

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

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New Evidence on Crowd Out in the Secondary Mortgage Market**

**Abstract**

The dramatic government takeover of Fannie Mae and Freddie Mac in September, 2008 was motivated in part by a desire to ensure adequate liquidity in the mortgage market. This study examines a closely related issue: the extent to which GSE activity crowds out mortgage purchases by private secondary market intermediaries. Evidence of substantial crowd out suggests that government support for the GSEs may be less warranted, while absence of crowd out implies that the GSEs enhance liquidity.

Using 1994-2007 HMDA data for conventional, conforming sized, home purchase loans, three distinct periods with regard to GSE crowd out are apparent. From 1994 - 2003, the share of loans sold to the secondary market increased from 60 percent to nearly 100 percent, private sector and GSE market shares of loan purchases were similar, and IV estimates indicate relatively little GSE crowd out. From 2004 to 2006, private loan purchases boomed and dominated those of the GSEs, while IV estimates indicate close to 100 percent crowd out. With the crash in housing and mortgage markets in 2007, private sector intermediaries pulled back, the GSEs regained market share, and importantly, evidence of GSE crowd out disappeared. These patterns suggest that the degree of GSE crowd out varies with market conditions, and that the federal takeover of Fannie Mae and Freddie Mac likely has served to enhance liquidity to the mortgage market during the current mortgage market crisis.

**Key Words:** GSEs, Crowd Out, Liquidity

**JEL Codes:** H3, G2, R2

## **I. Introduction**

Over the course of recent decades, the U.S. government has provided extensive support for the secondary mortgage market, notably through its longstanding implicit guarantee of debt issued by the federally chartered GSEs, Fannie Mae and Freddie Mac. That guarantee became more explicit in 2008 with the dramatic government takeover of Fannie and Freddie, motivated in part by a desire to assure adequate liquidity in the mortgage market. This study examines the extent to which the GSEs have been net providers of liquidity in residential mortgage markets. Specifically, it evaluates whether GSE loan purchase activity in the secondary market crowds out loan purchases by private secondary market intermediaries. High levels of crowd out suggest that government support for the GSEs may be less warranted, whereas the absence of crowd out implies that GSE purchases enhance market 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 mortgage market that would provide retail lenders with an expansive and reliable source of funds. Lenders in the primary market sell loans to investors in the secondary market who either hold those loans in portfolio or securitize and sell shares of loan pools to investors worldwide. The secondary market frees loan originators from reliance on local deposits as their primary source of funds, and as a consequence, has been shown to enhance the efficiency of mortgage credit allocation (e.g. Pennacchi (1988), Carlstrom and Samolyk (1995), Drucker and Puri (2008), and Gabriel and Rosenthal (2007)).<sup>1</sup>

Federal government support of the GSEs has been closely linked to GSE adherence to policy goals embodied in their charters. Under terms of the 1992 Federal Housing Enterprise Financial

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<sup>1</sup>Secondary 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. 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.

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.<sup>2</sup> Evidence from previous studies suggests that the GSEs have largely honored their loan purchase targets (e.g. Bunce and Scheessele (1996), Bunce (2002)).

In exchange for GSE adherence to federal policy goals, there has been a longstanding implicit understanding among the government, the GSEs, and GSE debt investors that the U.S. 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 could have been interpreted by market participants as a default on securities backed by the U.S. Government, with possible far-reaching and adverse implications for the cost of credit to the United States.<sup>3</sup> 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 should these companies have become insolvent and been allowed to fail. As of 2007, securitized home mortgage debt backed by the GSEs totaled \$4.0 trillion. This was close to the outstanding level of U.S. Treasury debt, almost double that of outstanding consumer debt, and roughly

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<sup>2</sup>Details on the GSE purchase goals set by HUD are provided later in the discussion.

<sup>3</sup> In September 2008, Treasury Secretary Paulson stated that the US Government takeover and injection of equity into the GSEs was “made necessary by ambiguities in the GSE Congressional charters, which have been perceived to indicate government support for agency debt and guaranteed MBS. Our nation has tolerated these ambiguities for too long, and as a result GSE debt and MBS are held by central banks and investors throughout the United States and around the world who believe them to be virtually risk-free.” See Statement by Secretary Henry M. Paulson, Jr. on Treasury and Federal Housing Finance Agency Action to Protect Financial Markets and Taxpayers, U.S. Department of the Treasury, September 7, 2008

two-thirds the value of all outstanding household pension reserves.<sup>4</sup> Given this background, it is imperative to better understand the potential impact of the GSEs on the supply of mortgage credit.

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 90 percent of MSA median income (AMI), 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 those loans that are below the conforming loan 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.<sup>5</sup>

Figure 1 displays plots of the purchase/origination ratios by neighborhood income status.<sup>6</sup> 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

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<sup>4</sup>See Table L.125, line 2, Federal Reserve Board Flow of Funds Accounts (2007) for data on outstanding mortgage debt. In 2007, Treasury 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).

<sup>5</sup>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.

<sup>6</sup>Some of the purchase/origination ratios in Figure 1 and Table 1 exceed 1. This is possible for two reasons. Some loans are sold in a year subsequent to the one in which they are originated. In addition, some loans are sold from one lender to another and count towards multiple loan sales in a given year.

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 comes from 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 private secondary market loan purchases boomed, and for the next three years – 2004 through 2006 – non-GSE purchases accounted for a substantially larger share of originations as compared to the GSEs. Indeed, between 2003 and 2006, the GSE share of loan purchases fell by at least 10 percentage points across most neighborhoods regardless of income status. Dramatically, that pattern 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 with regard to the relative market share of the GSEs: the early period – 1994 through 2003 – during which GSE purchases were similar in magnitude to those of the private sector, the recent period of housing boom – 2004 through 2006 – during which the GSEs took on a lesser 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 GSE and non-GSE intermediaries 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.<sup>7</sup> 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 GSE loan purchase activity does much to enhance liquidity in the mortgage market. While this may be true, such a conclusion may be premature. Later in the paper, we show that as secondary market loan supply becomes less elastic, GSE crowd out of non-GSE loan purchases becomes more pronounced. We further argue that when primary market institutions hold few loans in portfolio, as evidenced from 2004 onwards, they 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, increasing the degree of crowd out by the GSEs. On the other hand, the dramatic contraction of non-GSE demand for loans in 2007 could have moved the secondary market back to a more elastic portion of the loan supply function. This would tend to reduce GSE crowd out. Our simple model, therefore, predicts that the extent of GSE crowd out likely depends on market conditions and varies over time.

To assess the crowd out effects of GSE loan purchases, we regress private sector purchase/origination ratios on GSE purchase/origination ratios. Our unit of observation is the census tract, and we restrict our attention to conventional home purchase loans conforming to GSE loan size limitations, and also to tracts located within MSAs in 2000 (as in Figure 1 and Table 1). Evidence of a negative coefficient on GSE purchase/origination shares 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.<sup>8</sup>

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<sup>7</sup> 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.

