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**DISCRIMINATION AND SORTING IN THE REAL ESTATE**

**MARKET: EVIDENCE FROM TERROR**

**ATTACKS AND MOSQUES**

**by**

**Louis-Pierre Lepage**

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## SAMMANFATTNING AV SOFI WORKING PAPER 9/2023

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I den här studien utvärderar jag påverkan av islamistiska terrorattacker på fastighetsmarknaden nära moskéer i USA. Jag karaktäriserar terrorattacker som handlingar som skakar individens uppfattning av människor med bakgrund från Mellanöstern eller med islamisk trosbakgrund, och studerar huruvida dessa förändringar påverkar benägenheten för hushåll att bosätta sig i närheten av en moské.

Med hjälp av detaljerade transaktionsdata på fastighetsnivå, vilka täcker i stort hela USA, finner jag att fastighetspriser i moskéers direkta närhet föll med ca 5 % under de första två åren efter 11 september-attackerna 2001. Jag finner få direkta bevis på att antalet fastighetstransaktioner ändras, men jag observerar en ökning i andelen hushåll med bakgrund i Mellanöstern eller Nordafrika på upp till 30 % som bosätter sig nära moskéer. Dessa resultat indikerar en ökad etnisk och religiös sortering till följd av terrorangrepp, vilket kan bidra till bostadssegregationen.

Jag presenterar ytterligare bevis på de underliggande orsakerna genom att fokusera på differentiella svar i olika delstater. Jag finner här att prisminskningarna var särskilt stora och mestadels koncentrerade till delstater med liten andel muslimsk befolkning och karaktäristika sammankopplade med fördomar mot muslimer, vilket inkluderar hatbrott. Dessutom var prisminskningarna mestadels koncentrerade kring moskéer som sedermera rapporterade att det amerikanska samhället är fientligt inställt gentemot islam.

Resultaten är konsistenta med diskriminerande gensvar: hushåll i områden med få muslimer och moskéer fick en ökad negativ uppfattning efter 11 september, vilket leder till större negativa perceptioner och prisminskningar i dessa områden. Denna tolkning stödjer uppfattningen att fördomar mot specifika grupper av människor kan motverkas genom exponering och kontakt med dess medlemmar.

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# Discrimination and Sorting in the Real Estate Market: Evidence from Terrorist Attacks and Mosques

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## Abstract

I evaluate the impact of Islamist terrorist attacks, taken as exogenous shocks which may change individual perceptions towards Middle Easterners and Muslims, on the real-estate market. Using detailed property-level transactions data, I find that US property prices immediately near mosques fell by 5% in the two years following 9/11. I find little evidence of changes in the number of transactions, but an increase of up to 30% in the fraction of Middle Eastern and North African households locating near mosques, indicating increased ethnic and religious sorting from 9/11. Additional evidence suggests that price decreases across areas are in line with increased prejudice.

**Keywords:** Housing market, terrorism, household sorting, discrimination

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Identifying willingness to pay to interact or avoid interacting with other racial, ethnic or religious groups is central to the economics of discrimination. In the real estate market, how household location decisions are causally affected by the group composition of a neighborhood is of particular importance, given that neighborhood effects are an important determinant of outcomes like education and inequality (Durlauf, 2004; Chetty et al., 2020). The largest impediment to studying discrimination is that households sort into locations with different, often unobservable amenities which correlate with group membership. This sorting suggests the use of exogenous variation to identify the causal impact of the group composition of a neighborhood on household willingness to pay (WTP).<sup>1</sup>

In this paper, I evaluate the impact of the September 11 2001 attacks (9/11), taken as an event which influenced perceptions towards Muslim households and those from the Middle East and North Africa (MENA), on real estate market discrimination and sorting near mosques. The shock provides key variation since, outside of household perceptions, most general benefits and costs of living near a mosque along with property and neighborhood characteristics, are plausibly held constant. Discrimination theory and hedonic pricing models predict that a negative shock to perceptions may lead prices to fall in areas near mosques, using mosques as proxies for interacting with Muslims and nearby concentrations of Muslim households. Moreover, the shock may also affect quantity transacted and, through heterogeneous sorting responses across households, neighborhood composition.

Using detailed property-level US transactions data, I provide evidence on the impact of 9/11 using a Difference-in-Differences (DID) strategy. I identify changes in market outcomes attributable to the shock by comparing properties in the immediate vicinity of mosques to similar properties slightly farther away but in the same neighborhood. Using geographical

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<sup>1</sup>The rarity of exogenous variation has been recognized as one of the main challenges in the literature (Charles and Guryan, 2011).

coordinates for each property and mosque allows me to focus on narrow areas, exploiting hyperlocal variation to isolate the impact of the shock (Ang, 2020). Using ethnic name analysis of buyers and sellers, I also investigate whether MENA households were more likely to locate near mosques after the attacks. While a large fraction of MENA households in the US are not Muslim, terrorist attacks typically impact perceptions towards broad groups perceived as sharing a geographical or religious background with the perpetrators (Allen and Nielsen, 2002; Singh, 2002; Abu Ras and Abu Bader, 2009; Ven, 2012; Zogby, 2001).

I find that prices within 0.2 miles of mosques decreased by 5% in the two years after 9/11. Decreases were concentrated immediately around mosques and mostly reverted back to their pre-9/11 level after 18-24 months. I find little impact on the quantity of properties sold, but a large increase of 30% in MENA households locating in these areas. I show that these patterns are consistent with a simple model of the housing market with search frictions. Further, increased sorting has potential longer-run implications and suggests that households with a smaller than average decrease in WTP for properties near mosques were induced to move in these areas.<sup>2</sup>

One interpretation is that these impacts reflect a discriminatory response to the extent that they represent changes in property valuation due to exposure to certain groups, for example from changes in the perceived risk of living near mosques or increased prejudice. Abadie and Dermisi (2008) report that 9/11 led to increased vacancy rates of landmark buildings in Chicago, suggesting a reaction to risk in the commercial market. In contrast, Redfearn (2005) finds little price change in residential markets surrounding high risk targets after 9/11, suggesting little reaction to risk for housing. Looking at heterogeneity across

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<sup>2</sup>Changes in perceptions of MENA households towards other MENA or Muslim households may be smaller from a stereotyping or Bayesian updating standpoint if these households have more exposure to these groups. Alternatively, their relative WTP for properties near mosques may increase, for example if attacks increase hostility against these households in other areas.

states, I find little relationship between the magnitude of the price decrease near mosques following 9/11 and an ex-post risk measure of attack in the state. Rather, decreases were particularly large and mostly concentrated to states with smaller Muslim populations and characteristics linked to prejudice against Muslims, namely higher increases in hate crimes following 9/11. Moreover, price decreases were mostly concentrated to mosques which later reported more strongly that American society is hostile to Islam. These patterns are consistent with previous work on terrorism increasing bias, prejudice, hate crimes, and police profiling (Swahn et al, 2003; Lauderdale, 2006; Das et al., 2009; Shayo and Zussman, 2011; Hanes and Machin, 2014; Levin, 2017; Ivandic et al., 2019; Zorlu and Frijters, 2019; Lehrer and Lepage, 2020).

Terrorism is a long-standing policy issue, but there exists little evidence on how attacks affect perceptions and behavior in ways which influence economic markets.<sup>3</sup> Attacks also decrease assimilation of Muslim immigrants (Gould and Klor, 2014; Saleem and Ramasubramanian, 2019; Zorlu and Frijters, 2019), which my results indicate could partially result from increased residential sorting. I contribute to the literature on the dynamics of discrimination and sorting by presenting new causal evidence with improvements over previous work regarding both identification and data.<sup>4</sup> Gautier et al. (2009) and Ratcliffe and von Hinke Kessler Scholder (2015) study the impact of terrorism on the real-estate market using aggregate neighborhood data from two European cities. In contrast, I provide the first comprehensive analysis of the impact of 9/11 on the US real estate market, leveraging variation from a

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<sup>3</sup>Åslund and Rooth (2005), Dávila and Mora (2005), Kaushal et al. (2007) and Charles et al. (2018) find mixed evidence of labor-market discrimination against MENA and Muslims following 9/11 and US soldier casualties in the Middle-East. Ahmed and Hammarstedt (2008) and Wagner and Petev (2019) document discrimination in the Swedish rental housing market and on Airbnb in Paris, respectively.

<sup>4</sup>See Cutler et al. (1999, 2008a, 2008b), Sethi and Somanathan (2004), Bayer and McMillan (2005), and Card et al. (2008) on sorting. Exogenous variation has been used to identify WTP for neighborhood characteristics and amenities in other contexts (e.g. Linden and Rockoff, 2008; Currie et al., 2015; Dealy et al., 2017; Brooks et al., 2018).

national shock plausibly exogenous to local conditions with detailed transaction-level data.<sup>5</sup> Further, by exploiting heterogeneity in the impact of 9/11 across buyer, area and mosque characteristics, I provide novel evidence on household sorting and underlying mechanisms.

The rest of the paper is organized as follows. Section 1 presents the data and discusses the use of terrorist attacks and mosques. Section 2 outlines the empirical strategy, Section 3 presents the results, and Section 4 concludes. All appendix tables and figures mentioned in the text are included in the Online Appendix.

## 1 Transactions Data, Mosques, and Terrorist Attacks

I use data on housing transactions from a real-estate research firm covering the US between 1998 and 2016. For each sale, I observe the price and date, property characteristics, and detailed geographical information. Although the analysis focuses on residential properties, which account for the vast majority of transactions, I also provide evidence regarding commercial properties. Prices were adjusted to 2010 constant dollars and transactions with a price of 0 or in the top/bottom 1% of remaining transactions were excluded.

I merged information on 275 mosques for which I can pinpoint an exact address at the time of 9/11 from Bagby (2012). The 2010 mosque survey provides information on founding and moving dates as well as mosque characteristics and views of their religious leader. Appendix 3.1 shows the geographical distribution of all US mosques in 2016 overlapped with the subset

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<sup>5</sup>Bogin (2012) studies the impact of 9/11 on prices near mosques in Baltimore, reporting decreases of over 17%. In contrast, Nowak and Sayago-Gomez (2018) study price differentials for properties with a MENA neighbor in a single US county following 9/11, but also look at the impact near mosques in the county, finding no evidence of price decreases in their preferred specification. Similarly, Peralta and Tangvatcharapong (2020) report that mosque openings around Detroit do not affect nearby property values. I contribute to these mixed findings by showing clear evidence of price decreases, showing that restricting the analysis to a city or county severely alters substantive conclusions, and presenting novel evidence of changes in residential sorting near mosques.

of mosques in my sample, showing good representative coverage. Using a sample of mosques likely has little impact on the analysis, and sample selection likely underestimates the true impact of interest. Since properties near mosques account for a small fraction of properties, most missclassification arises from including properties in the comparison group that are near mosques not in the sample, underestimating the impact of 9/11 on market outcomes near mosques. Regarding representativeness, mosques were randomly surveyed, but restricting the sample to mosques which did not move between 2000 and 2010 to guarantee that I observe their address on 9/11 also likely underestimates the impact of interest if these mosques are particularly well established and accepted by their community, consistent with Figure 2. Lastly, Appendix 3.6 shows little evidence of changes in moving and founding of mosques immediately following 9/11, but if 9/11 caused some mosques to close, then my analysis likely recovers a lower bound on discriminatory responses by focusing on the sample of surviving, plausibly less affected mosques.

To focus on more comparable areas, I restrict the sample to properties sold within 1 mile of a mosque, although Appendix 2.5 shows that results are similar when relaxing this restriction. The final sample consists of over 1 million transactions near 275 mosques across 41 states and Washington D.C.<sup>6</sup>

The quarterly log price of transactions within 0.2, 0.2-0.4 and 0.4-1 mile of a mosque is shown in Panel A of Figure 1. Prices across the three categories evolve similarly, supporting the common trends assumption of the DID design. As made clearer below, the largest sustained discrepancy appears to be a lower price within 0.2 miles of mosques in the 18 to 24 months following 9/11, consistent with the paper’s main finding. Figure 2 shows that the fraction of MENA buyers also evolves similarly across the three categories, although

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<sup>6</sup>Excluded states have no transaction near a mosque (AK, HI, MT and WY) or report the transaction recording date, which can differ substantially from the transaction date (CT, MA, ME, NH, RI).



the fraction who locate within 0.2 mile exhibits higher variance such that it is difficult to interpret patterns from the raw data.

Using mosques provides several benefits. Since Muslim or MENA households account for a very small fraction of the US population (around 2-3% (Weeks, 2003; Wilz, 2014)), using aggregate measures like the fraction of MENA households within a neighborhood introduces imprecision since households are not randomly distributed within neighborhoods. In contrast, comparing transactions in the immediate vicinity of a mosque to transactions in the same neighborhood, but farther away, allows for precise, narrow treatment and comparison groups. Mosques provide a salient proxy, since they are intrinsically associated with Muslims and generally easily identifiable.<sup>7</sup> Their presence signals to a potential household that there likely is a Muslim community nearby. Even if a substantial share of a mosque’s attendees do not live in the vicinity of the mosque, they still regularly attend it. Mosques can therefore also be seen as indicators of interaction with households, even if they live farther away.

The transaction records contain no household characteristics, but do contain the names of sellers and buyers. I classify buyers and sellers using the Middle Eastern Surname List (MESL) developed and tested in Nasser (2007). The list includes names associated with countries of the Middle East and North Africa, excluding Israel. There is potential for misclassification, particularly if the name association is viewed as a proxy for the household being Muslim, since, although MENA households are more likely to be Muslim than the average US household, a large fraction are not Muslim and a large fraction of Muslims are not of MENA origin (Abu Ras and Abu Bader, 2009).<sup>8</sup> Nevertheless, as mentioned above,

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<sup>7</sup>A Google Street View inspection suggests that mosques are typically easy to discern from their architecture or a sign, as shown with facade pictures of 12 randomly-selected mosques in Appendix 4.

