrained and the least affordable area in the UK – and arguably one of the most supply constrained areas in the world – housing supply is comparably responsive to demand shocks near the English/Welsh border.[4]

Consistent with our theoretical predictions, we find that differences in the intensity of the HtB-treatment have heterogeneous effects depending on local supply restrictions and the local price elasticity of housing supply. In the GLA, where the supply elasticity is low, the introduction of the more generous London version of the ELS led to a significant increase in prices for new build units of roughly 6%. However, it had no appreciable effect on construction activity or on aggregate private mortgage lending. Conversely, in the relatively high supply elasticity areas around the English/Welsh border, where only a small fraction of land is developed and developable land is readily available, we find a significant effect on construction activity and no effect on prices. The introduction of the more generous HtB-price threshold on the English side of the border increased the likelihood of a new build sale by about 6 to 7% (compared to the Welsh side of the border). Moreover, it decreased the size of newly constructed units on the English side of the border by nearly 7%. Consistent with this, a bunching analysis reveals that the English ELS led to significant bunching of properties right below the price threshold, shifting construction away from larger properties above the threshold towards smaller units. We also provide evidence indicating that the scheme caused an increase in developers' financial performance, leading to larger revenues, gross profits and net profits.

Collectively, these results suggest that the effects of HtB largely depend on local supply conditions. We find that the scheme fails to trigger more construction activity, but instead causes house prices to increase inside the GLA, precisely the region that is most strongly adversely affected by the 'affordability crisis'. This has distributional implications. Our findings indicate that the main beneficiaries of HtB in already unaffordable areas may be developers and (typically well-off) landowners rather than struggling first-time buyers.

[4] We provide supporting evidence for this proposition in Section 3.2.

Our paper relates to the literature that looks at the effects of credit conditions and demand subsidies on housing markets. Previous research in this vast literature has mainly focused on the effect of credit supply on housing prices (see Stein 1995, Ortalo-Magne and Rady 2006, Mian *et al.* 2009, Duca *et al.* 2011, Favara and Imbs 2015). These and other studies provide theoretical and empirical credence to the notion that expansions in credit supply lead to higher prices, especially in areas with tight planning conditions. Other studies have explored the impact of demand subsidies on housing market outcomes. Hilber and Turner (2014) examine the impact of the U.S. mortgage interest deduction (MID). They find that MID boosts homeownership attainment only of higher income households in markets with lax land use regulation. In tightly regulated markets with inelastic long-run supply of housing, the MID lowers homeownership attainment, presumably because higher house prices also raise down-payment constraints of would-be-buyers. Sommer and Sullivan (2018) estimate a dynamic structural model of the housing market to study the effect of removing the MID and predict this would result in a substantial reduction in housing prices. Our analysis contributes to this literature by documenting how a credit expansion-policy affects prices, construction activity and developer performance.

Only a very limited number of studies have shed light on the effects of HtB on housing and mortgage markets. Finlay *et al.* (2016) estimate that since its introduction HtB has generated 43% additional new homes. They conclude that the scheme has been successful in increasing housing supply. While their analysis combines quantitative and qualitative methods, their study lacks proper identification of the effects using a rigorous empirical approach. Szumilo and Vanino (2018) use a spatial discontinuity approach similar to the one employed here but focus their analysis on the effect of HtB on lending volumes only. Benetton *et al.* (2019) focus on the effect of HtB on households' house purchase and financing decisions. Applying a difference-in-difference strategy, they find that households take advantage of an increase in the HtB maximum equity limit to buy more expensive properties. To date, we have no state-of-the-art evaluation of the impacts of the policy on house prices and construction volumes. Our paper aims to address this.

Finally, this paper links to previous research on housing and land supply, including work on the effects of supply constraints on the responsiveness of housing markets to economic shocks (Hilber and Vermeulen, 2016), the origin of supply restrictions (Saiz 2010, Hilber and Robert-Nicoud, 2013) and their consequences (see Gyourko and Molloy 2015 and the references therein). We contribute to this literature by studying in depth the effect on housing supply of arguably the most important new British housing policy since the implementation of Right to Buy in 1980.

The rest of this paper is structured as follows. Section 2 describes the details of the ELS and provides a simple theoretical framework to guide the empirical analysis. Section 3 outlines our empirical strategy. Section 4 discusses our results and concludes.

2. Background and Theoretical Framework

2.1. Background: The Help to Buy Equity Loan Scheme

Since the launch of HtB up to September 2018, over 195,000 properties were bought with a government equity loan. The total value of these loans was £10.7 billion, with the value of the

properties purchased under the scheme totaling £49.9 billion (Ministry of Housing, Communities and Local Government 2019).[5]

There are important differences across regions in the timing of introduction and the generosity (in terms of the eligible price- and equity loan-thresholds) of the ELS. We exploit these latter differences to draw comparisons between otherwise similar areas.[6]

The English version of the ELS was first introduced in April 2013. It offers government loans of up to 20% of a unit value to households seeking to buy a new residence. It is available to both first-time buyers and home-movers but it is restricted to new build homes with prices under £600,000. Given the prevalent maximum Loan-to-Value (LTV) ratios offered by British banks to first-time buyers were around 75% during this period; this implies a substantial reduction in the down-payment needed to buy a property. With the government loan covering part of the down-payment, buyers are only required to raise 5% of the property value as a deposit. The explicit goal of the ELS is that this reduction in the deposit required to the borrower helps households overcome credit constraints.

The ELS can also help liquidity constrained households by reducing interest payments on the combined loan. This occurs via two channels. In the first instance, no interest or loan fees on the equity loan is paid by the borrower for the five years after the house is purchased. Subsequently, there is a charge, which depends on the rate of inflation. We calculate the implied subsidy provided through this channel in Section 3.7. Secondly, by raising the combined deposit to 25%, the equity loan keeps borrowers away from high-LTV and high-interest products available in the mortgage market. It enables households to gain access to more attractive mortgage rates from lenders who participate in the scheme.[7]

Borrowers can choose to repay the government equity loan at any time without penalty. However, unless they want to sell the property, borrowers do not need to repay the loan at all. When they sell, the government will reclaim its 20% stake of the total amount of the home at its current value.

In our analysis we exploit differences between the English version of the ELS on the one hand and the Welsh and London versions on the other. The Welsh version was introduced in January 2014 and provided support for the purchase of properties with prices under £300,000.[8] The London-HtB scheme was introduced in February 2016 and offered an equity loan of up to 40% of the unit's price for properties under £600,000 located within the GLA. Table 1 summarizes the regional differences in the ELS that we exploit in our empirical analysis.

One important feature of the ELS is that it is only available for the purchase of newly built property. This condition is intended to leverage the increase in demand for these properties with the ultimate aim of triggering a supply response. It implies that demand faced by residential developers, construction companies and other actors in the construction sector will increase

[5] Ministry of Housing, Communities and Local Government (2019) provides a comprehensive overview and numerous summary statistics relating to the HtB ELS.
[6] By early 2014, one of the four HtB schemes was available in all UK countries. Therefore, we cannot rely on any regions that are not subject to the program to build our control group.
[7] Borrowers still need to be able to cover the monthly repayments and their credit score must be in order.
[8] Scotland also introduced an HtB ELS during 2014; however, we are not able to exploit the discontinuities at the English/Scottish border. This is because the Scottish Land Registry did not identify new build units until 2018.

with the policy. We can use information from these companies' accounting data to estimate the effect of this policy on their financial performance.

2.2. Theoretical Framework

In this sub-section we develop a simple theoretical framework—a partial equilibrium model of the housing market with heterogeneous households, featuring credit constraints and endogenous housing supply—to guide our empirical analysis.[9] The model illustrates how a relaxation of credit conditions affects housing quantity and prices, depending on the costs of developing new stock.

The framework is partial equilibrium in that it abstracts from the possibility that a relaxation of credit conditions in one location could affect supply or demand in other locations. Yet both prices and quantities are endogenous. A relaxation of credit conditions will lead to both an increase in the price and an expansion in quantity. The relative magnitude of the two effects depends on the price elasticity of supply. For low (high) supply elasticities, the price effect is stronger (weaker) and the quantity effect weaker (stronger). Differences in the elasticity of supply arise from varying costs of developing land in different locations. The theoretical insights from this framework can be summarized by the cross-elasticities of quantity and prices taken over the credit condition parameter and the cost of a building shifter.[10]

Suppose a two-period economy with a unit mass of households which can buy property in a given location in period 1. These households have preferences over consumption c and ownership-location amenity a, as given by a period utility $u(c,a)$ which is continuous, increasing and differentiable in both arguments, with limits satisfying standard assumptions.[11] Households can only obtain $a > 0$ if they buy a housing unit in the location and obtain 0 otherwise. This is consistent with both, a model in which renting is not possible and a model, where a captures the warm-glow from ownership (Iacoviello and Pavan 2013, Kiyotaki *et al.* 2011, Carozzi forthcoming). The discount factor is β.

Households receive an endowment e in period 1 and a location specific income w in period 2 which can be used for consumption or to buy property. Households are heterogeneous in the initial endowment e, which is continuously distributed over the positive interval $[\underline{e}, \overline{e}]$ with cumulative density function F_e. Housing units in the location are homogeneous and can be bought in period 1 for endogenous price P. Credit is available for the purchase of the property, yet a minimum down-payment, corresponding to a fraction $(1-\gamma)$ of the property value is required. Credit and savings pay interest r. We assume $w > \bar{e}\gamma(1+r)/(1+\gamma)$. This assumption ensures that, for sufficiently large a, demand for housing in the location is

[9] The model builds on Hilber and Vermeulen (2016) who consider a similar setting but abstract from the role of credit conditions.

[10] The model presented here introduces credit conditions via a change in required loan-to-value ratios (LTVs), as is customary in the literature. We treat housing as homogeneous, with all units being identical. An extension with two types of units in which credit conditions only change for units at the lower end of the market yields very similar insights.

[11] Specifically, $\lim_{a\to\infty} u(c,a) = \infty$ if $c > 0$, $\lim_{c\to\infty} u(c,a) = \infty$ if $a > 0$, and $u(c,a) > 0\ \forall c, a \geq 0$ .Note these assumptions are satisfied for both the linear additive and Cobb-Douglas specifications.

determined solely by the credit constraint.[12] In that case demand can be written as $Q_D = 1 - F_e((1-\gamma)P)$, which corresponds to the mass of agents that cannot afford a down-payment $(1-\gamma)P$. Note that demand is downward sloping as function F_e is strictly increasing.

Housing is provided by competitive developers facing construction costs $C(Q,X) = c(Q)X$ where X corresponds to a construction cost shifter, $c(Q)$ is a positive, increasing and convex function of quantity Q. Marginal construction costs may be increasing as more suitable land is used first to build new properties. Competitive firms will produce until the price of a built unit equals the marginal cost of building it, so that $P = Xc'(Q)$ will be the housing supply curve.[13] We can equate supply and demand to obtain implicit definitions for quantities and prices:

$$Xc'(Q)(1-\gamma) = G(1-Q) \tag{1}$$

$$P = c'\left(1 - F_e\big((1-\gamma)P\big)\right)X \tag{2}$$

Where were $G(.)$ is the inverse of the CDF of e, and $c'(.)$ is the marginal cost function. Note that both functions are strictly increasing. By virtue of the implicit function theorem we can write the derivatives:

$$\frac{\partial Q(\gamma,X)}{\partial \gamma} = \frac{G(1-Q)}{(1-\gamma)\big(G'(1-Q)+Xc''(Q)(1-\gamma)\big)} > 0 \tag{3}$$

$$\frac{\partial P(\gamma,X)}{\partial \gamma} = \frac{XP}{\left(c''\Big(1-F_e\big((1-\gamma)P\big)\Big)f_e\big((1-\gamma)P\big)\right)^{-1} + X(1-\gamma)} > 0 \tag{4}$$

Both derivatives are (strictly) positive because a credit expansion (i.e. an increase in γ), results in an increase in both prices and quantities. We can now obtain cross-elasticities:

$$\frac{\partial Q(\gamma,X)}{\partial \gamma \partial X} = \frac{(-G(1-Q)c''(Q)(1-\gamma)^2)}{\Big((1-\gamma)\big(G\prime(1-Q)+Xc''(Q)(1-\gamma)\big)\Big)^2} < 0 \tag{5}$$

$$\frac{\partial P(\gamma,X)}{\partial \gamma \partial X} = \frac{Pc''\Big(1-F_e\big((1-\gamma)P\big)\Big)f_e((1-\gamma)P)}{\Big(1+X(1-\gamma)c''\Big(1-F_e\big((1-\gamma)P\big)\Big)f_e((1-\gamma)P)\Big)^2} > 0 \tag{6}$$

Inequalities (3) through (6) illustrate the main hypothesis we test in this paper: *A credit expansion, such as the one induced by HtB, will result in an increase in quantities and prices. The magnitude of these changes will depend on the responsiveness of supply. For relatively inelastic supply, inequalities (5) and (6) indicate a relatively stronger effect for prices.*

Our analyses for the Welsh and London boundaries below loosely correspond to the cases of elastic and inelastic supply conditions, respectively (see Section 3.2). Hence, we expect different effects of the credit expansion policy in these locations.

[12] Note that $P < \frac{\bar{e}}{1-\gamma}$ for all positive quantities. Assumption $w > \frac{\bar{e}}{1-\gamma}\gamma(1+r)$ will therefore ensure that in period 2 all agents are able to pay the remaining part of any loans taken for the purchase of a property, including interest. Large enough a ensures buying property in period 1 is incentive compatible.

[13] The specification of supply present in Hilber and Vermeulen (2016) is a special case of the one used here.

3. Empirical Analysis

3.1. Data and Descriptive Statistics

Our empirical analysis employs geo-located data on housing sales in England and Wales, including information on unit characteristics and transaction prices. Our main data source is the Land Registry Price Paid Dataset, which covers the vast majority of residential transactions in England and Wales. This source includes property transactions from 1995 to 2018, recording the transaction price, postcode, address, the date the sale was registered (which proxies for the transaction date), and categorical data on dwelling type (detached, semi-detached, flat or terrace), tenure (freehold or leasehold) and whether the home is a new build property.

Our main estimation sample uses transaction data from 2012 to 2018, which includes a total of 6,366,690 transactions, of which 11% are transactions of new build units. All transactions are geo-coded using address postcodes. We then select all the new build transactions near the GLA boundary and the English/Welsh border for our spatial discontinuity designs. We replicate our analysis using new build transactions near the Greater Manchester boundary as a placebo test.

