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Do the GSEs expand the supply of mortgage credit? New evidence of crowd out in the secondary mortgage market

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ABSTRACT

The dramatic government takeover of Fannie Mae and Freddie Mac in September, 2008 was motivated in part by a desire to ensure a continued flow of credit to 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, whereas the absence of crowd out implies that GSE loan purchases enhance liquidity.
Using 1994–2008 HMDA data for conventional, conforming sized loans, three distinct periods with regard to GSE crowd out are apparent. From 1994 to 2003, the share of loans sold to the secondary market increased from 60 to over 90%, private sector and GSE market shares of loan purchases were roughly similar for most market segments, and IV estimates indicate relatively little GSE crowd out of private secondary market purchases. From 2004 to 2006, private loan purchases boomed and dominated those of the GSEs, while IV estimates indicate crowd out jumped to 50% at the peak of the boom. This is especially true in the market for home purchase as opposed to refinance loans. With the crash in housing and mortgage markets in 2007, private sector intermediaries pulled back, the GSEs regained market share, and evidence of GSE crowd out disappeared in both the home purchase loan and refinance markets. 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 served to enhance liquidity to the mortgage market during the 2007–2009 financial crisis.
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1. Introduction

In 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 Fannie Mae and Freddie Mac, the two giant federally chartered housing government sponsored enterprises (GSEs). Support for the GSEs has been controversial at times (e.g. Jaffee, 2006; Glaeser and Jaffee, 2006), and has been motivated primarily by a desire to ensure that loan originators had access to an expansive supply of mortgage credit that would free them from dependence on local deposits.[2] Provisions of the GSE charters have also been designed to increase access to credit among targeted, disadvantaged groups. Government backing of GSE debt was made explicit in September, 2008 with the dramatic government takeover of Fannie Mae and Freddie Mac. That takeover was motivated in part by a desire to ensure a continued flow of mortgage credit to the U.S. economy given the huge scale of GSE operations.[3] As of 2007, for example, 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 two-thirds the value of all outstanding household pension reserves.[4]

Against this backdrop, this study examines the extent to which the GSEs have been *net* providers of liquidity to residential mortgage

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[2] The enormous scale of the secondary market is widely believed to reduce regional imbalances in the supply and demand for credit while enhancing opportunities to manage risk (see Pennacchi, 1988; Carlstrom and Samolyk, 1995; Drucker and Puri, 2009; Gabriel and Rosenthal, 2010, for example).

[3] The government's rescue of Fannie and Freddie was further prompted by concern that a failure to support the GSEs could have been interpreted by market participants as a default on securities backed by the U.S. government. In September 2008, for example, Treasury Secretary Paulson stated that the U.S. 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. ..." 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.

[4] See Federal Reserve Board Flow of Funds Accounts (2007), Table L.125, line 2, Table L.4 line 3, Table L.222, line 1, and Table L.118, line 1.

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Table 1a
Conventional home purchase loans below the conforming size limit: sample means for mortgage market variables from the HMDA data[a].

Year	Average level of activity per census tract					Ratios of average activity across tracts[b]		
	Applications	Originations	All secondary market purchases	GSE secondary market purchases	Private secondary market purchases	All purchases/ originations	GSE purchases/ originations	Private sector purchases/originations
1994	52.81	38.95	23.68	14.68	9.00	0.58	0.36	0.22
1996	66.34	43.21	30.49	18.76	11.72	0.68	0.40	0.28
1998	86.40	53.44	46.19	26.67	19.52	0.84	0.43	0.41
2000	90.69	56.36	47.92	26.85	21.07	0.81	0.43	0.39
2001	88.92	60.10	53.55	31.97	21.58	0.86	0.48	0.38
2002	93.04	64.83	61.22	35.82	25.40	0.91	0.51	0.40
2003	108.12	74.51	72.21	37.24	34.98	0.94	0.47	0.47
2004	133.17	88.66	90.09	34.35	55.74	0.99	0.37	0.62
2005	165.09	105.63	109.41	31.42	77.99	0.99	0.29	0.70
2006	159.82	99.80	110.89	32.27	78.62	1.07	0.31	0.75
2007	104.38	65.72	73.84	34.53	39.31	1.06	0.49	0.57
2008	52.73	33.55	35.46	21.43	14.03	1.01	0.61	0.40

[a] All values are based on census tracts located within MSAs. The number of tracts reporting positive numbers of originations was between 50,352 and 50,602 depending on the year in question.
[b] Values were calculated by averaging individual census tract level ratios for all tracts with originations.

markets. Specifically, we evaluate 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. This is especially important in the context of the 2007 financial crisis and related freezing up of credit markets.[5]

As a starting point, it is useful to highlight how the scale of GSE and non-GSE secondary market activities has changed over time. This is done in Tables 1a and 1b for the home purchase and refinance portions of the market, respectively. Drawing on data from the Home Mortgage Disclosure Act (HMDA) from 1994 to 2008, each table displays annual measures of census tract level indicators of mortgage activity (e.g. originations and loan purchases) for all tracts located within a metropolitan statistical area (MSA). In all instances, we focus only on conventional, conforming size loans.