<sup>8</sup>Bagby (2012) reports that African-Americans are the largest group of mosque attendees in the US, followed by South-Asians and then by MENA. Together, these three groups account for nearly 90% of followers, while Caucasians and Hispanics account for around 2%.

existing work suggests that these distinctions are likely of limited importance for purposes of discrimination, because 9/11 impacted perceptions towards broad groups stereotypically associated with either the religion or the region of the perpetrators.

Islamist terrorist attacks like 9/11 have been some of the most marking moments in recent history. There is little doubt as to their salience (Mellon, 2014) or association with organizations from the Middle East, who often claim responsibility for the attacks. Attacks have been associated with extensive media coverage criticized for painting Muslims in a negative stereotypical light (Norris et al., 2004; Papacharissi and de Fatima Oliveira, 2008; Gadarian, 2010; Powell, 2011; Ivandic et al., 2019; Kearns et al. 2019) and survey evidence suggests that the public generally has little knowledge of Islam (Pew Research Center, 2010).

The paper’s main proposition is that 9/11 negatively affected the perceptions of non-MENA non-Muslim households towards mosques, MENA, and Muslim households, but the attacks could also have affected perceptions of MENA and Muslim households themselves, potentially in the opposite direction. Since I observe equilibrium prices, I am unable to directly identify changes in WTP across different groups, but price decreases are likely driven by the vast majority of non-MENA non-Muslim households. The sorting analysis below does suggest that responses systematically differed for MENA households, but identifying an average discriminatory response does not require that changes in WTP are homogeneous across households. Rather, it requires that changing WTP is due to household (potentially both MENA and non-MENA) group perceptions rather than property or area characteristics.

The analysis focuses on 9/11 given that its importance is unrivaled and death toll 60 times higher than the next deadliest Islamist attack in US history.<sup>9</sup> It provides the most

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<sup>9</sup>Some of the impact of 9/11 could be tied to the War in Afghanistan that followed. It is unlikely to account for a large share of the impact given that there is no observed impact of the 2003 War in Iraq and that foreign wars are likely less salient than domestic civilian casualties.

salient shock for identification, although I investigate other major domestic Islamist attacks in Appendix 2.3-2.4.

## 2 Empirical Strategy

The challenge in estimating household WTP over neighborhood characteristics arises from not observing characteristics of a property or area that are correlated with the characteristic of interest. Regardless of discrimination, properties near mosques sell for a different price because of differences in the areas in which they are located, and proximity to a mosque could affect value independent of discrimination. Appendix 2.1 shows that properties in census tracts with mosques sell for lower prices and that these tracts are younger, more likely to be non-white and foreign-born, slightly less educated, and lower income. These differences motivate the use of 9/11 as a shock to household WTP uncorrelated with local markets.

I first consider an event study specification, providing quarterly evidence of the impact of 9/11 on real estate prices near mosques. I use time windows of two years around the shock to minimize the risk of unobserved changes acting as confounders (Parmeter and Pope, 2013). I consider the following equation for the log price of property  $i$

$$\begin{aligned} \log(P_{itb}) = & \gamma_0 + \sum_{k=-8}^{-2} \gamma_k \mathbb{1}(Q_t = k) + \sum_{k=0}^8 \gamma_k \mathbb{1}(Q_t = k) \\ & + \sum_{k=-8}^{-2} \beta_k D_d * \mathbb{1}(Q_t = k) + \sum_{k=0}^8 \beta_k D_d * \mathbb{1}(Q_t = k) + \alpha_t + \delta_b + \varepsilon_{itb} \end{aligned} \quad (1)$$

where  $\alpha_t$  is a collection of month-of-the-year fixed effects,  $\delta_b$  corresponds to census block or tract fixed effects, and the price is a function of distance to a mosque ( $D_d$ ). Quarter -1 is omitted, quarter 0 corresponds to the quarter following 9/11, and  $\mathbb{1}(Q_t = k)$  takes the value

1 if the transaction took place in quarter  $k$  and 0 otherwise.<sup>10</sup> Indicator variables for each quarter ( $Q_t$ ) are included on their own to capture quarter-specific price effects and interacted with  $D_d$  to capture quarter-specific price effect differentials near mosques.

Which distance to include in the treatment group can be understood as a trade off between bias and variance. I consider precise areas within neighborhoods to minimize bias. I include properties within 0.2 mile of a mosque in the treatment group, corresponding to one or two housing blocks from the mosque, which seems reasonable given considerations of salience.<sup>11</sup> As shown below, increases in MENA buyers following 9/11 were also concentrated within 0.2 mile of mosques, suggesting along with sensitivity analyses conducted below that it is an appropriate radius to capture impacted areas. It is consistent with previous work considering radii between 0.1 and 0.3 and up to 0.5 (Linden and Rockoff, 2008; Currie et al., 2015; Dealy et al., 2017; Brooks et al., 2018; Ang, 2020).

I then turn to a DID specification for the log price of property  $i$  in census block  $b$  with distance to a mosque  $d$  sold at time  $t$ . The term  $Post_t$  denotes the period following 9/11 and is interacted with the distance indicator. This yields the following specification

$$\log(P_{idbt}) = \beta_0 + \beta_1 Post_t + \beta_2 D_d + \beta_3 Post_t * D_d + \alpha_t + \delta_b + \varepsilon_{idbt} \quad (2)$$

where  $\alpha_t$  is now a collection of year and month-of-the-year fixed effects.<sup>12</sup>  $\beta_3$  is the coefficient of interest, representing the differential price change for properties near mosques following

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<sup>10</sup>Technically, 9/11 happened at the end of the omitted quarter, but prices in that quarter were not affected due to the timing of the shock, as shown in Appendix 3.6.

<sup>11</sup>A very small fraction of properties are within 0.2 mile of more than one mosque, but too few to investigate differential treatments effects based on the number of mosques in the area, especially because these properties are likely to be disproportionately located in areas with characteristics associated with smaller price decreases as presented below.

<sup>12</sup>Adding household characteristics has little substantive impact on the estimates. See Tables 1-2 and Appendix 2.9.

9/11. A similar specification can be used to study the impact of 9/11 on the quantity of properties sold or the probability that a property is bought or sold by a MENA household.

Standard errors are clustered at the census tract level to allow for arbitrary correlation of errors within neighborhoods, although the results are robust to clustering at levels ranging from census block to state, including at the mosque level.

Estimates from equation (2) correspond to market capitalization rates. Kuminoff and Pope (2014) show that these rates provide an unbiased estimate of WTP if the exogenous shock is uncorrelated with housing and neighborhood characteristics, which appears plausible for 9/11. Further, properties near mosques represent a small fraction of the market, so the impact of 9/11 should be localized with little effect on the broader market.

### 3 Results

Panel B of Figure 1 presents event-study estimates from equation (1). The estimated price differential between properties within 0.2 mile of a mosque and other properties is mostly flat around 0 in the two years preceding 9/11. A test for statistical significance of the pre-period coefficients cannot reject the null hypothesis that they are jointly equal to zero, with a p-value of 0.9. Consistent with a causal impact of 9/11, the estimated price differential appears to fall in the quarter following the attack and remain below 0 for approximately two years after. The estimated price decrease is 5-10%, although individual coefficients are generally not statistically significant.

Panel A of Table 1 shows DID estimates from equation (2), pooling quarters surrounding the attack into one pre and post period and testing joint statistical significance. The first column shows that properties within 0.2 mile and 0.2 to 1 mile generally sell for a similar

price and that 9/11 did not affect overall prices when including time and location fixed effects. Column (2) adds the interaction term of interest, showing that properties within 0.2 mile of mosques were sold for nearly 6% less following 9/11. Column (3) adds an indicator for whether a property was sold between 0.2 and 0.4 mile of a mosque and interacts it with  $Post_t$ , showing that the impact is concentrated to properties in a 0.2 mile radius around mosques.<sup>13</sup> Column (4) includes individual property characteristics which have a minor impact on the estimates.<sup>14</sup> Column (5) shows that price decreases appear larger for non-residential properties, although there are few observations.<sup>15</sup> Column (6) restricts the comparison group to a 0.4 mile radius around mosques, with limited impact on the estimates. Across columns, the interaction term is statistically significant at the 5 or 10% level, except for non-residential properties. Appendix 2.5 shows that excluding states with the largest MENA concentrations (CA, MI, NY) from the analysis yields similar but larger price decreases near mosques, highlighting that the results are not solely driven by a few large population centers. Appendix 3.3 conducts sensitivity analyses varying the radius that defines the treatment group. These analyses highlight impacts mostly concentrated within 0.2 miles, highlighting largest impacts within approximately 0.15 to 0.23 mile of a mosque and smaller price decreases for further distances. Similarly, appendix 2.8 shows that considering a model continuous in distance also suggests that 9/11 disproportionately affected prices

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<sup>13</sup>Excluding properties between 0.2-0.4 mile yields similar results. Investigating properties between 0.2-0.4 mile while excluding those within 0.2 mile yields near 0 results. These suggest little spillover between areas, as shown in Appendix 2.6.

<sup>14</sup>Appendix 2.9 shows that adding more characteristics changes little, but also that holding the sample constant to properties with non-missing housing characteristics without controlling for housing characteristics yields very similar results, highlighting that these controls change little to the results as expected given the use of 9/11 as an exogenous shock. Alternatively, using a repeat-sales methodology investigating changes in price since the last time a property was sold, I find that properties within 0.2 mile of a mosque that were sold both within two years before 9/11 and within two years after 9/11 appreciated by 4% less than properties farther away. While the estimated coefficient is similar in magnitude to my main analysis, this method excludes the vast majority of properties from the sample and yields statistically non-significant estimates.

<sup>15</sup>The results are similar whether tax-exempt properties, including religious buildings, are included or not.

closer to mosques.

Panel B of Table 1 presents results with the log number of monthly transactions per census block as the outcome. It provides little evidence that 9/11 differentially affected the quantity of properties sold near mosques, suggesting no more than a 1% statistically non-significant change. A change in price without a change in quantity could indicate a decrease in demand combined with an increase in supply, or simply a decrease in demand with housing search frictions, as shown in Appendix 1 and in line with evidence on changes in buyer rather than seller composition shown below.

A natural consideration is whether other events or periods are associated with a similar impact on prices as 9/11. I conduct placebo tests from a series of rolling time window regressions. For each quarter excluding the first and last two years of my sample, I estimate equation (2) defining the placebo  $Post_t$  as the two years following the given quarter and comparing to the two years before. The results shown in Appendix 3.2 show that the two quarters following 9/11 (October-December 2001 and January-March 2002) are associated with the two largest differential price decreases. The only three statistically significant price decreases at the 5% level correspond to these two quarters and the third quarter following 9/11. The impact of 9/11 was unique in its magnitude and statistical significance, supporting a causal interpretation. Appendix 2.2 also provides additional placebo tests investigating the impact of 9/11 on prices near Christian churches as well as of deadliest mass-shootings with no link to Islamist terrorism on prices near mosques and Christian churches, indicating that results from Table 1 relate specifically to mosques and Islamist terrorist attacks.

Panels a-e of Figure 3 present heterogeneity analyses based on mosque characteristics. Price differentials appear mostly concentrated to mosques in the bottom or top 25% of attendance. Large mosques may be particularly salient, while smaller mosques tend to be

in states with lower Muslim population and higher prejudice, characteristics associated with larger price decreases as discussed below. Little apparent relationship between the price decrease and the MENA share of attendees indicates changing perceptions towards Muslims and mosques in general. Price decreases appear smaller around mosques established at their location for more than 10 years before 9/11, suggesting integration and acceptance by the community, although the difference is not statistically significant.<sup>16</sup> Interestingly, decreases are almost exclusively concentrated around mosques who reported more strongly that American society was hostile to Islam in 2010, and the differential decrease across low and high hostility areas is statistically significant. This relationship does not appear driven by these mosques being more conservative, because price decreases appear no greater around mosques whose representatives reported more strongly that America is an immoral society, as shown in Appendix 3.4. Decreases were also slightly larger around mosques which reported increased Muslim youth radicalism in the area, though that difference is not statistically significant.<sup>17</sup> The impact of 9/11 may have been stronger in these areas, or these perceptions may themselves have resulted from 9/11. In any case, these correlations suggest a link between price decreases and prejudice corroborated in the next subsection.

Panel B of Figure 2 presents event-study estimates from equation (1) with the probability that a buyer be of MENA origin as the outcome variable. The estimated differential between properties within 0.2 mile of a mosque and other properties is mostly flat around 0 in the two years preceding 9/11. A test for statistical significance of the pre-period coefficients cannot reject the null hypothesis that they are jointly equal to zero, with a p-value of 0.96. Consistent with a causal impact of 9/11, the estimated differential increases following the attack. The estimates correspond to an increase of around 40% in the first year and

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<sup>16</sup>See Appendix 2.12 for the underlying statistical tests using triple interaction terms.

<sup>17</sup>The response rate for these questions is around 98%.



around 13% in the second year, although individual coefficients are generally not statistically significant.

Table 2 investigates the impact of 9/11 on the probability that MENA households locate near mosques. Panel A presents results for buyers. Column 1 shows that MENA households are 32% more likely to locate within 0.2 mile of mosques in general. Column 2 adds the interaction term of interest, also restricting the sample to a one-year window around 9/11, and showing that the probability that a buyer is of MENA background disproportionately increased by roughly 30-40% in the year following 9/11 for properties within 0.2 mile of a mosque compared to 0.2-1 mile. Column (3) adds an indicator for transactions within 0.2 and 0.4 mile of mosques and interacts it with the indicator for the period following 9/11, showing a concentrated impact within 0.2 mile of mosques. Column (4) adds property characteristics which have limited impact on the coefficient of interest. Column (5) shows that the increase appears concentrated to residential properties. Column (6) restricts the comparison group to within 0.4 mile of mosques, which has little impact on the results. Estimates are statistically significant at the 5 or 10% level except for commercial properties. Panel B presents results for sellers. Estimated differentials are small and statistically non-significant, suggesting that impacts are primarily buyer-driven. Combining changes for buyers and sellers suggests a net increase of up to 30% in the fraction of MENA households.<sup>18</sup> Appendix 2.7 also shows that the number of MENA buyers - not just the proportion - increased near mosques. Combined with little change in overall quantity sold, it suggests that changes in composition were driven both by an increase in MENA buyers and decrease in non-MENA buyers.