<sup>8</sup>In 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

Central to our empirical analysis is the need to control for the likely endogenous character of GSE purchase/origination ratios. If unobserved tract attributes provide profitable loan purchase opportunities for both the GSEs and non-GSEs, this would suggest that GSE purchase/origination ratios would be positively correlated with an ordinary least squares (OLS) error term. This would cause the OLS coefficient on GSE activity to be biased upwards towards a less negative value. If instead, possibly because of distributional goals associated with their government charters, the GSEs seek to purchase loans in census tracts that differ systematically from those associated with private sector purchases, a negative OLS bias could result and this would cause the OLS estimates to overstate crowd out effects. 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 instruments motivated by the federal guidelines that regulate GSE purchase activity. First, we argue that absent the GSEs and related government intervention, household demand for mortgage debt and private supply thereof would depend on the *level* of borrower and neighborhood attributes (e.g. income, wealth, job security, etc). In contrast, the GSE charters mandate that minimum shares of Fannie and Freddie loan purchases originate from underserved census tracts and/or loans issued to lower income borrowers. Under provisions of the 1992 GSE Act, underserved tract status is defined on the basis of median household income in the tract *relative* to AMI (MSA or area median income), while low-income borrower designations depend on borrower income *relative* to AMI.<sup>9</sup>

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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.

<sup>9</sup>HUD guidelines 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

Accordingly, our identification strategy is based on a two-part approach. Our empirical models include county fixed effects, tract-level loan and borrower attributes (median loan amount, median borrower income, percent of borrowers minority or female), and a long list of tract-level socio-demographic (SES) features of the resident population (the distribution of tract income, poverty rates, welfare, distribution of education, gender, age, and attributes of the housing stock). These terms capture the underlying demand for credit and risk attributes of the local applicant pool that may affect the number and type of loans originated. We then instrument for GSE loan purchase-to-origination ratios using the census tract's underserved status and the tract's ratio of median borrower income to AMI.

It should be emphasized that conditional on GSE purchase activity and the other model controls, there is no particular reason why the *relative* economic status of the tract and borrower pool should appear in the second stage equation used to explain private sector purchase/origination ratios. In most instances, for example, it is unlikely that private sector secondary market purchasers even know the tract from which purchased loans are drawn, or the attributes of the underlying borrowers.<sup>10</sup> The GSE Act, however, mandates that the GSEs explicitly pay attention to these features. This further suggests that our instruments should be strongly correlated with GSE purchase activity, and that is confirmed empirically later in the paper. For these reasons, we feel that a compelling case can be made for the exogeneity of the instruments, and that weak instrument bias is not a problem (e.g. Murray (2006), Cameron and Trivedi (2005), Stock and Yogo (2005)).

Results based on the IV regressions can be briefly summarized. GSE crowd out of private sector intermediaries is modest during the 1994 - 2002 period, ranging from 0 to 25 percent. This

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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.

<sup>10</sup>Private sector purchasers do, however, know the type of loans being secured. To the extent that loan type is correlated with the level of borrower and tract attributes, this provides a further motivation for including such controls in the model. But as suggested above, it is difficult to see why the economic status of the tract and borrower *relative* to that of the metropolitan area should be systematically related to private sector purchase activity, once GSE purchases and related possible crowd out have been taken into account.

begins to change in 2003 when crowd out is estimated at 41 percent, and especially in the 2004-2006 period when crowd out jumps to roughly 100 percent. With the 2007 crash and pull back of private secondary market intermediaries, evidence of GSE crowd out largely disappears. Overall, our estimates indicate that GSE crowd out is pronounced during periods of heightened market activity, as was the case during the 2004 to 2006 boom in the housing and mortgage markets, but limited during less active periods, as from 1994 to 2003 and 2007. In the current environment, this suggests that the 2008 government takeover of Fannie Mae and Freddie Mac likely has achieved its primary goal of enhancing mortgage market liquidity during a period of capital markets crisis.

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 are required 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.<sup>11</sup> Collectively, these studies provide compelling evidence that the GSEs have largely met the administrative targets imposed by the regulating authorities.

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<sup>11</sup>See also Listokin and Wyly (2000), Myers (2002), Case, Gillen, and Wachter (2002), and Galster (2004) for related discussion.

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.<sup>12</sup> Bearing that in mind, 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 of private sector activity, 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.<sup>13</sup>

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<sup>12</sup>Full 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.

<sup>13</sup>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 associated with GSE operations. 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.<sup>14</sup> Sinai and Waldfogel (2005) and Eriksen and Rosenthal (2008) both find high rates of crowd out rates associated with publicly subsidized construction of low- and moderate income housing.<sup>15</sup> 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 mortgage market. The extent to which such crowd out occurs and its implications for GSE provision of liquidity is considered in the remaining sections of this paper, both on conceptual and empirical grounds.

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<sup>14</sup>Brown and Finkelstein (2004) and Brown, Coe, and Finklestein (2006) provide related evidence that Medicaid may crowd out private health insurance for up to two-thirds of the wealth distribution.

<sup>15</sup>Upon 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 80 percent 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, Murraray 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.

### 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 not only because lenders originate more loans, but also because they may sell a greater share of loans held in portfolio. We further assume that the loan supply function becomes more inelastic as loan supply increases. 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.

Suppose now that secondary market loan demand intersects the relatively elastic portion of the supply function. As demand shifts out in response to government subsidization of GSE purchases, a modest increase in price induces primary lenders to supply additional loans to the secondary market.<sup>16</sup> Under these conditions, GSE crowd out of private sector loan purchases occurs, but is quite limited.

Suppose instead that secondary market loan demand intersects loan supply in its more inelastic portion. Here also, government prompted GSE purchases push 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 small amount. In this instance, GSE crowd out of private secondary market loan purchases is more pronounced.

These two scenarios highlight core principles that are relevant to the timeframe of our empirical analysis: (i) crowd out arising from GSE purchases increases as the secondary market supply of loans becomes more inelastic, and (ii) crowd out is reduced when demand shifts back to a more elastic portion of the supply curve.

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<sup>16</sup>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. In related work, Gabriel and Rosenthal (2007), we estimate that secondary market purchases increase the share of applications that are originated 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 lenders in the primary market. Bearing that in mind, the number of loans originated by primary lenders in period  $t$  ( $L_t$ ) equal applications ( $A_t$ ) minus denials ( $D_t$ ),

$$L_t \equiv A_t - D_t \quad . \quad (4.1)$$

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

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

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 loan originators 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  $P_t = P_t(P_t^{GSE})$ . Denials are then represented by,

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

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

$$L_t^* = L(r_t, P_t(P_t^{GSE}), Z_t) \quad . \quad (4.4)$$

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,  $1-\theta$  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,

$$S_t^{Supply} = S(r_t, P_t(P_t^{GSE}), Z_t) \leq L_t^* \quad . \quad (4.5)$$

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,

$$S_t^{Demand} = S(r_t, \Omega_t, P_t^{GSE}, Z_t) \quad . \quad (4.6)$$

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

$$r_t^* = r(\Omega_t, P_t(P_t^{GSE}), Z_t) \quad . \quad (4.7)$$

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,

$$P_t^{private} = P(\Omega_t, P_t^{GSE}, Z_t) \quad . \quad (4.8)$$

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,

$$P_{t,i}^{private} = \lambda_t + b_{z,t} Z_{t,i} + b_{GSE,t} P_{t,i}^{GSE} + u_{t,i} \quad . \quad (4.9)$$

In (4.9), the subscript  $i$  denotes the individual census tract. The term  $\lambda_t$  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 for and supply of credit.<sup>17</sup> 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 by the GSEs would imply that  $b_{GSE,t}$  equals -1.