For the home purchase market (Table 1a), note first that secondary market purchases averaged 23.68 loans per tract in 1994, or just 58% of originations per census tract. In that environment, lenders were heavily reliant on local depositors as a source of funds. That situation changed dramatically over the 1990s and 2000s, as purchase-to-origination ratios rose to 100% in 2004 and remained at that high level through 2008.[6] Today, despite the 2007 financial crisis, nearly all capital used to finance conventional, conforming sized home purchase loans comes from the secondary market, a dramatic change from just fifteen years ago.

Also evident in Table 1a is that the GSEs accounted for a notably higher share of loan purchases than the non-GSE secondary market intermediaries during the first half of the 1990s (e.g. 14.68 GSE loan purchases versus 9.00 non-GSE purchases per tract in 1994). As reflected in the purchase-to-origination rates, the relative magnitudes of GSE and non-GSE purchases (scaled by originations) were more similar over much of the 1998 to 2003 period: this is evident in the last two columns of the table. In 2004, private secondary market loan purchases then boomed relative to those of the GSEs, peaking in 2006 at a purchase-to-origination ratio of 75% versus just 31% for the GSEs. Dramatically, that pattern began to reverse in 2007 with the crash in mortgage and housing markets and the concurrent pullback in private secondary market purchase activity. In 2008, GSE purchase-to-origination ratios were 60% versus just 41% in the non-GSE sector, a near reversal of positions from just two years earlier. These patterns of GSE activity relative to non-GSE mortgage purchase activity over the 1994–2008 period are largely mirrored in the refinance segment of the market, as seen in the last two columns of Table 1b.

Taken at face value, the large volume and share of GSE loan purchases is suggestive that the GSEs have done much to enhance the liquidity in the mortgage market. While this may be true, such a conclusion may be premature because of the potential for crowding out of private sector activity. To assess the crowd out effects of GSE loan purchases, we regress the number of private sector purchases on the number of GSE purchases. Moreover, we do this separately for each sample year from 1994 to 2008. This allows for differences in market conditions that likely affect the extent of crowd out (in a manner to be clarified). In all cases our unit of observation is the census tract, and we restrict our analysis to conventional, conforming sized home purchase and refinance loans as in Tables 1a and 1b. Evidence of a negative coefficient on GSE purchases 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] While conceptually straightforward, two challenges must be addressed in order to identify GSE crowd out effects. We must control for the potential supply of loans available for purchase, and we must also allow for the possibly endogenous nature of GSE loan purchases. We comment on each of these in turn.

The supply of loans that could potentially be sold to secondary market entities would affect both GSE and private sector purchases and must therefore be taken into account. That potential supply depends on the number of loan applications as well as the propensity for applications to be originated. To proxy the latter, we draw on

[5] A number of recent studies have considered the role that mortgage markets have played in the 2007 financial crisis. DiMartino and Duca (2007) document the dramatic rise in subprime lending and subsequent crash in housing and mortgage activity. Foote et al. (2008) argue that default rates are likely to remain elevated until house prices regain their former peaks. Bucks and Pence (2008) find that many ARM borrowers do not know the terms of their loans or understand their exposure to interest rate risk. Sufi and Mian (2009) show that during the 2002–2005 lending boom, extension of mortgage credit to "subprime" neighborhoods was closely tied to the securitization of subprime loans. Mayer and Pence (2008) show that subprime lending in 2005 was concentrated in lower income and minority communities, as well as in fast growing areas that were experiencing sharp increases in house prices and housing starts. Green and Wachter (2005) offer an historical perspective. While these and other studies add greatly to our knowledge base, none consider the question raised here: the extent to which GSE loan purchases crowd out private sector purchases, and related implications for the 2008 federal rescue of Fannie Mae and Freddie Mac.

[6] Some of the purchase/origination ratios in Table 1a exceed 1. This is possible because some loans are sold in a year subsequent to when they are originated, and also because some loans are sold multiple times within a year.

[7] In principle, crowding-in effects could occur to the extent that local GSE activity helps to create infrastructure necessary for the operation of the private sector of the secondary market. This would imply a positive as opposed to negative coefficient on GSE loan purchases. We discuss this possibility more completely later in the paper.

Table 1b
Conventional refinance loans below the conforming size limit: sample means for mortgage market variables from the HMDA data[a].