I conducted placebo tests from a series of rolling time window regressions for this outcome, similar to that conducted for prices. The results shown in Appendix 3.2 show that the same

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<sup>18</sup>Appendix 3.3 presents results using 0.1 mile bins, which decreases precision, but indicates that MENA buyer increases appear concentrated within 0.2 mile.

two quarters following 9/11 are associated with two of the three largest differential increases in the probability that a buyer near mosques be of MENA origin. The only statistically significant increase at the 5% level corresponds to the quarter following 9/11. The impact of 9/11 on MENA sorting near mosques was also unique in its magnitude and statistical significance, again supporting a causal interpretation.

Next, I provide evidence on the persistence of net inflows of MENA households near mosques. For each year following 9/11, I show how the fraction of MENA buyers minus the fraction of MENA sellers changed differentially near mosques, compared to the year before 9/11. While extending the period of analysis following the shock is valuable to investigate persistence and identify underlying mechanisms driving responses to 9/11, one caveat is that extending the time horizon increases the likelihood that the parallel trends assumption fails, in contrast to the main analysis using narrow time windows. Still, the results from Panel A indicate net increases in the fraction of MENA households near mosques over the first 3 years following 9/11. The magnitude corresponds to an average increase of around 50% for these three years, although only the estimate in year 1 is statistically significantly different from 0 at the 10% level. Over subsequent years, net inflows appear to subside and hover around 0. Panel B shows the net cumulative inflow of MENA households near mosques, suggesting that 9/11 was still associated with a cumulative increase of around 30% in the fraction of MENA households near mosques even 8 years after.

Increased ethnic and religious sorting around mosques caused by 9/11 provides a potential mechanism through which terrorism decreases assimilation of Muslim immigrants, as found in previous work, and could have longer run implications for these neighborhoods (Ludwig et al., 2013; Chetty et al., 2016). Sorting also informs the interpretation of price differentials. The pattern is consistent with a subset of households locating near mosques following the

attack, for example because their WTP for these properties was not affected to the same extent as other households. The estimated price decrease likely constitutes a lower bound on the average decrease in WTP for non-MENA households. Nevertheless, the proportion of MENA buyers near mosques remained relatively small at around 7%, suggesting that these areas, although disproportionately non-white, are fairly diverse. They are also likely more religiously than ethnically segregated, given that MENA individuals account for a minority of mosque followers (mean 33%, median 17% in the mosque survey).

Taken together, the evidence indicates a substantial real estate price decrease near mosques in the 18 to 24 months following 9/11 as well as an increase in residential sorting in the years following the attack. In the longer run, attacks do not substantially affect prices and inflows of MENA households subside, but changes in neighborhood composition remain. Appendix 1 presents a simple housing search model which jointly rationalizes these findings and highlights that it is sufficient to observe the equilibrium sale price rather than listing and offer prices to identify changes in WTP.

In particular, the model proposes that 9/11 was a shock to perceptions of Muslim households and/or mosques which decreased the WTP of some households to locate near mosques. Due to moving frictions, the set of buyers in the market immediately after the attack is restricted to households who were already in the market to buy a property near a mosque: it takes time and resources for households who were not planning to move to enter the market, sell their property, and find a new one. Because sellers face a restricted set of buyers, some whose WTP for properties near mosques fell following the attack, sellers lower their reservation price and the sale price falls. Moreover, if the WTP of some buyers in the market, like MENA households, was affected to a lesser extent or even increased, then more of them locate near mosques as a result of the price decrease. In the longer run, the set of potential

buyers is unrestricted and any household whose WTP was less affected by the attack has an incentive to sort near mosques given the price differential. Accordingly, prices eventually revert back to their pre-9/11 level.

The model explains the temporariness of the price effects using moving frictions rather than assuming that the WTP decrease itself was temporary. Although I cannot directly test between the two alternatives, previous research has documented robust evidence that housing prices are slow to adjust to market changes due to search costs, transactions costs, tax considerations, and non-rational behavior or expectations. In particular, evidence from adjustments to monetary policy surprises, demographic changes, and environmental shocks often suggests an adjustment of approximately two years, in line with my findings (Case and Shiller, 1989; Mankiw and Weil, 1989; Riddell, 2004; Almer et al., 2013; Kuttner, 2014; Williams, 2016). Moreover, the evidence on household sorting from Figure 4 suggests sustained net inflows of MENA households over the period during which prices near mosques reverted back to their pre-9/11 level. Since the fraction of households near mosques remained higher for several years following 9/11, the results are consistent with the attacks leading to a new sorting equilibrium. Lastly, the next subsection ascribes this WTP decrease to a discriminatory response and discusses evidence of increased discrimination and hostility against mosques and Muslims which lasted much longer than for two years following 9/11. Together with previous evidence, these findings suggest that a new long-term sorting equilibrium which takes some months to achieve is the most plausible explanation for the temporariness of price decreases.

Although 9/11 affected the composition of neighborhoods, price decreases appear unlikely to have been primarily driven by neighborhood tipping. The increase in MENA households near mosques was large in relative terms, but they remained a small minority even near

mosques and represent too small a group to tip neighborhoods in most areas. In fact, when excluding areas with the largest MENA or Muslim populations, as shown in Appendix 2.5 and in heterogeneity analyses below, the price decreases near mosques following 9/11 are in fact larger.<sup>19</sup>

### 3.1 Interpretation as Discrimination

By restricting the analysis to a city or county, previous work has been unable to investigate the substantial heterogeneity in pricing responses across areas that I document next and which provides suggestive evidence on underlying mechanisms driving decreased household WTP for properties near mosques. Namely, one natural interpretation is that 9/11 changed perceptions towards Middle Easterners and Muslims, leading to a discriminatory response. Indeed, it is evident from previous work that terrorism increases negative perceptions and prejudice (Swahn et al, 2003; Lauderdale, 2006; Das et al., 2009; Shayo and Zussman, 2011; Levin, 2017; Ivandic et al., 2019; Zorlu and Frijters, 2019).

Panel h of Figure 3 shows larger price decreases in states with higher increases in hate crimes against MENA or Muslims following 9/11, with the difference being statistically significant at the 10% level.<sup>20</sup> Nearly 75% of states with above-median increases in hate crimes are located in the South or Midwest and nearly 80% leaned Republican in 2000. Panel i suggests that price decreases were larger in states with higher prejudice against

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<sup>19</sup>Price decreases were also larger near mosques which had a lower pre-9/11 share of MENA buyers and were therefore less likely to tip. Larger decreases in areas with lower Muslim population and population densities shown below are also inconsistent with increased attendance or traffic causing price decreases, and Abu Ras and Abu Bader (2009) report only a modest increase in religious attendance of Arab-Americans following 9/11.

<sup>20</sup>Again, the underlying statistical tests are shown in Appendix 2.10 through specifications with triple interactions. Data on hate crimes is from the FBI Uniform Crime Reporting. Alternatively, using more detailed data on per-Muslim-capita hate crimes against Muslims between 2012 and 2017, available at <https://www.newamerica.org/in-depth/anti-muslim-activity/>, also indicates higher price decreases in states that later have more hate crimes.

African-Americans as measured in Stephens-Davidowitz (2014), which is likely correlated with prejudice against other minority groups and time persistent, although the contrast is less stark than for hate crimes and not statistically significant. The Pew Research Center reports that less favorable opinions of Islam are higher among Republicans, older people and the less educated, consistent with Panels j-l, although differences are not statistically significant. Appendix 3.4 suggests that this heterogeneity is exacerbated when looking at the county level, and that price decreases appear larger in counties with lower population density. The results indicate a consistent mapping between the magnitude of price decreases and measures of prejudice and hostility in the area, both immediately following 9/11 and in the years after.

In contrast, price decreases do not appear driven by rational responses to changing risk. Panel f of Figure 2 shows no greater price decreases in states with higher ex-post risk based on being targeted by at least two attacks/threats since 9/11 (CA, NY, IL, NJ, DC, FL).<sup>21</sup> In fact, most of the price decrease in those states is driven by Florida, which differs starkly on prejudice measures. Panel g suggests larger price decreases in states with below-median Muslim population, indicating a negative link with the propensity to interact with Muslims, although the difference is not statistically significant.

It is also possible that changing perceptions of Muslim households and mosques affected other neighborhood characteristics. Namely, police presence (Di Tella and Schargrodsky, 2004; Lehrer and Lepage, 2020) or crime could have increased, either because mosques or Muslims were perceived as dangerous or because of retaliation and hostility. In both cases, these can be seen as symptomatic of discrimination. For example, if price decreases partly

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<sup>21</sup>Results are similar for attacks and threats per capita or for the number of mosques per capita. A list of terrorist plots is available at [https://en.wikipedia.org/wiki/List\\_of\\_unsuccessful\\_terrorist\\_plots\\_in\\_the\\_United\\_States\\_post-9/11](https://en.wikipedia.org/wiki/List_of_unsuccessful_terrorist_plots_in_the_United_States_post-9/11).

resulted from households anticipating increases in hate crimes (which did seem to arise, as shown above), then these households responded to anticipated discrimination from other households, even though their perception of Muslims and mosques may not have changed. Similarly, if these areas were expected to be more dangerous because of increased prejudice causing reprisals or hostility, then this increased prejudice would likely also directly affect the WTP of prejudiced households to live there. Accordingly, while evidence on mechanisms remains suggestive, an interpretation based at least in part on discriminatory responses appears particularly plausible. Moreover, hate crimes against Muslims have never reverted back to their pre-9/11 levels and have only increased since, suggesting that 9/11 was a persistent negative shock to perceptions of Muslims and mosques (Levin and Grisham, 2016).

## 4 Conclusion

This paper uses 9/11 as an exogenous shock to perceptions of Middle-Eastern and Muslim households to estimate changes in WTP for properties near mosques and household sorting in those areas.

In the two years following 9/11, prices immediately near mosques around the US fell by approximately 5%. I find little impact on the number of transactions, but a large increase of up to 30% in the fraction of MENA households locating near mosques. Prices seemed to revert back to their pre-9/11 level in the longer run, but a re-allocation of households remained. These results are consistent with a simple housing search model in which household WTP is negatively affected by the shock.

Evidence on heterogeneity in price decreases across mosque and state characteristics suggests responses consistent with prejudice and negative stereotypes. Households in areas with

fewer Muslims and mosques may have updated their views particularly strongly after 9/11, leading to larger negative perceptions in these areas (Lepage, 2022). This idea is consistent with growing evidence that individuals with more exposure to Muslims and knowledge of Islam are less likely to hold negative perceptions of the group (Pew Research Center, 2016; Saleem et al., 2016; Bursztyn et al., 2021).