#### 4.2 Identification

An important feature of (4.9) is that  $P_{t,i}^{GSE}$  may be endogenous. This is 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,

$$\frac{P_{t,i}^{private}}{L_{t,i}} = \lambda_t + b_{z,t} Z_{t,i} + b_{GSE,t} \frac{P_{t,i}^{GSE}}{L_{t,i}} + u_{t,i} \quad . \quad (4.10)$$

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 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.

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<sup>17</sup>For that reason, in the discussion to follow, we do not focus on those terms.

To allow for this second source of correlation we instrument for GSE purchases using the underserved status of the census tracts and tract median borrower income relative to AMI as discussed in the Introduction. As also discussed in the Introduction, the model further controls for tract loan and borrower attributes, as well as a long list of tract socioeconomic attributes. These are the  $Z$  attributes in (4.10) and serve to control for the underlying demand for mortgage debt and the credit attributes of the local population that affect the number of loan originations in a given tract. In the presence of these controls, there is no natural role in the estimating model for the relative economic status of the tract and borrower pool as discussed in the Introduction. As will also become apparent, our instruments are strongly correlated with the GSE purchase/origination ratio. We discuss the properties of our instruments including diagnostic tests in detail later in the paper.

## **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 were 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 for the year 2000 and beyond, we used year 2000 census tract control measures. Census controls include a wide range of socioeconomic indicators of the resident population in the tract. Additional controls are drawn from each year of the

HMDA data to further describe attributes of the borrowers and loans originated in a given estimation year. A detailed description of all of the model control variables is provided in the following section.<sup>18</sup>

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.<sup>19</sup>

## 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). In all cases, we present ordinary least squares (OLS) and GMM estimates for each sample year. The OLS estimates are in Panel A of Table 2 while the GMM model estimates are in Panel B. In both panels, each column corresponds to a different sample year.

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<sup>18</sup>As is well known, 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 in the data because secondary market purchases are based on broad features of the pooled mortgages rather than on the characteristics of specific borrowers.

<sup>19</sup>We thank Glenn Canner of the Federal Reserve Board for assisting us in identifying the relevant conforming loan size limits.

It is important to recognize that for all models the standard errors are clustered at the county level. In addition, all models include controls for county fixed effects, tract-level loan and borrower attributes, as well as 17 tract-level indicators of the socioeconomic status of the resident population. Loan and borrower attributes are obtained from HMDA and include the ratio of tract median borrower income to median loan amount, median loan amount, median borrower income, percent of borrowers that are minority (Hispanic or African American), and percent of borrowers that are female. Tract socioeconomic indicators of the resident population include the income distribution of the tract (25th, 50th, and 75th percentiles), unemployment rate, welfare rate, poverty rate, percentage of families that are female headed with children, percentage population that is Hispanic, percentage African American, average age, percentage of adults that are male, percent of adults with a high school degree, percent with some college, and percent with college or more. Also included among the tract attributes are the average age of the housing stock, percent of stock that is single family, and population density of the tract.

To maintain focus on the impact of GSE purchases, Table 2 does not report the coefficients on the variables just described. Instead, only the coefficients on the GSE purchase/origination variables and diagnostic statistics are provided. For select years, complete results for the first and second-stage GMM regressions are provided in the Appendix for review.

## *6.2 OLS estimates of crowd out*

We begin with the OLS estimates in Panel A. In viewing this panel, recall that a coefficient of 0 on the GSE purchase/origination ratio indicates the complete absence of GSE crowd out of private sector loan purchases, whereas a coefficient of -1 implies complete crowd out. Reading across the columns from left to right, certain patterns are worth highlighting.

First, all of the estimates are very precisely estimated and, with the exception of 2007, highly significant. Second, the point estimates imply that crowd out increases from roughly 19 percent in 1994 to 36 percent in 1998, and then levels off at roughly 24 percent from 2000 through 2002. Crowd

out increases thereafter, to 31 percent in 2003 and 44 percent in 2004 and 2005, and then slips back to 27.6 percent in 2006. With the market crash in 2007, evidence of crowd out disappears, as the point estimate is positive 0.02 (with a t-ratio of 0.95).

Summarizing, the OLS estimates suggest that crowd out increased during the early part of the 1990s, leveled off in the middle years of our sample, increased sharply during the peak years of the housing boom in 2004 and 2005, and then disappeared with the crash in 2007. As will be apparent, the qualitative nature of this pattern is broadly similar to patterns in the GMM estimates.

## *6.2 GMM estimates of crowd out*

Consider now the GMM estimates in Panel B. In discussing these results, we will first comment on the point estimates for GSE crowd out and compare those estimates to the OLS models in Panel A. In a later subsection, we discuss various diagnostic checks that shed light on the validity of the instruments and robustness of our estimates. For now, it is sufficient to note that we believe the various diagnostics as well as the conceptual arguments offered earlier support the validity of the instruments.

Reading from left to right in Panel B of Table 2, the estimates suggest that in the early sample years, GSE purchase activity may have actually produced a small “crowd in” effect: In 1994, the coefficient on GSE Purchase/Origination ratios is positive 0.17 with a t-ratio of 1.04. Although imprecisely estimated, this point estimate is consistent with early arguments by Lang and Nakamura (1994)), and suggests the possibility that GSE activity in the early 1990s may have helped to establish information networks and other infrastructure necessary for the development of a private secondary market.<sup>20</sup> That indeed was one of the motives behind the government’s expanded mandate for the GSEs as reflected in the 1992 GSE Act. It was also implicitly a reason for the government rescue of the GSEs in September 2008.

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<sup>20</sup>Harrison et al (2002) suggest that Fannie Mae purchases have had such an effect in parts of Florida.

Moving to the right in Panel B, the coefficient on GSE purchase activity implies 17 percent crowd out in 1996 (the coefficient is -0.17 with a t-ratio of 1.54), and 26 percent crowd out in 1998 (a coefficient of -0.26 with a t-ratio of 2.81). Crowd out remains close to that level through 2001, but then falls back close to zero in 2002 (the estimate is -0.038). These patterns are suggestive that the private segment of the secondary market gained traction in the 1996 to 2001 period, eliminating early crowd-in effects from GSE activity, but that the GSEs were important net providers of liquidity immediately after the 2001 recession.

