Do the GSEs Expand the Supply of Mortgage Credit?  
New Evidence of Crowd Out in the Secondary Mortgage Market

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Do the GSEs Expand the Supply of Mortgage Credit? 
New Evidence on Crowd Out in the Secondary Mortgage Market 

Abstract 

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For years, the U.S. government has provided extensive support for the secondary mortgage market, in part through its implicit guarantee to back the debt issued by the federally chartered GSEs, Fannie Mae and Freddie Mac. That guarantee became explicit with the recent dramatic government takeover of Fannie and Freddie, motivated in part by a desire to ensure liquidity in the mortgage market. This study examines the extent to which GSE activity crowds out purchases by private secondary market entities. High levels of crowd out would imply that government support for the GSEs may be less warranted, while absence of crowd out implies that GSE purchases increase liquidity and, in that respect, play an essential role in the provision of mortgage credit. 

We focus on 1994 - 2007 HMDA data for conventional home purchase loans below the conforming size limit. Based on these data, three distinct periods are apparent. From 1994 - 2003, the share of loan originations sold to the secondary market increased from roughly 60 to nearly 100 percent. During this period, private sector and GSE shares of loan purchases were similar, while IV estimates suggest little GSE crowd out of private loan purchases. In contrast, during the final years of the housing boom, from 2004 to 2006, private sector share of loan purchases substantially exceeded that of the GSEs, and IV estimates indicate high levels of GSE crowd out: 93 percent, 54 percent, and 74 percent, respectively for 2004, 2005, and 2006. With the crash in mortgage markets in 2007, the private sector greatly curtailed purchases of loans in the secondary market, GSE purchases remained at levels similar to the 2004-2006 period, and evidence of GSE crowd out disappears. Together, these patterns suggest that GSE loan purchases crowd out those of private sector entities during periods of heightened market activity. But in less active periods, as in 1994 to 2003 and importantly, 2007, it is clear that GSE loan purchases enhance liquidity. We argue that these patterns are important to current policy debate about the future status of the GSEs.
I. **Introduction**

For years, the U.S. government has provided extensive support for the secondary mortgage market, in part through its implicit promise to insure debt issued by the federally chartered GSEs, Fannie Mae and Freddie Mac. That promise became explicit with the recent dramatic government takeover of Fannie and Freddie, motivated in part by a desire to assure adequate provision of liquidity in the mortgage market. This study examines net provision of liquidity on the part of the GSEs. Specifically it evaluates whether GSE activity crowds out purchases by private secondary market entities, and the degree to which crowd out varies over time with changes in market conditions. High levels of crowd out suggest that government support for the GSEs may be counterproductive and unwarranted, whereas the absence of crowd out implies that GSE purchases enhance liquidity and, in that respect, play an essential role in the provision of mortgage finance. Some further background is in order.

The GSEs were established with the primary goal of facilitating development of an active secondary market for mortgages that would provide retail lenders with an expansive and reliable source of funds. Lenders in the primary market sell loans to secondary market investors who either hold those loans in portfolio (as with many financial institutions) or securitize and sell shares of loan pools worldwide to investors in mortgage backed securities (as with Fannie Mae and Freddie Mac). The secondary market frees primary lenders from reliance on local deposits as their primary source of funds, and as a consequence, enhances both the efficiency with which mortgage credit is allocated and access to credit (e.g. Pennacchi (1988), Carlstrom and Samolyk (1995), Drucker and Puri (2008), and Gabriel and Rosenthal (2007)).

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1Secondary credit markets improve efficiency in several ways. They increase liquidity for primary lenders, smooth regional imbalances in the supply and demand for credit, and enhance opportunities to manage risk. All of these gains stem from economies of scale associated with the large size of the secondary market. Early theoretical work on secondary credit markets by Pennacchi (1988) and Carlstrom and Samolyk (1995) argued that factors including lender comparative advantage in loan origination and risk diversification should result in increased loan sales. Drucker and Puri (2008) document an empirical relationship between bank loan sales and increased borrowing by businesses. Gabriel and Rosenthal (2007) find a similar relationship for the mortgage market.
The federal government support of the GSEs has been closely linked to GSE adherence to policy goals embodied in their charters, including provision of liquidity among low-moderate income households and neighborhoods. Under terms of the 1992 Federal Housing Enterprise Financial Safety and Soundness Act of 1992 (GSE Act of 1992), the GSES were required to devote a large share of their loan purchases to low-income families and/or individuals residing in low-income and/or minority communities. The Act further mandated that specific affordable housing purchase goals be established by the Department of Housing and Urban Development (HUD). Over time, HUD ratcheted up the GSE purchase targets: at the time of government takeover of Fannie Mae and Freddie Mac in 2008, over 50 percent of loans purchased by the GSEs must have been issued to “low-moderate” income borrowers, and nearly 40 percent of loans must have been purchased from “underserved” census tracts. Evidence from several recent studies documents that the GSEs largely adhered to their obligatory purchase targets (e.g. Bunce and Scheessele (1996), Bunce (2002)).

In exchange for GSE adherence to federal policy goals, there was a longstanding implicit understanding among the GSEs and the investment community that the federal government would stand behind the debt of those entities. Although the federal government was not legally bound to come to Fannie and Freddie's recent rescue, a failure to do so would have been interpreted among market participants as a default on U.S. sovereign debt, with far-reaching and adverse implications for the cost of credit to the U.S. government. Further, the sheer size of Fannie Mae and Freddie Mac presented an untenable risk to U.S. mortgage markets and by extension to the larger macro economy.

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2 HUD guidelines currently set three specific purchase goals to which the GSEs must adhere: the “low-moderate income” goal, the “special affordable” goal, and the “geographically targeted” or “underserved areas” goal. For the low-moderate income goal, lower-income borrowers are defined as individuals with income below that of MSA (metropolitan statistical area) median income. For the special affordable goal, very low income borrowers are those with income less than 60 percent of the area median income. The special affordable goal also includes borrowers with income less than 80 percent of the area median income who reside in census tracts defined as low-income (tracts with median income less than 90 percent of MSA median income). Under the geographically targeted goal, low-income, underserved neighborhoods are defined as census tracts with median income less than 90 percent of MSA median income or tracts with over 30% minority population and median income less than 120% of area median income. For 2008, the low-moderate income goal is 52 to 56 percent of total GSE purchases, the geographically targeted goal is 37 to 39 percent of GSE purchases, and the special affordable goal is 22 to 27 percent of GSE purchases (U.S. Department of Housing and Urban Development (2004)). These categories are not mutually exclusive, so a single loan purchase can count towards multiple goals.
should these companies have been allowed to fail. As of 2007, securitized home mortgage debt backed by the GSEs totaled $4.0 trillion. This is close to the outstanding level of U.S. Treasury debt, almost double that of outstanding consumer debt, and roughly two-thirds the value of all outstanding household pension reserves.\(^3\) Looking ahead, the future status of Fannie Mae and Freddie Mac will be the focus of considerable public policy debate. Given the size and importance of the GSEs to the secondary market for home mortgages, it is imperative to better understand the potential impact of the GSEs on the supply of mortgage credit. This paper seeks to shed light on that question.