Year	Average level of activity per census tract					Ratios of average activity across tracts[b]		
	Applications	Originations	All secondary market purchases	GSE secondary market purchases	Private secondary market purchases	All purchases/ originations	GSE purchases/ originations	Private sector purchases/originations
1994	47.05	31.93	19.09	13.17	5.92	0.57	0.38	0.19
1996	63.37	36.23	22.08	13.46	8.61	0.61	0.35	0.27
1998	162.72	94.70	77.18	48.96	28.22	0.79	0.43	0. .35
2000	95.60	35.19	21.30	9.17	12.13	0.61	0.25	0.36
2001	208.55	114.34	91.97	61.23	30.74	0.76	0.47	0.29
2002	258.46	151.50	134.18	89.43	44.75	0.84	0.53	0.31
2003	370.16	227.33	224.63	146.55	78.08	0.93	0.57	0.36
2004	236.49	110.87	103.56	46.03	57.53	0.90	0.39	0.50
2005	233.70	104.04	100.87	33.80	67.07	0.92	0.31	0.61
2006	210.18	91.32	89.91	25.60	64.31	0.94	0.27	0.67
2007	168.36	69.78	69.34	29.42	39.92	0.95	0.40	0.55
2008	99.56	45.08	42.71	26.49	16.23	0.91	0.56	0.35

[a] 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.
[b] Values were calculated by averaging individual census tract level ratios for all tracts with originations.

HMDA data and control for tract level attributes of the loan applicants, including median loan size requested, median income, racial composition, and percent female. We also use census data to control for socioeconomic attributes of the tract's residential population, including racial composition, education, unemployment, population density, median family income, and median income divided by the median income in the metropolitan area (the motive for this later variable will be clarified shortly). All of our models also control for county fixed effects to further address local unobserved factors that might affect the supply of loans that could potentially be sold to the secondary market.

Our remaining empirical challenge is to address the possibly endogenous character of GSE loan purchases. It is plausible, for example, that even after conditioning on the extensive set of controls just described, unobserved tract attributes that generate GSE loan purchases may also generate private sector loan purchases. This would cause OLS estimates of crowd out to be downward biased, towards a more positive (less negative) number. This also suggests that OLS estimates of the private sector purchase equation yield lower bound estimates of the extent of GSE crowd out. While such estimates can be informative, a more precise estimate of crowd out is clearly desired.

To address these concerns, we instrument for GSE purchases using a census tract's "underserved status" as defined by Congress under provisions of the Federal Housing Enterprise Financial Safety and Soundness Act of 1992 (GSE Act of 1992). Under the GSE Act, a large share of GSE loan purchases must be comprised of loans issued to borrowers residing in underserved census tracts, and/or to borrowers of low income status. For these purposes, a census tract is designated underserved if its median family income is less than 90% of MSA median income (referred to as area median income, or AMI), or between 90 and 120% of AMI with over 30% of the resident population African American or Hispanic. Analogously, individual borrowers are classified as low–moderate income if their income is less than AMI.[8] Congress delegated to the Department of Housing and Urban Development (HUD) the authority to specify the magnitudes of GSE loan purchase goals among underserved populations and neighborhoods. Over time, those purchase requirements tended to be ratcheted up. At the time of the 2008 government takeover of Fannie Mae and Freddie Mac, over 55% of loans purchased by the GSEs had to be loans issued to "low–moderate" income borrowers, and 39% or more of loans must have been purchased from "underserved" census tracts (Bunce, 2007). Prior studies have confirmed that the GSEs have largely honored their loan purchase targets (e.g. Bunce and Scheessele, 1996; Bunce, 2002, 2007; Manchester et al., 1998).[9]

Several features of a census tract's underserved status are central to our identification strategy. First, and perhaps most important, is that underserved tract status is defined on the basis of median household income in the tract *relative* to MSA median income. But absent the GSEs and related government intervention, there is no particular reason why relative economic status of a tract or borrower should affect private sector purchases. Instead, private sector purchases should depend only on the *level* of borrower and neighborhood income to the extent that those factors affect the risk and return on investment in a pool of loans. This is our core economic argument for the validity of underserved status as an instrument.

Second, the targeting of loan purchases in underserved communities by the 1992 GSE Act implies a discrete upward shift in mortgage activity in such communities, ceteris paribus. Evidence of such a shift would suggest that markets are affected by the policy focus on underserved census tracts, a necessary condition for our identification strategy to have power. Fig. 1 explores this implication. In the figure, we plot home purchase mortgage activity (i.e. counts of applications and loan purchases) grouping census tracts along the horizontal axis from relatively low income to relatively high-income. For these purposes, relative income is based on the degree to which tract median income is below or above 90% of AMI, the primary income limit used by HUD and Congress to define an underserved tract. To conserve space, we provide such plots only for 2003 to 2008, with each year represented in a separate panel. These years largely capture the range of patterns over the entire sample horizon. Several patterns are evident that have direct implications for specification and identification of our empirical models.[10]

Note first the upward trend in mortgage activity in each panel as one moves to the right towards communities of higher relative economic status. Given that these are raw data plots, this likely

[8] "Special affordable" purchase goals also target very low income borrowers, defined as individuals with income less than 60% of the AMI or less than 80% of AMI if the borrower lives in a tract with median income below 90% of AMI (see Bunce, 2007). The underserved tract, low–moderate income borrower, and special affordable goals are not mutually exclusive, so a single loan purchase can count towards multiple goals.