We also utilize Energy Performance Certificate (EPC) data that contains information on the floor area and other physical characteristics of newly built units. We match this data to the Land Registry (LR) in order to augment the latter dataset with additional information on the transacted newly built units.[14]

Demographic and neighborhood characteristics at LSOA level are collected from the 2011 Census. These variables (interacted with year dummies) are used as controls and are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications. We use the National Statistics Postcode Lookup Directory to match postcodes to coordinates and LSOAs. To construct the baseline estimation sample for the price effect, we select all the new build transactions within 5 kilometers from the GLA boundary and Greater Manchester boundary, and within 10 kilometers from the English/Welsh border.[15] We then merge these selected Land Registry transactions with the EPC dataset and Census data to control for a wide range of neighborhood and hedonic housing characteristics.

Basic summary statistics computed for a sample of housing transactions within 5 kilometers of the GLA boundary from January 2012 to December 2018 are detailed in Panel A of Table 2. There are 32,127 newly built property transactions in this area. The average value of the house price is £394,703, and the average size of these properties is 87.2 square meters. Panel B of

[14] EPCs provide information on buildings consumers plan to purchase or rent. Since 2007 an EPC has been required whenever a home is constructed or marketed for social rent, private rent or sale. We use a dataset that contains all EPCs issued between 2008 and 2019. The dataset includes the type of transaction that triggered the EPC, the energy performance of properties and their physical characteristics. Following Koster and Pinchbeck (2017), we merge the EPC data into the Land Registry (LR) dataset using a sequential match strategy. First, we match a LR sale to certificates using the primary address object name (PAON; typically, the house number or name), secondary address object name (SAON; typically, the identification of separate unit/flat), street name, and full postcode. We then retain the certificate that is closest in days to the sale or take the median value of characteristics where there is more than one EPC in the same year as the sale. We then repeat this exercise for unmatched properties but allow one of the PAON or SAON to be different. Our final round of matching is on the full postcode. The matched dataset provides us total floor area; whether the property has a fireplace or not; total energy consumption and total CO_2 emission of the property.

[15] The number of transactions for the resulting samples are reported in Appendix Table B1. This table also reports sample sizes for smaller bands around the respective boundaries.

Table 2 shows the descriptive statistics for a baseline sample of new build transactions within 10 kilometers of the English/Welsh border from 2012 to 2018. The average value of house price there is £234,202, and the average size of these properties is 102.2 square meters.

When estimating the effect of the policy on housing construction, we assemble a ward by month panel using data from January 2012 to December 2018. We obtain ward-level observations by aggregating from individual new build sales. Panels C and D of Table 2 document the descriptive statistics of our estimation sample for the construction effect. The datasets for the GLA boundary-area and the English/Welsh border-area consist of 436 wards and 272 wards respectively. The propensity for having at least one new build transaction in any month is 0.2 for the GLA sample and 0.13 for the English/Welsh sample. On average, 0.88 new builds are transacted each month near the GLA boundary and 0.37 near the English/Welsh border.

We construct an additional dataset in the form of a developer/construction company panel, covering 84 companies over the same period as the transaction level dataset (2012-2018). We label the full sample of 84 developers our *difference-in-differences* sample. The panel includes financial information of these companies from Orbis. It also includes information on whether these companies are registered with a HtB agency or not. A builder must be registered with one of the regional government offices managing the scheme for its properties to be eligible for an equity loan. Finally, we include hand-coded data on the fraction of properties sold through the scheme from annual reports in a selected sample of 30 residential developers. This is our *intensity* sample. The large sample of 84 companies is obtained after combining a list of the main builders in the United Kingdom from Zoopla – one of the main property websites in the country – and financial data from Orbis. This list includes residential developers, commercial developers and construction companies.

3.2. The Role of Local Supply Conditions

We compare estimates of the effect of HtB obtained from a sample of properties near the GLA boundary with a sample of properties from near the English/Welsh border as well as with a sample derived from properties near the Greater Manchester boundary. We choose the first two areas because they both provide an ideal quasi-natural setting to identify the economic effects of HtB. We use the area near the Greater Manchester boundary for our placebo tests, as the same HtB policies and thresholds apply inside and outside of that boundary.

One crucial difference between our two focal areas – the area near the GLA boundary and the area near the English/Welsh border – is that the former has overall vastly more unresponsive supply, driven by both, tighter local planning regulations as well as a greater relative scarcity of undeveloped developable land. Theory thus suggests that the positive impact of HtB on house prices should be much larger and the positive impact on new construction much smaller in the area near the GLA boundary.

In order to illustrate the differences in supply conditions between the areas, we employ a number of measures that capture long-term housing supply constraints. These measures are the share of land designated as green belt (provided by the Ministry of Housing, Communities and Local Government), the average planning application refusal rate taken over the period from 1979 to 2008, the average share of developed developable land, and the average elevation range

(all derived from Hilber and Vermeulen, 2016). We calculate these measures for all three areas[16] using Local Planning Authority (LPA)-level data and LPA surface areas as weights.

Table 3 (rows 1 to 4) illustrates the differences in supply conditions between the three areas. The most striking difference between the two focal areas lies in the share of 'green belt' land. Land in green belts is typically off limits for any development (residential or commercial) and thus represents a 'horizontal' supply constraint. This share is 66.5% for boroughs along the boundary of the GLA but only 3.8% for English boroughs along the English/Welsh border. Another measure to capture physical supply constraints is the share of developable land already developed. This share is 27.6% for boroughs along the GLA boundary but only 6.3% for English boroughs along the English/Welsh border.

The arguably quantitatively most important long-term supply constraint are restrictions imposed by the British planning system (Hilber and Vermeulen 2016). The weighted average of this refusal rate is 35.6% for boroughs along the GLA boundary and 27.2% for English boroughs along the English/Welsh border.

While the area near the English/Welsh border is subject to greater topographical (slope related) supply constraints, Hilber and Vermeulen (2016) demonstrate that these constraints, while statistically significant, are quantitatively unimportant in explaining local price-earnings elasticities.

Lastly, it is important to point out that the area near the GLA boundary is not only characterized by vastly more restrictive supply conditions, but these constraints are also significantly more binding in practice, simply because aggregate housing demand there is much stronger. To illustrate this point, consider a ten-story height restriction in the heart of a superstar city such as London and compare it to the same constraint in the desert. The restriction is extremely binding in the former location, while completely irrelevant in the latter.

To explore the differences in supply responsiveness across the three areas further, we employ the estimated coefficients from Hilber and Vermeulen (2016) to compute an implied house price-earnings elasticity. Table 3 (rows 5 and 6) reports our estimated elasticities based on these coefficients. Using the OLS estimates, we find, consistent with our priors, that the price-earnings elasticity along the GLA boundary (0.40) is higher than that of the area along the Greater Manchester boundary (0.28), which in turn is higher than the elasticity of the area near the English/Welsh border (0.25). As two of the three supply constraints measures employed in their estimation, refusal rate and share developed land, are likely endogenous, we employ the instrumental variable strategy proposed in Hilber and Vermeulen (2016). This provides exogenous variation in our supply constraint measures, which we use to re-compute the unbiased price-earnings elasticities. The rank order remains unchanged. The GLA has again the highest elasticity (0.21) followed by Greater Manchester (0.16) and the English/Welsh border area (0.13).

The higher price-earnings elasticity along GLA boundary suggests that due to local supply constraints, housing prices respond more strongly to a given change in local housing demand.

[16] We do not currently have data for LPAs on the Welsh side of the English/Welsh border. We will incorporate these figures in a subsequent paper version. We expect that the differences between the GLA and the English/Welsh border will be even more striking when taking account of the Welsh LPAs.

This also implies a lower supply price elasticity in the GLA boundary area. In the next section, we outline our identification strategy and discuss how we measure the impact of HtB on house prices and construction activity.

3.3. Identification Strategy and Empirical Specifications

Our empirical strategy is designed to test the impact of HtB on housing construction and house prices. We exploit spatial differences in the intensity of the HtB policy. As mentioned above, HtB Wales was rolled out nine months later than in England, and offered a government-backed loan for the purchase of new build properties under £300,000 (£600,000 in England). There were also differences in the intensity of the HtB policy between the GLA and its surroundings, starting in 2016. In this case, the difference lies in the size of the government-backed loan available to households. London-HtB offered loans of up to 40% of a new build's value, while this figure was 20% elsewhere (i.e., outside the GLA boundary). We exploit these regional differences in policy in a differences-in-discontinuities design combining time variation in prices and new build construction with local variation in policy intensity around the regional boundaries.

The samples of new build properties used in the analyses of prices and construction effects near the English/Welsh border and the GLA boundary are illustrated in Figures 1 and 2, respectively.[17] Our boundary approach is meant to ensure that we are comparing properties affected by similar economic and amenity shocks, as compared to a standard Difference-in-Differences strategy that simply takes whole regions as control groups. The identifying assumption in both cases can be likened to the typical assumption of parallel trends: in the absence of the policy, prices and construction on either side of the boundary would have followed a parallel evolution over time. Figure 3 and Figure 4 depict the house price index at the GLA boundary and English/Welsh border respectively prior to and post HtB, indicating that prices move in parallel prior to the implementation of the policy.

We complement these strategies by studying bunching in new build property prices around the £600,000 price threshold in England to show whether HtB affected the type of properties offered by developers. This specific analysis further elucidates developers' responses to the policy beyond those provided in our boundary analysis.

3.3.1. Specification: Impact of Help to Buy on House Prices

The HtB policy is meant to operate as a relaxation of households' credit constraints. Hence, it can lead to an increase in demand for new builds, and as a result, to an increase in the price of new builds. To test this, we use observed transactions of new build units close to the boundary of the GLA and the English/Welsh border. We conduct both exercises separately. We first provide graphs of prices at different distances to the boundaries before and after the differences in HtB intensity arise, including flexible polynomials in distance to illustrate how the differences in prices at the boundary change with the policy. To estimate the magnitude of these differences in our differences-in-discontinuities framework we estimate:

$$\ln(P_{it}) = \phi_p + \beta HTB_{it} + \delta_t + \gamma' X_{it} + f(Distance_i) + \gamma_y Distance_i \times d_y + \varepsilon_{it} \qquad (7)$$

[17] Appendix Figure A1 depicts the corresponding map for our placebo sample, properties near the Greater Manchester boundary.

where i indexes individual properties and t indexes time periods. The variable HTB_{it} is a dummy that takes value 1 in the region with a more generous HtB policy (i.e. inside the GLA or on the English side of the Welsh/English border) after the difference in policy takes place. A vector of postcode fixed effects is represented by ϕ_p, δ_t is a set of time dummies and X_{it} is a set of controls including housing characteristics as well as neighborhood characteristics (from the 2011 Census) interacted with year dummies. In every specification we control for distance to the boundary by estimating different linear terms on either side. After we control for postcode fixed effects, we include distance to boundary interacted with year dummies to account for potential time varying shocks that differ spatially. We estimate this equation by OLS, clustering standard errors at the postcode-level to account for potential spatial correlation in local price shocks. This is estimated on properties at specific bandwidths around the corresponding boundaries. In the case of the London HtB, we use a 5km bandwidth around the GLA boundary. Because transactions near the English/Welsh border are sparser, we use a 10km bandwidth for that exercise. In the robustness checks section, we show that our results are robust to these specific bandwidth choices.

Our parameter of interest is β. It measures the effect of differences in the intensity of the HtB policy on the price of new build properties.

3.3.2. Specification: Impact of Help to Buy on Housing Construction

The government's equity loan is available only for the purchase of new build units. In this way, the government attempts to ensure the policy results in a supply response by developers. In order to test whether this is the case, we estimate the effect of differences in the intensity of the policy on both sides of the regional boundaries mentioned above on construction activity. Again, we use a difference in discontinuities specification. This exercise is conducted by aggregating new build counts at the ward level for every month. As in the exercise for prices, we first provide graphs of the differences in new building activity at different distances from the boundary. Next, we estimate:

$$New\ builds_{jt} = \omega_j + \beta HtB_{jt} + \delta_t + f\left(Distance_j\right) + \gamma_y Distance_j \times d_y + \varepsilon_{jt} \qquad (8)$$

Where j indexes wards and t indexes periods. The dependent variable is now $new\ builds_{jt}$, which can represent either the number of new build transactions in ward j and period t, or a dummy taking value 1 if there are any new build sales in ward j and period t. The variable HtB_{it} is a dummy taking value 1 in the region with a more generous HtB policy (i.e., inside the GLA boundary or on the English side of the English/Welsh border) after the difference in policy arises. We include a set of ward fixed effects, represented by ω_j and time fixed effects δ_t. We also control flexibly for distance between the ward centroid and the boundary by including two linear terms in distance, estimated separately on each side. After we control for ward fixed effects, we include distance to boundary interacted with year dummies to account for potential time varying shocks that differ spatially. In all specifications we cluster standard errors at the ward level to account for potential spatial correlation. We estimate our specification using observations within 5km of the boundary in the case of the London GLA, and 10km in the case of the English/Welsh border.

Our parameter of interest is β, measuring the effect of differences in the intensity of HtB on new construction. Because the differences in intensity are not the same across the English/Welsh border and across the GLA boundary, we will obtain separate estimate for these two exercises.

3.3.3 Help-to-buy and Developers' Financial Performance

By inducing an increase in demand for new build housing, help to buy may have an impact on the financial performance of firms participating in the design, planning and building of residential units. On the first place, the policy should induce an increase in revenue of existing developers.[18] Moreover, barriers to entry and imperfect competition in the housing production and land markets imply the policy could also translate into increases in profits. This last point, however, depends on whether the increase in revenues is neutralized by an increase in the costs of land after the policy is implemented. Uncovering how HtB affected the performance of developers can therefore identify some of the beneficiaries of this policy.

To study this empirically, we use our developer dataset which financial information for 84 large British developers and construction companies. Crucially, our dataset includes information on the participation of these firms in HtB. We use this dataset to compare how the change in performance of firms before and after 2013 varied with their participation in HtB. For this purpose, we estimate a fixed effect model specified as:

$$Financial_{it} = \beta HtB_i \times Post_t + \alpha_i + \delta_t + \varepsilon_{it} \quad (9)$$

$Financial_{it}$ is an indicator of financial performance for developer i in year t. We look at turnover (i.e. total revenues), gross profits, net profits before taxes and the difference between gross and net profits. HtB_i is a measure of the developer's participation in the program. We use two different definitions of this variable depending on the information available and therefore conduct the analysis on two separate samples. Our intensity sample consists of the 30 developers for which we know the fraction of the units produced that were sold under the HtB scheme. We average this figure over time to obtain a time-invariant average fraction of units by developer. Our second definition of HtB_i is based on the registry of developers in regional HtB offices across the country. In this case, the variable is a dummy taking value 1 if the developer is included in the registry. The information on registrations is available across a larger group of firms, so we can estimate this specification for our larger differences-in-differences sample of 84 developers. Variable $Post_t$ is a variable taking value 1 after 2012. Finally, α_i is a developer fixed-effect and δ_t represents a set of year dummies.