The pattern shifts dramatically beginning in 2003. Recall from Figure 1 and Table 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 period subprime lending peaked, along with any number of other indicators of housing and mortgage market activity. In 2007 the housing and mortgage markets crashed. Given these conditions, the simple conceptual model outlined earlier suggests that GSE crowd out effects should have been much more pronounced during the peak of the boom years, and then fallen off in 2007. This is exactly what appears in Panel B of Table 2.

In 2003, crowd out is estimated at 41 percent (with a t-ratio of 3.76). For 2004 through 2006, crowd out is roughly 100 percent and highly significant in each year (the point estimates are for 2004, 2005, and 2006, respectively are -1.18, -0.83, and -1.0, with t-values ranging from 4.4 to 6.9). As noted, the years 2004-2006 were characterized by a dramatic increase in secondary market demand for loans at the same time that primary market lenders held few mortgages in portfolio. Given these market conditions, competition for loan purchases in the secondary market was intense, and it is not surprising that GSE crowd out of private sector loan purchases was extensive. This result also suggests that during the frenzied peak years of 2004 to 2006 the GSEs provided relatively little net liquidity to the market for conventional home purchase loans conforming to GSE loan size limitations.

Recent events, however, underscore that market conditions can change rapidly. With the crash of housing and mortgage markets in 2007, the GMM coefficient on GSE purchase/origination

ratios flips sign, taking on a positive value of 0.24 (with a t-ratio of 0.90) which implies an absence of crowd out. The wholesale scaling back of private sector loan demand during the 2007 (and 2008) period would have greatly reduced competition for secondary market purchases. That seemingly moved the loan demand function to a more elastic portion of the secondary market supply curve in Figure 1, eliminating GSE crowd out. Importantly, as intended, this suggests that GSE purchases *did* provide a substantial infusion of liquidity to the mortgage market in 2007. Moreover, there is every reason to expect that GSE net provision of funds continued and even gained in importance in 2008.

### *6.3 Selection effects and endogenous GSE activity*

As noted above, the qualitative patterns of the OLS and GMM estimates across sample years in Table 2 are broadly similar: limited crowd out by the GSEs early in the 1990s, moderate crowd out in the mid-1990s to early 2000s, much higher crowd out during the peak years of the housing boom in the mid-2000s, and then absence of crowd out with the crash in 2007. While qualitatively similar, the precise patterns of coefficients over time do differ between the OLS and GMM models in Panels A and B. It is informative to look more closely at those differences.

We approach this comparison with the assumption that the GMM estimates are consistent. Bearing that in mind, a more negative OLS estimate of GSE crowd out implies that the GSEs tend to purchase loans in census tracts with unusually limited private sector purchase activity, conditional on the extensive model controls. A more positive OLS estimate implies the reverse. Bearing this in mind, the OLS estimates of GSE crowd out are more negative than the GMM counterparts for 1994 through 1998. This is suggestive that during these years the GSEs tended to concentrate on census tracts that received unusually limited attention from private secondary market intermediaries given the observable features of the tracts. This could potentially be construed as consistent with GSE efforts to adhere to the spirit of their charters, which require the GSEs to do business in tracts that policy makers believed underserved by the private market. In 2000 and 2001, the OLS and GMM estimates are nearly identical, but in 2002, immediately following the 2001 recession, we again see evidence that the

GSEs sought out business opportunities in tracts that received unusually low levels of private sector activity.

The pattern is different in 2003-2006. For these years, the GMM estimates are more negative, indicating if anything that the GSEs tended to seek out business opportunities in tracts that experienced unusually high levels of private sector purchases. But in 2007, once again the pattern changes, and there is little evidence of a significant difference in estimates between the OLS and GMM models.

It is difficult to interpret precisely the differences between the OLS and GMM estimates. This is because the drivers of correlation between GSE purchase activity and unobserved factors imbedded in the OLS error term are, by definition, unobservable. However, two points are worth emphasizing here. First, once again we see that the estimated patterns differ with market conditions, and seemingly in a systematic fashion. Second, the difference in magnitude between the OLS and GMM estimates in some sample years highlights the importance of controlling for endogenous GSE activity. For that reason, the following subsection focuses on empirical evidence of the strength and validity of the instruments.

#### *6.4 Robustness*

Two considerations are paramount in assessing the robustness of our estimates given the IV research design. The first is whether the instruments are exogenous, and the second is whether the correlation between the instruments and the endogenous variable is sufficiently strong to avoid weak instrument bias (e.g. Murray (2006), Stock and Yogo (2005)). We consider both issues here. To facilitate, Table 3 presents three sets of GMM estimates of GSE crowd out for each sample year. The first set are those from Table 2 which were obtained using both tract underserved status and the tract ratio of borrower median income to AMI as instruments. The second set use only underserved status as an instrument, while the third use only tract ratio of borrower median income to AMI as an instrument. These three sets of estimates are presented in Panels A, B, and C, respectively, of Table 3.

Note also that each of these panels reports the first-stage coefficients and t-ratios on the instruments as well as the Kleibergen-Paap test statistic. Panel A further reports the p-value associated with the Hansen-J test of the overidentifying restrictions.

We focus first on the question of instrument strength. In Panel A, observe that the first-stage coefficient on tract underserved status is negative and highly significant in all sample years except for 2007 when the corresponding t-ratio is only 2.44. The first-stage coefficient on borrower median income relative to AMI is positive in all years prior to 2005 and negative thereafter. Moreover, this instrument is highly significant up through 2002, but only marginally significant or insignificant thereafter. The Kleibergen-Paap test statistic is relatively large, ranging from 15 to 80 depending on the year in question, well above the oft-cited “10” that has become a benchmark of sorts for whether weak instruments may cause a substantial bias in the second stage estimates (e.g. Stock and Yogo (2005)).<sup>21</sup> The exception is for 2007 when the test statistic is just 5.13, consistent with the comparatively low t-ratios on the first-stage instruments in this year (2.44 for underserved status and 1.35 for tract borrower median income relative to AMI). Overall, these results confirm that in each year, with the possible exception of 2007, underserved tract status is strongly correlated with GSE purchase activity conditional on the other model covariates, and in all years prior to 2003 both instruments are strongly correlated with the endogenous variable.

The instrument strength tests just discussed are mirrored in Panels B and C of Table 3. In Panel B, the first-stage coefficient on underserved status is nearly identical to that reported in Panel A, and with nearly the same t-ratio, in every sample year. The same is true when comparing the first stage coefficient and t-ratio on tract borrower median income relative to AMI in Panel A versus Panel

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<sup>21</sup>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.

C. Our assessment of the strength of the individual instruments, therefore, is not sensitive to whether the instruments are included together in the first stage or entered separately.