As a starting point, it is illuminating to further characterize the relative size of GSE and non-GSE loan purchases in an evolving secondary mortgage market. We do this by examining the ratio of secondary market loan purchases relative to loan originations, both for the market overall, and also for GSE and non-GSE purchases separately. These ratios are calculated for each even year from 1994 through 2000, and annually from 2001 through 2007. Moreover, in light of the 1992 GSE Act focus on lower income communities, we calculate purchase/origination ratios separately for different groups of census tracts based on the degree to which tract median income is below or above the income limit used by HUD and Congress to define an underserved tract. In all cases, our analysis is based on data for conventional home purchase mortgage loans obtained through the Home Mortgage Disclosure Act (HMDA). We also restrict our attention to just those loans that are below the conforming size limit set by the Office of Federal Housing Enterprise Oversight (OFHEO). Our focus is consistent with the GSE mandate to enhance liquidity in the secondary market for conventional “conforming” loans.\(^4\)

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\(^3\)See Table L.125, line 2, Federal Reserve Board Flow of Funds Accounts (2007) for data on outstanding mortgage debt. In 2007, Treasure debt outstanding equaled roughly $4.9 trillion (Table L.4 line 3), outstanding consumer debt totaled $2.4 trillion (L.222, line 1), and total pension fund reserves held by the household sector totaled $5.8 trillion (Table L.118, line 1).

\(^4\)The primary underwriting criteria used to define conventional conforming loans is the maximum allowable loan size that governs purchases by the GSEs as set by OFHEO. Although debt-to-income ratios and documentation requirements may also play a role, this has not always characterized the purchase behavior of Fannie Mae and Freddie Mac, especially in the 2004-2006 period. In the HMDA data we are able to observe loan size which permits us to group loans into those below versus above the loan size limit. HMDA does not provide information on payment-to-income ratios or the degree of borrower documentation.
Figure 1 displays plots of the purchase/origination ratios by neighborhood income status.\textsuperscript{5} Separate panels are provided for each sample year and illuminate several stark patterns. First, over time, the share of originations purchased by entities in the secondary market – as approximated by the ratio of purchases to originations – has increased. In 1994, roughly 50 to 60 percent of originations were purchased by secondary market institutions, with higher purchase rates occurring in the higher income communities. Purchase rates increased monotonically over time, reaching roughly 100 percent in 2004 for all neighborhoods regardless of income status. Purchase rates remained at these very high levels through 2007. Overall, this pattern documents the well known rise of the secondary market in the 1990s as the primary source of funds for mortgage finance. Today, nearly all capital used to finance conforming sized home purchase loans is obtained on the secondary market, a dramatic change from just fifteen years ago.

A second pattern in Figure 1 is the changing relative share of GSE versus private sector loan purchases. Between 1994 and 2003, the GSEs accounted for roughly the same share of purchases as private non-GSE secondary market institutions. In 2004 the private secondary market loan purchases boomed, and for the next three years – 2004 through 2006 – non-GSE purchases accounted for a much larger share of originations as compared to the GSEs. Indeed, between 2003 and 2006, the GSE share of originations purchased fell by at least 10 percentage points across most neighborhoods regardless of income status. Dramatically, that pattern completely reversed in 2007 with the crash in mortgage markets and the concurrent pullback in private non-GSE secondary market purchase activity. On average, over 2007, GSE purchase shares of originations were broadly similar to their 2003 levels. Taken together, the various plots in Figure 1 indicate three distinct periods between 1994 through 2007: the early period – 1994 through 2003 – in which GSE purchases were similar in magnitude to the private sector, the middle period – 2004 through 2006 – in which the GSEs took on a lesser

\textsuperscript{5} Some of the purchase/origination ratios in Figure 1 and Table 1 exceed 1. This is possible for two reasons. First, some loans are sold in a year subsequent to the one in which they are originated. Second, some loans are sold from one lender to another, and it is the latter of those entities that then sells the loan (or loan pool) to established players in the secondary market. Both practices can shift the timing of when loans are securitized relative to their origination date, and cause purchase/origination ratios to exceed 1.
relative role, and 2007 when the private sector scaled back activity and the GSEs regained their parity with private entities as a source of secondary market financing.

These patterns are echoed in Table 1 which displays summary measures of the average number of loans per census tract originated and purchased by the GSEs and non-GSEs in each of our sample years, along with purchase/origination ratios. Most dramatic, originations of conforming-sized conventional home purchase loans rose from 38.9 per tract in 1994 to a peak of 105.6 in 2005. As is widely appreciated, originations then fell back markedly to 65.7 in 2007. However, over the 2005 to 2007 period, GSE purchases actually increased slightly, from 31.4 to 34.5 per tract, while private sector purchases fell from 78 to 39.3 per tract. Moreover, numerous anecdotal reports suggest that the pull-back of private sector purchases of mortgage loans has continued into 2008.

On the surface, the patterns in Figure 1 and Table 1 are suggestive that the GSEs do much to enhance access to mortgage credit by purchasing such a large share of originated loans. While this may be true, such a conclusion could be premature. Later in the paper we present a simple conceptual model of GSE crowd out of private sector purchases. In that model we show that as secondary market loan supply becomes more inelastic crowd out becomes more pronounced. We further argue that when portfolio loan retention is largely absent, as from 2004 onwards, primary lenders can only supply additional loans to the secondary market by originating more mortgages. This likely would cause the secondary market loan supply function to become less elastic. An implication is that GSE crowd out may have been more pronounced in recent years. On the other hand, the dramatic contraction of non-GSE demand for loans in 2007 would have reduced competition for mortgages in the secondary market. This pronounced inward shift in demand could potentially have pulled the secondary market back to a more elastic portion of the loan supply function, resulting in reduced GSE crowd out. Our simple model, therefore, predicts that the extent of GSE crowd out likely depends on market conditions and varies over time.

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6 The rapid growth in originations in recent years has coincided with the surge in popularity of new mortgage designs, including interest-only, payment option, sub-prime and related instruments.
To assess the crowd out effects of GSE loan purchases, we regress private sector purchase/origination ratios on GSE purchase/origination ratios. In each instance, our unit of observation is the census tract, and we restrict our attention to conforming sized conventional home purchase loans, and also to census tracts located within MSAs in 2000 (as in Figure 1 and Table 1). Evidence of a negative coefficient on GSE purchase/origination shares then suggests that GSE purchases crowd out loan purchases by private secondary market entities; evidence of a -1 coefficient would be consistent with full crowd out.7

Central to our empirical analysis, of course, is the need to control for the likely endogenous character of GSE purchase/origination ratios. If unobserved tract attributes provide similarly profitable loan purchase opportunities for the GSEs and non-GSEs, this would suggest that GSE purchase/origination ratios would be positive correlated with an ordinary least squares (OLS) error term. This would cause the OLS coefficient on GSE activity to be biased upwards towards a more positive value. If instead, possibly because of their government charters, the GSEs seek to purchase loans in different census tracts than private sector entities, a negative OLS bias could result. Although we cannot sign the OLS bias a priori, it seems likely that GSE purchase/origination ratios are endogenous.