Estimates of β will measure the impact of the policy of firms and revenues under the assumption that unobservables ε_{it} are uncorrelated with $HtB_i \times Post_t$ conditional on individual and year effects. Because firms actively self-select into the program, the identifying assumption requires that the difference in performance between firms that self-select into the scheme and does that do not is fixed over time. In other words, other shocks to performance in the 2010-2018 period are uncorrelated with program participation.

[18] The increased supply could in principle by taken up exclusively by new entrants. Yet the presence of economies of scale in housing production and the learning curve required to navigate the British planning system mean the volume of new entrants will probably be very small.

3.3.4. Bunching Analysis

The English HtB policy is only available for properties purchased under 600,000 GBP. We can use this threshold to study bunching of property sales close to this price level. In doing so, we apply some of the methods recently developed in Chetty *et al.* (2011), Kleven (2016) and Best and Kleven (2017). The purpose of this analysis is two-fold. First, we want to test whether HtB induced a change in the *type* of properties supplied by developers. In addition, we want to obtain an alternative method to study the effect of the policy on building volumes. We first document that indeed there is substantial bunching at the £600,000 price threshold. Next, we construct a counterfactual distribution of new builds at different price levels using information on sales excluding the region around the bunching thresholds. Following Kleven (2016), we estimate this counterfactual distribution by calculating the number of new build transactions in 5000 GBP bins and using these to estimate:

$$S_{lt} = \sum_{q=0}^{3} p_{lt}^{q} + \sum_{r \in R} \rho_r 1\left\{\frac{p_j}{r} \in \mathbb{N}\right\} + \varepsilon_{lt} \quad (10)$$

where l indexes price bins and t indexes time. The dependent variable S_{lt} measures the number of new build transaction in bin l at time t. The first two sums correspond to the estimate of the counterfactual price distribution. The first sum is a third degree polynomial on the distance between price bin l and the cutoff of £600,000, and q is the order of the polynomial. The second sum estimates fixed effects for round numbers with $\mathbb{N}$ representing the set of natural numbers and $R = \{5000, 10000, 25000, 50000\}$ representing a set of round numbers. We estimate this equation with data for new build transactions in England taking place after April of 2013 (the introduction of HtB in England). We then obtain differences between this estimated counterfactual distribution and the observed distribution of prices to estimate bunching effects induced by HtB.

The difference between the size of the spike just under the threshold and the gap just after the threshold can be used to estimate the size of the local effect of HtB on new building activity. This can be driven by changes in the types of properties sold after accounting for local shifting in prices induced by the policy.

3.4. Main Results

3.4. 1. Visual Evidence of Boundary Discontinuity

We first provide a series of graphs illustrating the main results in our paper. Figure 5 represents the prices for newly built units at different distances from the GLA boundary. Positive distances correspond to locations inside the GLA, and negative distances to locations outside of this area. Circles depict the mean value of new build house prices for 500-meter-wide distance bins with the size of each circle being proportional to the number of observations in that bin. Lines in both panels represent fitted values from 2nd order polynomials estimated separately on each side of the boundary. Gray bands around them represent 95% confidence intervals.[19] Panels A and B illustrate results before and after the introduction of London HtB, respectively. Comparing both panels, we find that a discontinuity in prices at the boundary emerges after the

[19] We report 2nd degree polynomials in these figures because they yield a lower Akaike Information Criterion statistic than 1st degree polynomials. Appendix Figure A2 reports results when using linear equations on either side of the threshold.

implementation of London's HtB. We interpret this as evidence that this scheme has a significant and positive effect on the price of newly built properties.

Figure 6 illustrates our results for the new build price effect at the English/Welsh border. Circles depict the mean value of house prices for 1000-meter-wide distance bins. As above, solid lines represent 2nd degree polynomials estimated on both sides of the boundary.[20] In this case, however, we do not observe a spatial discontinuity of house prices in either Panel A or B.

We conduct a similar exercise looking at changes in construction volumes at these boundaries before and after the corresponding changes in HtB. Results are illustrated in Figures 7 and 8. The former shows construction as measured by new build sales near the GLA boundary with Panels A and B corresponding to the periods prior and post implementation of London HtB, respectively. We do not find a spatial discontinuity in homebuilding at the London boundary in either period. Figure 8 shows results for English/Welsh border before and after the English HtB policy was rolled. In this case, we find a clear discontinuity emerging in Panel B, indicating more building took place on the English side of the boundary after the policy was introduced.

Finally, we conduct a placebo experiment using properties sold around the greater Manchester boundary to test whether any spatial discontinuities in prices emerge after the introduction of London HtB in 2016. Note that the intensity of the policy is identical inside and outside the Manchester boundary. Results are provided in Figure A4 in the Appendix. As expected, we observe no discontinuity in prices at the boundary before or after the London HtB policy was put in place.

Overall, these graphs indicate that more generous versions of the policy triggered a price response in the supply inelastic areas around London. Conversely, the policy generated a quantity response in the relatively supply elastic areas around the English/Welsh border. This is in line with the intuition that price or quantity responses to shifts in demand depend on the shape of the supply curve, as illustrated in the theoretical framework provided in Section 2.2. In the following two sections, we present reduced-form estimates for the magnitudes of these effects.

3.4.2. Effect of HtB on House Prices

Table 4 summarizes the results from estimating equation (7) using the sample of transactions of new build properties within 5 kilometers from the GLA boundary. Additional covariates are included into the estimation sequentially from columns 1 to 5. Column 1 controls for time effects and independent linear terms in distance of each property to the GLA boundary. Column 2, adds a vector of housing characteristics such as total floor area, type of the property, tenure of the property. Column 3 adds postcode fixed effects. In column 4, we allow for heterogeneous spatial price trends by controlling for interactions between distance from the GLA boundary and year dummies. Finally, column 5 includes a set of neighborhood controls. Our preferred specifications are those including property characteristics, as it is likely that the policy would affect the characteristics of sold units.[21] The standard errors in all specifications are clustered at the postcode level to allow for a degree of spatial correlation in the error term.

[20] Appendix Figure A3 reports results when using a linear polynomial.
[21] We return to this point in Section 3.5.2.

The resulting estimates show that London's HtB policy increased newly built house prices inside the GLA by between 4.5% and 6.5% depending on the specification. All estimates are significant at the 5% level. The average property price in this sample is £394,703, so this finding suggests that homebuyers are paying £23,682 more to buy newly built properties inside the GLA because of London HtB. In Section 3.7, we compare this effect to that which would result from the implicit interest subsidy provided by the equity loan granted by the scheme.

Table 6 summarizes the results from estimating equation (7) for the sample of properties around the English/Welsh border. Again, we successively include additional controls from columns 1 to 5. Once we control for postcode fixed effects, we observe no significant effect of the policy on the price of new build sales. The point estimates in columns 3 to 5 are positive but small, ranging between 1.7 and 2.4%, and not statistically significant, with p-values above 0.4 in all of these specifications.

These estimates confirm the results reported in the graphical analysis provided in Section 3.4.2 and are also in line with the predictions highlighted in our theoretical framework. As land supply is relatively inelastic near the GLA boundary, the shift in demand induced by HtB is capitalized into prices. Near the English/Welsh border, where developable land is available, the response is more likely to happen in quantities. Naturally, this hypothesis is testable; we estimate the effect of HtB on housing supply in the next section.

3.4.3. Effect of HtB on Housing Construction

Table 6 summarizes the results from estimating equation (8) for the sample including all wards within 5 kilometers of the GLA boundary. We define the post-HtB period as extending from Q1 2017 to Q4 2018, – starting one year after the implementation of London's HtB – to allow for a one-year construction lag. From Table 6, we observe that London HtB did not have a significant effect either on construction volumes or on the probability that any newly built property was sold in a ward. Coefficients are insignificant and small in all specifications, indicating that the policy did not lead to an increase in housing supply.

In Table 7, we provide estimates of equation (8) for wards around the English/Welsh border. As above, the post-treatment period is defined as starting one year after the introduction of the English HtB. We find a significant and positive effect of HtB on housing construction in all specifications. Our estimate suggests that HtB increases the number of new build transactions at each ward by 0.355 on average, and the propensity for any new build construction at each ward by 6.67%. These results are consistent with the predictions from our theoretical framework indicating HtB will have differential effects in London and the areas around Wales as a consequence of differences in supply elasticities between both areas.

3.4.4. Effect of HtB on Financial Performance of Developers

Our findings in previous sections indicate that HtB increased demand, translating into higher housing prices or building output. How did this affect the financial performance of residential developers? Table 8 presents our estimates for the effect of the scheme on revenues, gross profits and net profits before taxes, obtained from a developer panel as detailed in Section 3.4.4. Panel A presents estimates of the effects for our continuous measure of HtB participation. The first column shows a 1 percentage-point increase in the fraction of HtB properties supplied by that developer leads to a 1.1% increase in revenues. The effect is large and significant. The

estimates for gross profits and net profits, displayed in columns 2 and 3 are even larger, indicating that changes in costs – e.g. costs of acquiring land – did not neutralize the changes in revenue. Hence, these estimates suggest that the policy improved the performance of residential developers. The estimate in column 4 measures the effect of the policy on operating and interest expenses, obtained by taking the difference between gross and net profits. The effect is positive and significant for both samples.

Panel B of Table 8 shows estimates using our larger differences-in-differences sample, where participation in HtB is measured using a dummy variable taking value 1 if the developer is registered with one of the regional HtB offices in the country. Participation in the program appears to increase revenues substantially, with program participants obtaining over 70% higher revenues than non-participants.[22] Again, the coefficients for gross and net profits are even larger. The estimate in column 4 of Panel B tells us that operating plus interest expenses of companies registered with the program increased by 34% relative to the control group. The policy is unlikely to have had an impact of financing costs, so we interpret this as suggestive evidence that the scheme affected the operating costs of the developers, possibly including management costs.

In Figure 9, we display yearly average profits adjusted for individual company fixed-effects for the HtB and non-HtB groups of developers before and after the policy. The pre-trends are reasonably parallel, and we observe a divergence after 2013, with substantial growth for developers registered for HtB. These results reinforce the notion that developers improved their financial performance as a result of Help-to-buy. An additional implication is that, on the supply side of the residential market, the benefits of the scheme did not go exclusively to land owners.

Some caution is warranted when interpreting these findings. Both the intensity and difference-in-difference samples used to produce the estimates in Table 8 cover a small number of relatively large developers and are only partially representative of the population. In addition, there are substantial observable differences in characteristics between the developers self-selecting into the scheme and other developers in the sample. For example, luxury developers typically fall in the control group, as they will not normally be registered with HtB. Our estimates can be interpreted causally only if we consider that these differences have a time-invariant influence on performance. Unfortunately, lack of detailed information on the location of developers' assets prevents us from deploying the spatial techniques used in our analysis of price and construction effects.

3.5. Additional Results

3.5.1. Bunching Effect

We now turn to documenting that the English HtB program led to significant bunching of sales right below the price threshold. Figure 10 shows two histograms of new build frequencies for prices between £550,000 and £650,000. The left-panel represents properties sold in the period from Q1 2010 to Q1 2013, before the implementation of HtB in England. The right-panel corresponds to histogram for properties sold between Q2 2013 and Q4 2018, after HtB was

[22] The coefficient β is 0.5374, so we can write the proportional difference in revenues is $\Delta r = e^{0.5347} - 1$.

introduced. We can observe a substantial increase in the amount of bunching in the price distribution of new builds just below £600,000 taking place between both periods.

We provide two alternative ways of showing the bunching at this price point in figures A5 and A6 of the Appendix. To produce Figure A5, we first group sales into £10,000 price bins and then plot the evolution of the fraction of new builds over total sales for each bin from 2010 to 2018. The black line represents the price bin of interest, £590,000 to £600,000. Grey lines correspond to the other bins between £510,000 and £700,000. The gaps between the black line and the grey lines increase substantially from 2015, implying a significant amount of bunching of new builds at £600,000 after this year. Figure A6 shows the fraction of new builds over total sales for £5000 price bins. Horizontal dashed lines represent averages above and below the £600,000 threshold. We also observe significant bunching at £600,000.

Finally, Figure A7 illustrates the difference between the observed density of property transactions and our estimated counterfactual density around the £600k notch.[23] We observe substantial bunching below the cut-off of £600,000 and a large hole in the distribution above the cut-off. Using our counterfactual price distribution, we estimate there are 2,033 more transactions for properties valued from £590,000 to £600,000 and 982 *less* transactions for properties valued from £600,000 to £630,000.[24] These estimates suggest that HtB leads to a significant shift in housing construction away from properties above the price threshold, towards properties below the threshold.

3.5.2. Size Effect

Figure A8 provides a descriptive analysis of the impact of HtB on the size of newly constructed units at the English/Welsh border. Circles depict the mean value of new build housing size for 2000-meter-wide distance bins. The size of each circle is proportional to the number of observations in that bin. Panel A represents the housing size before the English version of HtB was put in place, while Panel B depicts the housing size after the scheme was rolled out. Lines in both panels represent 2nd order polynomial fits of housing size on the distance to the English/Welsh border, with the band around them representing 95% confidence intervals. Comparing Panels A and B, we find a sharp discontinuity in the total floor area of new build properties at the boundary after the implementation of the English HtB. This result provides strong evidence that HtB has a significant and negative association with the size of newly built properties.

Next, we apply a difference-in-discontinuities design to estimate the effect of HtB on the size of newly built housing units. Table B2 summarizes the results. We estimate the new build transactions between £300,000 and £600,000 within 20 kilometers from the English/Welsh border. We assume that the post-HtB period starts from April 2014, one year after the implementation of the English HtB. We include additional variables sequentially from columns 1 to 5. Only the coefficients and standard errors for the key treatment estimates of HtB are reported. We observe that HtB has a significant and negative effect on the total floor area of properties. The estimated results are robust across all specifications.