Strong instruments are necessary but not sufficient conditions for the IV models to yield consistent estimates. The instruments must also be exogenous. Accordingly, Panel A also reports results from Hansen-J tests of the overidentifying restrictions. We caution that these tests are known to have weak power against the null that the model is correctly specified. Moreover, it should be emphasized that the tests for overidentification are only possible when there are more instruments than endogenous variables. In the years from 2003 onward, when tract borrower median income relative to AMI is insignificant in the first stage or nearly so, the Hansen-J test results are not credible and we ignore them for that reason. For the earlier years, the p-values on the Hansen-J test range from roughly 0.25 to 0.98 as one reads across the columns, consistent with the null that the instruments and the model are correctly specified.<sup>22</sup>

An alternative approach to assessing instrument validity is to estimate the IV models separately with different groups of instruments. This strategy draws on the principle that two different groups of valid instruments should yield the same asymptotic estimates in the second stage. This strategy also requires that both sets of instruments be strongly correlated with the endogenous variable. Bearing this in mind, notice that the estimates in Panels B and C are similar for the sample years from 1994 through 2002. The largest discrepancies are in 1996 and 2000, where the crowd out estimates differ by roughly 0.16 and 0.2, respectively. However, those differences are not large enough to affect the qualitative nature of the pattern of crowd out estimates over this period: crowd-in is possibly present in 1994, followed by moderate levels of GSE crowd out through 2001, and the disappearance of crowd out effects in 2002.

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<sup>22</sup>Looking across the years from 2003 to 2007, the Hansen-J p-values are high in each year except for 2005 when the p-value is just 0.0149. Note, however, that for 2005 the t-ratio on the first-stage tract borrower median income to AMI instrument is 1.03 in Panel A and 0.80 in Panel C. This suggests that the 2005 IV model is exactly identified as underserved status is the only viable instrument, and for that reason, the Hansen-J test is simply not credible.

Finally, we consider the sign and the evolution over estimation years in the magnitude of the first-stage instrument coefficients. In panel A of Table 3, notice that the first-stage coefficients on tract underserved status are negative (and significant). Moreover, the coefficients initially increase in magnitude from 1994 to 1998, and diminish thereafter, and especially after 2002. The first-stage coefficients on tract borrower median income relative to AMI are positive in most years, increase in magnitude from 1994 to 1998, and then also diminish thereafter, becoming slightly negative in 2005-2007.

Broadly interpreted, a negative sign on tract underserved status and a positive sign on tract borrower median income relative to AMI is suggestive that the GSEs favor loan purchases in census tracts of higher relative economic standing (conditional on the model covariates). This echoes patterns evident in Figure 1, where GSE purchase-origination ratios increase with neighborhood economic status. On the surface, this appears contrary to the intent of the GSE purchase goals discussed earlier. Recall, however, that the GSEs are subject to two quite different types of purchase goals: goals that target individual *borrower* income relative to AMI regardless of location (the borrower low-moderate and special affordable goals) and goals that target *census tract* median income relative to AMI regardless of borrower income (the underserved neighborhood goal). The former are the more prominent of the numeric goals in all years other than 1994 and 1995. In 1996, for example, the borrower low-moderate income goal was set at 40 percent of each GSE's loan purchases while the underserved neighborhood goal was set at 21 percent.<sup>23</sup> Because GSE loan purchases can count towards multiple goals, it seems likely that the borrower income goals are the more binding of the two (because many of the lower-income borrowers reside in underserved tracts). Under such circumstances, it would not be surprising for the GSEs to minimize further exposure to lower income neighborhoods in order to offset their increased exposure to credit risk stemming from the purchase of

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<sup>23</sup>In that same year the special affordable goal was set at 12 percent. Recall also that these targets specify *minimum* shares of GSE purchases

so many low-income loans. Such behavior would account for the negative sign on underserved tract status and the positive sign on tract borrower median income to AMI obtained in most sample years.

A further consideration is the change over sample years in magnitude of the first-stage instrument coefficients. Note that the HUD purchase requirements were ratcheted up sharply over the sample period, from 1994 to 2007. Indeed, by 2007, the low-moderate income goal was set at 55 percent of GSE loan purchases while the underserved neighborhood goal was set at 38 percent. As both goals become more stringent, it is likely that the GSEs would increasingly be forced to seek out loan purchases in lower income tracts. The evolution in the instrument coefficients described above matches that prediction.

Summarizing, both of our instruments are strong prior to 2003, but only tract underserved status is particularly strong thereafter. Hansen-J tests for the earlier years support the idea that our instruments are valid. Comparisons of IV models using separate instruments provide further support for the validity of the instruments. In addition, the temporal pattern on the first-stage instrument coefficients matches largely the ratcheting up of the GSE purchase goals that require the GSEs to do an increasing share of their business in lower income communities. Finally, the OLS and GMM estimates suggest a broadly similar qualitative pattern of crowd out effects over time.

## **VII. Conclusion**

The housing government-sponsored enterprises (GSEs), most notably Fannie Mae and Freddie Mac, have occupied a unique and important position in the U.S. housing finance system. As federally-chartered private corporations, those entities have used their implicit federal guarantee and related cost-of-funds advantage to gain substantial market share. At times, the GSEs have accounted for more than 60 percent of purchases of conforming-sized conventional mortgages in the secondary market. Longstanding federal support for the GSEs, including their takeover by the U.S. Government in 2008, has been motivated in part by the 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 percent to over 90 percent. During this period, GSE and private non-GSE shares of loan purchases were similar, while IV estimates suggest little GSE crowd out of loan purchases by private secondary market intermediaries. Between 2004 through 2006, portfolio lending by primary market lenders nearly disappeared, private secondary market loan purchases boomed, and IV estimates indicate nearly 100 percent crowd out. With the crash in housing and mortgage markets in 2007, private companies 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 disappeared. 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 2007, our estimates indicate that GSE crowd out is more limited. Importantly, our estimates indicate that in the wake of the 2007-2008 implosion in the capital markets, government takeover of Fannie Mae and Freddie Mac likely served its intended purpose of enhancing liquidity in the mortgage market.

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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