[9] See also Listokin and Wyly (2000), Myers (2002), and Case et al. (2002) for related discussion.

[10] Plots for the refinance sector display the same upward trend as in Fig. 1 but a less pronounced upward shift in activity among underserved tracts. The lesser upward shift likely reflects the confounding effect of other drivers of refinance activity that play a lesser role in the home purchase market. These include changes in market mortgage rates that affect the value of the prepayment option, and also changes in property values that affect incentives to engage in cash-out refinancing (e.g. Bostic et al., 2009).

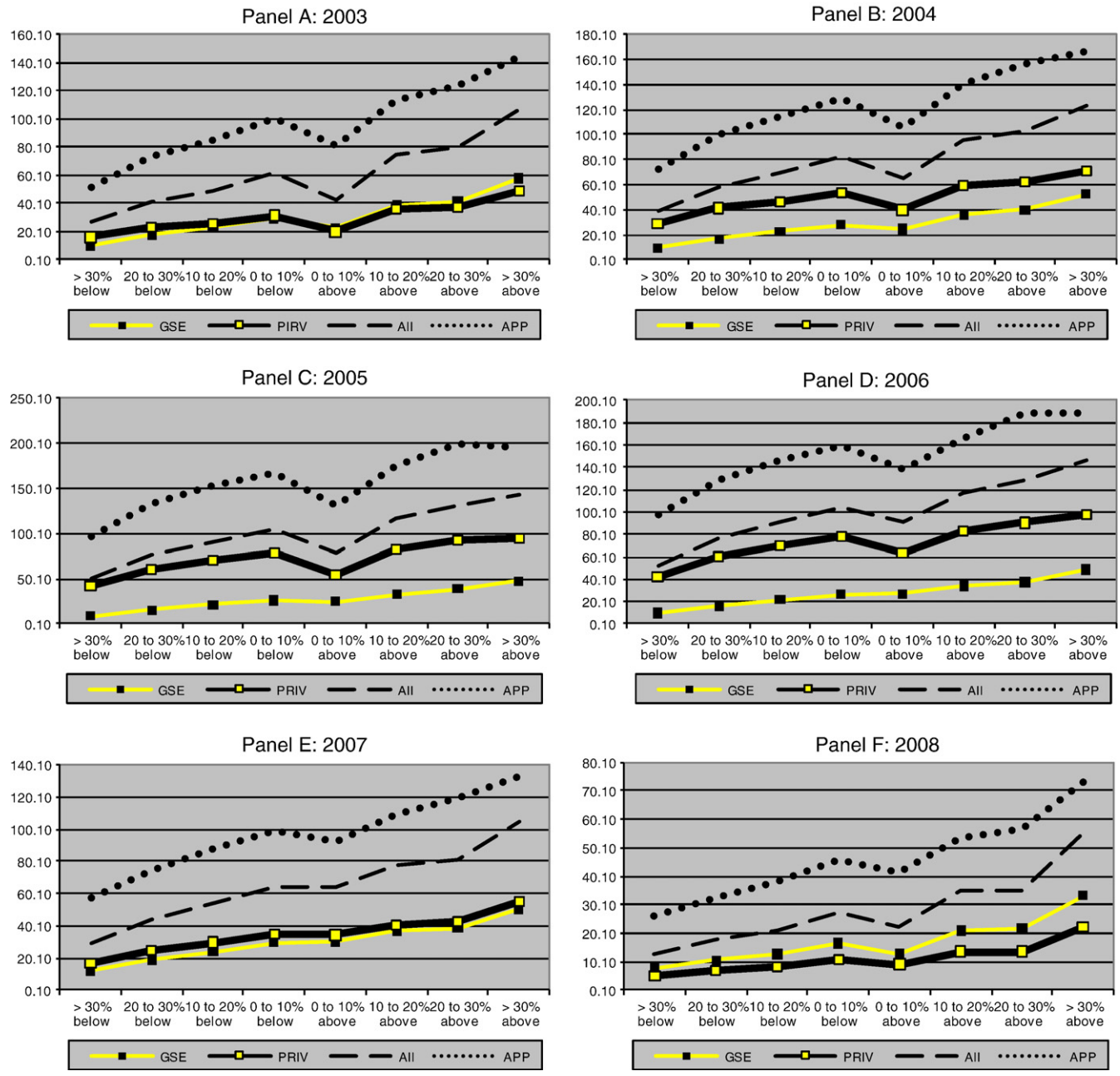

Fig. 1. Home purchase mortgage activity below the conforming size limit by census tract median income relative to the GSE underserved target.