To address this concern, we instrument for GSE purchase/origination ratios using the census tract’s underserved status. As discussed above, the GSE charters mandate that Fannie and Freddie purchase a disproportionate share of their loans in underserved census tracts, and this provides motivation for the instrument. Of course, absent other controls in the model, underserved status would also proxy for a census tract’s demand for mortgage originations and the risk attributes of the applicant pool. To control for these factors, all of our models include MSA fixed effects along with a long list of

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7In principle, agglomeration economies arising from the presence of the GSEs could enhance opportunities for private sector entities to purchase loans (e.g. Rosenthal and Strange (2004)). This might occur if GSE activity helped to establish information networks and other infrastructure necessary to support the entire market (e.g. Lang and Nakamura (1994)). Harrison et al (2002) suggest that Fannie Mae purchases have had such an effect in parts of Florida. In practice, however, evidence presented later in the paper suggests that crowd out – which implies that GSE purchases reduce private sector activity – dominates, and especially in recent years.
census tract socio-demographic (SES) attributes (e.g. age distribution of the population, education, race, poverty etc.), including the tract’s average income and income squared. These terms capture the underlying demand for credit and risk attributes of the applicant pool. These factors also likely vary in a smooth continuous fashion with SES attributes, including income and income squared.\(^8\)

Identification is then obtained by the discrete shift in GSE purchase activity associated with the income limit used by HUD to define underserved tracts.

It should be emphasized that having controlled for GSE purchase activity, there is no particular reason why a tract’s underserved status should appear directly in the second stage equation used to explain private sector purchase/origination ratios. We therefore believe that a compelling argument can be made for the exogeneity of a tract’s underserved status conditional on inclusion of a suitably rich set of SES and MSA controls. In addition, test results presented later in the paper confirm that underserved status is strongly correlated with GSE purchase/origination ratios, and for this reason, weak instrument bias is not a concern (e.g. Murray (2006), Cameron and Trivedi (2005), Stock and Yogo (2005)).

Results based on the IV regressions can be briefly summarized. We see evidence of at most limited GSE crowd out during the 1994 - 2003 period when portfolio lending still accounted for an important share of loan activity. In contrast, GSE crowd out jumps up to 97 percent, 54 percent, and 77 percent, respectively, for 2004, 2005, and 2006. This coincides with dramatic relative and absolute increases in private sector purchase activity coupled with limited retention of originated loans in primary lender portfolios as noted above. In 2007, evidence of GSE crowd out largely disappears, coinciding with the crash in mortgage markets and related pull-back in private sector demand for mortgage purchases. Overall, our estimates indicate that GSE crowd out is pronounced during periods of heightened market activity, but in less active periods, as from 1994 to 2003 and importantly, 2007, GSE loan purchases appear to enhance liquidity. From a policy perspective, this suggests that

\(^8\)All of the models were also estimated including tract average income cubed and to the fourth power. Adding these higher order terms did not change the results.
liquidity enhancements associated with ongoing operations of Fannie and Freddie will depend on future market conditions: if markets remain soft, Fannie and Freddie likely will enhance liquidity, but less so as private players return to the secondary markets.

To clarify these results, the plan of the paper is as follows. Section 2 provides additional background on the GSEs and related regulation. Section 3 presents a simple conceptual model of GSE crowd out of private sector loan purchases. Section 4 develops the empirical model. Section 5 presents data and summary statistics. Section 6 presents the results, and Section 7 concludes.

II. Background

As noted earlier, the GSEs have been obliged to secure a minimum share of their annual loan purchases from targeted communities and groups. Bunce and Scheessele (1996), Bunce (2002), and others provide evidence that in the years following enactment of the 1992 GSE Act, the GSEs increased the proportion of loan purchases from targeted populations. Between 1992 and 1995, for example, Fannie Mae doubled the share of loan purchases from lower-income borrowers while Freddie Mac increased its share by roughly 50 percent. Manchester (1998) documents that in 1995, Fannie Mae and Freddie Mac both surpassed the affordable loan purchase housing goals established by HUD. Manchester, Neal, and Bunce (1998) reach similar conclusions. Collectively, these studies provide compelling evidence that the GSEs have largely met the administrative targets imposed by the regulating authorities.

A different set of studies have sought to identify the impact of GSE purchase targets on mortgage loan originations. While not directly addressing the possibility that GSE activity may crowd out private sector loan purchases, evidence that the GSE purchase targets increase originations in underserved census tracts would be suggestive of less than full crowd out. Bearing that in mind,

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10Full crowd out would imply that in the absence of GSE activity, the private sector would provide services otherwise offered by the GSEs. Under such circumstances, GSE purchase targets would not affect loan originations.
Ambrose and Thibodeau (2004) use data from the latter half of the 1990s to analyze the impact of the percentage of an MSA’s census tracts defined by the 1992 GSE Act as underserved on MSA-level mortgage originations (including purchase and refinance loans that do and do not conform to GSE underwriting requirements). Ambrose and Thibodeau (2004) conclude that between 1995 and 1999, only in 1998 did GSE activity increase originations. An and Bostic (1996, forthcoming) restrict their attention to census tracts in 1996 and 2000 just below and just above 90 percent of an MSA’s median income, the cutoff used to define underserved tracts for purposes of the GSE purchase targets. An and Bostic conclude that GSE purchases reduce subprime and FHA originations in underserved tracts close to the target cutoff. Although all three of these papers are suggestive of less than full GSE crowd out, none of these papers actually consider crowd out directly or offer any guidance as to the possible extent of the phenomenon. Moreover, the sample and econometric design used in each of these papers precludes such an attempt.\footnote{An and Bostic (2006) treat GSE and FHA purchases as exogenous when estimating the impact of changes in GSE and FHA purchase shares on changes in subprime loan origination shares between 1996 and 2000. This is problematic because originations affect supply on the secondary market and have a direct impact on GSE and other secondary market activity. In addition, FHA and subprime originations respond to common unobserved attributes causing FHA activity to be endogenous. An and Bostic (forthcoming) instrument for GSE purchases using census tract underserved status and homeownership rate, along with other local neighborhood and MSA-level control measures. This is also problematic because tract income is omitted from the model specification even though tract income affects mortgage demand and underserved tract status. This implies that underserved status in their specification is not excludable. In addition, homeownership is sensitive to access to mortgage credit and is likely correlated with the model error term. Ambrose and Thibodeau (2004) adopt a switching regression model based on Fair and Jaffee (1972) in which they treat the switching mechanism as exogenous. Increases in MSA-level mortgage rates are treated as indicative of excess demand and as a signal that the local market is on the supply curve. Stratifying their sample on this basis, Ambrose and Thibodeau estimate the supply of loan originations including controls for the share of census tracts in an MSA that meet underserved status. Results from this approach are sensitive to the veracity of the sample stratification scheme.}

To our knowledge, no previous studies of the mortgage market have directly considered the crowd out effects of the GSEs. This is in contrast to other markets in which public sector crowd out of private sector activity has been carefully studied. This includes previous experimental research on crowd out associated with the provision of public goods (Andreoni (1993)), as well as studies that examine crowd out from publicly provided health insurance (Culter and Gruber (1996), Brown and Finkelstein (2004), Brown, Coe, and Finkelstein (2006), and Gruber and Simon (2007)), and public
construction of low- and moderate-income housing (Murray (1982, 1999), Sinai and Waldfogel (2005), and Eriksen and Rosenthal (2007). A common theme across all of these studies is that public sector crowd out of private activity can be substantial, especially when a viable private sector alternative is present. Consider the following examples.