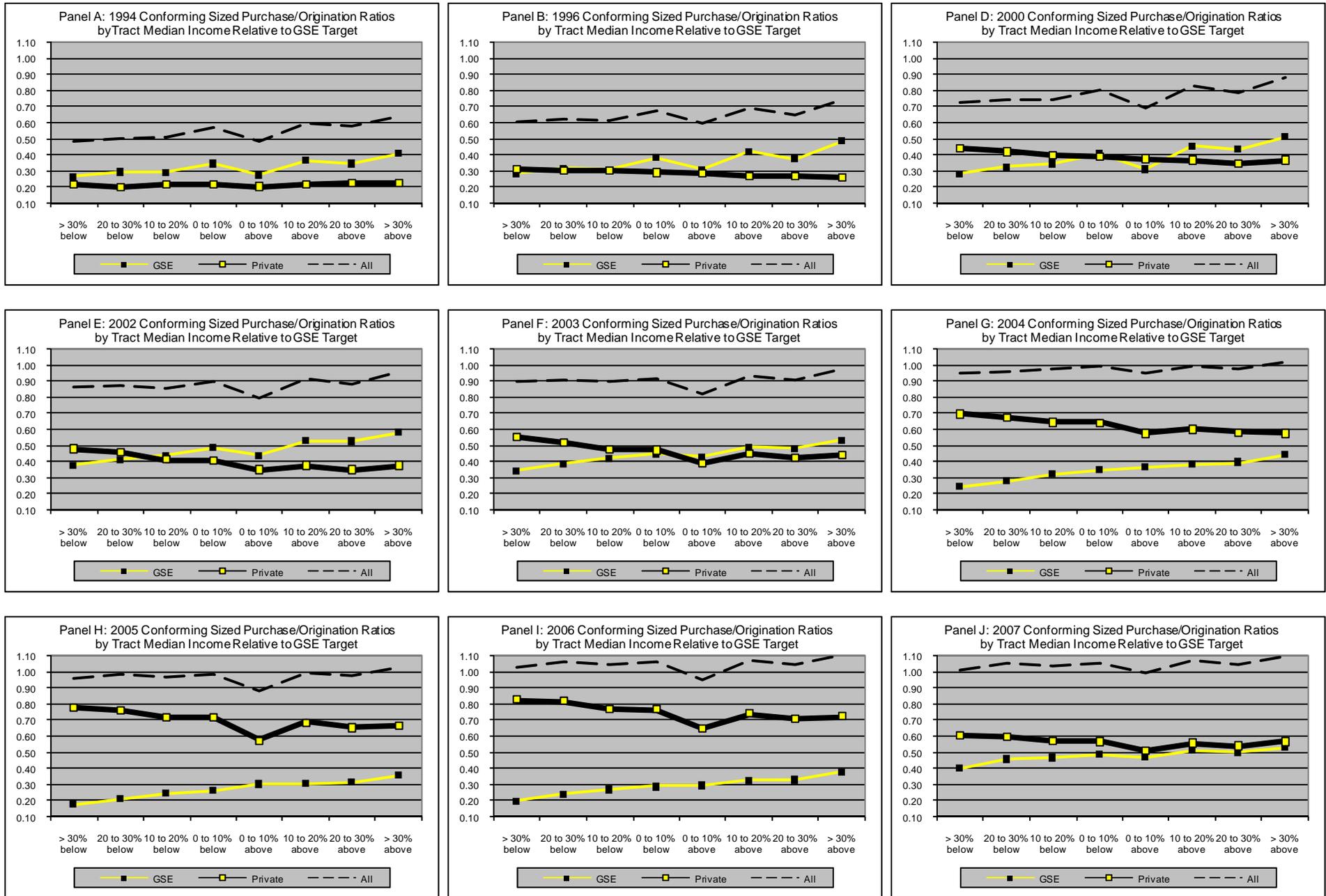
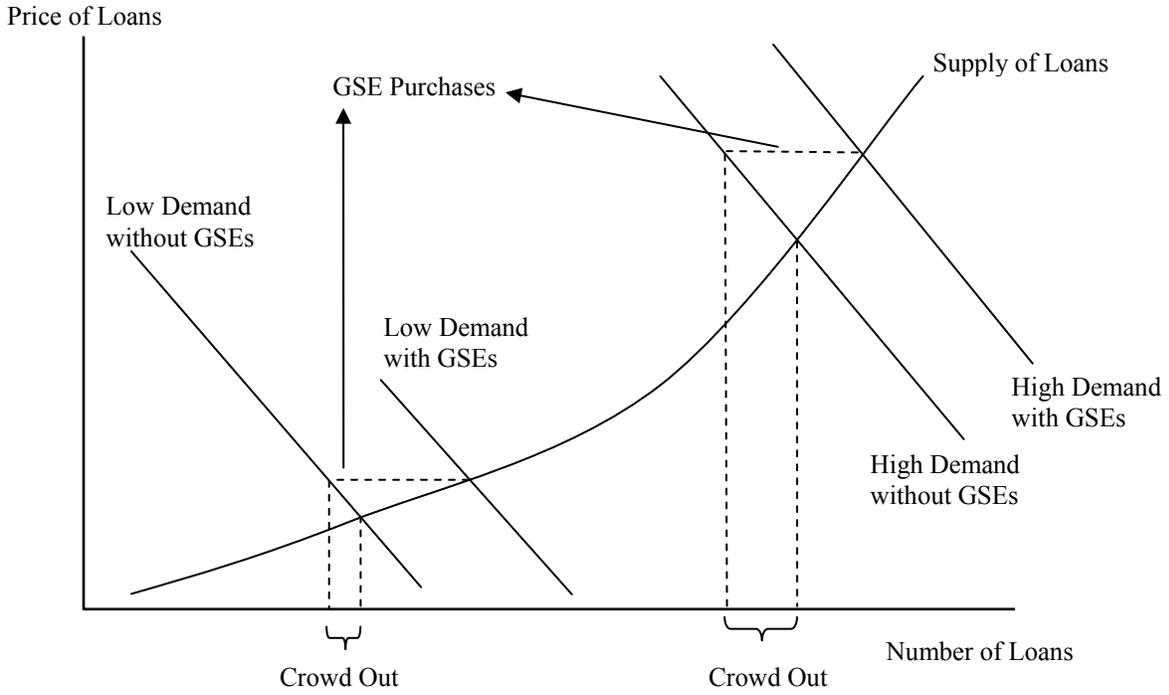


Figure 2: Crowd Out in the Secondary Market



**Table 1: Conventional Home Purchase Loans Below the Conforming Size Limit  
Sample Means for Mortgage Market Variables from the HMDA Data<sup>a</sup>**

Year	Average Level of Activity Per Census Tract				Average Activity Ratios Across Tracts <sup>b</sup>		
	Originations	All Secondary Market Purchases	GSE Secondary Market Purchases	Private Secondary Market Purchases	All Purchases/ Originations	GSE Purchases/ Originations	Private Sector Purchases/ Originations
1994	38.95	23.68	14.68	9.00	0.58	0.36	0.22
1996	43.21	30.49	18.76	11.72	0.68	0.40	0.28
1998	53.44	46.19	26.67	19.52	0.84	0.43	0.41
2000	56.36	47.92	26.85	21.07	0.81	0.43	0.39
2001	60.10	53.55	31.97	21.58	0.86	0.48	0.38
2002	64.83	61.22	35.82	25.40	0.91	0.51	0.40
2003	74.51	72.21	37.24	34.98	0.94	0.47	0.47
2004	88.66	90.09	34.35	55.74	0.99	0.37	0.62
2005	105.63	109.41	31.42	77.99	0.99	0.29	0.70
2006	99.80	110.89	32.27	78.62	1.07	0.31	0.75
2007	65.72	73.84	34.53	39.31	1.06	0.49	0.57

<sup>a</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.