reflects a positive correlation between tract relative income and the level of income and socioeconomic status in the census tract. This also underscores a further important part of our identification strategy. It is necessary to adequately control for a tract's level of socioeconomic status since that could be correlated with the tract's income relative to AMI, and therefore, underserved status. The controls described earlier for a tract's level of socioeconomic status perform that function. Moreover, recall that we also include tract median income divided by AMI as a further control in all of our regressions. Thus, our identification is based on market responses to a census tract's underserved status conditional on both the tract's level of economic status and its income relative to that of the MSA.[11] This further implies that identification relies on an anticipated upward shift in mortgage activity among underserved tracts. Consistent with that strategy, in each panel of Fig. 1, observe that the various plots do display a pronounced upward shift in mortgage activity among tracts below the underserved tract cutoff.[12]

A final important pattern in Fig. 1 has implications for our treatment of the applications variable. As described earlier, applications should vary with mortgage interest rates and the attributes of the applicant pool. Absent other considerations, applications can therefore be treated as exogenous to loan purchase activity. In Fig. 1, however, notice that the application plots also display a pronounced upward shifted pattern below the underserved income cutoff. That

[11] In practice, adding tract income relative to AMI did not change the qualitative nature of our crowd out estimates.

[12] Consistent with the aggregate summary measures in Table 1a, notice that in 2003, GSE and non-GSE purchases were broadly similar across low- to high-income groups of census tracts. Beginning in 2004, non-GSE market share rose relative to GSE activity across all census tract groups, peaking in 2006. That pattern reversed in 2007 and 2008 as the private sector of the market retrenched, both in aggregate (as in Table 1a), and also for individual groups of census tracts as organized in Fig. 1.

shift is suggestive that targeting of underserved tracts by the 1992 GSE Act may cause local lenders to ease underwriting standards and/or reduce mortgage interest rates, presumably to accommodate increased demand for loan purchases by generating additional loan applications.[13] Such behavior could cause applications to be endogenous to secondary market purchases. For that reason, we estimate all of our instrumental variable models twice. In the first set we treat only GSE loan purchases as endogenous. In the second set we treat both GSE loan purchases and applications as endogenous. In the latter case, for a second instrument we use the lagged homeownership rate in the census tract. The presence of homeowners clearly generates mortgage applications, both for home purchase and refinance activities. However, conditional on applications, GSE loan purchases, the extensive set of socioeconomic controls described above, and county fixed effects, it is difficult to see why lagged homeownership rates would have any natural role in a model of private sector secondary market loan purchases. Accordingly, we believe a case can be made for using lagged local homeownership rates as a valid instrument.[14]

Results from our estimation confirm that it is important to control for the endogenous nature of GSE purchases: in nearly every sample year and for both home purchase and refinance loans, OLS yields downward biased estimates of GSE crowd out relative to the IV regressions, as anticipated. In contrast, treating applications as endogenous has less effect on most of our estimates. Our findings also indicate that for home purchase loans, evidence of GSE crowd out is limited during the 1994–2001 period, jumps up to a peak of roughly 45 to 50% in 2005, but then disappears in 2007 and 2008 with the onset of the financial crash. These patterns are mirrored in the refinance segment of the market, although the patterns there are more muted and more sensitive to whether applications are treated as endogenous. 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 to 2008. In the current environment, our results suggest that the 2008 government takeover of Fannie Mae and Freddie Mac likely did much to ensure a continued flow of credit to the mortgage market 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 and develops the empirical model. Section 4 presents data. Section 5 presents the results, and Section 6 concludes.

2. Previous studies of crowd out and GSE effects

Several previous studies have sought to provide evidence of the effects of the GSE loan purchase goals 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.[15] 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, 2008) restrict their attention to census tracts in 1996 and 2000 just below and just above 90% of an MSA's median income, the cutoff used to define underserved tracts. 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.

To our knowledge, no previous study of the mortgage market has directly considered the crowd out effects associated with GSE loan purchases. This is in contrast to other markets in which public sector crowd out of private 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 et al., 2006; Gruber and Simon, 2007), and public construction of low- and moderate income housing (Murray, 1983, 1999; Sinai and Waldfogel, 2005; Eriksen and Rosenthal, in press). 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% of the expansion in public health insurance during the 1996–2002 period was offset by crowd out of private market insurance.[16] Sinai and Waldfogel (2005) and Eriksen and Rosenthal (in press) both find high rates of crowd out associated with publicly subsidized construction of low- and moderate income housing.[17] Given evidence of substantial crowd out in these studies, it is plausible that similarly large crowd out effects could arise from GSE loan purchases in the secondary mortgage market. The extent to which such crowd out occurs and its implications for GSE provision of mortgage market liquidity are considered in the remaining sections of this paper.