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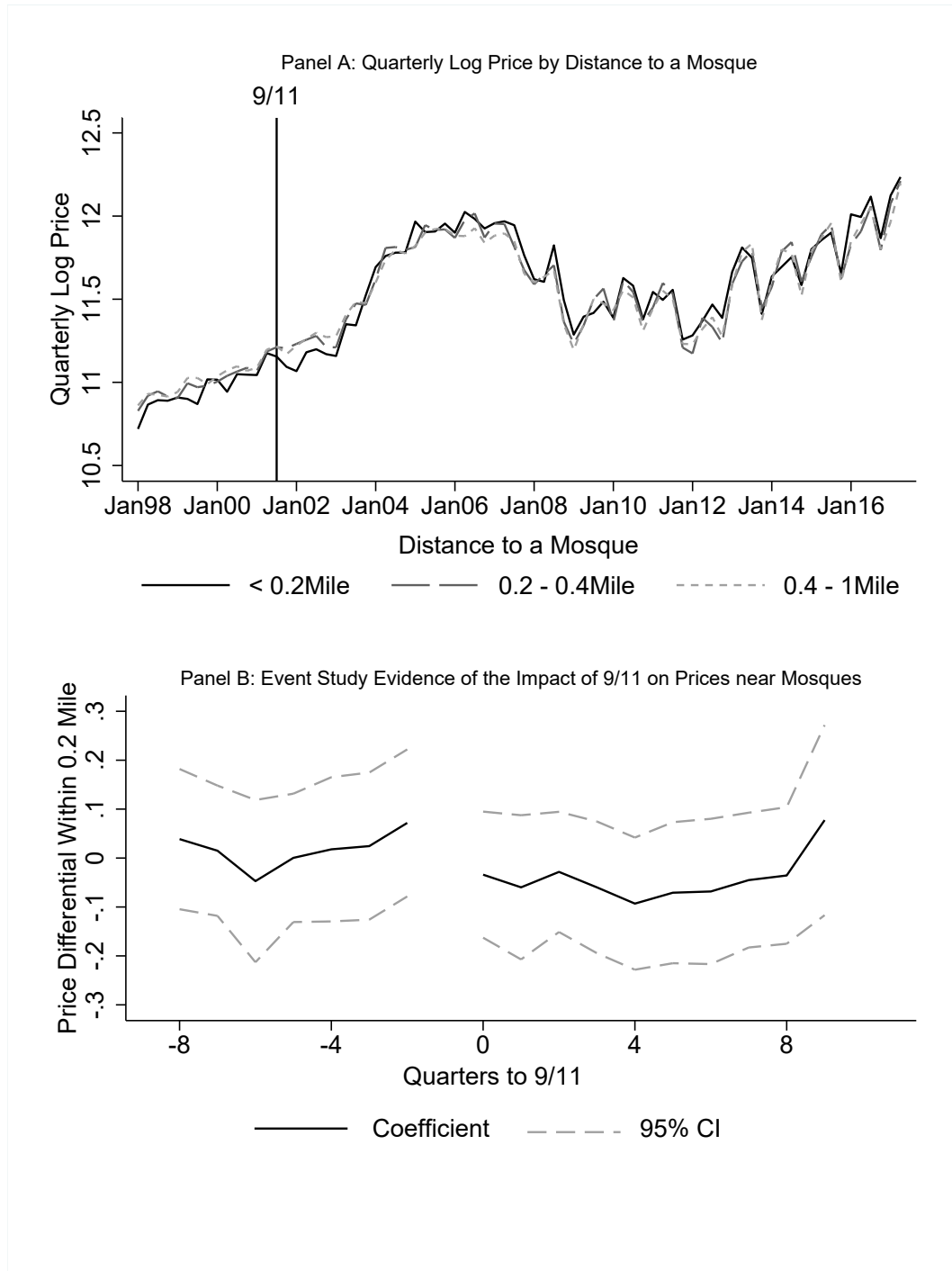
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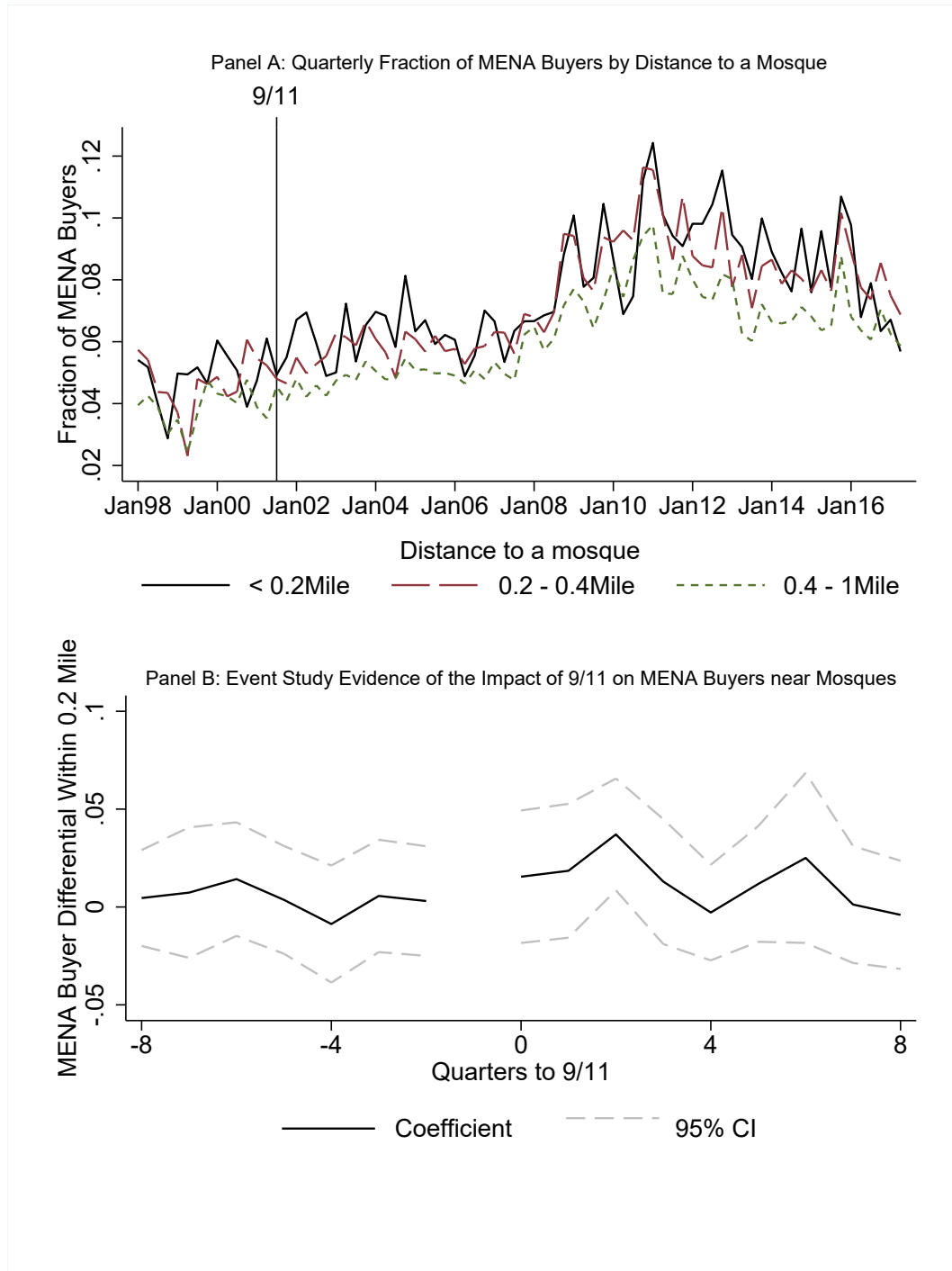
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Figure 1: Real Estate Prices and Event Study Evidence of the Impact of 9/11 on Real Estate Prices near Mosques



Prices are in constant 2010 dollars. Coefficients in Panel B represent the estimated quarterly price differential from equation (1) for real estate transactions within 0.2 mile of a mosque compared to between 0.2 and 1 mile. Standard errors are clustered at the census tract level and dashed lines represent pointwise 95% confidence intervals. Data source: Bagby (2012).

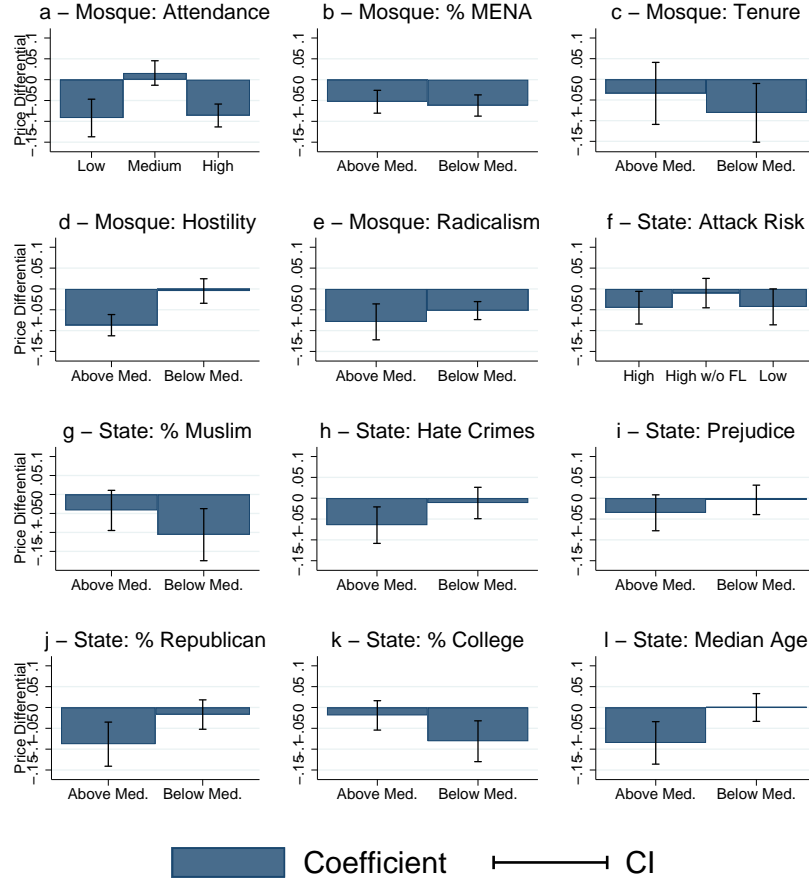
Figure 2: Fraction of MENA Buyers and Event Study Evidence of the Impact of 9/11 on the Fraction of MENA Buyers near Mosques



The dependent variable is the probability that a buyer is of MENA origin. Coefficients in Panel B represent the estimated quarterly price differential from equation (1) for real estate transactions within 0.2 mile of a mosque compared to between 0.2 and 1 mile. Standard errors are clustered at the census tract level and dashed lines represent pointwise 95% confidence intervals. Data source: Bagby (2012).

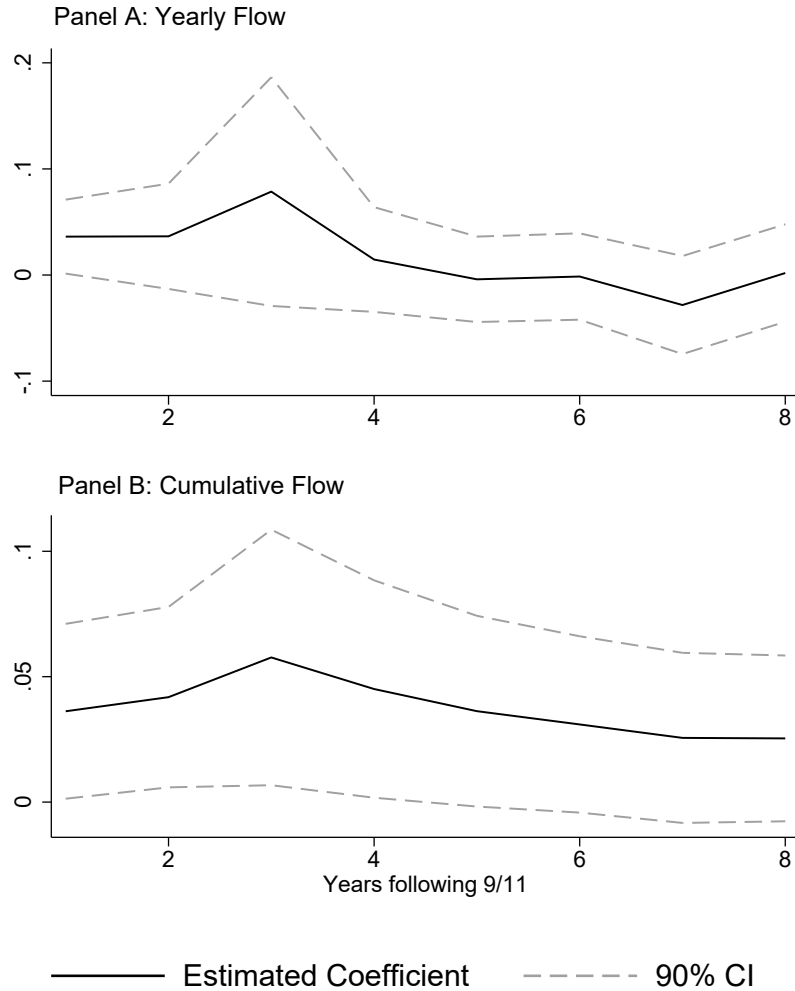


Figure 3: Heterogeneity in Price Differentials by Mosque and State Characteristic



Low/Medium/High attendance corresponds to mosques in the first/middle two/last quartile. Hostility/Radicalism corresponds to a rating from 1 (Strongly Disagree) to 5 (Strongly Agree) by the mosque official to whether American society is hostile to Islam/radicalism is increasing among Muslim youth in the area. High risk corresponds to states targeted by two or more terrorist attacks/threats between 9/11 and 2017. Hate Crimes is the percentage increase in hate crimes against MENA or Muslims over the two years before and after 9/11. Prejudice corresponds to the index against African-Americans from Stephens-Davidowitz (2014). % Republican corresponds to the Republican voting share from the 2000 presidential election. See Table 1 for regression details. Data source: “List of unsuccessful terrorist plots in the United States post-9/11” (n.d.); Federal Election Commission (2001); Meyer (2001); Bauman and Graf (2003); Weeks (2003); Bagby (2012); FBI UCR (1998-2003) and Stephens-Davidowitz (2014).

Figure 4: Impact of 9/11 on the Fraction of MENA Households near Mosques



The figure reports estimates and 90% confidence intervals from a regression of the net change in the monthly fraction of MENA households in a census block on indicator variables for the 8 years following 9/11 interacted with whether properties are within 0.2 mile of a mosque. The baseline period used as a comparison is the year before 9/11. The net change corresponds to the difference between the fraction of MENA buyers and sellers. The plotted coefficients correspond to estimates of the interaction term between the years following 9/11 and proximity to a mosque. Panel A displays yearly changes in the fraction of MENA households, while Panel B displays cumulative changes over previous years. The regression includes census block as well as year and month-of-the-year fixed effects. Standard errors are clustered at the census tract level. Data source: Nasser (2007); Bagby (2012).

Table 1: Difference-in-Differences Estimates of the Impact of 9/11 on Real Estate Prices and Quantities Traded near Mosques

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Log Price						
D20	-0.002 (0.020)	0.029 (0.025)	0.028 (0.025)	0.012 (0.027)	0.046 (0.096)	0.036 (0.031)
Post911	0.006 (0.013)	0.008 (0.013)	0.010 (0.013)	0.019 (0.014)	0.091 (0.080)	-0.007 (0.032)
D20*Post911		-0.057 (0.026)	-0.059 (0.027)	-0.046 (0.027)	-0.082 (0.104)	-0.044 (0.027)
D40			0.003 (0.014)			
D40*Post911			-0.010 (0.015)			
N. Observations	239,595	239,595	239,595	171,679	18,889	40,410
Panel B: Log Quantity						
D20	-0.014 (0.009)	-0.018 (0.010)	-0.025 (0.011)	-0.012 (0.011)	0.012 (0.024)	-0.022 (0.013)
Post911	-0.017 (0.004)	-0.017 (0.004)	-0.017 (0.005)	-0.011 (0.005)	-0.015 (0.014)	-0.014 (0.010)
D20*Post911		0.008 (0.008)	0.008 (0.008)	0.002 (0.009)	0.003 (0.021)	0.010 (0.008)
D40			-0.010 (0.007)			
D40*Post911			-0.004 (0.006)			
N. Observations	195,888	195,888	195,888	143,689	15,155	33,527
Time and Location FE	Y	Y	Y	Y	Y	Y
Clustered SE (Census Tract)	Y	Y	Y	Y	Y	Y
Housing Characteristics	N	N	N	Y	N	N
Commercial Properties	N	N	N	N	Y	N
Within 0.4M of a Mosque Only	N	N	N	N	N	Y

Clustered standard errors at the census tract level are presented in parentheses. Estimates obtained from equation (2) where D20 (D40) are indicator variables for properties sold within 0.2 (0.2-0.4) mile of a mosque. The comparison group is restricted to within 1 mile of a mosque and 0.4 mile in column 6. The analysis is restricted to a two-year time window before and after 9/11 and to mosques which did not move between 9/11 and their reported location in the 2011 data. “Time and Location FE” include year, month-of-year and census block fixed effects. When included, housing characteristics include lot size in square feet, the decade of construction, and the number of units in the lot. “Log Quantity” corresponds to the log of the monthly number of transactions per census block. Data source: Bagby (2012).