Gruber and Simon (2007) estimate that 60 percent of the expansion in public health insurance during the 1996-2002 period was offset by crowd out of private market insurance.12 Sinai and Waldfogel (2005) and Eriksen and Rosenthal (2007) both find high rates of crowd out rates associated with publicly subsidized construction of low- and moderate income housing.13 Given evidence of substantial crowd out in these studies, it is plausible that similarly large crowd out effects could arise from government sponsored GSE loan purchases in the secondary market. The extent to which such crowd out occurs is considered in the remaining sections of this paper, both on conceptual and empirical grounds.

III. Conceptual Model

This section outlines a simple model that clarifies market conditions under which GSE loan purchases are likely to crowd out purchases by private entities in the secondary market. As drawn in Figure 2, we assume that the secondary market loan supply function is initially relatively elastic as higher purchase prices induce lenders in the primary market to supply additional loans to the secondary market. The increase in supply is made possible because lenders originate more loans, but also because they may sell a greater share of loans held in portfolio. As one moves further out along

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12Brown and Finkelstein (2004) and Brown, Coe, and Finkelstein (2006) provide related evidence that Medicaid may crowd out private health insurance for up to two-thirds of the wealth distribution.

13Upon controlling for MSA fixed effects Sinai and Waldfogel estimate crowd out from public and other forms of subsidized rental housing at roughly one-third. Eriksen and Rosenthal (2008) obtain estimates closer to three-quarters for the Low Income Housing Tax (LIHTC) program. Murray (1982, 1997) also examines crowd out of subsidized construction of lower income housing. In both studies, Murrary uses aggregate time series data in contrast to Sinai and Waldfogel (2005) and Eriksen and Rosenthal (2008) who use micro data. Murray reports finds little crowd out from public construction of very low income housing – a market segment that sees little unsubsidized construction – but more pronounced crowd out in the moderate income portion of the market. Murray’s results confirm the general principle that crowd out will be greater when government provides services that would otherwise have been provided by the private sector.
the loan supply function we assume that it becomes more inelastic. This reflects the presumption that lenders in the primary market find it increasingly difficult and costly to originate more loans and/or to sell off their remaining loans held in portfolio.

We now examine two cases. In the first case, demand intersects supply on its relatively elastic portion, and government prompted GSE purchase activity pushes demand out and up along the supply function. This pushes up the price of loans on the secondary market, inducing primary lenders to supply additional loans to the secondary market.\(^{14}\) As a result, crowd out of private entity loan purchases occurs, but is limited.

In the second case, secondary market loan demand intersects loan supply on its more inelastic, portion. Here also, government prompted GSE purchases expand demand for loans, pushing the loan demand function up the supply curve. The price of loans traded on the secondary market rises to clear the market, but the number of loans sold on the secondary market increases by only a modest amount. As a result, a much larger share of the GSE purchases are offset by a decline in private non-GSE purchases of loans in the secondary market. The general principle highlighted in Figure 2, and also noted in the Introduction, is that crowd out increases as the supply of loans to the secondary market becomes more inelastic. To the extent that implosion in the non-GSE segment of the secondary mortgage market serves to reduce demand for loans, as was the case in 2007 and 2008, the loan demand curve may shift down to a more elastic portion of the loan supply function. In that case, the magnitude of any GSE crowd out of private non-GSE loan purchasers would be reduced.

\(^{14}\)For our purposes here, it is not necessary to distinguish whether the increase in supply is generated by a reduction in the number of loans held in portfolio, or because primary lenders originate a greater share of applications received. Gabriel and Rosenthal (2007), in contrast, model the impact of secondary market purchases on the share of applications originated. They estimate that secondary market purchases increase origination shares by an amount roughly comparable to the prevailing loan denial rate, about 15 percent of applications.
IV. Empirical Model

4.1 Specification

As discussed above, the supply of GSE-conforming loans in the secondary market is directly related to primary market originations and to the number of loans held in portfolio by primary lenders. Bearing that in mind, the number of loans originated by primary lenders in period \( t \) \((L_t)\) equal applications \((A_t)\) minus denials \((D_t)\),

\[
L_t \equiv A_t - D_t . \quad (4.1)
\]

Applications are approximate demand and depend on mortgage rates \((r_t)\) and the attributes of the applicant pool \((Z_t)\),

\[
A_t = A(r_t, Z_t) . \quad (4.2)
\]

The number of applications denied also depends on \(r_t\) and \(Z_t\) where in this case, \(Z\) proxies for applicant credit risk. Gabriel and Rosenthal (2007) provide evidence that a more active secondary market reduces the share of applications that are denied. This occurs because active secondary markets manage risk more efficiently and provide opportunities for primary lenders to shift risk to that sector. We denote the level of secondary market purchases as \(P_t\). If GSE loan purchases are not fully offset by crowd out of private sector activity, then \(P_t\) is sensitive to GSE activity, or \(P_t = P_t^{GSE}\). Denials are then represented by,

\[
D_t = D_t(r_t, P_t^{GSE}, Z_t) . \quad (4.3)
\]

Substituting (4.2) and (4.3) into (4.1), the equilibrium number of loans originated is,

\[
L^*_t = L(r_t, P_t^{GSE}, Z_t) . \quad (4.4)
\]

This says that the number of loans originated depends on market mortgage rates, the level of secondary market activity, and attributes of the potential pool of applicants. Of these loans, a fraction \((\theta_t)\) are held in portfolio by primary lenders, while the remaining portion, \(1 - \theta_t\) is sold on the secondary market.

Portfolio lending, of course, has declined dramatically in recent years as discussed in the Introduction. Nevertheless, depository institutions typically still hold at least some of their originations in
portfolio and that affects supply in the secondary market. It is sufficient here to note that in any given year, $\theta$ depends on loan applicant attributes, $Z$, and market interest rates, $r$. Accordingly, supply in the secondary market is given by,

$$S_{t}^{Supply} = S(r_t, P_t(P_{GSE}^{t}), Z_t) \leq L_t^*$$  \hspace{1cm} (4.5)

where the inequality is provided as a reminder that primary lenders can sell loans only up to the number originated.

Demand for loans in the secondary market is sensitive to interest rates, conditions in global capital markets ($\Omega_t$), government policy that affects GSE purchases, and attributes of the loan applicant pool,

$$S_{t}^{Demand} = S(r_t, \Omega_t, P_{GSE}^{t}, Z_t)$$  \hspace{1cm} (4.6)

Equilibrium mortgage rates are determined in the secondary market by the supply and demand for residential loans. We represent this as,

$$r_t^* = r(\Omega_t, P_t(P_{GSE}^{t}), Z_t)$$  \hspace{1cm} (4.7)

Bearing in mind that secondary market purchases equal the sum of private and GSE purchases, we substitute (4.7) into (4.5) and (4.6) and solve for the private sector level of secondary market loan purchases,

$$P_t^{private} = P(\Omega_t, P_t^{GSE}, Z_t)$$  \hspace{1cm} (4.8)

This expression says that the level of private sector secondary market loan purchases depends on global capital market conditions at time $t$, GSE purchases, and attributes of the applicant pool.