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

**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 Standard Errors at the County Level)<sup>a</sup>**

<b>Panel A: Ordinary Least Squares</b>											
	<b>1994</b>	<b>1996</b>	<b>1998</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
GSE Purchases/Originations	-0.19383 (13.21)	-0.22654 (21.67)	-0.36003 (22.66)	-0.24786 (17.06)	-0.24541 (15.98)	-0.25580 (14.82)	-0.31427 (17.49)	-0.44086 (22.74)	-0.43888 (22.32)	-0.27558 (10.39)	0.02263 (0.95)
County Fixed Effects	832	854	854	853	853	853	854	854	854	854	854
County Clustering	832	854	854	853	853	853	854	854	854	854	854
Within R-square	0.08	0.13	0.27	0.12	0.19	0.21	0.20	0.19	0.22	0.15	0.05
Overall R-square	0.03	0.08	0.23	0.09	0.17	0.21	0.25	0.26	0.37	0.26	0.15
Root MSE	0.1236	0.1426	0.1698	0.1452	0.1517	0.1391	0.1514	0.1747	0.1554	0.1767	0.1897
Observations	45949	47779	49589	49381	49314	49393	49637	50011	50104	50145	49616

<b>Panel B: GMM Using Underserved Status and Ratio of Borrower Median Inc/AMI as Instruments</b>											
	<b>1994</b>	<b>1996</b>	<b>1998</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
GSE Purchases/Originations	0.17381 (1.04)	-0.17403 (1.54)	-0.25964 (2.81)	-0.22622 (2.99)	-0.24326 (2.78)	-0.03787 (0.50)	-0.41249 (3.76)	-1.1769 (6.50)	-0.82555 (6.89)	-0.99534 (4.38)	0.24357 (0.49)
First-Stage: Underserved status	-0.01449 (3.90)	-0.02082 (4.63)	-0.03482 (9.43)	-0.02699 (8.43)	-0.02924 (10.51)	-0.02930 (11.59)	-0.02349 (8.43)	-0.02002 (6.87)	-0.01992 (8.38)	-0.01435 (5.98)	-0.00629 (2.44)
First-Stage: Borrower Med Inc/AMI	0.15761 (3.78)	0.22686 (5.09)	0.28738 (6.04)	0.17671 (4.91)	0.20164 (6.61)	0.18501 (5.94)	0.08862 (2.48)	0.02776 (0.96)	-0.02512 (1.03)	-0.03783 (1.82)	-0.02299 (1.35)
Kleibergen-Paap Weak Inst. test	14.80	23.19	67.99	41.41	76.66	84.63	51.84	25.03	35.78	18.66	5.13
Hansen-J OverID test P-Value	0.9833	0.4215	0.4842	0.2526	0.9501	0.7973	0.3937	0.5171	0.0149	0.2840	0.8948
County Fixed Effects	812	849	848	848	847	847	848	849	849	849	849
County Clustering	812	849	848	848	847	847	848	849	849	849	849
R-square	-0.0495	0.1296	0.2648	0.1225	0.1931	0.1802	0.1935	-0.0013	0.1706	-0.0091	0.0308
Root MSE	0.1321	0.1428	0.1703	0.1453	0.1517	0.1420	0.1519	0.1945	0.1603	0.1929	0.1920
Observations	45,929	47,774	49,584	49,376	49,309	49,388	49,631	50,006	50,099	50,140	49,611

<sup>a</sup>Additional model controls include census tract attributes of the loans and borrowers in each year as obtained from the HMDA files, and socioeconomic (SES) attributes of the tract population as obtained from the decennial census. For years prior to 2000, year-1990 SES controls are included in the model. For 2000 and later, year-2000 SES controls are used. Loan and borrower controls include the ratio of tract median loan amount to borrower median income, median loan amount, borrower median income, percent of borrowers that are minority (Hispanic or African American), and percent of borrowers that are female. The SES controls include the 25th, 50th, and 75th percentile of tract household income, unemployment rate, percent of individuals on welfare, poverty rate, percent of female headed households with children, the percent of the tract population that is Hispanic, percent African American, average age of the tract population, percent of adults that are male, percent of adults with high school degree, percent with some college, and percent with college or more, average age of the housing stock, percent of housing stock that is single family, and population density of the tract.

**Table 3: Alternate Instruments**  
**(Absolute value of t-ratios in Parentheses Based on Standard Errors Clustered at the County Level)<sup>a</sup>**

**Panel A: GMM Using Underserved Status and Ratio of Borrower Median Inc/AMI as Instruments**

	<b>1994</b>	<b>1996</b>	<b>1998</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
GSE Purchases/Originations	0.17381 (1.04)	-0.17403 (1.54)	-0.25964 (2.81)	-0.22622 (2.99)	-0.24326 (2.78)	-0.03787 (0.50)	-0.41249 (3.76)	-1.1769 (6.50)	-0.82555 (6.89)	-0.99534 (4.38)	0.24357 (0.49)
First-Stage: Underserved status	-0.01449 (3.90)	-0.02082 (4.63)	-0.03482 (9.43)	-0.02699 (8.43)	-0.02924 (10.51)	-0.02930 (11.59)	-0.02349 (8.43)	-0.02002 (6.87)	-0.01992 (8.38)	-0.01435 (5.98)	-0.00629 (2.44)
First-Stage: Borrower Med Inc/AMI	0.15761 (3.78)	0.22686 (5.09)	0.28738 (6.04)	0.17671 (4.91)	0.20164 (6.61)	0.18501 (5.94)	0.08862 (2.48)	0.02776 (0.96)	-0.02512 (1.03)	-0.03783 (1.82)	-0.02299 (1.35)
Kleibergen-Paap Weak Inst test	14.80	23.19	67.99	41.41	76.66	84.63	51.84	25.03	35.78	18.66	5.13
Hansen-J OverID test P-Value	0.9833	0.4215	0.4842	0.2526	0.9501	0.7973	0.3937	0.5171	0.0149	0.2840	0.8948

**Panel B: 2SLS Using Underserved Status Instrument**

	<b>1994</b>	<b>1996</b>	<b>1998</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
GSE Purchases/Originations	0.17637 (0.85)	-0.08309 (0.54)	-0.29931 (2.73)	-0.15478 (1.61)	-0.24641 (2.43)	-0.04169 (0.54)	-0.42944 (3.94)	-1.1683 (6.56)	-0.68244 (5.30)	-0.90581 (4.02)	0.29279 (0.46)
First-Stage: Underserved status	-0.01563 (4.21)	-0.02250 (4.91)	-0.03769 (10.02)	-0.02856 (8.49)	-0.03145 (10.71)	-0.03138 (12.14)	-0.024640 (9.31)	-0.02035 (7.04)	-0.01964 (8.23)	-0.01388 (5.80)	-0.00598 (2.26)
Kleibergen-Paap Weak Inst test	17.73	24.06	100.33	72.11	114.66	147.47	86.69	49.54	67.67	33.62	5.13