Table 2: Difference-in-Differences Estimates of the Impact of 9/11 on the Fraction of Middle Eastern and North African Buyers and Sellers near Mosques

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Probability of a MENA Buyer						
D20	0.018 (0.007)	0.003 (0.007)	0.005 (0.008)	0.008 (0.009)	0.011 (0.021)	-0.005 (0.007)
Post911		-0.007 (0.006)	0.008 (0.008)	-0.010 (0.007)	0.010 (0.032)	-0.005 (0.013)
D20*Post911		0.019 (0.010)	0.019 (0.010)	0.023 (0.010)	-0.008 (0.025)	0.024 (0.011)
D40			0.005 (0.005)			
D40*Post911			-0.003 (0.004)			
Outcome Mean	0.057	0.047	0.047	0.048	0.068	0.058
N. Observations	1,075,547	78,459	78,459	55,737	5,575	13,285
Panel B: Probability of a MENA Seller						
D20	0.013 (0.006)	0.008 (0.005)	0.008 (0.005)	0.005 (0.007)	-0.006 (0.012)	0.006 (0.005)
Post911		-0.012 (0.006)	-0.012 (0.007)	-0.014 (0.008)	-0.039 (0.034)	-0.021 (0.013)
D20*Post911		0.005 (0.006)	-0.004 (0.003)	0.009 (0.008)	0.025 (0.028)	0.007 (0.007)
D40			0.004 (0.006)			
D40*Post911			-0.004 (0.003)			
Outcome Mean	0.041	0.032	0.032	0.034	0.038	0.038
N. Observations	987,558	75,052	75,052	52,446	6,373	12,710
Time and Location FE	Y	Y	Y	Y	Y	Y
Clustered SE (Census Tract)	Y	Y	Y	Y	Y	Y
Housing Characteristics	N	N	N	Y	N	N
Commercial Properties	N	N	N	N	Y	N
Within 0.4M of a Mosque Only	N	N	N	N	N	Y

See Table 1 for information on definitions. Column 1 includes the entire sample period, while columns 2-6 restrict the analysis to a one-year time window around 9/11. Data source: Nasser (2007); Bagby (2012).

# Discrimination and Segregation in the Real Estate Market: Evidence from Terrorist Attacks and Mosques

Louis-Pierre Lepage

Online Appendix

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# 1 Theoretical Framework

Consider a stylized search model of the real estate market. There are two types of properties, those near mosques and those in other areas. The stock of properties is fixed and the fraction of properties near mosques is a small share of the overall market. I abstract from area and property characteristics for simplicity. Sellers incur a per-period cost  $c$  to keep ownership of their property. Buyer willingness to pay for properties near mosques,  $v$ , is distributed according to the distribution function  $G(v)$ . In the short-run period surrounding 9/11, there is a fixed subset of buyers and sellers active in the market who are moving for reasons unrelated to 9/11, with the subset of buyer WTP drawn from  $G(v)$  and distributed according to  $F_{SR}(v)$ . This reflects the notion that entering the market as a buyer or seller and moving into a new property takes time, as well as the fact that households presumably did not anticipate 9/11. The arrival rate of buyers for properties near mosques is given by  $\lambda$ . The optimal strategy of sellers is to set a reservation price  $p^R$  and sell their property for offers above it. The probability of sale,  $s$ , is given by

$$s = \lambda \int_{v \geq p^R} dF_{SR}(v)$$

and the reservation price is characterized by

$$\int_{v \geq p^R} (v - p^R) dF_{SR}(v) = \frac{(c + p^R)r}{\lambda} \quad (1)$$

where  $r$  is the interest rate. The reservation price is chosen such that the expected benefit from selling the property, on the left side of equation (1), is equal to the opportunity cost of waiting one more period, taking into account the arrival rate of buyers, on the right side of equation (1). The expected sale price can be expressed as

$$E_{F_{SR}}[p|p \geq p^R] = \frac{\int_{v \geq p^R} v dF_{SR}(v)}{1 - F_{SR}(p^R)}. \quad (2)$$

The 9/11 attacks are a shock to perceptions that make mosques and surrounding areas more salient, decreasing the WTP of some buyers for nearby properties.<sup>1</sup> Specifically,

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<sup>1</sup>Since I observe equilibrium outcomes, I can't directly distinguish the extent to which changes in WTP reflect reactions of buyers versus sellers, although a reaction primarily driven by buyers appears more likely. Even if the shock pushes some households sell properties near mosques, this could be mitigated by others

the attacks generate new WTP distribution functions for properties near mosques  $\tilde{G}(v)$  and  $\tilde{F}_{SR}(v)$ , which are first-order stochastically dominated (FOSD) by  $G(v)$  and  $F_{SR}(v)$ , respectively.<sup>2</sup> In contrast, I assume that WTP for properties in other areas remains unchanged.

The impact of a terrorist attack on the reservation price and the expected sale price follow from the first-order stochastic dominance assumption by comparing expressions (1) and (2) with WTP distributions  $F_{SR}(v)$  versus  $\tilde{F}_{SR}(v)$ , leading to a first prediction.

**Prediction 1** *In the short run, a terrorist attack lowers  $p^R$  and  $E[p|p \geq p^R]$ .*

*See Appendix 1.1 for details.*

The decrease in buyer WTP leads sellers to lower their reservation price, because the expected gain of waiting another period is lower.<sup>3</sup> The expected value of offers is lower and some offers that would have previously been rejected are now accepted. Thus, the expected sale price falls. One takeaway is that it is sufficient to observe the equilibrium sale price rather than listing and offer prices to identify changes in WTP from  $F_{SR}(v)$  to  $\tilde{F}_{SR}(v)$ .

Next, the impact of an attack on the probability of sale is ambiguous, depending on whether the change in reservation price is less than, more than, or proportional to the change in the offer distribution.<sup>4</sup> Accordingly, it is possible to observe a price decrease with little change to quantity sold.

**Prediction 2** *In the short run, a terrorist attack has an ambiguous impact on the probability of sale.*

*See Appendix 1.1 for details.*

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who delay selling due to the price decrease. Combined with potential baseline sorting of households near mosques before 9/11, possible moving costs, and results presented below indicating little change in quantity sold, the interplay of several factors suggests a price decrease primarily driven by changes in buyer WTP.

<sup>2</sup>This assumption rules out potential scenarios where some households have a higher WTP for housing near mosques following an attack, for example Muslim or MENA households facing hostility in other areas, in a way which violates FOSD. Since these groups account for a very small fraction of US households, this simplification is unlikely to affect the qualitative predictions of the model.

<sup>3</sup>This decrease arises even if buyer WTP eventually reverts back to its pre-attack level and sellers have rational expectations about the evolution of buyer WTP if some sellers need to move in the short run for reasons unrelated to the attack.

<sup>4</sup>Mortensen (1986) shows that a decrease in the mean of an offer distribution generally leads to a less than proportional decrease in the reservation price and an increase in the probability of sale. In contrast, a change in the variance can lead to a less or more than proportional decrease in the reservation price, with an ambiguous impact on the probability of sale. It follows that the change in the offer distribution considered here has an ambiguous impact on the probability of sale, since it combines a potential change in the mean, variance, as well as higher moments of the distribution.



If buyers and sellers are randomly matched, the observed price decrease across properties sold near mosques reflects the average change in WTP for short-run buyers, that is the mean price change implied by the change from  $F_{SR}(v)$  to  $\tilde{F}_{SR}(v)$ . Yet, an attack could also lead to buyers sorting across areas. In the short run, this sorting is limited to the fixed set of buyers active in the market. A plausible sorting pattern is that households with below average decrease in WTP are induced to buy properties near mosques and others to buy elsewhere. In that case, price decreases from sales near mosques underestimate the mean price change implied by the change from  $F_{SR}(v)$  to  $\tilde{F}_{SR}(v)$ .

In the longer run, the set of potential buyers and sellers is unrestricted. There is not a fixed exogenous subset of buyers and sellers as in the short run, but households sort based on their WTP for properties in certain areas. Even if the overall distribution of buyer WTP for properties near mosques remains at  $\tilde{G}(v)$ , households that were less reactive to the shock have an incentive to locate near mosques given the price differential, potentially increasing both the arrival rate and the value of offers. As a result, sellers increase their reservation price and the expected sale price increases compared to the short run.

**Prediction 3** *In the longer run,  $E[p|p \geq p^R]$  increases from its short-run level.*

If the increase in the number of potential buyers and their WTP is large enough, prices may eventually revert back to their pre-attack level.<sup>5</sup> Alternatively, the price differential could also subside if the salience of the shock itself dissipates over time, such that  $\tilde{G}(v)$  reverts back to  $G(v)$  and  $\tilde{F}_{LR}(v) \stackrel{d}{=} F_{SR}(v)$ , even if evidence suggests that general attitudes towards Muslims have never recovered from 9/11 (Levin and Grisham, 2016). In this framework, terrorist attacks may thus cause shorter-run price decreases with little change in quantity sold and longer-run changes in residential sorting.

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<sup>5</sup>On one hand, this adjustment may take a substantial period of time to close the price differential if there are moving frictions or households do not fully anticipate the price decrease following 9/11. On the other hand, since the relative supply of properties near mosques is very small, this requires a relatively small fraction of households moving as a result of the shock.

## 1.1 Additional Derivations

**Prediction 1.** For Prediction 1, I first show that a terrorist attack lowers  $p^R$ . The seller's reservation price before ( $p_0^R$ ) and after ( $p_1^R$ ) a terrorist attack are implicitly defined by

$$\int_{v \geq p_0^R} (v - p_0^R) dF(v) - \frac{r(p_0^R + c)}{\lambda} = \int_{v \geq p_1^R} (v - p_1^R) d\tilde{F}(v) - \frac{r(p_1^R + c)}{\lambda}.$$

The expression  $\int_{v \geq p^R} (v - p^R) d\tilde{F}(v) - \frac{r(p^R + c)}{\lambda}$  is a decreasing function of  $p^R$  since

$$\begin{aligned} \frac{\partial}{\partial p^R} \left( \int_{v \geq p^R} (v - p^R) d\tilde{F}(v) - \frac{r(p^R + c)}{\lambda} \right) &= -(p^R - p^R) \tilde{F}(p^R) + \int_{v \geq p^R} \frac{\partial}{\partial p^R} (v - p^R) \tilde{F}(v) dv - \frac{r}{\lambda} \\ &= - \int_{v \geq p^R} \tilde{F}(v) dv - \frac{r}{\lambda} \\ &= - \left( 1 - \tilde{F}(p^R) + \frac{r}{\lambda} \right) \end{aligned}$$

where the first equality holds by Leibniz rule. Also,

$$\int_{v \geq p_0^R} (v - p_0^R) dF(v) - \frac{r(p_0^R + c)}{\lambda} > \int_{v \geq p_1^R} (v - p_1^R) d\tilde{F}(v) - \frac{r(p_1^R + c)}{\lambda}$$

since  $F$  first order stochastically dominates  $\tilde{F}$ . Then,

$$\int_{v \geq p_0^R} (v - p_0^R) dF(v) - \frac{r(p_0^R + c)}{\lambda} = \int_{v \geq p_1^R} (v - p_1^R) d\tilde{F}(v) - \frac{r(p_1^R + c)}{\lambda} \text{ if and only if } p_1^R < p_0^R$$

because  $\int_{v \geq p^R} (v - p^R) d\tilde{F}(v) - \frac{r(p^R + c)}{\lambda}$  is a decreasing function of  $p^R$ .

Second, I show that a terrorist attack lowers  $E[p|p \geq p^R]$ . The expected price before and after a terrorist attack is given by

$$E_F[p|p \geq p^R] = \frac{\int_{v \geq p_0^R} v dF(v)}{1 - F(p_0^R)} \text{ and } E_{\tilde{F}}[p|p \geq p^R] = \frac{\int_{v \geq p_1^R} v d\tilde{F}(v)}{1 - \tilde{F}(p_1^R)}.$$

First order stochastic dominance implies that

$$\frac{\int_{v \geq p_0^R} v d\tilde{F}(v)}{1 - \tilde{F}(p_0^R)} < \frac{\int_{v \geq p_0^R} v dF(v)}{1 - F(p_0^R)} \text{ and } \frac{\int_{v \geq p_1^R} v d\tilde{F}(v)}{1 - \tilde{F}(p_1^R)} < \frac{\int_{v \geq p_0^R} v d\tilde{F}(v)}{1 - \tilde{F}(p_0^R)}$$

since  $p_1^R < p_0^R$ . Then,

$$\frac{\int_{v \geq p_1^R} v d\tilde{F}(v)}{1 - \tilde{F}(p_1^R)} < \frac{\int_{v \geq p_0^R} v dF(v)}{1 - F(p_0^R)}.$$

**Prediction 2.** For prediction 2, FOSD and  $p_1^R < p_0^R$  imply that

$$\tilde{F}(p_0^R) \geq \tilde{F}(p_1^R) \geq F(p_1^R) \text{ and } \tilde{F}(p_0^R) \geq F(p_0^R) \geq F(p_1^R).$$

The impact on the probability of sale depends on the relationship between  $\tilde{F}(p_1^R)$  and  $F(p_0^R)$ , which is not pinned down without making additional assumptions on the relationship between  $F$  and  $\tilde{F}$ .