3. Model

3.1. Conceptual framework

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 Fig. 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 is based on the presumption that the remaining loans held in portfolio by primary lenders tend to be highly valued, and that for any given pool of loan applicants primary lenders originate the most profitable loans first.

[13] See Gabriel and Rosenthal (2010) for further discussion of this issue.

[14] For sample years prior to 2000 we instrument with the 1990 tract homeownership rate. For subsequent years we use the 2000 tract homeownership rate. Details are provided later in the paper.

[15] 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.

[16] Brown and Finkelstein (2004) and Brown et al. (2006) provide related evidence that Medicaid may crowd out private health insurance for up to two-thirds of the wealth distribution.

[17] 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 (in press) obtain estimates closer to 100% for the Low Income Housing Tax (LIHTC) program. Murray (1983, 1999) 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 (in press) who use micro data. Murray 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.

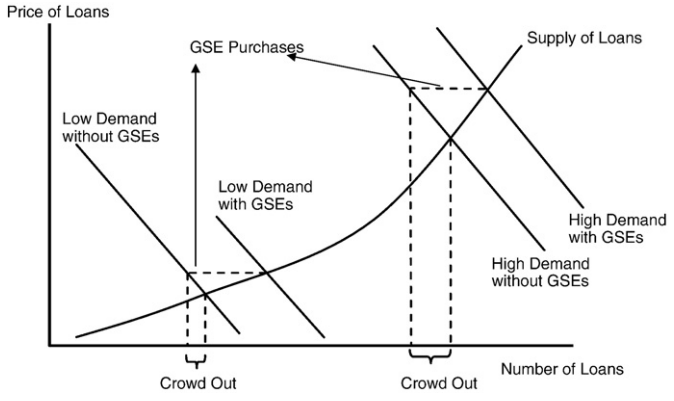

Fig. 2. Crowd out in the secondary market.

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 lenders in the primary market to supply additional loans to the secondary market.[18] Under these conditions, GSE crowd out of private sector loan purchases 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 a much smaller amount. In this instance, GSE crowd out of private secondary market loan purchases is more pronounced.

These two scenarios highlight core principles of our analysis: crowd out from GSE activity increases when demand for loan purchases is high and secondary market loan supply is inelastic, and crowd out is reduced when demand shifts back to a more elastic portion of the supply curve. This implies that our analysis should allow for differences in of GSE crowd out effects over time.

3.2. Empirical model

This subsection describes our empirical approach. Given the principles just outlined, our empirical work is conducted separately for different sample years from 1994 to 2008. Recall also from the Introduction that our unit of observation is the census tract. For that reason, in the discussion below, we subscript the relevant variables with t and n to denote the time period and neighborhood.

In each time period and location, the supply of loans potentially available for sale in the secondary market is determined by the number of applications submitted to primary lenders and the propensity for applications to be denied. This is because only loans that have been originated can be sold. Applications reflect household demand for mortgage credit and depend on mortgage rates (r_t) and the attributes of the applicant pool (Z_{tn}),

$$A_{tn} = A(r_t, Z_{tn}). \tag{3.1}$$

In Eq. (3.1) we implicitly assume that mortgage rates (and related underwriting standards) do not vary across locations, and that applications do not depend on the local level of secondary market activity. These assumptions are relaxed shortly.

Denials of applications in a given community also depend on r_t and Z_{tn} where in this case Z proxies for credit risk associated with the local applicant pool. Local secondary market loan purchases may also influence denials because of the secondary market's potential to manage risk more efficiently relative to primary lenders. We denote the level of secondary market purchases in a neighborhood and period as P_{tn}, including both GSE and non-GSE purchases. If GSE loan purchases are not fully offset by crowd out of private sector activity, then P_{tn} is sensitive to GSE activity, and P_{tn} is written as $P(P_{tn}^{GSE})$. Denials are then represented by,

$$D_{tn} = D\left(r_t, P\left(P_{tn}^{GSE}\right), Z_{tn}\right). \tag{3.2}$$

From Eqs. (3.1) and (3.2), supply in the secondary market is given by,

$$S_{tn}^{Supply} = S_t(A_{tn}, D_{tn}) = S_t\left(A_{tn}, r_t, P\left(P_{tn}^{GSE}\right), Z_{tn}\right). \tag{3.3}$$

In Eq. (3.3), notice that supply depends on GSE purchases only to the extent that those purchases are not fully offset by crowd out of private sector loan purchases. We retain applications in the second line of Eq. (3.3) for reasons that will become apparent.