In the empirical work to follow, we approximate with a linear specification for (4.8) and treat each census tract as a separate observation. The model is then estimated separately for each sample year from 1994 through 2007. We begin with a possible estimating equation as follows,

$$P_{t,i}^{private} = \lambda_t + b_{z,i}Z_{t,i} + b_{GSE,i}P_{t,i}^{GSE} + u_{t,i}$$  \hspace{1cm} (4.9)
In (4.9), the subscript $i$ denotes the individual census tract. The term $\lambda$ captures broader capital market conditions common to all neighborhoods in period $t$ (i.e., $\Omega_t$). The coefficients on $Z_{t,i}$ are reduced form in nature as they reflect the influence of $Z$ on both the local demand and supply for credit. The coefficient on $P_{t,i}^{GSE}$ has a clear interpretation as GSE crowd out of private sector activity implies that $b_{GSE,t}$ is negative. Full crowd out would imply that $b_{GSE,t}$ equals -1.

4.2 Identification

An important feature of (4.9) is that $P_{t,i}^{GSE}$ is endogenous. This arises for two reasons. The first is that unobserved factors that affect originations also directly affect the supply of loans in the secondary market. That in turn causes GSE loan purchases to be correlated with the model error term. As a first step in addressing this issue, we normalize private and GSE loan purchases by the number of loans originated in a given tract and period. The estimating equation becomes,

$$
\frac{P_{t,i}^{private}}{L_{t,i}} = \lambda_i + b_{t,i}Z_{t,i} + b_{GSE,t} \frac{P_{t,i}^{GSE}}{L_{t,i}} + u_{t,i}.
$$

(4.10)

Adjusting private and GSE purchases in this fashion differences away the influence of unobserved factors that have a common effect on originations and secondary market loan purchases.

Correlation between the GSE purchase-to-origination ratio and the model error term could still remain, however. This is because additional unobserved factors may affect both the share of originations that primary lenders hold in portfolio ($\theta$) as well as secondary market purchases. This could also cause $P_{t,i}^{GSE} / L_{t,i}$ to be correlated with the model error term resulting in biased estimates of GSE crowd out effects.

To allow for this second source of correlation we instrument for GSE purchases using the underserved status of the census tracts as discussed in the Introduction. As also discussed in the

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15For that reason, in the discussion to follow, we do not focus on those terms.
Introduction, the model further controls for a long list of tract socioeconomic attributes, including average income and average income squared. These are the Z attributes in (4.10) and serve to control for the continuous and smooth change in demand and supply in response to marginal changes in Z. In the presence of these controls, there is no natural role for a tract’s underserved status in the model. Identification is then based on the discrete shift in GSE purchase goals as one transitions across the income border between “served” and “underserved” tracts. As will become apparent, underserved status is strongly correlated with the GSE purchase/origination ratio. For this reason, weak instrument bias appears not to be a concern (e.g. Stock and Yogo (2005), Murray (2006)).

V. Data and Summary Measures

Data for the analysis were obtained from the Home Mortgage and Disclosure Act (HMDA) and the decennial Census. Specifically, we drew upon the HMDA data files for every even year from 1994 to 2000 and each year from 2000 through 2007. Census tract socio-demographic attributes for 1990 and 2000 were obtained from the Geolytics neighborhood change database. All of the HMDA data was initially reported by financial institutions. For years up through 2002, the HMDA data are reported based on 1990 census tract geography. For years beyond 2002, the HMDA data are reported based on year-2000 census tract geography. In all cases, we converted the HMDA and earlier census tract data to year-2000 census tract geography. This ensures that we follow the same neighborhoods over time and facilitates proper matching of the HMDA and Census files across years.

When estimating using HMDA data from the 1990s, 1990 census tract control measures were included in the models. When estimating using HMDA data from 2000 on, we used year 2000 census tract control measures. Census controls include tract racial composition, educational characteristics, income, gender, unemployment, poverty status, the presence of female-headed families with children, population density, and characteristics of the housing stock.\textsuperscript{16}

\textsuperscript{16}Recall also, HMDA data do not provide information on individual loan applicant wealth or credit score (credit history). However, as described earlier, our focus on secondary market behavior largely mitigates this limitation.
Census tract underserved status was determined based on guidelines outlined by the 1992 GSE Act and HUD. Specifically, 1990 census tract and MSA attributes were used to determine underserved status for the 1994-2002 HMDA regressions, while year 2000 census tract attributes were used to determine underserved status for the 2003-2007 HMDA regressions. In both instances, a tract was coded as underserved if the tract median income was below 90 percent of the tract’s MSA median income, or if the tract median income is below 120 percent of MSA median income and the tract’s minority population (Hispanic plus African American) exceeded 33 percent.

To further clean the data, certain observations were dropped. In calculating tract-level mortgage attributes (e.g. purchases, originations), individual loan records from the HMDA data were dropped if the type or purpose of the loan could not be determined. As also noted earlier, we focus only on conventional, home purchase loans below the conforming size limit for the MSA and year in which the census tract is located.17

VI. Estimation Results

6.1 Overview

This section presents estimates of the impact of GSE loan purchases on private sector purchases of mortgages in the secondary market. The estimating equation is as described in (4.10) with related details noted above. In all cases, we present two-stage least squares (2SLS) and ordinary least squares (OLS) estimates for each sample year. The 2SLS estimates are in Panel A while the OLS estimates are presented in Panel B. Each column corresponds to a different sample year. In addition, all of the models include 16 tract socioeconomic control variables and MSA fixed effects, as previously noted. To maintain focus on the impact of GSE purchases, only the coefficients on the

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17We thank Glenn Canner of the Federal Reserve Board for assisting us in identifying the relevant conforming loan size limits.
GSE purchase/origination variables are presented. Complete results for both the first and second-stage regressions of the 2SLS models are provided in the Appendix for select years.

6.2 Weak Instrument Tests

Consider now Panel A of Table 2. This panel reports 2SLS results using the tract underserved status as an instrument. As discussed earlier, we argue, on a priori grounds, that census tract underserved status is exogenous relative to private sector secondary market loan purchase to origination ratios. Moreover, because the model is exactly identified, it is not possible to formally test this assumption. On the other hand, recent literature has emphasized that weak instruments can generate biased estimates in the second stage, and this is a condition for which tests are available (e.g. Murray (2006), Stock and Yogo (2005)). Accordingly, before reviewing the coefficient estimates that pertain to GSE crowd out, we first examine instrument strength in each sample year.

We focus on two measures often considered when attempting to assess the strength of an instrument. The first is the first-stage regression coefficient on undeserved status and its corresponding t-ratio (computed using robust standard errors). The second is the Kleibergen-Paap test statistic. Both are reported in the lower half of Panel A for each sample year.