## 2 Supplementary Tables

### 2.1 Mosques and Neighborhood Characteristics

Table OA2.1: Summary Statistics for Census Tracts With and Without Mosques

	Mosque	No Mosque
Sale Price	201,688 (153496)	315,501 (366953)
Median Age	33.13 (5.75)	36.07 (6.33)
White	0.53 (0.31)	0.74 (0.27)
Black	0.31 (0.33)	0.14 (0.24)
Other Race	0.16 (0.15)	0.12 (0.15)
Hispanic	0.08 (0.12)	0.06 (0.15)
Foreign Born	0.16 (0.15)	0.10 (0.13)
More than High School	0.41 (0.17)	0.44 (0.17)
Median Income	39,569 (20995)	44,313 (20782)
N. Observations	379	63,201

Data is aggregated at the census tract level to merge information on area sociodemographics. Data source: Manson et al. (2019).

## 2.2 Placebo Tests: Christian Churches and Mass Shootings

Table OA2.2: Difference-in-Differences Estimates of the Impact of 9/11 on Real Estate Prices Near Christian Churches and of the Impact of Non-Islamic Mass Shootings on Real Estate Prices Near Mosques and Christian Churches

	Churches and 9/11		Mosques and Shootings		Churches and Shootings	
D20	-0.014 (0.015)	-0.018 (0.015)	0.002 (0.021)	-0.003 (0.021)	0.001 (0.015)	-0.005 (0.016)
Post	0.010 (0.009)	0.010 (0.009)	-0.045 (0.015)	-0.044 (0.015)	-0.028 (0.007)	-0.029 (0.007)
D20*Post	0.015 (0.016)	0.015 (0.016)	0.001 (0.036)	0.000 (0.037)	0.006 (0.013)	0.007 (0.014)
D40		-0.006 (0.008)		-0.006 (0.011)		-0.013 (0.008)
D40*Post		0.002 (0.009)		-0.006 (0.018)		0.009 (0.008)
N. Observations	528k	685k	522k	522k	1055k	1055k
Time and Location FE	Y	Y	Y	Y	Y	Y
Clustered SE (Census Tract)	Y	Y	Y	Y	Y	Y
Housing Characteristics	Y	Y	Y	Y	Y	Y

See Table 1 for information on definitions and sources. Shootings include events with over 25 casualties: the 2007 Virginia Tech shooting and the 2012 Sandy Hook shooting. Churches include large protestant churches listed in the Hartford Institute for Religion Research's database. Data source: Hartford Institute for Religion Research (2019).

## 2.3 Impact of Other Islamic Domestic Attacks on Prices and Quantity

Estimates from Table OA2.3 suggest differential price decreases of 2-3% near mosques after these attacks, although estimates are not consistently statistically significant across specifications. There is little evidence of an impact on the number of transactions or residential sorting as shown in Table OA2.4, suggesting that these attacks may have had a limited impact on prices, but that 9/11 unsurprisingly had a larger, broader impact on the real estate market.

Table OA2.3: Difference-in-Differences Estimates of the Impact of Other Islamic Terrorist Attacks on Real Estate Prices and Quantities Traded near Mosques

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Log Price						
D20	0.013 (0.014)	0.032 (0.017)	0.030 (0.017)	0.025 (0.020)	0.176 (0.091)	0.048 (0.023)
Post	0.031 (0.006)	0.033 (0.006)	0.032 (0.006)	0.035 (0.008)	-0.020 (0.035)	0.030 (0.013)
D20*Post		-0.032 (0.017)	-0.031 (0.018)	-0.020 (0.023)	-0.003 (0.073)	-0.040 (0.020)
D40			-0.007 (0.012)			
D40*Post			0.007 (0.014)			
N. Observations	772,278	772,278	772,278	439,943	65,672	137,565
Panel B: Log Quantity						
D20	-0.018 (0.004)	-0.027 (0.006)	-0.036 (0.007)	-0.029 (0.007)	-0.017 (0.016)	-0.023 (0.007)
Post	0.006 (0.002)	0.007 (0.002)	0.007 (0.002)	0.005 (0.002)	0.000 (0.008)	0.000 (0.004)
D20*Post		0.010 (0.005)	0.009 (0.005)	0.005 (0.005)	0.013 (0.014)	0.011 (0.006)
D40			-0.015 (0.004)			
D40*Post			-0.001 (0.003)			
N. Observations	919,657	614,687	614,687	372,621	48,251	111,638
Time and Location FE	Y	Y	Y	Y	Y	Y
Clustered SE (Census Tract)	Y	Y	Y	Y	Y	Y
Housing Characteristics	N	N	N	Y	N	N
Commercial Properties	N	N	N	N	Y	N
Within 0.4M of a Mosque Only	N	N	N	N	N	Y

See Table 1 for information on definitions and specifications. Attacks correspond to the 2013 Boston bombing, 2015 San Bernadino shooting and 2016 Orlando shooting. Identification is complicated by the attacks' temporal proximity. Similarly, the San Bernadino shooting may capture a response to the Paris Attacks one month before. Data source: Bagby (2012).

## 2.4 Impact of Other Islamic Domestic Attacks on Sorting

Table OA2.4: Difference-in-Differences Estimates of the Impact of Other Islamic Terrorist Attacks on the Fraction of Middle Eastern and North African Buyers and Sellers near Mosques

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Fraction of MENA Buyers						
D20	0.011 (0.006)	0.013 (0.005)	0.015 (0.005)	0.011 (0.006)	0.018 (0.012)	0.011 (0.005)
Post		-0.001 (0.002)	-0.001 (0.002)	-0.002 (0.002)	0.004 (0.008)	0.002 (0.004)
D20*Post		-0.003 (0.004)	-0.003 (0.004)	0.004 (0.005)	-0.008 (0.017)	-0.005 (0.005)
D40			0.005 (0.003)			
D40*Post			0.002 (0.003)			
Outcome Mean	0.054	0.070	0.070	0.076	0.096	0.081
N. Observations	1,755,620	462,813	254,934	177,215	26,105	82,966
Panel B: Fraction of MENA Sellers						
D20	0.007 (0.005)	0.001 (0.003)	0.002 (0.003)	0.002 (0.004)	-0.014 (0.014)	-0.000 (0.004)
Post		-0.005 (0.002)	-0.006 (0.002)	-0.002 (0.002)	-0.007 (0.009)	-0.007 (0.003)
D20*Post		-0.001 (0.003)	0.003 (0.004)	-0.002 (0.003)	-0.005 (0.016)	-0.000 (0.003)
D40			0.002 (0.002)			
D40*Post			-0.002 (0.003)			
Outcome Mean	0.040	0.048	0.045	0.054	0.059	0.055
N. Observations	1,612,429	430,887	296,205	246,054	24,205	75,591
Time and Location FE	Y	Y	Y	Y	Y	Y
Clustered SE (Census Tract)	Y	Y	Y	Y	Y	Y
Housing Characteristics	N	N	N	Y	N	N
Commercial Properties	N	N	N	N	Y	N
Within 0.4M of a Mosque Only	N	N	N	N	N	Y

See Tables 1, 2 and OA2.3 for information on definitions and specifications. Data source: Nasser (2007); Bagby (2012).

## 2.5 Additional Sample Restrictions

Table OA2.5: Difference-in-Differences Estimates of the Impact of 9/11 on Real Estate Prices Near Mosques

	Comparison Group Within 2 miles (1)	Excluding NY, MI, CA (2)
D20	0.009 (0.019)	0.043 (0.031)
Post	0.004 (0.008)	0.004 (0.016)
D20*Post	-0.040 (0.024)	-0.081 (0.032)
N. Observations	854,859	167,411
Time and Location FE	Y	Y
Clustered SE (Census Tract)	Y	Y

Column 1 restricts the comparison group to properties within 2 miles of a mosque. Column 2 excludes the states of New York, Michigan and California from the analysis. See Table 1 for information on definitions and specifications. Data source: Bagby (2012).



## 2.6 Additional Evidence on Spillovers

Table OA2.6: Difference-in-Differences Estimates of the Impact of 9/11 on Real Estate Prices Near Mosques

	Excluding 0.2-0.4m (1)	Excluding within 0.2m (2)
D20	-0.003 (0.030)	
Post	0.011 (0.015)	0.05 (0.015)
D20*Post	-0.048 (0.026)	
D40		0.003 (0.015)
D40*Post		-0.001 (0.011)
N. Observations	205,684	236,298
Time and Location FE	Y	Y
Clustered SE (Census Tract)	Y	Y

See Table 1 for information on definitions and specifications. Data source: Bagby (2012).

## 2.7 Increase in the Number of MENA Buyers Near Mosques

Table OA2.7: Difference-in-Differences Estimates of the Impact of 9/11 on the Log Number of MENA Buyers

	(1)	(2)
D20	-0.061 (0.018)	-0.071 (0.019)
Post911	-0.005 (0.009)	-0.005 (0.010)
D20*Post911	0.056 (0.027)	0.056 (0.029)
D40		-0.024 (0.013)
D40*Post911		0.005 (0.020)
N. Observations	204,540	204,540

The outcome variable corresponds to the log of the monthly number of MENA buyers per census block. See Tables 1, 2 and OA2.3 for information on definitions and specifications. Data source: Nasser (2007); Bagby (2012).

## 2.8 Model Continuous in Distance

Table OA2.8: Difference-in-Differences Estimates of the Impact of 9/11 on Real Estate Prices Near Mosques, Continuous Distance Measure

Log Price	
Distance	-0.068 (0.120)
Post911	-0.008 (0.046)
Dist.*Post911	0.174 (0.105)
N. Observations	32,708

Properties more than 0.5 mile away from mosques are excluded. The regression also includes detailed property characteristics: lot size in square feet, decade of construction, number of units in the lot, number of stories, number of bedrooms, number of bathrooms, and total number of rooms. See Table 1 for information on definitions and specifications. Data source: Bagby (2012).

## 2.9 Additional Housing Characteristics

Table OA2.9: Difference-in-Differences Estimates of the Impact of 9/11 on Real Estate Prices Near Mosques, Housing Characteristics

Log Price	(1)	(2)
D20	0.016 (0.030)	0.017 (0.029)
Post911	0.042 (0.015)	0.042 (0.015)
D20*Post911	-0.062 (0.032)	-0.058 (0.032)
Housing Characteristics	N	Y
N. Observations	126,881	126,881

Column 1 holds the sample constant to properties with non-missing information on detailed property characteristics: lot size in square feet, decade of construction, number of units in the lot, number of stories, number of bedrooms, number of bathrooms, and total number of rooms, but omits these controls. Column 2 includes these detailed property characteristics in the regression. See Table 1 for information on definitions and specifications. Data source: Bagby (2012).

## 2.10 Statistical Tests for Heterogeneity in Price Decreases

Table OA2.10: Interaction Between the Price Decrease Following 9/11 and Mosque or Area Characteristics

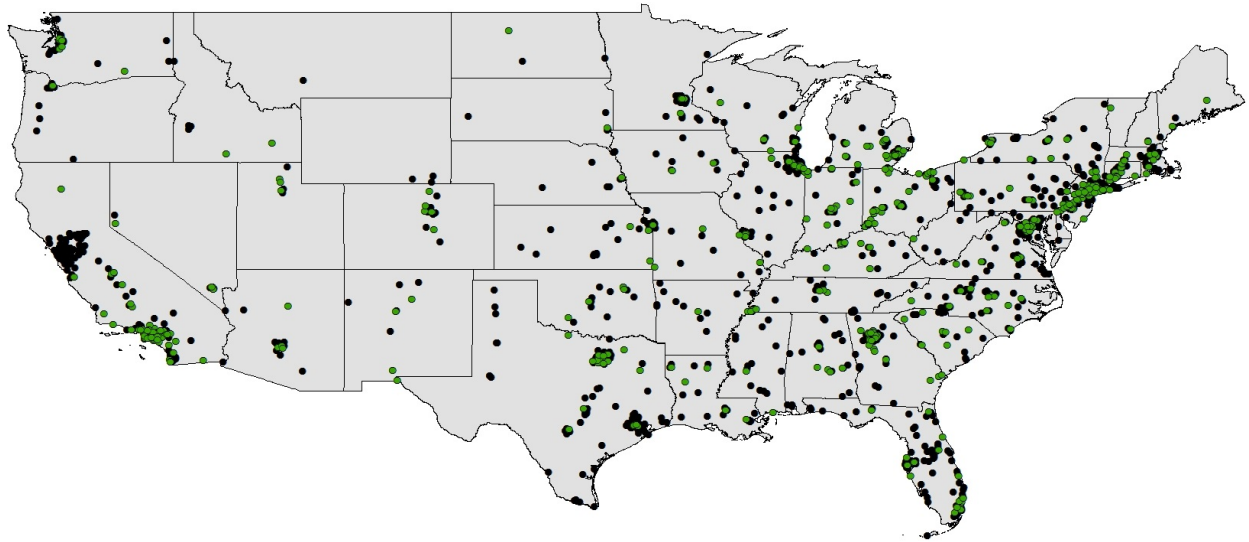
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
D20*Post911*Low Attendance	-0.092 (0.064)												
D20*Post911*High Attendance		-0.110 (0.066)											
D20*Post911*High Fraction MENA			0.010 (0.051)										
D20*Post911*High Tenure				0.046 (0.053)									
D20*Post911*High Hostility					-0.082 (0.048)								
D20*Post911*High Radicalism						-0.027 (0.067)							
D20*Post911* High Attack Risk							-0.035 (0.051)						
D20*Post911*High Fraction Muslim								0.030 (0.049)					
D20*Post911*High Hate Crimes									-0.076 (0.040)				
D20*Post911*High Prejudice										-0.027 (0.044)			
D20*Post911*High Fraction Republican											-0.076 (0.051)		
D20*Post911*High Fraction College												0.055 (0.049)	
D20*Post911*High Median Age													-0.072 (0.050)
N. Observations	147,695	179,618	239,595	239,595	232,012	239,595	239,595	239,595	239,418	178,220	239,595	239,595	239,595

See Figure 3 for additional details.