[23] See Section 3.3.3 for details on the estimation of this counterfactual density.
[24] These numbers amount, respectively, to 10.4% and 5% of all sales in the £550000-£650000 range.

Our estimation results suggest that HtB decreases the size of newly built housing units on the English side of the English/Welsh border by 6.73%. Although HtB does not have a significant price effect at the border, it does decrease the size of newly constructed units. Tables B3 and B4 report the results of two corresponding placebo tests (replicate estimation for new build transactions valued less £300,000 and for new build transactions between 2010 and 2014). We do not find significant effects.

3.5.3. Credit Supply Effect

We use mortgage lending data from UK Finance to measure the effects of HtB on mortgage origination inside the GLA boundary. UK Finance data covers mortgage lending within UK postcode sectors from Q2 2013 until Q2 2018. Once again, we explore a difference in discontinuities design. We estimate postcode sectors within 5 kilometers from the GLA boundary. Table B5 reports our results. We include additional covariates into the estimation sequentially and all the estimated results show that HtB does not have a significant effect on mortgage lending. The estimated coefficients are negative and small, ranging from 0.14 to 0.16, and are statistically insignificant.

3.6. Robustness Checks

3.6.1. Robustness of Price effects

We conducted a number of additional robustness checks. First, we alter the distance band around the GLA boundary for the price estimate from 5km (Table 4) to 2.5 and 7.5 km, respectively. Our results, reported in Table B6, are robust to this check: house prices increase after the implementation of London's HtB. Next, we conduct the same check for the English/Welsh border but alter the band from 10km (Table 5) to 5 and 15km, respectively (Table B7). Again, our findings are robust to this check: we find no price effect near the English/Welsh border. Lastly, we conduct a placebo check for Greater Manchester—reported in Table B8. This yields no significant price effect.

3.6.2. Potential sorting of homebuyers near boundary

We estimate new build transactions close to the GLA boundary and one might be concerned that would-be buyers who had originally planned to purchase housing just outside the GLA move across the boundary and buy a home just inside the GLA after the implementation of London's HtB scheme in 2016 to benefit from the more generous scheme inside the GLA. To the extent that such short-distance sorting occurs, demand for housing may fall just outside the GLA-boundary, implying that our control group is in fact negatively treated. We may thus overestimate the price effect. To address this concern, we conduct another robustness check whereby we sequentially drop new build transactions closest to the boundary from our baseline model; first we drop transactions within 0.5km on each side of the boundary, then within 1km and finally within 1.5km. Table B9 reports the results. The estimated coefficients are all statistically significant and positive, ranging from 6.3 to 8.4%. Reassuringly, the estimated coefficients do not drop in magnitude but in fact somewhat increase. This is indicating that short-distance sorting of homebuyers along the GLA-boundary is highly unlikely to inflate our baseline estimates of the price effect.

3.6.3. Robustness of Construction effects

Our construction estimates allow for a one-year construction lag. In Tables B10 and B11 we replicate the specifications reported in Tables 6 and 7 but estimate contemporaneous construction effects (i.e., the post-treatment-period is defined as the implementation date of the policy). Again, we find that HtB does not have a significant impact on housing construction at the GLA boundary, but increases construction significantly at the English/Welsh border. We also find no significant contemporaneous construction effect for Greater Manchester, our placebo area (Table B12).

3.6.4. Difference in timing of implementation at the English/Welsh border

One caveat relating to our analysis of price and construction effects at the English/Welsh border is the fact that the English version of HtB was implemented 9 months prior to the Welsh version. Thus, our estimated effect has to be interpreted as a weighted average effect of the difference in generosity of HtB (i.e., the fact that the price threshold on the English side of the border is twice that as in Wales) and the difference arising from the timing in implementation. To identify the effect of the differential generosity more cleanly, in a robustness check, we drop observations between April and December 2013 (i.e., the time period with only English HtB) for our price estimates. The pre-period thus is January 2012 till March 2013 and the post period is January 2014 to December 2018. Our results are virtually unaffected. The results are reported in Appendix Table B13. For our construction estimates we define the pre-period as running from January 2012 till March 2013. This is the time period prior to any HtB-scheme in either England or Wales. We define the post-period as running from January 2015 till December 2018. This takes into account the fact that it may take up to a year for construction to respond to the implementation of the HtB-scheme in Wales. The results are again very similar to our base estimates and are reported in Appendix Table B14.

3.7. Back-of-the-Envelope Calculation of Price Effect

In our empirical analysis, we estimated the effect on the price of new build homes of the *additional* 20% interest free equity loan inside versus outside the GLA. Our preferred estimate in Table 4 (column 5) suggests that this effect amount to 6%.

To examine whether the additional subsidy is partially, fully or overcapitalized into house prices, we next compare this estimated effect to a 'theoretical' present value of the additional subsidy derived from a simple back-of-the-envelope calculation.

To do so, we compare the present value of a 20% interest free HtB-equity loan (i.e., the difference in the subsidy between inside and outside the GLA) to a 20% non-HtB 10-year fixed rate mortgage. We assume that the interest rate for this latter product is 2.74%, the amount charged in June 2018.

The HtB mortgage in contrast guarantees no interest for the first 5 years of the mortgage-life. After that, the interest rate is 1.75% × (1 + (1%+Retail Prices Index RPI)). We assume the RPI of May 2018 (3.3%). We discount the difference in the mortgage payments between the two products in each year by 1.41%, the UK 10-year gilt yield in May 2018.

We assume that both, the HtB- and the non-HtB-borrower, repay their respective mortgages after 10 years. While for the non-HtB borrower, only the purchase price has relevance, the HtB-

borrower needs to repay the 20% equity loan based on the market value of the property. We assume that house prices over this period grow by 1% annually. This rather low assumption takes into account the facts that house price growth has stalled in 2019 and the outlook is very uncertain due to Brexit.

We then calculate the present value of the difference between the two mortgage products. We obtain a present value of the additional HtB-subsidy of 1.6% of house values (see Table B15 for details). This implies that the HtB-subsidy is strongly overcapitalized into house prices. This finding is plausible because the HtB-mortgage does not only represent a mortgage payment subsidy that, in a supply inelastic market such as the GLA, can be expected to be fully capitalized into house prices. It also—and crucially—relaxes credit constraints of first-time buyers, leading to a strong increase in demand for starter homes. This in turn should increase prices of such homes further in price inelastic markets.

4. Discussion and Conclusions

In 2013 the UK government announced the HtB scheme, which provides different forms of assistance to households aiming to buy a property as owner-occupiers. We exploit differences in the intensity of implementation of the policy's equity loan scheme across two regional boundaries to estimate the effect of the policy on the price of newly built homes and on construction volumes. We estimate different effects depending on the boundary under consideration. In the case of the GLA, we find that the more generous London HtB program led to higher new build prices but had no discernible effect on construction volumes. Both of these effects are arguably contrary to the policy's objectives which are to improve affordability and promote new construction.

The estimated effects of the policy are more encouraging in the relatively supply-elastic markets around the English/Welsh border, with no significant effect on prices and a substantial and statistically significant effect on construction activity. Yet, the housing affordability crisis in the UK tends to be most severe in the supply inelastic markets of the South East and especially in the GLA.

Our findings suggest that HtB has stimulated housing construction in the 'wrong areas'; that is, it has stimulated construction in areas where planning constraints are less rigid and it is therefore comparably easy to build, not in areas where productivity and employment concentration are highest and new housing is most needed. This is consistent with observed patterns in the intensity of HtB-construction across England and Wales (see Appendix Figure A9): The policy has led to the construction of housing outside of the green belt areas of the most productive agglomerations in the UK (London, Oxford and Cambridge). This is in line with other stylized facts that suggest that workers increasingly commute excessively long distances through green belts to get from their place of residence to their work place.

Contrary to the policy's title, HtB may not have 'helped' the population of credit constrained households in the most unaffordable areas of the country. There are two reasons for this. First, the policy pushed up house prices, increasing housing costs rather than housing consumption in square meters. Only developers or land owners, not new buyers, benefited from the policy-induced price increases. The price effect limits substantially the impact of the policy on the affordability conditions faced by credit constrained households. Second, the design of the ELS

is such that those borrowers who took advantage of the scheme to gain access to the owner-occupied housing ladder, unlike existing homeowners, do not participate in the same way in future capital gains. This is because, at the time of sale, they have to pay back the equity loan at market value. If the price increases, so does the amount that the borrower owes the government. Ultimately, HtB arguably did little to 'help' young credit constrained households in unaffordable areas.

So who benefited from HtB, if not the credit constrained households in the most unaffordable areas? Landowners in supply constrained areas (including developers who held land in those areas prior to the policy's implementation) are likely beneficiaries. Moreover, our analysis of the financial performance of developers indicates that the developers benefited too. Our findings reveal that HtB increased revenues, profits and operating expenses of those developers intensively engaged in the HtB business. This suggests that HtB not only had limited effects on affordability but may have also led to unwanted regressive distributional effects.

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TABLES

Table 1:
Equity Loan Scheme in Different Regions in UK (applies to new build only)

Region	Introduction date	House value up to	Loan from government
England	April 2013	£600,000	Up to 20%
London	February 2016	£600,000	Up to 40%
Wales	January 2014	£300,000	Up to 20%

Table 2:
Descriptive Statistics: Regression Sample

	Observations	Mean	SD	Max	Min
Panel A: London, price effect					
House price	32127	394703.1	290817.7	7850000	27720
HtB treatment	32127	0.26	0.44	1	0
Inside GLA	32127	0.6	0.49	1	0
Post London HtB	32127	0.45	0.5	1	0
Total floor area	32127	87.27	49.77	797.5	0
Terrace	32127	0.18	0.38	1	0
Flat	32127	0.65	0.48	1	0
Detached	32127	0.08	0.27	1	0
Semi-detached	32127	0.09	0.29	1	0
Leasehold	32127	0.67	0.47	1	0
Energy consumption	32127	98.47	67.49	1038	-124
Fireplace	32127	0.12	0.33	1	0
CO2 emissions	32127	1.4	1.08	36.9	-1.8
Distance to boundary	32127	2492.09	1392.62	4999.27	4.75
Panel B: English/Welsh border, price effect					
House price	8471	234201.7	111031.9	1550000	16260
HtB treatment	8471	0.48	0.5	1	0
Inside GLA	8471	0.47	0.5	1	0
Post English HtB	8471	0.88	0.33	1	0
Total floor area	8471	102.21	41.63	575	0
Terrace	8471	0.18	0.39	1	0
Flat	8471	0.13	0.34	1	0
Detached	8471	0.49	0.5	1	0
Semi-detached	8471	0.2	0.4	1	0
Leasehold	8471	0.27	0.44	1	0
Energy consumption	8471	102.33	42.7	1076	-19
Fireplace	8471	0.11	0.31	1	0
CO2 emissions	8471	1.84	1.23	61	-0.2
Distance to boundary	8471	4899.43	2765.6	9980.05	11.18
Panel C: London, construction effect (ward-level sample)					
Number of units constructed	36624	0.88	3.57	87	0
Any new build in ward, by month	36624	0.2	0.4	1	0
HtB Treatment	36624	0.12	0.33	1	0
Inside GLA	36624	0.55	0.5	1	0
Post London HtB	36624	0.27	0.45	1	0
Distance to boundary	36624	2989.04	1731.07	9214.15	186.91
Panel D: English/Welsh border, construction effect (ward-level sample)					
Number of units constructed	22848	0.37	1.55	73	0
Any new build in ward, by month	22848	0.13	0.34	1	0
HtB treatment	22848	0.25	0.43	1	0
In Wales	22848	0.63	0.48	1	0
Post HtB in England	22848	0.68	0.47	1	0
Distance to boundary	22848	6059.57	3581.42	15102.6	162.69

Table 3:
Supply Constraints Measures and Implied Price-Earnings Elasticities

Region	English/Welsh border	GLA boundary	Greater Manchester boundary
Share of land in green belts	3.77%	66.5%	52.6%
Average refusal rate 1979-2008	27.2%	35.6%	25.1%
Average share of developed land	6.3%	27.6%	18.2%
Average elevation range	476.0	143.9	382.3
Implied price-earning elasticity (OLS)	0.252	0.403	0.284
Implied price-earning elasticity (IV)	0.127	0.205	0.164

Notes: The refusal rate, share developed land and elevation range are weighted by the surface area of the Local Planning Authority. Data on refusal rates, share developed land and elevation range come from Hilber and Vermeulen (2016). The green belt shape file comes from the Ministry of Housing, Communities and Local Government.

Table 4:
Price Effect at GLA Boundary

Specifications	(1)	(2)	(3)	(4)	(5)
HtB [1)]	0.1613***	0.0712***	0.0446*	0.0641***	0.0599**
	(0.0423)	(0.0261)	(0.0245)	(0.0232)	(0.0241)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary on each side	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Postcode FEs	No	No	Yes	Yes	Yes
Census variables by year [3)]	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes
N	32127	32127	32127	32127	32127
R^2	0.0906	0.6232	0.9187	0.9191	0.9192

Notes: [1)] HtB captures the difference between the 40% and the 20% equity loan threshold (inside vs. outside GLA). [2)] Housing controls include total floor area, dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level.

Table 5:
Price Effect at English/Welsh Border

Specifications	(1)	(2)	(3)	(4)	(5)
HtB [1)]	0.1483*	0.0869	0.0168	0.0226	0.0240
	(0.0863)	(0.0532)	(0.0265)	(0.0283)	(0.0270)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary on each side	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Postcode FEs	No	No	Yes	Yes	Yes
Census variables by year [3)]	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes
N	8471	8471	8471	8471	8471
R^2	0.1013	0.6745	0.9224	0.9229	0.9230

Notes: [1)] HtB captures the difference between the £600k and the £300k price-threshold (English vs. Welsh side of border). [2)] Housing controls include total floor area, dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level.

Table 6:
Construction Effect at GLA Boundary

Dependent Variable:	#New builds				Dummy			
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HtB [1)]	0.1452	0.1452	0.1452	0.1299	0.0170	0.0170	0.0170	0.0182
	(0.1935)	(0.1935)	(0.1947)	(0.1899)	(0.0233)	(0.0233)	(0.0234)	(0.0232)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to boundary on each side	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Ward fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Distance by year	No	No	No	Yes	No	No	No	Yes
N	36624	36624	36624	36624	36624	36624	36624	36624
R^2	0.0062	0.0129	0.1785	0.1791	0.0076	0.0229	0.2125	0.2129

Note: [1)] HtB captures the difference between the 40% and the 20% equity loan threshold (inside vs. outside GLA).