Observe that the first-stage coefficient is negative and highly significant in all sample years except for 2007. Reading across columns, the t-ratios are in excess of 10 in most years, and nearly equal to 10 in 2004 and 2006. This not only confirms that these models are identified, but further confirms that underserved tract status is very highly correlated with GSE purchase/origination ratios conditional on the other model covariates.\(^{18}\) This finding is further corroborated by the very high Kleibergen-Paap test statistics for each of these years. Whereas Stock and Yogo (2005) critical values for weak instrument tests are in the neighborhood of 10 (depending on the level of weak instrument

\(^{18}\)Moreover, the negative sign on the first stage coefficient indicates that, conditional on the other model control variables, the ratio of GSE purchases to originations is somewhat lower in underserved tracts.
bias), our estimated test statistics for 1994 through 2006 exceed 100 in most years or nearly so.\textsuperscript{19} Also apparent in Panel A is that instrument strength is far weaker in 2007: the t-ratio on the first-stage coefficient is 2.68 while the Kleibergen-Paap statistic is 7.16. These results suggest that our 2SLS estimates for 2007 may indeed suffer from some degree of weak instrument bias, although as will become apparent, it seems unlikely that this would affect the qualitative nature of the year-2007 estimates of GSE crowd out.

6.3 GSE Crowd Out Estimates

Focus now on the coefficients on GSE purchase/origination ratios in Panel A and recall that a coefficient of 0 indicates the complete absence of GSE crowd out, whereas a coefficient of -1 implies complete crowd out. Reading from left to right, the estimates suggest that in the early sample years, GSE purchase activity actually produced a “crowding in” effect: In 1994, the coefficient on GSE Purchase/Origination ratios is positive 0.47 with a t-ratio of 4.94. This is consistent with early arguments by Lang and Nakamura (1994), and suggests the possibility that GSE activity in the first half of the 1990s helped to establish information networks and other infrastructure necessary for the private sector of the market to develop.\textsuperscript{20} That indeed was one of the motives behind the government’s expanded mandate for the GSEs as reflected in the 1992 GSE Act. It is also implicitly one of the motives for why the government came to the rescue of the GSEs in September 2008.

As one reads further to the right in Panel A of Table 2, the coefficient on GSE purchase activity declines to positive 0.16 in 1996 (with a t-ratio of 2.18), and then takes on relatively small, negative and typically insignificant values between 1998 and 2001. In 2002, immediately following

\textsuperscript{19}The Stock-Yogo (2005) critical values for weak instrument tests are based on a model with homoscedastic errors whereas the Kleibergen-Paap test allows for heteroscedasticity. Nevertheless, using the Stock-Yogo critical values as an approximate guide in assessing evidence of weak instrument for two reasons. First, because the Stock-Yogo (2005) critical values are the only published assessments that we are aware of for evaluating critical values associated with weak instrument tests. Second, even though the Kleibergen-Paap test allows for heteroscedasticity and is not exactly conformable to the model examined by Stock and Yogo, our test statistics far exceed the Stock-Yogo critical values in all years except 2007.

\textsuperscript{20}Harrison et al (2002) suggest that Fannie Mae purchases have had such an effect in parts of Florida.
the 2001 recession, the coefficient on GSE activity bumps up to positive 0.27 with a t-ratio of 3.83. These patterns are suggestive that the private sector of the secondary market gained traction in the 1998 to 2001 period, eliminating positive crowd-in effects from GSE activity, but that the GSEs once again led the way immediately after the 2001 recession. By 2003 the economy was well into a recovery and crowd-in effects disappear once again.

The most dramatic patterns in Panel occur between 2004 and 2007. Recall from Figure 1 that between the years 2004 through 2006 the private segment of the secondary market boomed and also took on a much larger share of purchases relative to the GSEs. During this time subprime lending peaked, along with any number of other indicators of housing and mortgage market activity. Under these conditions, the simple conceptual model outlined earlier suggests that GSE crowd out effects should have become much more pronounced. This is exactly what appears in Panel A of Table 2. The estimates of GSE crowd out for 2004 through 2006 are 92.8 percent, 54.5 percent, and 73.6 percent, respectively. These estimates are also all highly significant, with t-ratios of 6.4, 4.9, and 3.8, respectively. It appears that during this period, the dramatic increase in demand for secondary market purchases along with the approximate liquidation of primary lender portfolios, greatly increased competition for loan purchases in the secondary market. Under these conditions, it is not surprising that GSE crowd out was extensive. Moreover, this suggests that during the frenzied peak years of 2004 to 2006 the GSEs did not provide much additional liquidity to the market, at least relative to the scale of GSE purchase activity.

Recent events and our estimates for 2007, however, underscore that market conditions can change rapidly. With the crash in mortgage markets in 2007, the coefficient on GSE purchase/origination ratios once again takes on a positive value although in this instance the estimate is very imprecisely estimated and is not significant (the t-ratio is just 0.90). As documented in Table 1 and also confirmed through a host of anecdotes, private sector demand for secondary market purchases of mortgages crashed in 2007 (and on into 2008). In part, this corresponded to the failure of a number of prominent private secondary market institutions. This wholesale scaling back of private sector
demand would have greatly reduced competition for secondary market purchases and, presumably, moved the market demand function to a more elastic portion of the secondary market supply curve in Figure 1. Importantly, this suggests that in 2007 GSE purchases did provide a substantial infusion of liquidity to the mortgage market. Moreover, there is every reason to expect that this continued into 2008.

6.4 OLS Estimates and Selection

It is also informative to compare the OLS estimates of GSE crowd out in Panel B to the 2SLS estimates in Panel A. Notice that the OLS estimates are more negative for each year between 1994 and 2003, less negative for 2004-2006, and more negative (less positive) once again in 2007. A more negative OLS estimate implies that, conditional on the other control measures in the model, GSE purchase/origination ratios are high when private sector purchase/origination ratios are unexpectedly low (i.e. GSE purchases are negatively correlated with the model error term). This implies that the GSEs seek out opportunities to purchase loans in census tracts that receive limited attention by the private segment of the secondary market, at least based on unobserved factors embedded in the OLS error term. This is consistent with the estimates above that GSE purchase activity had at most a limited crowd out effect on private sector purchases in 1994-2003 and again in 2007.

In contrast, a less negative OLS estimate implies that GSE purchase/origination ratios are high when private sector purchase/origination ratios are unexpectedly high. This suggests that the GSEs and the private sector of the secondary market are drawn to purchase opportunities in similar census tracts, based again on unobserved factors in the OLS error term. This also is consistent with the estimates above as it is suggestive that GSE purchase activity would compete directly with private sector purchases and should result in crowd out effects as documented for 2004-2006.
VII. Conclusion

The housing government sponsored enterprises (GSEs), most notably Fannie Mae and Freddie Mac, have occupied a unique and important position in U.S. mortgage markets. These have been enormous federally-chartered private corporations that attained substantial market shares, at times accounting for more than 60 percent of purchases of conforming sized conventional home purchase loans in the secondary market. Historical support for the GSEs, and their recent rescue by the federal government, have been motivated in part by belief that the GSEs provide an essential source of liquidity to the mortgage market. This paper has examined that assertion drawing on HMDA data from 1994 through 2007.