### 3 Supplementary Figures

#### 3.1 Mosques in the Continental US

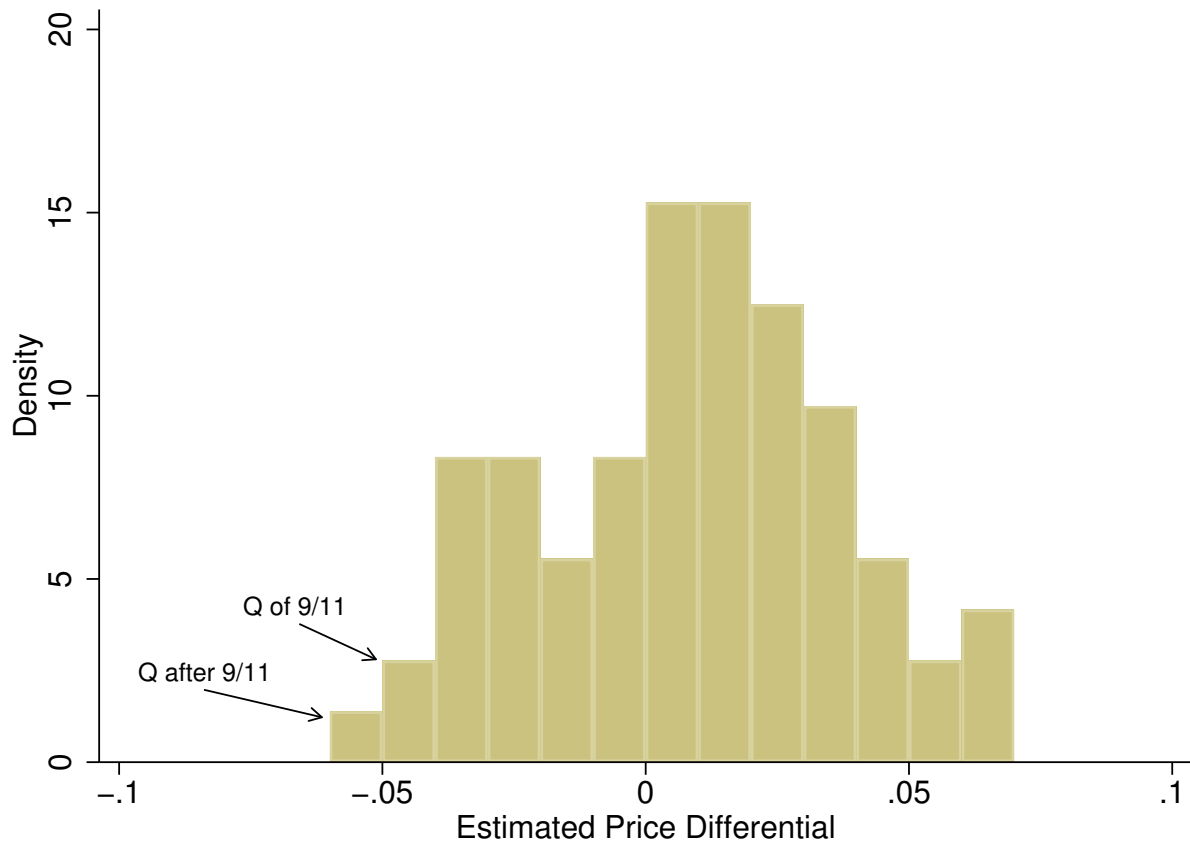
Figure OA3.1: Zip Codes with a Mosque (black) and with a Mosque included in the Survey (green)



Black dots represent all zip codes in the lower 48 states which contain at least 1 mosque, green dots represent all zip codes with at least 1 mosque in the survey from Bagby (2012). Data source: Bagby (2012), Hartford Institute for Religion Research (2016).

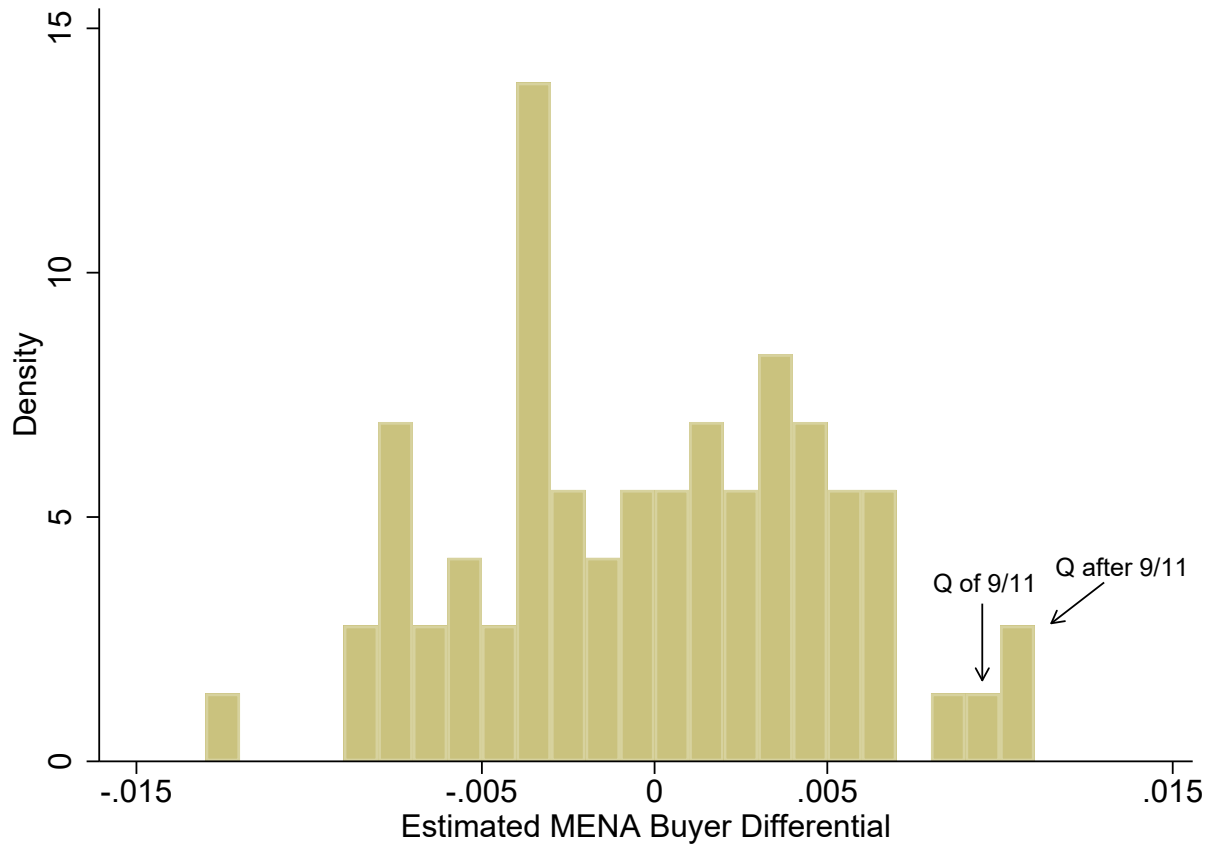
### 3.2 Placebo Tests from Rolling Regressions

Figure OA3.2-1: Temporal Placebo Tests for the DID Analysis of the Impact of 9/11 on Real Estate Prices near Mosques



The histogram plots the distribution of estimated price differentials for real estate transactions within 0.2 mile of a mosque compared to between 0.2 and 1 mile. Coefficients are obtained by estimating a version of equation (2) for every quarter in the sample period (excluding the first and last two years) comparing prices in the two years after a given quarter compared to the two years before. The analysis is restricted to mosques which did not move between 9/11 and their reported location in the 2011 data. Specifications include year, month-of-year and census block fixed effects. Standard errors are clustered at the census tract level. Data source: Bagby (2012).

Figure OA3.2-2: Temporal Placebo Tests for the DID Analysis of the Impact of 9/11 on the Fraction of MENA Buyers near Mosques

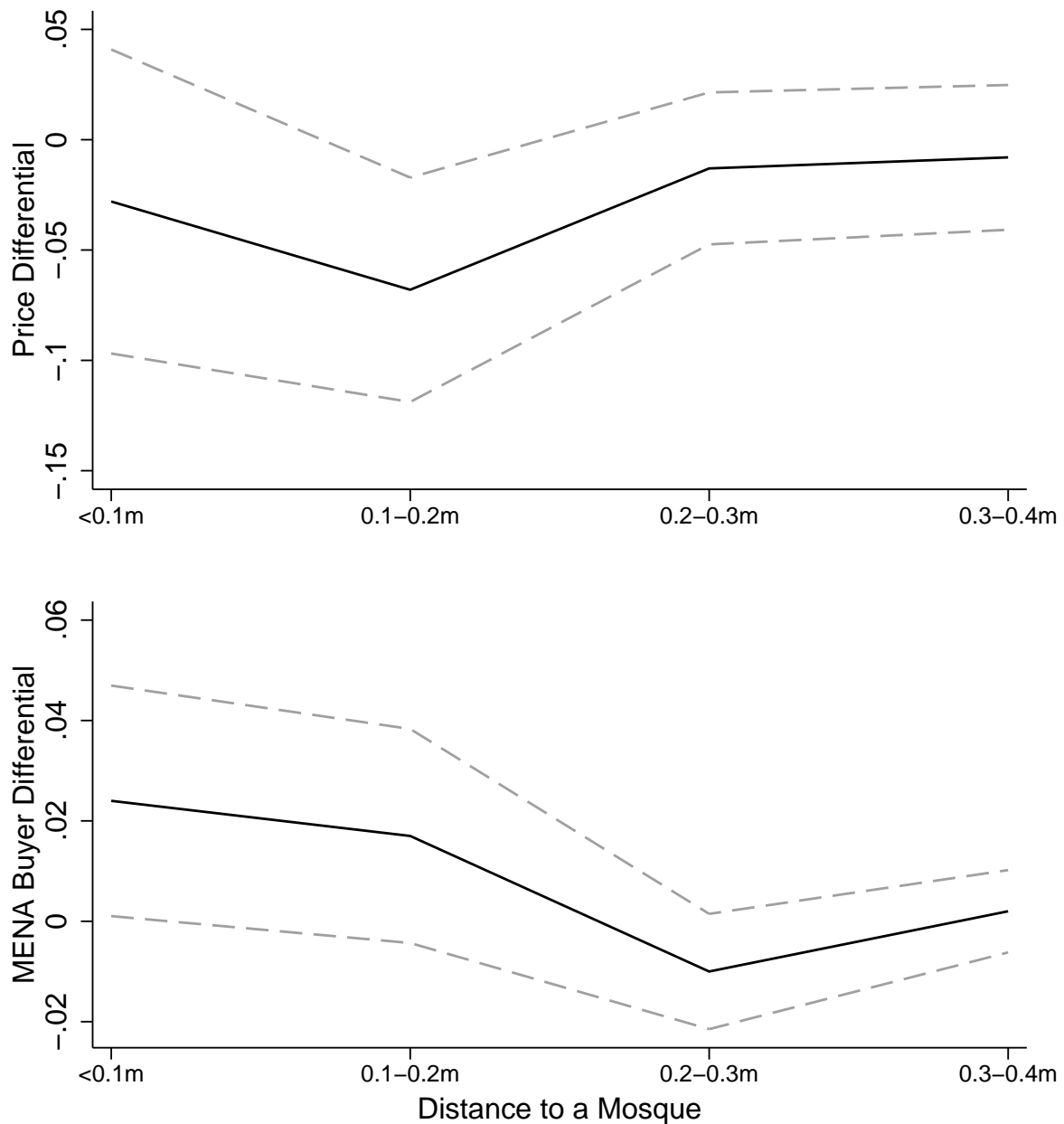


The histogram plots the distribution of estimated differentials in the likelihood that a buyer is of MENA origin for real estate transactions within 0.2 mile of a mosque compared to between 0.2 and 1 mile. Coefficients are obtained by estimating a version of equation (2) for every quarter in the sample period (excluding the first and last two years) comparing prices in the two years after a given quarter compared to the two years before. The analysis is restricted to mosques which did not move between 9/11 and their reported location in the 2011 data. Specifications include year, month-of-year and census tract fixed effects. Standard errors are clustered at the census tract level. Data source: Bagby (2012).