Table 7:
Construction Effect at English/Welsh Border

Dependent Variable:	#New builds				Dummy			
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HtB [1)]	0.3250***	0.3250***	0.3250***	0.3549***	0.0632**	0.0632**	0.0632**	0.0667***
	(0.1043)	(0.1043)	(0.1049)	(0.1046)	(0.0249)	(0.0249)	(0.0251)	(0.0248)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to boundary on each side	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Ward fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Distance by year	No	No	No	Yes	No	No	No	Yes
N	22848	22848	22848	22848	22848	22848	22848	22848
R^2	0.0163	0.0271	0.2684	0.2696	0.0157	0.0382	0.2960	0.2969

Note: [1)] HtB captures the difference between the £600k and the £300k price-threshold (English vs. Welsh side of border).

Table 8:
Effects on Financial Performance of Developers

Specifications	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Ln(turnover)	Ln(gross profit)	Ln(net profit before tax)	Ln(△(2)-(3))	Ln(cost of employees)
Panel A: HtB intensity sample					
HtB intensity	1.1200**	1.4607**	2.4509*	0.8786**	0.9383***
× Post [1)]	(0.4168)	(0.6219)	(1.4252)	(0.3222)	(0.2875)
N	193	193	193	193	193
R^2	0.9732	0.9651	0.8625	0.9059	0.9875
Panel B: DID sample					
HtB dummy	0.4863***	0.6781***	1.5559***	0.3045***	0.4143***
× Post [2)]	(0.1510)	(0.1900)	(0.5577)	(0.0889)	(0.1346)
N	499	499	499	499	499
R^2	0.9755	0.9733	0.8942	0.9458	0.9872
Year FEs	Yes	Yes	Yes	Yes	Yes
Developer FEs	Yes	Yes	Yes	Yes	Yes

Note: [1)] HtB intensity is defined as the 5-year average ratio of HtB-completions relative to all completions. [2)] HtB dummy equals to one if a developer is involved in HtB business. Standard errors are clustered at developer level.

FIGURES

Fig. 1
New Builds near the Greater London Authority Boundary

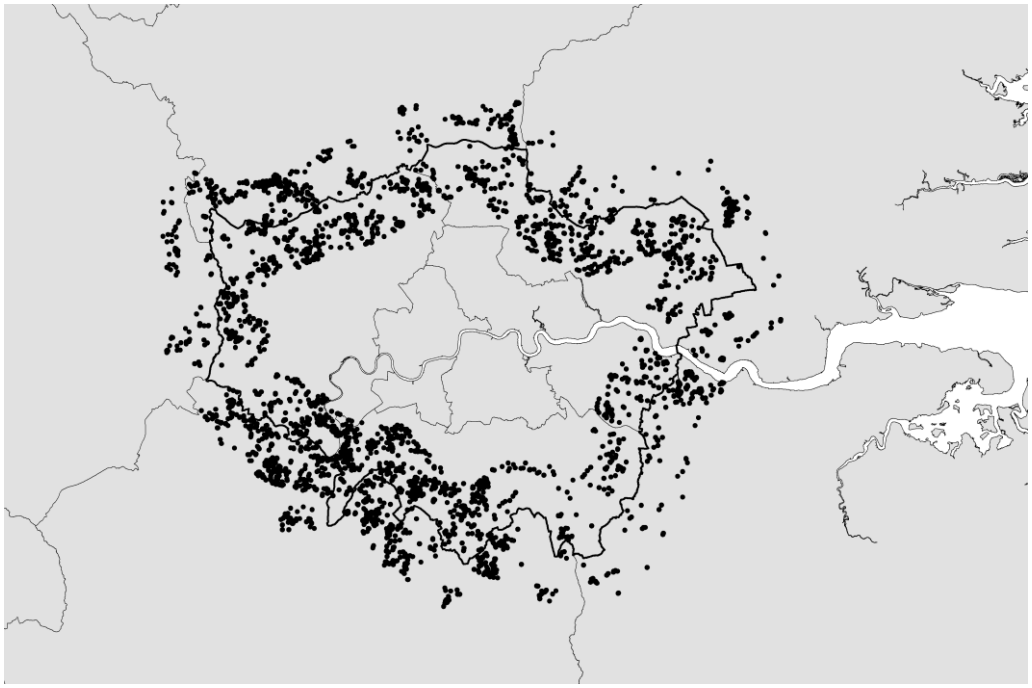


Fig. 2
New Builds near English/Welsh Border

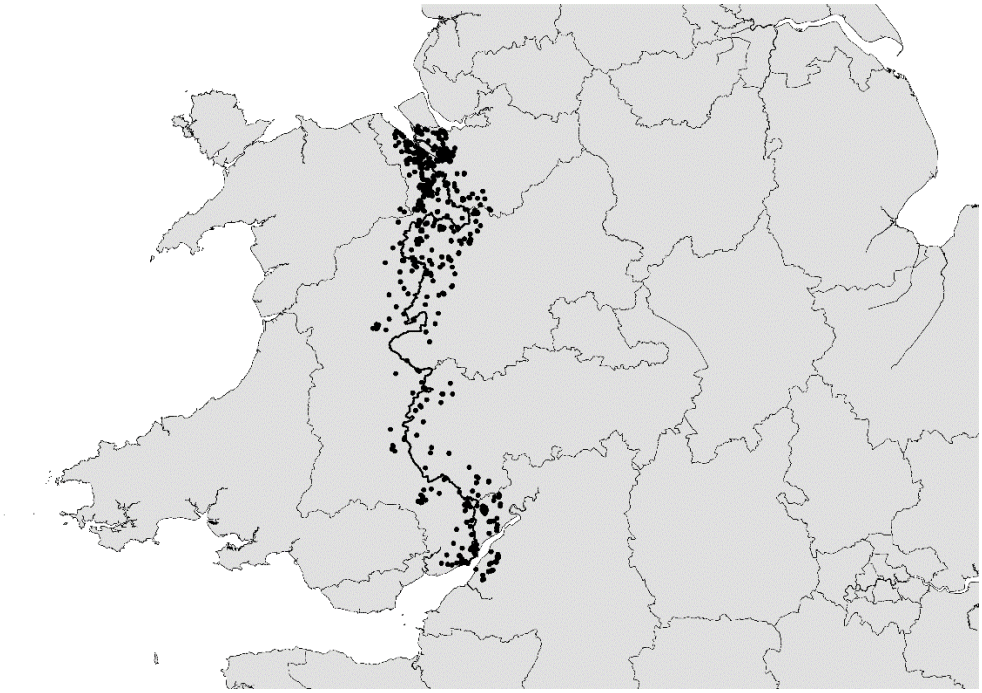


Fig. 3:
House Price Index at GLA boundary

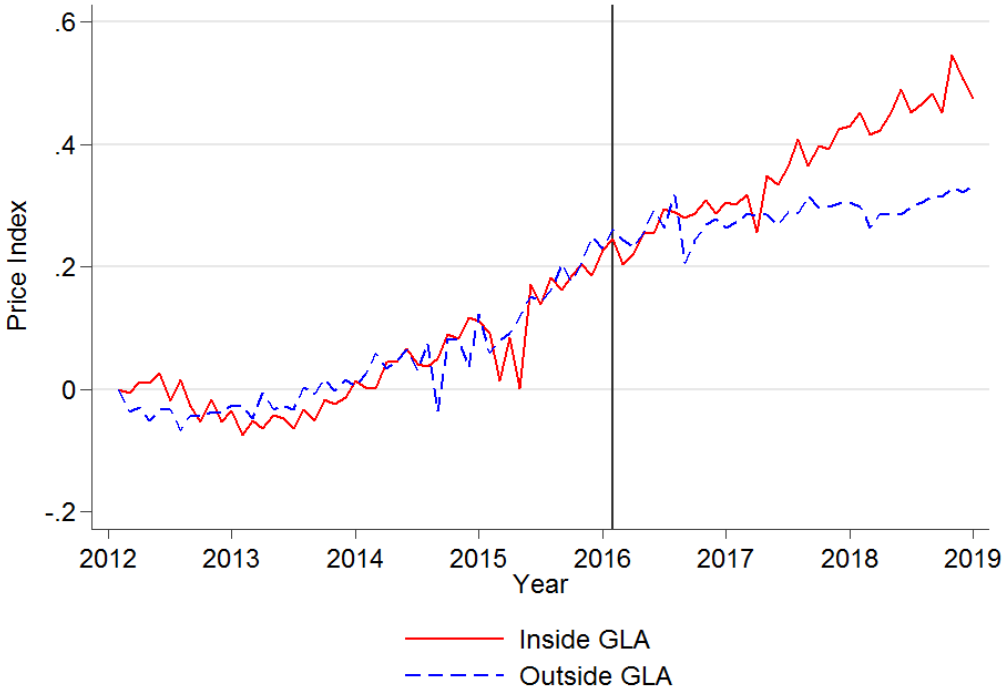


Fig. 4:
House Price Index at English/Welsh Border

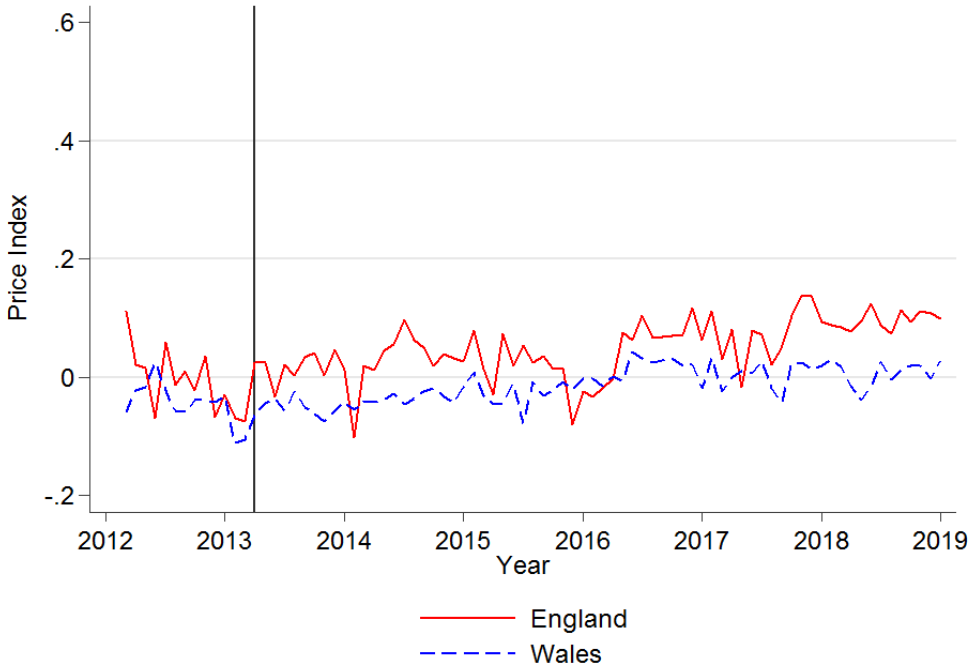
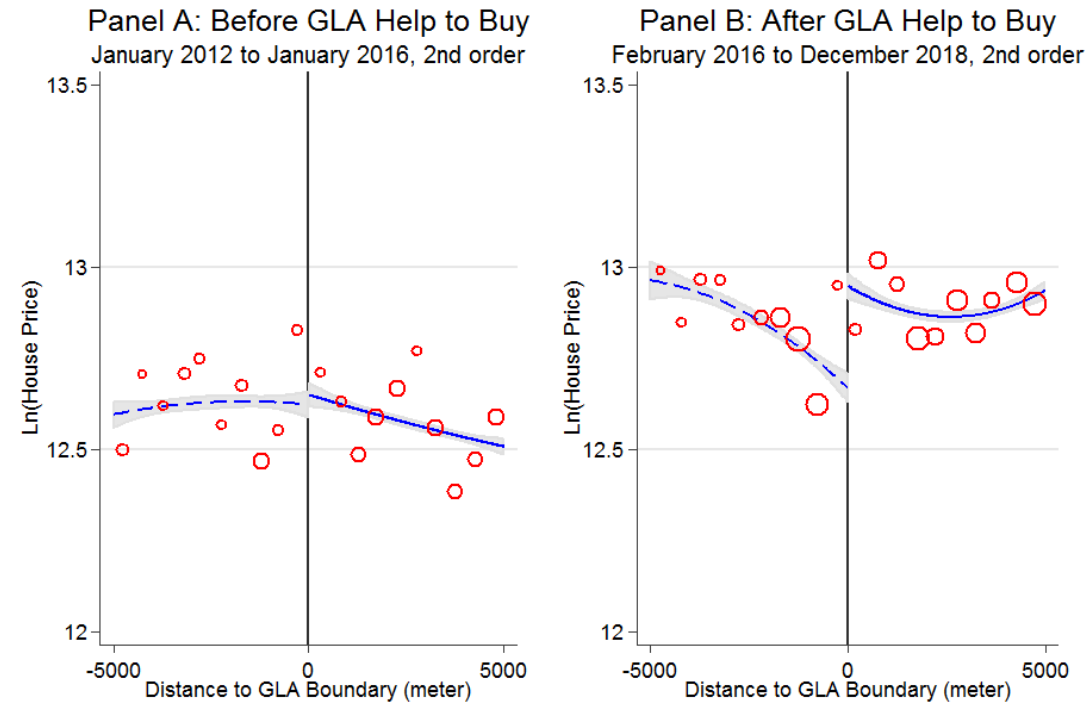
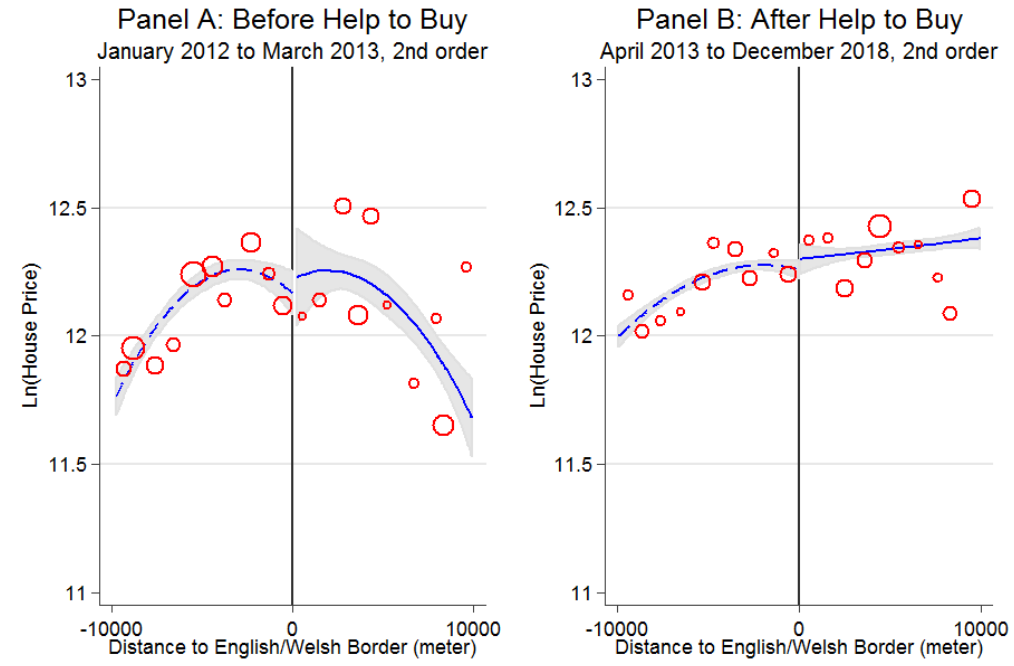