From 1994 through 2003, the share of loan originations sold to the secondary market increased dramatically from roughly 60 to over 90 percent. During this period, private sector and GSE shares of loan purchases were similar, while IV estimates suggest little crowd out. Between 2004 through 2006, portfolio lending by primary market lenders nearly disappeared, private sector secondary market loan purchases boomed, and IV estimates indicate high levels of GSE crowd: 93 percent, 54 percent, and 74 percent, respectively for 2004, 2005, and 2006. With the crash in mortgage markets in 2007, the private sector pulled back from loan purchases in the secondary market, GSE purchases remained at levels similar to the 2004-2006 period, and evidence of GSE crowd out disappears. Together, these patterns suggest that GSE purchases crowd out private sector purchases during periods of heightened market activity. But in less active periods, as in 1994-2003 and importantly, 2007, evidence in the data indicate that GSE loan purchases do enhance liquidity. We argue that these patterns should be considered in on-going policy debates about the future status of the GSEs.
References


An, Xudong and Raphael W. Bostic, “Have the Affordable Housing Goals Been a Shield Against Subprime? Regulatory Incentives and the Extension of Mortgage Credit,” mimeo.


U.S. Department of Housing and Urban Development (2004), *HUD’s Housing Goals for the Federal National Mortgage Association (Fannie Mae) and the Federal Home Loan Mortgage Corporation (Freddie Mac) for the Years 2005-2008 and Amendments to HUD’s Regulation of Fannie Mae and Freddie Mac; Final Rule*, 69 Federal Register 63579, 24 CFR Part 81 (November 2).
Table 1: Conventional Home Purchase Loans Below the Conforming Size Limit
Sample Means for Mortgage Market Variables from the HMDA Data

<table>
<thead>
<tr>
<th>Year</th>
<th>Average Level of Activity Per Census Tract</th>
<th>Aggregate Activity Ratios&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Average Activity Ratios Across Tracts&lt;sup&gt;b&lt;/sup&gt;</th>
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<tr>
<td>1994</td>
<td>38.95</td>
<td>23.68</td>
<td>14.68</td>
</tr>
<tr>
<td>1996</td>
<td>43.21</td>
<td>30.49</td>
<td>18.76</td>
</tr>
<tr>
<td>1998</td>
<td>53.44</td>
<td>46.19</td>
<td>26.67</td>
</tr>
<tr>
<td>2000</td>
<td>56.36</td>
<td>47.92</td>
<td>26.85</td>
</tr>
<tr>
<td>2001</td>
<td>60.10</td>
<td>53.55</td>
<td>31.97</td>
</tr>
<tr>
<td>2002</td>
<td>64.83</td>
<td>61.22</td>
<td>35.82</td>
</tr>
<tr>
<td>2003</td>
<td>74.51</td>
<td>72.21</td>
<td>37.24</td>
</tr>
<tr>
<td>2004</td>
<td>88.66</td>
<td>90.09</td>
<td>34.35</td>
</tr>
<tr>
<td>2005</td>
<td>105.63</td>
<td>109.41</td>
<td>31.42</td>
</tr>
<tr>
<td>2006</td>
<td>99.80</td>
<td>110.89</td>
<td>32.27</td>
</tr>
<tr>
<td>2007</td>
<td>65.72</td>
<td>73.84</td>
<td>34.53</td>
</tr>
</tbody>
</table>

<sup>a</sup>Values were calculated by forming ratios based on aggregate values of activity counts.

<sup>b</sup>Values were calculated by averaging ratios for individual census tracts for all tracts with originations.

<sup>c</sup>All values are based on census tracts located within MSAs. The number of tracts reporting positive numbers of originations were between 50,352 and 50,602 depending on the year in question.
### Table 2: Private Sector Purchase/Origination Ratios
For Conventional Home Purchase (CHP) Loans Below the Conforming Size Limit
(Absolute value of t-ratios in Parentheses Based on Robust Standard Errors)

**Panel A: Two Stage Least Squares with MSA Fixed Effects Using Census Tract Underserved Status as the Instrument**

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
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<tbody>
<tr>
<td>GSE Purchases/Originations</td>
<td>0.46784</td>
<td>0.15963</td>
<td>-0.12583</td>
<td>-0.04269</td>
<td>-0.06505</td>
<td>0.27396</td>
<td>-0.10424</td>
<td>-0.92783</td>
<td>-0.54425</td>
<td>-0.73559</td>
<td>0.47731</td>
</tr>
<tr>
<td>(4.94)</td>
<td>(2.18)</td>
<td>(2.26)</td>
<td>(0.78)</td>
<td>(1.14)</td>
<td>(3.83)</td>
<td>(0.96)</td>
<td>(6.38)</td>
<td>(4.86)</td>
<td>(3.76)</td>
<td>(0.90)</td>
<td></td>
</tr>
<tr>
<td>First-Stage Coefficient and t-ratio on Underserved Status</td>
<td>-0.02594</td>
<td>-0.03190</td>
<td>-0.04588</td>
<td>-0.03638</td>
<td>-0.03013</td>
<td>-0.02097</td>
<td>-0.01886</td>
<td>-0.02021</td>
<td>-0.01400</td>
<td>-0.00545</td>
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<td>Kleibergen-Paap Weak ID test</td>
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<td>203.21</td>
<td>416.72</td>
<td>346.63</td>
<td>353.85</td>
<td>272.7</td>
<td>112.56</td>
<td>97.39</td>
<td>127.88</td>
<td>72.65</td>
<td>7.16</td>
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<td>MSA Fixed Effects</td>
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<td>330</td>
<td>330</td>
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<td>331</td>
<td>331</td>
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<td>331</td>
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<tr>
<td>Observations</td>
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<td>49567</td>
<td>49350</td>
<td>49285</td>
<td>49365</td>
<td>49618</td>
<td>49985</td>
<td>50083</td>
<td>50122</td>
<td>49592</td>
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<tr>
<td>Centered R-square</td>
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<td>0.02</td>
<td>0.27</td>
<td>0.10</td>
<td>0.18</td>
<td>0.02</td>
<td>0.18</td>
<td>0.12</td>
<td>0.23</td>
<td>0.10</td>
<td>-0.05</td>
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<tr>
<td>Root MSE</td>
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<td>0.16</td>
<td>0.18</td>
<td>0.15</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
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<td>0.16</td>
<td>0.19</td>
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<td>SES Controls&lt;sup&gt;a&lt;/sup&gt;</td>
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</tbody>
</table>

<sup>a</sup>For years prior to 2000 year-1990 SES controls are included in the model. For 2000 and later, year-2000 SES controls are used. For both sets of years, the SES controls include the percent of the tract population that is Hispanic, percent African American, average age of the tract population, percent of adults that are male, average income and income squared, percent of adults with high school degree, percent with some college, percent with college or more, unemployment rate, poverty rate, percent of female headed households with children, average age of the housing stock, percent of housing stock that is single family.