**Panel C: 2SLS Using Ratio of Borrower Median Inc/AMI as Instrument**

	<b>1994</b>	<b>1996</b>	<b>1998</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>
GSE Purchases/Originations	0.17127 (0.83)	-0.2413 (1.73)	-0.19482 (1.47)	-0.35718 (2.62)	-0.23399 (1.36)	-0.00403 (0.03)	-0.18490 (0.61)	-1.7569 (1.48)	-4.3946 (0.86)	-1.6833 (1.94)	0.11770 (0.11)
First-Stage: Borrower Med Inc/AMI	0.16283 (3.93)	0.23341 (5.26)	0.30058 (6.37)	0.18350 (5.09)	0.21042 (6.92)	0.19362 (6.27)	0.09691 (2.67)	0.03474 (1.18)	-0.01976 (0.80)	-0.03526 (1.66)	-0.02173 (1.26)
Kleibergen-Paap Weak Inst test	15.42	27.72	40.59	25.94	47.94	39.28	7.16	1.39	0.64	2.75	1.59

<sup>a</sup>Additional model controls include county fixed effects, census tract attributes of the loans and borrowers in each year as obtained from the HMDA files, and socioeconomic (SES) attributes of the tract population as obtained from the decennial census. For years prior to 2000, year-1990 SES controls are included in the model. For 2000 and later, year-2000 SES controls are used. Loan and borrower controls include the ratio of tract median loan amount to borrower median income, median loan amount, borrower median income, percent of borrowers that are minority (Hispanic or African American), and percent of borrowers that are female. The SES controls include the 25th, 50th, and 75th percentile of tract household income, unemployment rate, percent of individuals on welfare, poverty rate, percent of female headed households with children, the percent of the tract population that is Hispanic, percent African American, average age of the tract population, percent of adults that are male, percent of adults with high school degree, percent with some college, and percent with college or more, average age of the housing stock, percent of housing stock that is single family, and population density of the tract.

**Table A1: Selected GMM Regressions**  
**Dependent Variable: Private Sector Purchase/Origination Ratios**  
**(Absolute value of t-ratios in Parentheses Based on Standard Errors Clustered at the County Level)**

Tract Attribute Controls	1998		2002		2006	
	1st Stage	2nd Stage	1st Stage	2nd Stage	1st Stage	2nd Stage
Underserved tract	-0.03482 (9.43)	-	-0.0293 (11.59)	-	-0.01435 (5.98)	-
Median Borrower Inc /AMI	0.28738 (6.04)	-	0.18501 (5.94)	-	-0.03783 (1.82)	-
GSE Purchases/Originations	-	-0.25964 (2.81)	-	-0.03787 (0.50)	-	-0.99534 (4.38)
Med Loan Size/Med Borrower Inc.	0.00246 (1.56)	-0.00245 (3.10)	0.0028 (0.95)	0.0059 (1.28)	-0.04824 (5.07)	0.05149 (3.52)
Median Loan Size (\$1,000s)	0.00206 (7.96)	-0.00028 (0.96)	0.00076 (3.65)	-0.00013 (0.74)	0.00078 (7.00)	0.00002 (0.09)
Median Borrower Inc. (\$1,000s)	-0.00634 (6.40)	-0.00136 (3.53)	-0.0045 (7.07)	0.00002 (0.06)	-0.00057 (1.11)	0.00015 (0.47)
% of Borrowers Af. Amer. or Hispanic	-0.23375 (7.78)	-0.00054 (0.01)	-0.23706 (11.43)	0.23992 (5.56)	-0.35527 (18.21)	-0.0072 (0.08)
% of Borrowers Female	-0.07471 (3.33)	0.06531 (2.49)	-0.02648 (1.16)	0.08565 (2.92)	0.01842 (1.34)	0.0455 (1.76)
25th percentile tract household income	-0.00044 (2.06)	0.00059 (2.84)	-0.0011 (6.32)	0.0009 (4.54)	-0.00004 (0.32)	-0.00006 (0.22)
50th percentile tract household income	-0.00115 (6.80)	0.00031 (1.93)	-0.00023 (2.27)	0.00025 (3.21)	-0.00032 (3.05)	-0.00005 (0.28)
75th percentile tract household income	-0.00071 (8.29)	0.0002 (1.64)	-0.00043 (5.96)	-0.00006 (0.65)	-0.00014 (2.10)	-0.00016 (1.65)
Unemployment rate	-0.07546 (1.99)	0.32801 (5.03)	-0.05353 (1.45)	0.06748 (1.73)	0.01403 (0.50)	0.0515 (0.95)
Welfare rate	0.00373 (0.09)	0.22853 (4.25)	-0.04374 (1.16)	0.22664 (4.75)	-0.10098 (4.15)	0.01306 (0.24)
Poverty rate	-0.15287 (5.78)	0.02319 (0.56)	-0.07321 (2.68)	0.03677 (1.34)	0.07622 (2.73)	-0.05533 (1.53)
% Female headed with children	-0.02474 (1.19)	-0.00411 (0.20)	-0.00952 (0.52)	0.02185 (1.38)	-0.01896 (1.50)	0.00463 (0.17)
% Hispanic residents	0.1717 (4.38)	-0.04395 (1.31)	0.0753 (2.35)	-0.07043 (2.87)	-0.10436 (7.56)	-0.03115 (1.08)
% African American residents	-0.0355 (1.99)	0.10719 (5.12)	-0.08496 (4.51)	0.03742 (2.20)	0.02445 (2.12)	-0.05181 (2.00)
Average age of resident	0.00324 (9.80)	-0.00215 (3.88)	0.00212 (6.31)	-0.00262 (7.19)	0.00313 (10.69)	-0.00135 (1.52)
% Male residents	-0.15301 (4.35)	0.02929 (0.66)	-0.10033 (2.63)	0.08065 (2.06)	0.04373 (1.53)	-0.033 (0.55)
% of age 25+ residents High School Deg.	0.04742 (1.80)	0.00245 (0.06)	0.01158 (0.33)	0.00863 (0.28)	-0.00474 (0.20)	-0.04628 (1.07)
% of age 25+ residents Some College	0.30131 (9.58)	0.09347 (1.63)	0.12459 (3.78)	0.09998 (2.82)	0.00829 (0.36)	0.19514 (4.62)
% of age 25+ residents College Deg	0.3713 (14.76)	-0.0504 (1.11)	0.25399 (9.92)	-0.07243 (2.25)	0.24868 (11.93)	0.06931 (0.98)
Average age of housing stock	-0.00208 (8.03)	0.00019 (0.76)	-0.00114 (5.75)	0.00071 (3.93)	-0.0012 (9.90)	0.00000 (0.01)
% Housing single family	0.08977 (11.39)	-0.02395 (2.17)	0.02683 (4.34)	0.00728 (1.00)	-0.00698 (1.29)	0.00959 (1.06)
Population Density	1.06e-07 (0.41)	3.81e-07 (1.40)	-1.21e-07 (0.62)	3.30e-07 (1.47)	2.07e-07 (1.42)	1.03e-07 (0.35)
Kleibergen-Paap Weak Inst. test	-	67.99	-	84.63	-	18.66
Hansen-J OverID test P-Value	-	0.4842	-	0.7973	-	0.2840
County Fixed Effects & County Clustering	848	848	847	847	849	849
R-Square	0.43	0.26	0.29	0.18	0.36	-0.01
Root MSE	0.14	0.17	0.13	0.14	0.11	0.19
Observations	49583	49583	49393	49387	50145	50140