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

$$S_{tn}^{Demand} = S\left(r_t, \Omega_t, P_{tn}^{GSE}, Z_{tn}\right). \tag{3.4}$$

Equilibrium mortgage rates (and underwriting standards) are determined in the secondary market by the supply and demand for residential loans. Both here and going forward, we allow for the possibility that *locally* active secondary markets may help to ease underwriting standards so as to elicit additional loan applications. This would be consistent with the upward shift in applications among underserved census tracts described in the Introduction and displayed in Fig. 1.[19] Accordingly, we write the local equilibrium mortgage rate as,

$$r_{tn}^{*} = r\left(\Omega_t, P\left(P_{tn}^{GSE}\right), Z_{tn}\right). \tag{3.5}$$

Substituting Eq. (3.5) back into Eq. (3.1), it is clear that applications may be sensitive to local secondary market activity and may be endogenous. We address this issue in the empirical work to follow.

Bearing in mind that secondary market purchases equal the sum of private intermediary plus GSE purchases, we now substitute Eq.(3.5) into Eqs. (3.3) and (3.4) and solve for the private sector level of secondary market loan purchases,

$$P_{tn}^{private} = P\left(\Omega_t, A_{tn}, P_{tn}^{GSE}, Z_{tn}\right). \tag{3.6}$$

This expression says that the level of private sector secondary market loan purchases in the local market depends on global capital market conditions at time t, the local number of applications, GSE loan purchases, and attributes of the local applicant pool. In the empirical work to follow, we approximate Eq. (3.6) with a linear specification, treating each census tract as a separate observation, and estimating separately for each sample year from 1994 through 2008.

[18] 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.

[19] The impact of local secondary market activity on local access to credit is examined more fully in Gabriel and Rosenthal (2010). In that paper we show that the size of loan applications is higher in census tracts with locally active secondary markets, ceteris paribus.

Table 2a
Private sector purchases of conventional home purchase loans below the conforming size limit (standard errors clustered at the county level in parentheses)[a].

Panel A: Ordinary least squares

	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSE purchases	0.06592	0.0901	0.09067	0.18806	0.06425	−0.05108	−0.19572	−0.248	−0.24729	−0.06113	0.30063	0.36201
	(0.0194)	(0.0140)	(0.0136)	(0.0175)	(0.0231)	(0.0400)	(0.0384)	(0.0429)	(0.0749)	(0.0695)	(0.0481)	(0.0651)
Applications	0.17914	0.16189	0.1931	0.18935	0.24087	0.3311	0.43431	0.53388	0.6205	0.58943	0.35483	0.12934
	(0.0079)	(0.0050)	(0.0057)	(0.0076)	(0.0137)	(0.0210)	(0.0164)	(0.0227)	(0.0296)	(0.0255)	(0.0196)	(0.0331)
Overall R-square	0.73	0.75	0.79	0.84	0.85	0.88	0.9	0.93	0.95	0.96	0.93	0.86
Root MSE	5.13	5.91	8.01	8.44	9.33	10.06	14.19	20.3	28.97	25.99	17.19	8.05
Observations	45979	47807	49826	49425	49357	49436	49668	50043	50131	50166	49634	46733

Panel B: 2SLS with applications exogenous

	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSE purchases	−0.14329	0.06511	0.0341	0.05152	−0.04202	−0.12543	−0.26388	−0.29707	−0.51782	−0.26262	−0.05655	0.32732
	(0.0913)	(0.0437)	(0.0550)	(0.0736)	(0.0778)	(0.0742)	(0.0693)	(0.1088)	(0.1224)	(0.0928)	(0.0992)	(0.1789)
Applications	0.23957	0.16822	0.21097	0.23226	0.28482	0.36281	0.45914	0.54697	0.66957	0.62686	0.47611	0.14504
	(0.0289)	(0.0132)	(0.0180)	(0.0250)	(0.0349)	(0.0340)	(0.0263)	(0.0389)	(0.0425)	(0.0290)	(0.0389)	(0.0869)
1st Stage: Underserved	−1.5814	−2.9676	−3.3749	−2.6934	−2.9015	−2.8460	−4.5526	−5.1149	−6.5391	−6.3987	−3.3434	−0.9700
	(−9.76)	(−10.67)	(−6.44)	(−6.53)	(−8.48)	(−9.03)	(−9.57)	(−9.56)	(−13.22)	(−12.14)	(−9.37)	(−4.78)
Kleibergen–Paap	95.22	113.91	41.50	42.71	71.94	81.59	91.54	91.48	174.71	147.32	87.77	22.82