Fig. 5:
Boundary Discontinuity Design: Price Effect at GLA Boundary



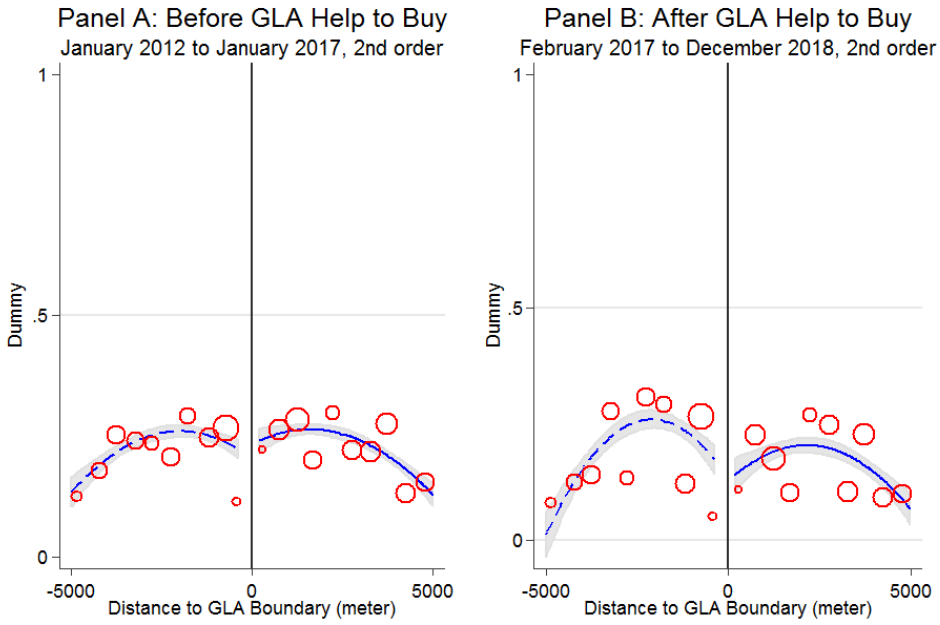
Positive distance = transactions inside GLA ; Negative distance = transactions outside GLA

Fig. 6:
Boundary Discontinuity Design: Price Effect at English/Welsh Border



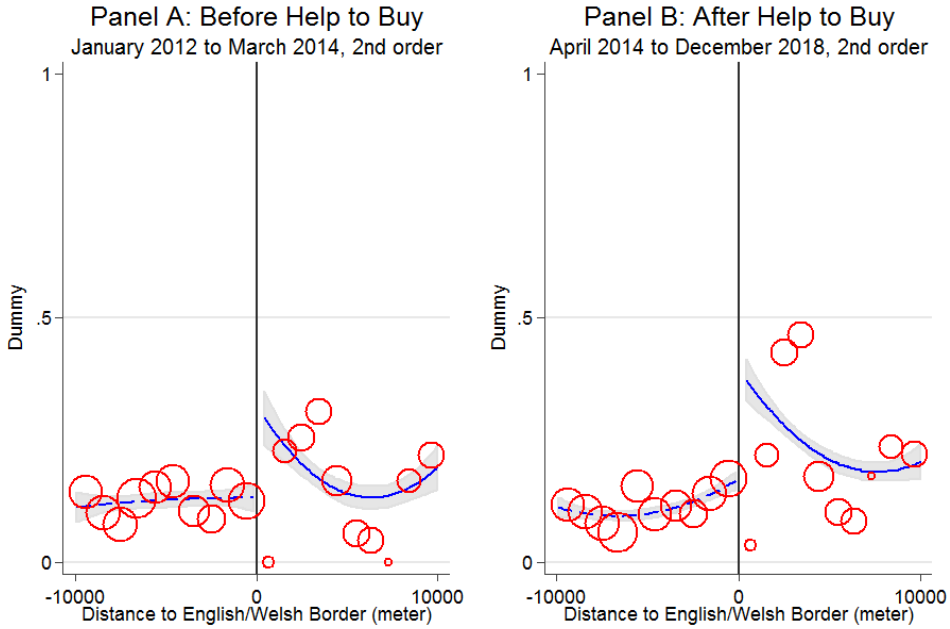
Positive distance = transactions in England ; Negative distance = transactions in Wales

Fig. 7:
Boundary Discontinuity Design: Construction Effect at GLA Boundary



Positive distance = transactions inside GLA ; Negative distance = transactions outside GLA

Fig. 8:
Boundary Discontinuity Design: Construction Effect at English/Welsh Border



Positive distance = transactions in England ; Negative distance = transactions in Wales

Fig. 9:
Developers' Profits over Time

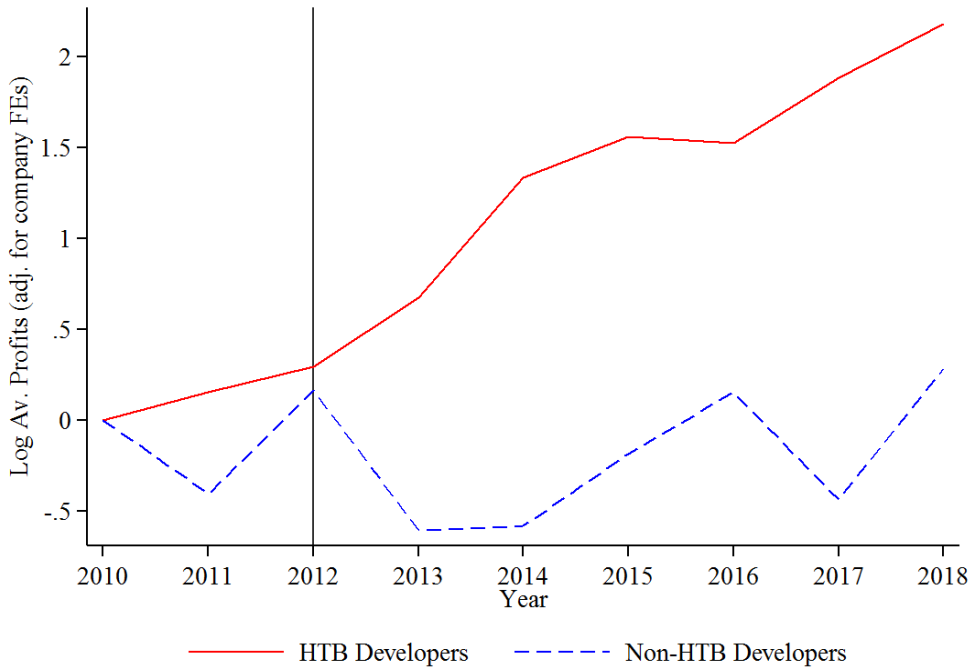
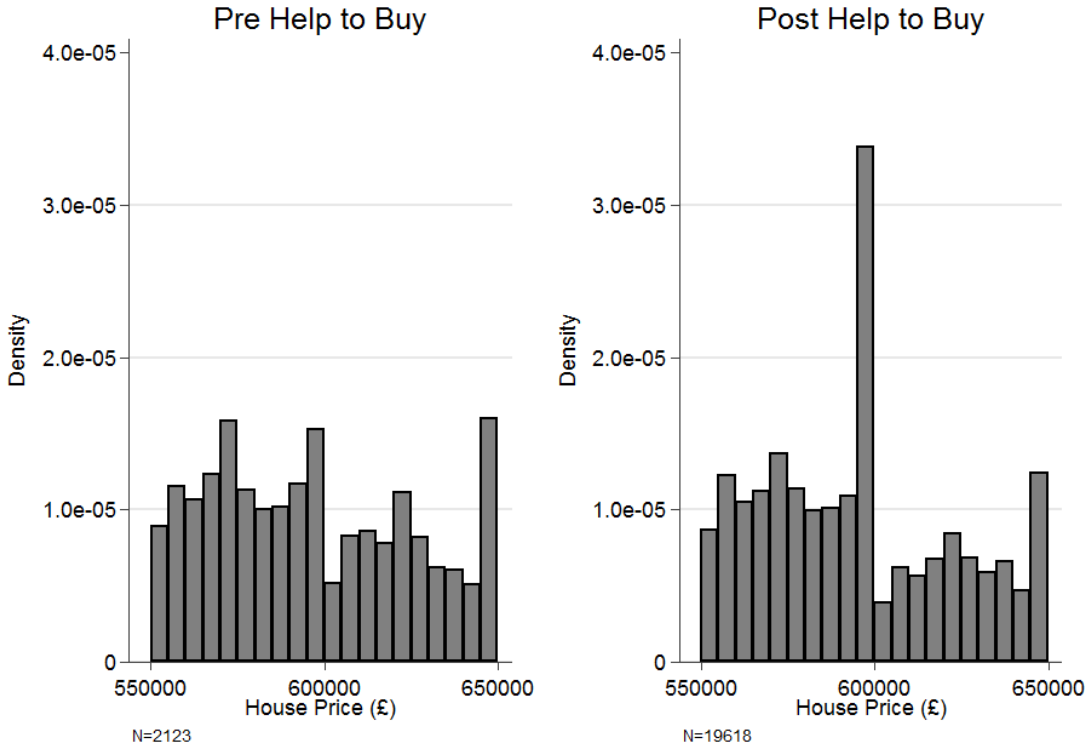


Fig. 10:
Histogram of House Prices in England



APPENDICES

Appendix A: Appendix Figures

Fig. A1:
New Builds near Greater Manchester Boundary

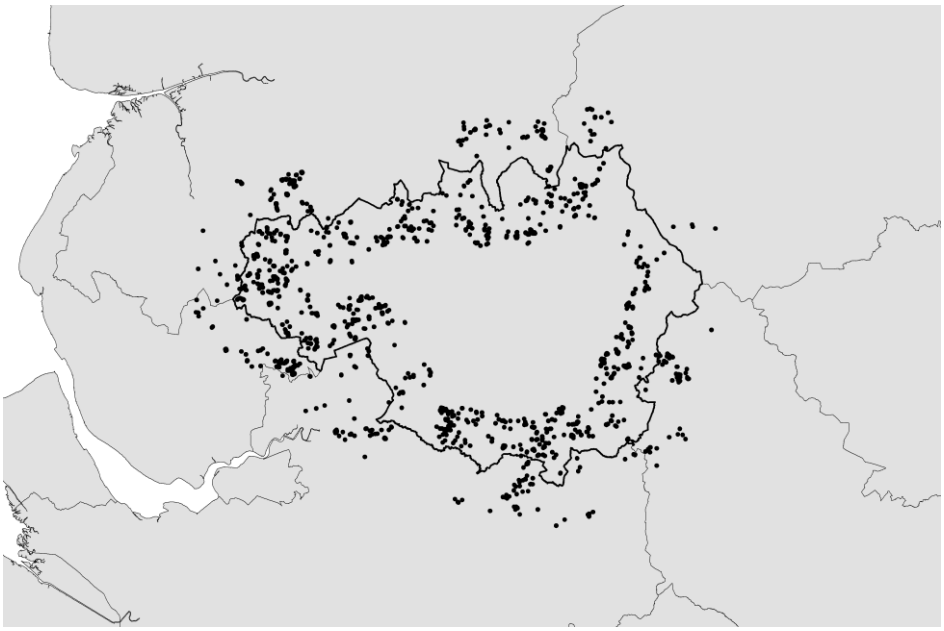


Fig. A2:
BDD Robustness – GLA Boundary HtB Price Effect, Linear Polynomial

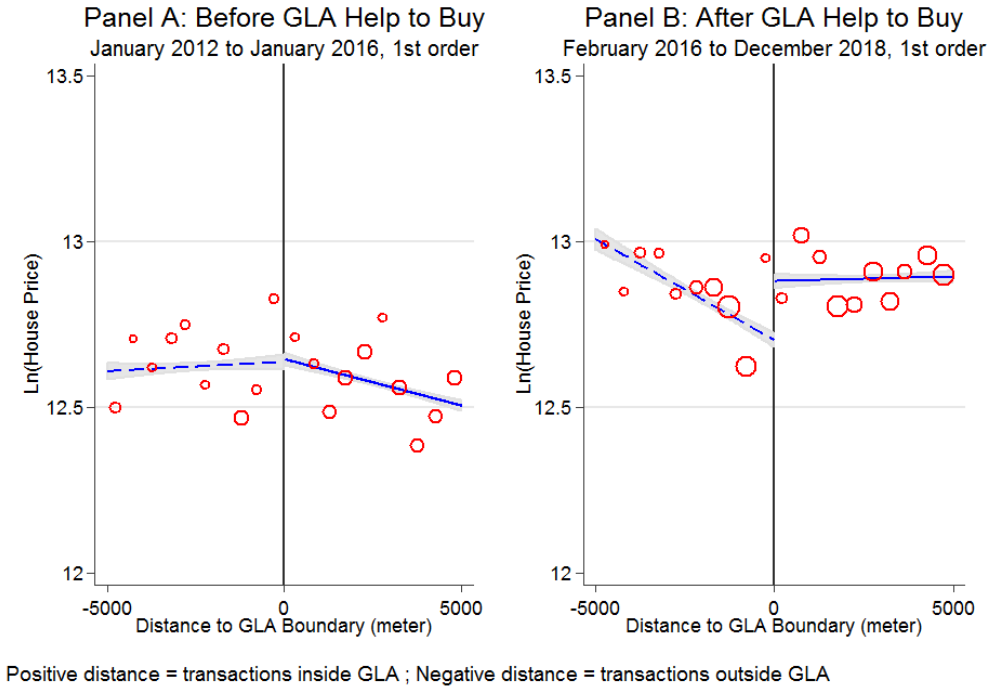


Fig. A3:

BDD Robustness – English/Welsh Border Price Effect, Linear Polynomial

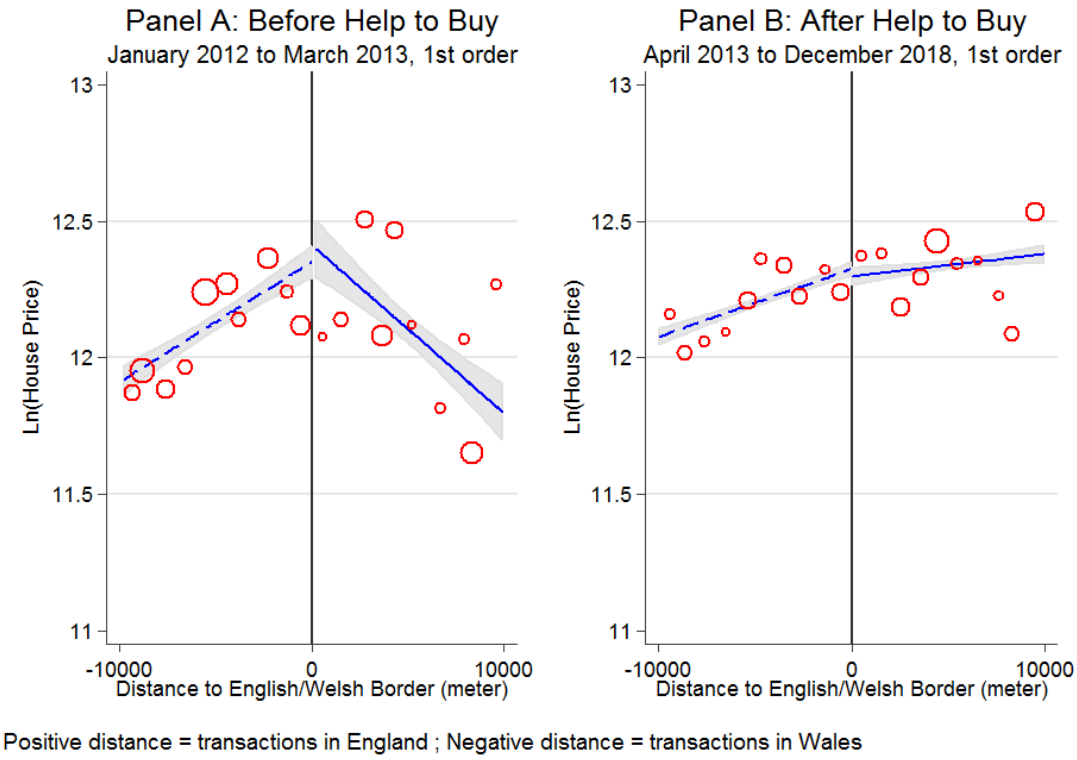


Fig. A4:
Boundary Discontinuity Design: Placebo Manchester

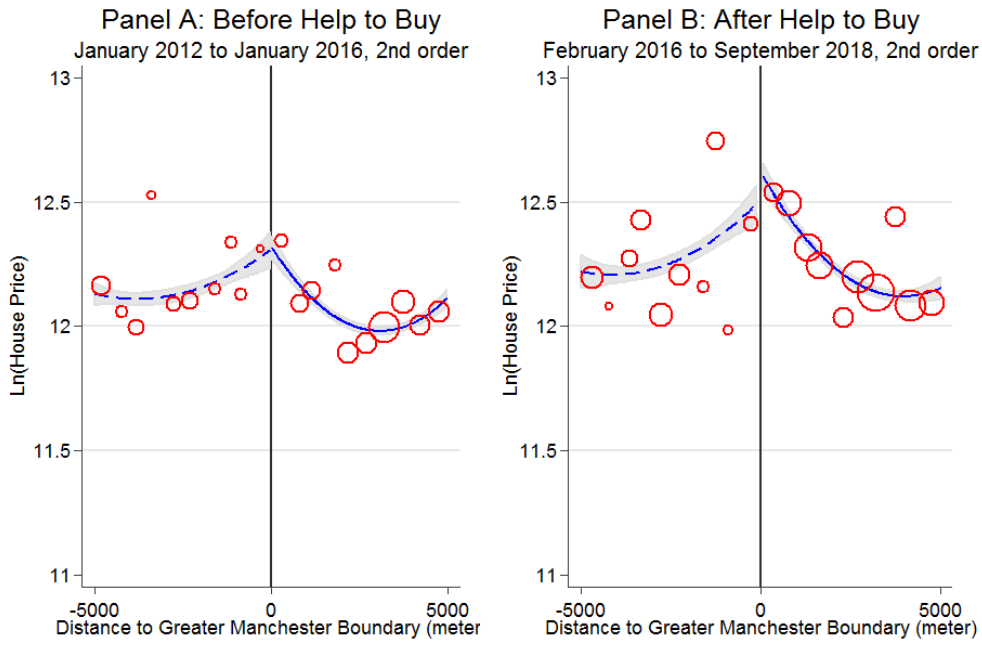


Fig. A5:

Fraction of New Builds over Total Sales

Fig. A6:
The Fraction of New Builds over Total Sales

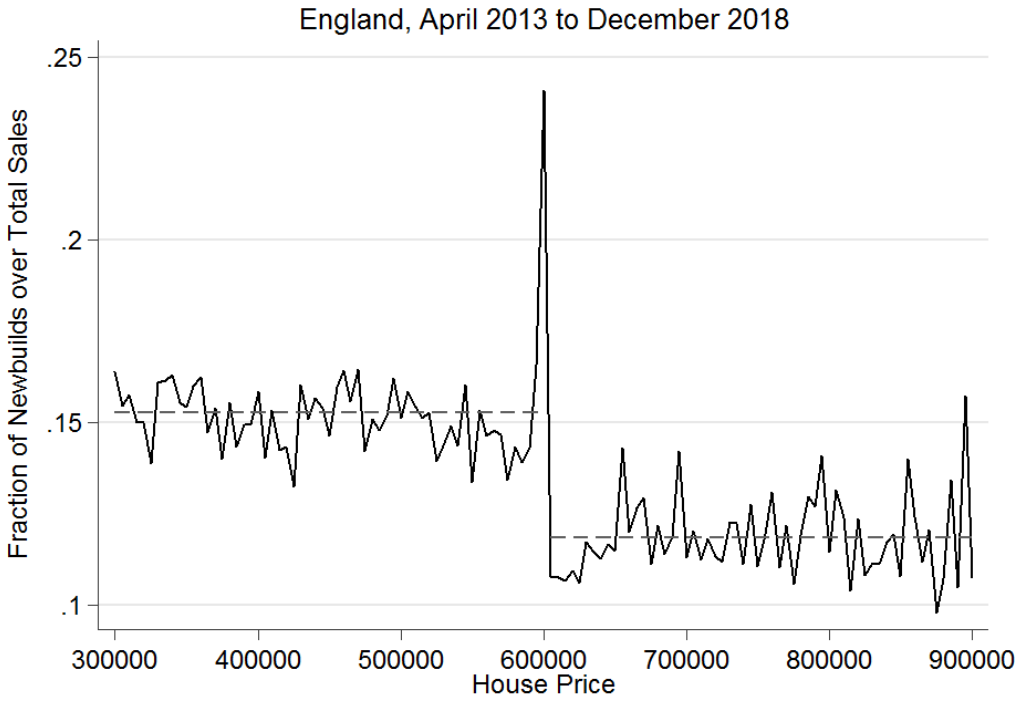


Fig. A7:

Estimated Bunching Effect

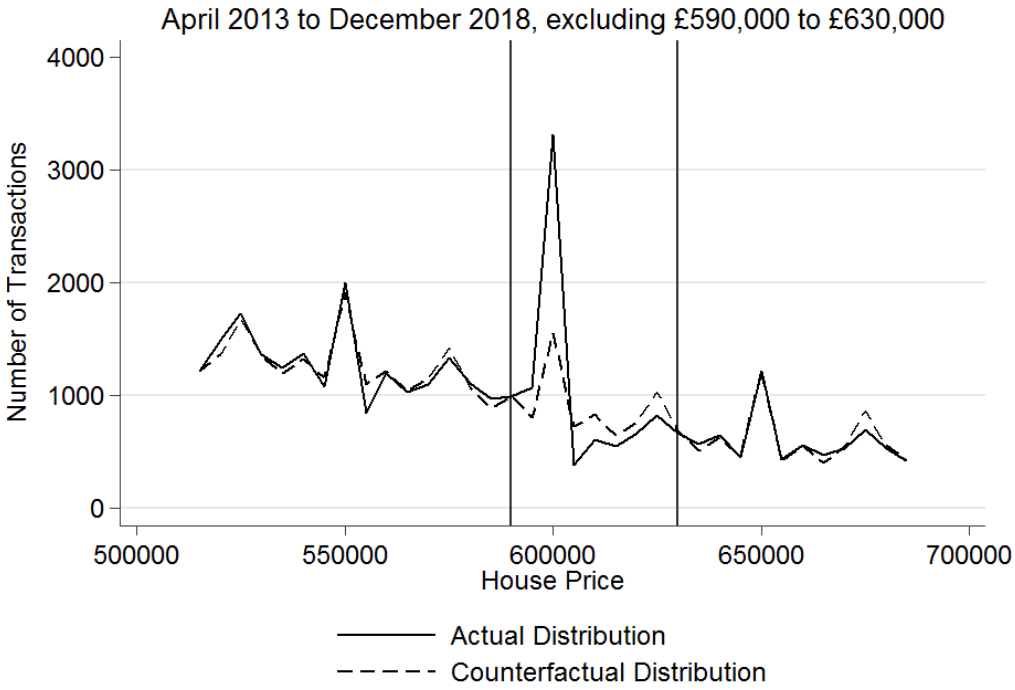
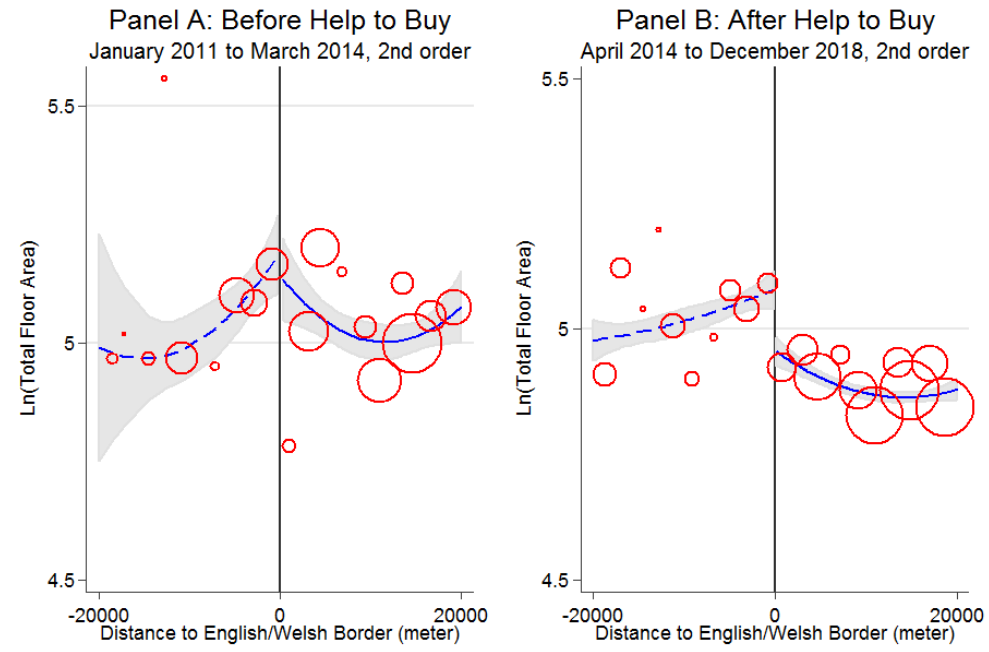
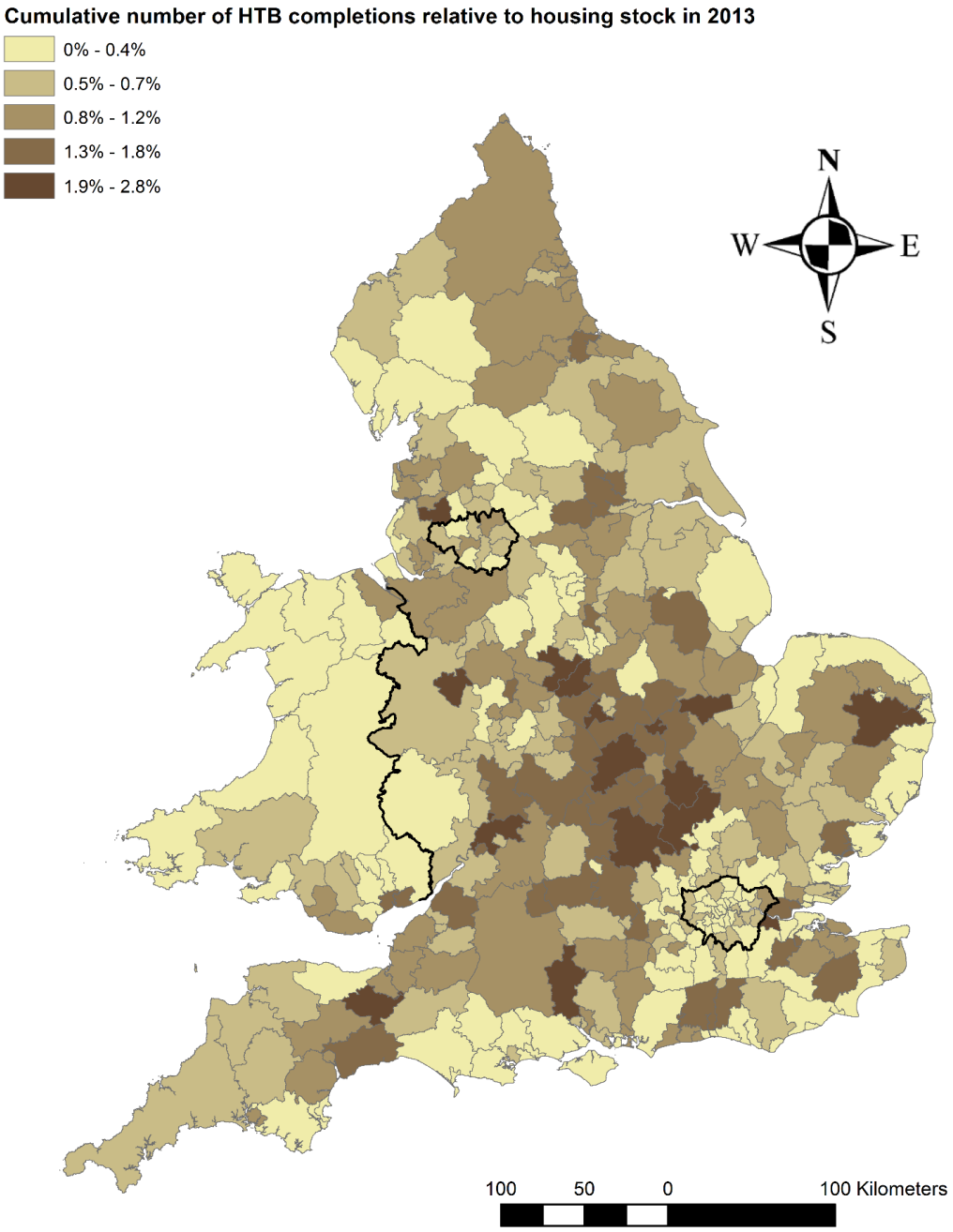