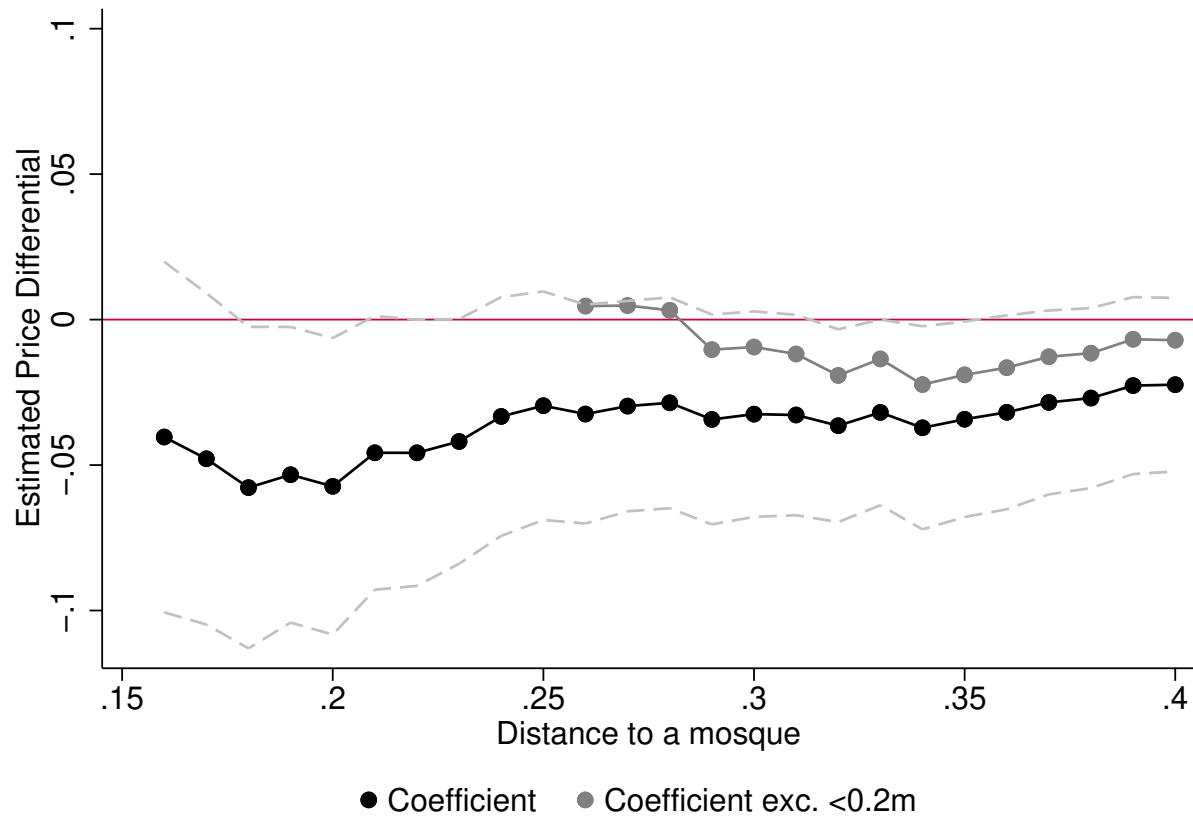
### 3.3 Estimates of the Impact of 9/11 by Distance to a Mosque

Figure OA3.3-1: Estimates of the Impact of 9/11 by Distance to a Mosque, 0.1 Mile Bins



Coefficients are obtained by estimating a version of equation (2) with distance categories from mosques and their interactions, which are plotted in the graphs. Precision is lower for radii closer to mosques given that they include fewer properties. The analysis is restricted to a two-year time window before and after 9/11 and to mosques which did not move between 9/11 and their reported location in the 2011 data. Specifications include year, month-of-year and census block fixed effects. Standard errors are clustered at the census tract level. Data source: Nasser (2007); Bagby (2012).

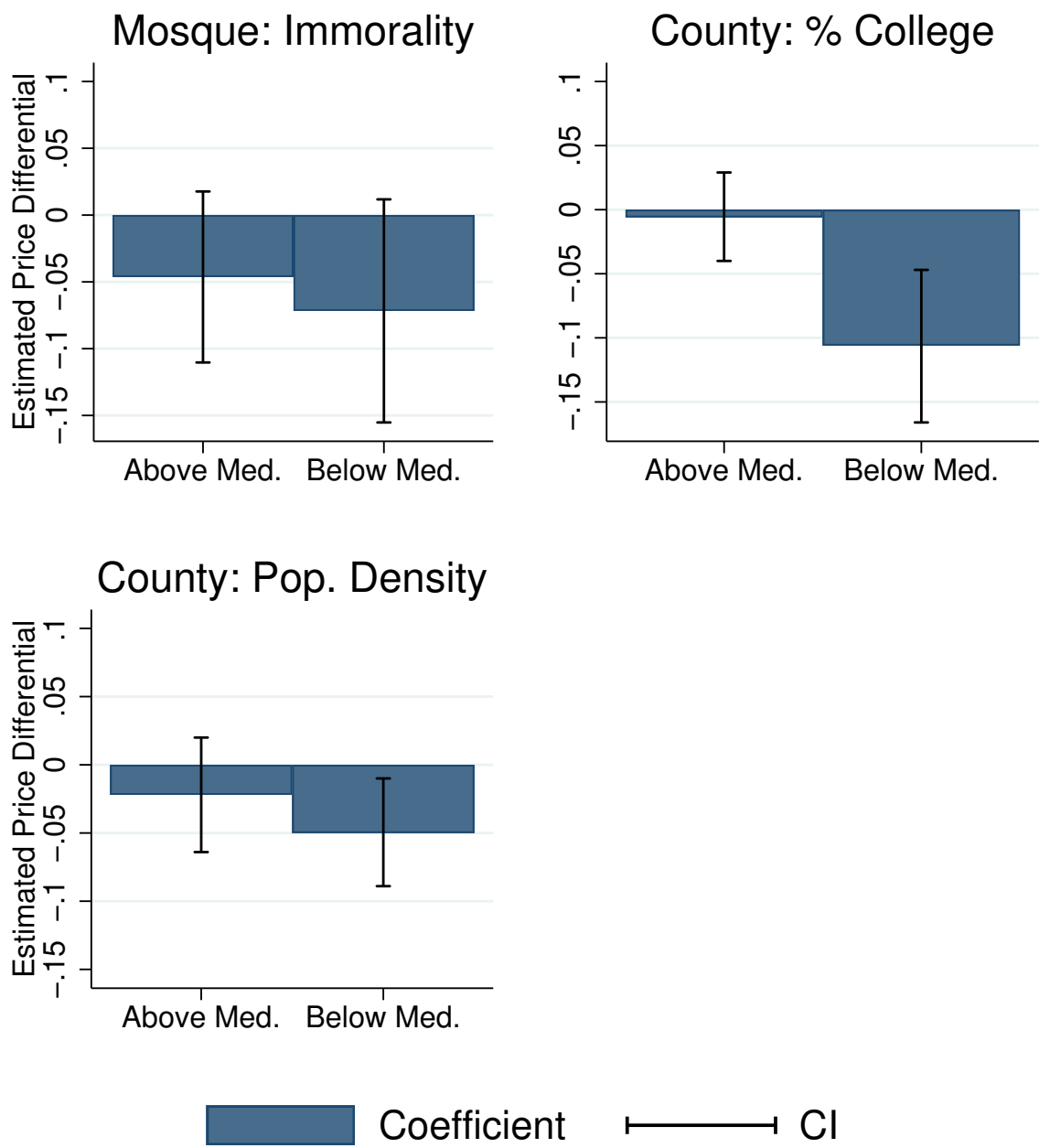
Figure OA3.3-2: Estimates of the Impact of 9/11 by Distance to a Mosque, Sensitivity Analysis



Coefficients are obtained by estimating a version of equation (2) with distance categories from mosques and their interactions, which are plotted in the graphs. Precision is lower for radii closer to mosques given that they include fewer properties. The dark gray line plots the estimated price differential excluding properties within 0.2 mile of a mosque to investigate how much of the differential for further distances is still driven by properties closer to a mosque. The analysis is restricted to a two-year time window before and after 9/11 and to mosques which did not move between 9/11 and their reported location in the 2011 data. Specifications include year, month-of-year and census block fixed effects. Standard errors are clustered at the census tract level. Data source: Nasser (2007); Bagby (2012).

### 3.4 Additional Heterogeneity in Price Differentials

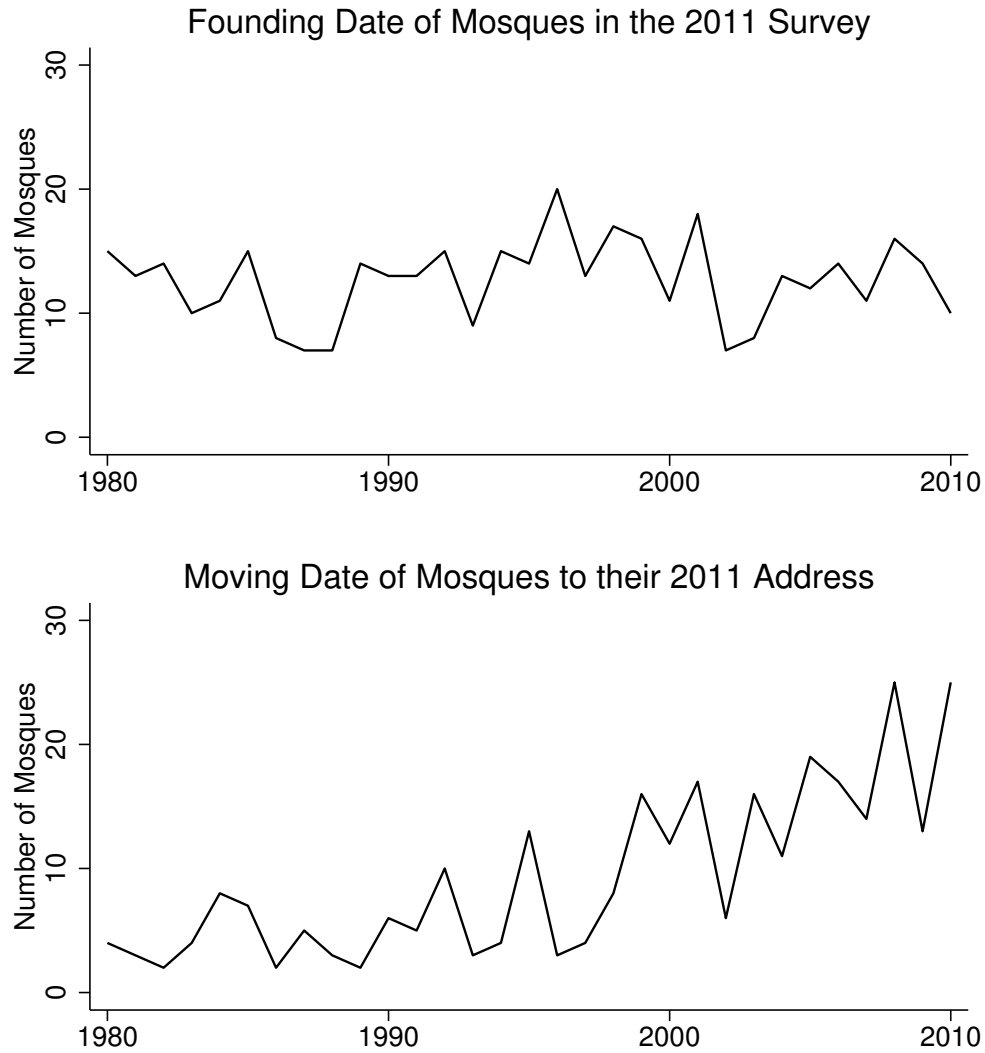
Figure OA3.4: Additional Heterogeneity in Price Differentials



See Table 1 and Figure 2 for regression details. Immorality corresponds to a rating from 1 (Strongly Disagree) to 5 (Strongly Agree) by the mosque official to whether American society is immoral. Data on college education corresponds to college completion rates in 2000, data on population density is for 2010. Data source: Bagby (2012), USDA Atlas of Rural and Small-Town America, (2019).

### 3.5 Mosque Founding and Moving

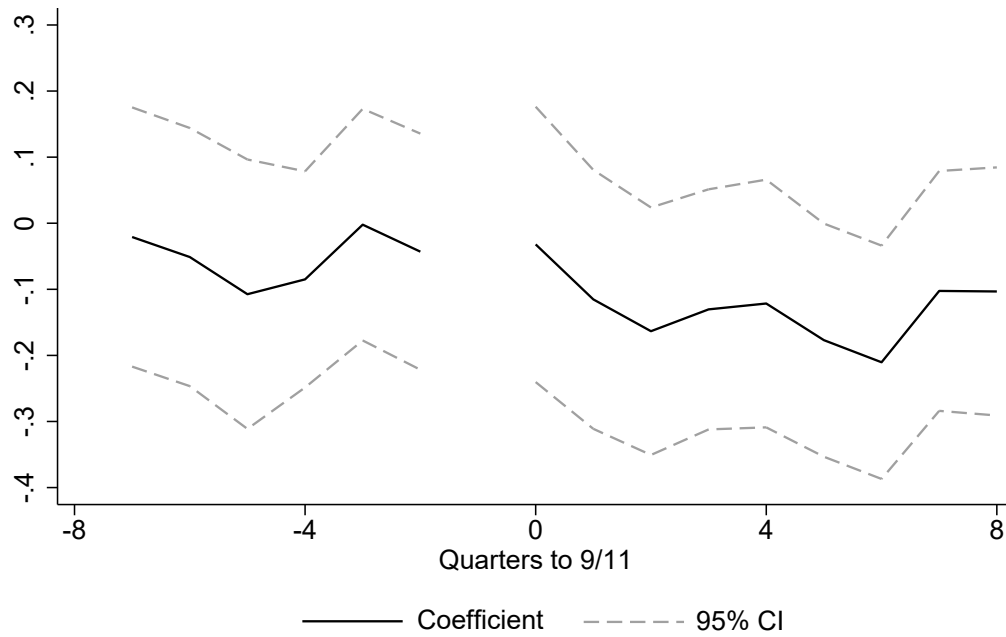
Figure OA3.5: Yearly Number of Mosques Which were Founded or Moved to their 2011 Address



The moving date to their current 2011 address assigned to each mosque corresponds to the founding date for mosques which did not move since their foundation and the year of their most recent relocation for others. Data source: Bagby (2012).

### 3.6 Event Study Evidence Omitting the Quarter Before 9/11

Figure OA3.6: Event Study Evidence, Omitting Quarter Before 9/11



See Figure 1 for information on definitions and specifications. Data source: Bagby (2012).

## 4 Snapshot of Mosques in the US

Figure OA4: Picture of US Mosques



Image shows the outside appearance of twelve randomly-selected mosques in the US from Google Street View.

## 5 Bibliography

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