**Panel B: Ordinary Least Squares with MSA Fixed Effects**

<table>
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<tr>
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<tbody>
<tr>
<td>GSE Purchases/Originations</td>
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<td>(9.95)</td>
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<td>(10.75)</td>
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<td>Within R-square</td>
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<td>0.23</td>
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<tr>
<td>Root MSE</td>
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<td>0.15</td>
<td>0.17</td>
<td>0.15</td>
<td>0.15</td>
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<td>0.16</td>
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</tbody>
</table>

<sup>a</sup>For years prior to 2000 year-1990 SES controls are included in the model. For 2000 and later, year-2000 SES controls are used. For both sets of years, the SES controls include the percent of the tract population that is Hispanic, percent African American, average age of the tract population, percent of adults that are male, average income and income squared, percent of adults with high school degree, percent with some college, percent with college or more, unemployment rate, poverty rate, percent of female headed households with children, average age of the housing stock, percent of housing stock that is single family.
Figure 1: Purchase/Origination Ratios for CHP Mortgage Loans Below the Conforming Size Limit by Census Tract Median Income Relative to the GSE Underserved Target

Panel A: 1994 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel B: 1996 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel C: 2000 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel D: 2002 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel E: 2003 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel F: 2004 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel G: 2005 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel H: 2006 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target

Panel I: 2007 Conforming Sized Purchase/Origination Ratios by Tract Median Income Relative to GSE Target
Figure 2: Crowd Out in the Secondary Market

- High Demand with GSEs
- Low Demand with GSEs
- Low Demand without GSEs
- High Demand without GSEs

Price of Loans

Number of Loans

GSE Purchases

Supply of Loans

Crowd Out
Table A1: Loans BELOW the Conforming Size Limit for Purchases/Originations of Conventional Home Purchase (CHP) Loans
(Absolute value of t-ratios in Parentheses Based on Robust Standard Errors; SES attributes from 1990 for the 1998 regression and from 2000 for the 2000-2006 regressions)

<table>
<thead>
<tr>
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</thead>
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<td></td>
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<td>2nd Stage</td>
<td>1st Stage</td>
<td>2nd Stage</td>
<td>1st Stage</td>
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<tr>
<td>Underserved tract</td>
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<td>-12583</td>
<td>-0.03638</td>
<td>-0.03013</td>
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<tr>
<td></td>
<td>(20.41)</td>
<td>(2.26)</td>
<td>(18.62)</td>
<td>(16.51)</td>
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<td>GSE Purchases/Originations</td>
<td>-</td>
<td>-0.12583</td>
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<td>0.273959</td>
<td>-0.92783</td>
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<td>-</td>
<td>(2.26)</td>
<td>(0.78)</td>
<td>(3.83)</td>
<td>(6.38)</td>
</tr>
<tr>
<td>% Hispanic</td>
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<td>(5.90)</td>
<td>(0.60)</td>
<td>(7.51)</td>
<td>(5.48)</td>
<td>(5.05)</td>
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<tr>
<td>% Black</td>
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<td>0.165829</td>
<td>-0.16418</td>
<td>0.075412</td>
<td>-0.18616</td>
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<tr>
<td></td>
<td>(23.28)</td>
<td>(13.34)</td>
<td>(26.03)</td>
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<td>(28.14)</td>
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<tr>
<td>Average age of resident</td>
<td>0.002852</td>
<td>-0.00252</td>
<td>0.002528</td>
<td>0.001678</td>
<td>-0.00313</td>
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<tr>
<td></td>
<td>(13.07)</td>
<td>(8.12)</td>
<td>(12.02)</td>
<td>(7.30)</td>
<td>(7.73)</td>
</tr>
<tr>
<td>% Male</td>
<td>-0.03828</td>
<td>-0.07351</td>
<td>-0.06385</td>
<td>0.165748</td>
<td>-0.02237</td>
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<tr>
<td></td>
<td>(1.10)</td>
<td>(1.75)</td>
<td>(1.88)</td>
<td>(4.57)</td>
<td>(0.66)</td>
</tr>
<tr>
<td>Average family income</td>
<td>0.000263</td>
<td>0.000187</td>
<td>-0.00076</td>
<td>-9.5E-05</td>
<td>4.22E-05</td>
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<tr>
<td></td>
<td>(1.11)</td>
<td>(0.83)</td>
<td>(2.97)</td>
<td>(0.90)</td>
<td>(0.30)</td>
</tr>
<tr>
<td>Average family income squared</td>
<td>-5.1E-06</td>
<td>5.8E-07</td>
<td>1.0E-06</td>
<td>2.37E-06</td>
<td>-1.4E-06</td>
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<tr>
<td></td>
<td>(5.72)</td>
<td>(0.83)</td>
<td>(1.58)</td>
<td>(3.65)</td>
<td>(2.9)</td>
</tr>
<tr>
<td>% No High School</td>
<td>-0.29532</td>
<td>-0.03357</td>
<td>-0.25251</td>
<td>-0.17807</td>
<td>-0.15697</td>
</tr>
<tr>
<td></td>
<td>(13.52)</td>
<td>(1.05)</td>
<td>(10.33)</td>
<td>(5.65)</td>
<td>(6.21)</td>
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<tr>
<td>% Some High School</td>
<td>-0.49665</td>
<td>0.376581</td>
<td>-0.49234</td>
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<td>(22.24)</td>
<td>(8.18)</td>
<td>(20.10)</td>
<td>(7.62)</td>
<td>(14.52)</td>
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<tr>
<td>% High School</td>
<td>-0.36713</td>
<td>0.072682</td>
<td>-0.33308</td>
<td>0.001559</td>
<td>-0.2387</td>
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<td>(25.18)</td>
<td>(2.77)</td>
<td>(21.93)</td>
<td>(0.07)</td>
<td>(17.58)</td>
</tr>
<tr>
<td>% Some College</td>
<td>-0.02701</td>
<td>0.212812</td>
<td>0.013835</td>
<td>0.129359</td>
<td>-0.07363</td>
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<tr>
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<td>(7.79)</td>
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<td>Unemployment rate</td>
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<td>(4.04)</td>
<td>(7.23)</td>
<td>(0.73)</td>
<td>(4.45)</td>
<td>(2.76)</td>
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<td>Poverty rate</td>
<td>-0.1059</td>
<td>0.03147</td>
<td>-0.10558</td>
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<td>-0.03734</td>
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<tr>
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<td>(5.54)</td>
<td>(1.20)</td>
<td>(5.74)</td>
<td>(0.51)</td>
<td>(1.95)</td>
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<tr>
<td>% Female headed with children</td>
<td>-0.007927</td>
<td>0.030335</td>
<td>0.028245</td>
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<td>0.011061</td>
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<tr>
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<td>(0.61)</td>
<td>(1.77)</td>
<td>(2.45)</td>
<td>(1.24)</td>
<td>(0.94)</td>
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<tr>
<td>Average age of housing stock</td>
<td>-0.00201</td>
<td>0.000629</td>
<td>-0.00084</td>
<td>-0.00023</td>
<td>-0.00078</td>
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<tr>
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<td>(19.74)</td>
<td>(3.84)</td>
<td>(9.93)</td>
<td>(2.14)</td>
<td>(9.30)</td>
</tr>
<tr>
<td>% Housing that is single family</td>
<td>0.083289</td>
<td>0.041826</td>
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<tr>
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<td>(19.60)</td>
<td>(5.94)</td>
<td>(9.79)</td>
<td>(2.61)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>Population Density</td>
<td>1.8E-07</td>
<td>1.07E-06</td>
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<tr>
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<td>(1.44)</td>
<td>(6.88)</td>
<td>(0.56)</td>
<td>(2.21)</td>
<td>(2.35)</td>
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</table>

Kleibergen-Paap Weak ID test 416.72 346.63 272.77 97.39 72.65
MSA Fixed Effects 331 330 330 331 331
Observations 49567 49350 49365 49985 50122
Centered R-square 0.27 0.10 0.02 0.12 0.10
Root MSE 0.18 0.15 0.16 0.19 0.19

Root MSE