Fig. A8:
Size Effect at English/Welsh Border



Positive distance = transactions in England ; Negative distance = transactions in Wales

Fig. A9:
Accumulated Help to Buy Completions (2013-2017)



Appendix B: Appendix Tables

Table B1:
Number of Transactions

London					
	5 km	4 km	3 km	2 km	1 km
Total number of sales	32127	25845	19850	14006	5149
Postcodes	1446	1250	948	634	246
Sales in treatment group	8495	6196	4596	2860	1108
Postcodes in treatment group	576	409	312	208	81
Wales					
	10 km	9 km	8 km	7 km	6 km
Total number of sales	8471	7612	6689	6204	5827
Postcodes	269	238	233	226	219
Sales in treatment group	4106	3527	3155	2960	2797
Postcodes in treatment group	171	142	138	132	125

Table B2:
Size Effect at English/Welsh Border (Units valued between £300-600k; 2011-2018)

Specifications	(1)	(2)	(3)	(4)	(5)
HtB [1)]	-0.1198***	-0.0717*	-0.0671*	-0.0849***	-0.0673**
	(0.0445)	(0.0369)	(0.0340)	(0.0293)	(0.0271)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Log house price	No	No	Yes	Yes	Yes
Postcode district fixed effects	No	No	No	Yes	Yes
Census variables by year [3)]	No	No	No	No	Yes
N	4763	4763	4763	4763	4763
R^2	0.1553	0.6921	0.7631	0.8227	0.8301

Notes: [1)] HtB captures the difference between the £600k and the £300k price-threshold (English vs. Welsh side of border). We estimate using new build transactions valued between £300,000 and £600,000 within 20km from the English/Welsh border from 2011 to 2018. We define 'post HtB' as starting from April 2014, which is one year after the implementation of the English HtB. [2)] Housing controls include dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level. Standard errors are clustered at postcode district level.

Table B3:
Placebo Size Effect at English/Welsh Border (Units valued <£300k; 2011-2018)

Specifications	(1)	(2)	(3)	(4)	(5)
HtB (placebo) [1)]	-0.0560	-0.0354	-0.0350	-0.0384	-0.0358
	(0.0360)	(0.0273)	(0.0250)	(0.0252)	(0.0238)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Log house price	No	No	Yes	Yes	Yes
Postcode district fixed effects	No	No	No	Yes	Yes
Census variables by year [3)]	No	No	No	No	Yes
N	17640	17640	17640	17640	17640
R^2	0.0798	0.6359	0.6872	0.7176	0.7208

Notes: [1)] Placebo variable captures non-existing differences between the English and the Welsh side of the border in (the generosity of) HtB for units valued below £300k. We estimate using new build transactions valued less than £300,000 within 20km from the English/Welsh border from 2011 to 2018. We define 'post HtB' as starting from April 2014, which is one year after the implementation of the English HtB. [2)] Housing controls include dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level. Standard errors are clustered at postcode district level.

Table B4:
Placebo Size Effect at English/Welsh Border
(Units valued between £300-600k; 2010-2014)

Specifications	(1)	(2)	(3)	(4)	(5)
HtB (placebo) [1)]	-0.1236*	-0.0283	-0.0325	-0.0509	-0.0483
	(0.0723)	(0.0557)	(0.0564)	(0.0455)	(0.0513)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Log house price	No	No	Yes	Yes	Yes
Postcode district fixed effects	No	No	No	Yes	Yes
Census variables by year [3)]	No	No	No	No	Yes
N	1275	1275	1275	1275	1275
R^2	0.1163	0.5561	0.6261	0.7375	0.7407

Notes: [1)] Placebo variable captures non-existing differences between the English and the Welsh side of the border for time prior to 2015. We estimate using new build transactions valued between £300,000 and £600,000 within 20km away from the English/Welsh border from 2010 to 2014. We define year 2013 and 2014 as post HtB period. [2)] Housing controls include dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level. Standard errors are clustered at postcode district level.

Table B5:
Effects on Mortgage Origination Inside of GLA Boundary

Specifications	(1)	(2)	(3)	(4)	(5)
HtB [1)]	-0.0014	-0.0014	-0.0014	-0.0014	-0.0016
	(0.0080)	(0.0080)	(0.0080)	(0.0082)	(0.0083)
Year-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary	No	Yes	Yes	Yes	Yes
Postcode area fixed effects	No	No	Yes	No	No
Postcode sector fixed effects	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes
N	10836	10836	10836	10836	10836
R^2	0.0191	0.0206	0.1876	0.9955	0.9955

Note: [1)] HtB captures the difference between the 40% and the 20% equity loan threshold (inside vs. outside GLA).

Table B6:
Robustness – Bandwidth Selection & Price Effect at GLA Boundary

Specifications	(1)	(2)	(3)	(4)	(5)
Panel A: 2.5 km Bandwidth					
HtB [1)]	0.1044*	0.0413	0.0436*	0.0602**	0.0432*
	(0.0548)	(0.0330)	(0.0262)	(0.0276)	(0.0245)
N	17005	17005	17005	17005	17005
Panel B: 7.5 km Bandwidth					
HtB [1)]	0.1243***	0.0745***	0.0457**	0.0550**	0.0546**
	(0.0352)	(0.0218)	(0.0219)	(0.0248)	(0.0248)
N	51079	51079	51079	51079	51079
Year-month FEs	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Postcode FEs	No	No	Yes	Yes	Yes
Census variables by year [3)]	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes

Notes: [1) - 3)] see Table 4.

Table B7:
Robustness – Bandwidth Selection & Price Effect at English/Welsh Border

Specifications	(1)	(2)	(3)	(4)	(5)
Panel A: 5 km Bandwidth					
HtB	0.0207	-0.0379	0.0182	0.0278	0.0228
	(0.0879)	(0.0447)	(0.0280)	(0.0307)	(0.0315)
N	4864	4864	4864	4864	4864
Panel B: 15 km Bandwidth					
HtB	0.1496**	0.0810**	-0.0064	-0.0027	-0.0029
	(0.0635)	(0.0386)	(0.0194)	(0.0205)	(0.0206)
N	14496	14496	14496	14496	14496
Year-month FEs	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Postcode FEs	No	No	Yes	Yes	Yes
Census variables by year [3)]	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes

Notes: [1) - 3)] see Table 5.

Table B8:
Placebo - Price Effect at Greater Manchester Boundary

Specifications	(1)	(2)	(3)	(4)	(5)
HtB (placebo) [1)]	0.0451	0.0151	-0.0035	-0.0056	-0.0047
	(0.0570)	(0.0344)	(0.0183)	(0.0184)	(0.0179)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Postcode fixed effects	No	No	Yes	Yes	Yes
Census variables by year [3)]	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes
N	13318	13318	13318	13318	13318
R^2	0.0874	0.6767	0.9221	0.9223	0.9224

Notes: [1)] Placebo variable captures non-existing differences between inside and outside the Greater Manchester boundary in the generosity of HtB. [2)] Housing controls include total floor area, dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level.

Table B9:
Price Effect at GLA Boundary – Donut Approach

	Keep new build transactions between …		
Specifications	0.5-5km	1- 5 km	1.5 - 5 km
HtB [1)]	0.0632**	0.0685**	0.0836***
	(0.0249)	(0.0274)	(0.0292)
Year-month fixed effects	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes
Housing controls [2)]	Yes	Yes	Yes
Postcode FEs	Yes	Yes	Yes
Census variables by year [3)]	Yes	Yes	Yes
Distance by year	Yes	Yes	Yes
N	30170	26978	22682
R^2	0.9167	0.9146	0.9085

Notes: [1)] HtB captures the difference between the 40% and the 20% equity loan threshold (inside vs. outside GLA). [2)] Housing controls include total floor area, dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level.

Table B10:
Robustness – GLA Boundary Contemporaneous Construction Effects

Dependent Variable:	#New builds				Dummy			
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HtB [1)]	0.0445	0.0445	0.0445	0.0238	0.0113	0.0113	0.0113	0.0116
	(0.1682)	(0.1682)	(0.1692)	(0.1659)	(0.0231)	(0.0231)	(0.0233)	(0.0232)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to boundary	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Ward fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Distance by year	No	No	No	Yes	No	No	No	Yes
N	36624	36624	36624	36624	36624	36624	36624	36624
R^2	0.0062	0.0129	0.1784	0.1791	0.0075	0.0229	0.2125	0.2129

Note: [1)] HtB captures the difference between the 40% and the 20% equity loan threshold (inside vs. outside GLA).

Table B11:
Robustness - English/Welsh Border Contemporaneous Construction Effects

Dependent Variable:	#New builds				Dummy			
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HtB	0.3147***	0.3147***	0.3147***	0.3448***	0.0630***	0.0630***	0.0630***	0.0664***
	(0.1052)	(0.1052)	(0.1058)	(0.1074)	(0.0234)	(0.0234)	(0.0236)	(0.0236)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to boundary	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Ward FEs	No	No	Yes	Yes	No	No	Yes	Yes
Distance by year	No	No	No	Yes	No	No	No	Yes
N	22848	22848	22848	22848	22848	22848	22848	22848
R^2	0.0155	0.0263	0.2676	0.2687	0.0151	0.0377	0.2954	0.2963

Note: [1)] HtB captures the difference between the £600k and the £300k price-threshold (English vs. Welsh side of border).

Table B12:
Placebo - Construction Effect at Greater Manchester Boundary

Dependent Variable:	#New builds				Dummy			
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HtB (placebo) [1)]	-0.1769	-0.1769	-0.1769	-0.1693	0.02	0.02	0.02	0.0176
	(0.2122)	(0.2122)	(0.2135)	(0.2107)	(0.0406)	(0.0406)	(0.0409)	(0.0406)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to boundary	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Ward fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Distance by year	No	No	No	Yes	No	No	No	Yes
N	17808	17808	17808	17808	17808	17808	17808	17808
R^2	0.0277	0.0401	0.2339	0.2342	0.0236	0.0539	0.3343	0.3345

Note: [1)] Placebo variable captures non-existing differences between inside and outside the Greater Manchester boundary in the generosity of HtB.

Table B13:
Price Effect at English/Welsh Border
(Pre-period: January 2012 to March 2013; Post period: January 2014 to December 2018)

Specifications	(1)	(2)	(3)	(4)	(5)
HtB [1)]	0.1405	0.0840	0.0271	0.0291	0.0308
	(0.0909)	(0.0566)	(0.0372)	(0.0413)	(0.0412)
Year-month fixed effects	Yes	Yes	Yes	Yes	Yes
Distance to boundary	Yes	Yes	Yes	Yes	Yes
Housing controls [2)]	No	Yes	Yes	Yes	Yes
Postcode FEs	No	No	Yes	Yes	Yes
Census variables by year [3)]	No	No	No	Yes	Yes
Distance by year	No	No	No	No	Yes
N	7660	7660	7660	7660	7660
R^2	0.0983	0.6787	0.9225	0.9230	0.9232

Notes: [1)] HtB captures the difference between the £600k and the £300k price-threshold (English vs. Welsh side of border). [2)] Housing controls include total floor area, dwelling type, the tenure of properties, whether the property has a fireplace, energy consumption and CO_2 consumption. [3)] Neighborhood controls (from the 2011 Census) are the percentage of (1) married residents and (2) residents with level-4 and above educational qualifications at LSOA level.

Table B14:
Construction Effect at English/Welsh Border
(Pre-period: January 2012 to March 2013; Post period: January 2015 to December 2018)

Dependent Variable:	#New builds				Dummy			
Specifications	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HtB [1)]	0.3991***	0.3991***	0.3991***	0.4379***	0.0768***	0.0768***	0.0768***	0.0814***
	(0.1286)	(0.1286)	(0.1296)	(0.1317)	(0.0282)	(0.0282)	(0.0284)	(0.0285)
Year-month FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Distance to boundary	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Ward fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Distance by year	No	No	No	Yes	No	No	No	Yes
N	17136	17136	17136	17136	17136	17136	17136	17136
R^2	0.0182	0.0291	0.2668	0.2682	0.0185	0.0424	0.3045	0.3057

Note: [1)] HtB captures the difference between the £600k and the £300k price-threshold (English vs. Welsh side of border).

Table B15:
Back-of-the-Envelope Calculation

Year	HtB interest	Mortgage Rate	Net Interest Subsidy	Difference of Equity Loan	Present Value
1	0.00%	2.74%	2.74%	20.00%	0.54%
2	0.00%	2.74%	2.74%	20.00%	0.53%
3	0.00%	2.74%	2.74%	20.00%	0.53%
4	0.00%	2.74%	2.74%	20.00%	0.52%
5	0.00%	2.74%	2.74%	20.00%	0.51%
6	1.75%	2.74%	0.99%	20.00%	0.18%
7	1.81%	2.74%	0.93%	20.00%	0.17%
8	1.86%	2.74%	0.88%	20.00%	0.15%
9	1.92%	2.74%	0.82%	20.00%	0.13%
10	1.98%	2.74%	0.76%	20.00%	-1.70%
Sum					1.56%