Panel C: 2SLS with applications endogenous

	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSE purchases	−0.11981	−0.09869	−0.07674	0.00636	−0.06531	−0.11522	−0.31852	−0.43904	−0.35283	−0.18094	0.1299	−0.11725
	(0.1024)	(0.0649)	(0.0752)	(0.0795)	(0.0710)	(0.0729)	(0.0863)	(0.1200)	(0.0956)	(0.0896)	(0.1065)	(0.1987)
Applications	0.22911	0.25658	0.28131	0.26129	0.30144	0.35543	0.48844	0.6101	0.60472	0.59416	0.38599	0.25775
	(0.0341)	(0.0238)	(0.0295)	(0.0255)	(0.0301)	(0.0345)	(0.0359)	(0.0377)	(0.0277)	(0.0269)	(0.0429)	(0.0976)
1st stage GSE:	−3.284	−4.234	−4.447	−3.064	−4.086	−4.72	−10.895	−9.665	−9.557	−9.412	−8.698	−4.286
underserved	(0.2994)	(0.3780)	(0.7927)	(0.7698)	(0.9480)	(1.0000)	(0.8836)	(0.8599)	(0.8085)	(0.7876)	(0.7340)	(0.4649)
1st stage GSE: ownership	15.483	18.972	31.06	28.913	36.524	39.391	42.207	38.184	31.937	31	32.205	23.714
	(0.8626)	(1.0569)	(1.4144)	(1.8787)	(2.3234)	(2.4978)	(3.0876)	(3.2804)	(3.0857)	(3.1568)	(3.3512)	(2.0355)
Kleibergen–Paap	32.63	22.96	18.90	22.76	43.24	41.80	23.39	25.14	27.58	20.73	18.27	10.14

[a] Model controls include census tract attributes of the loans and loan applicants for each year from the HMDA files, and socioeconomic (SES) attributes of the tract population from the decennial census. SES controls are drawn from the 1990 census for years prior to 2000, and from the 2000 census from 1998 on. HMDA controls include tract median size loan requested, median applicant income, percent of applicants minority (Hispanic or African American), and percent of applicants female. Census SES controls include tract percent Hispanic, percent African American, average age of the tract population, percent of adults with high school degree, percent with some college, percent with college or more, population density, median income, and the ratio of tract median income to MSA median income (AMI). All models include county fixed effects and standard errors are clustered at the county level.

4. Data

Data for the analysis were partly described in the Introduction and include information 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 2008. 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 for local socioeconomic attributes of the census tract population were described in the Introduction.[20]

Census tract underserved status was determined based on guidelines outlined by the 1992 GSE Act and HUD. For the 1994–2002 HMDA regressions, 1990 census tract and MSA attributes were used to determine a tract's underserved status, consistent with HUD procedures. For the 2003–2008 sample HMDA regressions, year 2000 census tract attributes were used to determine underserved status. In both instances, a tract was coded as underserved if the tract median income was below 90% of the tract's MSA median income, or if tract median income is below 120% of MSA median income and the tract's Hispanic plus African American population exceeded 30%.

To further clean the data, certain observations were dropped. In calculating tract level mortgage attributes (e.g. purchases, applications), individual loan records from the HMDA data were dropped if the type or purpose of the loan could not be determined. As indicated above, we also limit our analysis to conventional, conforming sized loans in census tracts located within defined MSAs.[21]

5. Estimation results

5.1. Overview

Tables 2a and 2b present our estimation results for each sample year for the home purchase and refinance sectors, respectively. In each table, three sets of results are provided that differ in the model specification: Panel A presents OLS estimates, Panel B presents 2SLS estimates treating GSE purchases as endogenous, and Panel C presents 2SLS estimates treating both GSE purchases and applications as endogenous. In all cases, standard errors are reported based on

[20] As is well known, HMDA data do not provide information on individual loan applicant wealth or credit score (credit history). However, 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.

[21] We thank Glenn Canner for assisting us in identifying the relevant conforming loan size limits.

Table 2b
Private sector purchases of conventional refinance loans below the conforming size limit (standard errors clustered at the county level in parentheses).[a]

Panel A: Ordinary least squares

	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSE purchases	0.04469	0.12723	−0.03128	0.27568	0.15273	0.15886	0.11189	0.15963	0.47447	0.56686	0.63716	0.51286
	(0.0239)	(0.0224)	(0.0222)	(0.0554)	(0.0139)	(0.0155)	(0.0212)	(0.0347)	(0.0858)	(0.0551)	(0.0264)	(0.0313)
Applications	0.11173	0.09684	0.18884	0.09975	0.11197	0.12941	0.18205	0.2507	0.27557)	0.28245	0.13561	0.02634
	(0.0090)	(0.0081)	(0.0107)	(0.0093)	(0.0051)	(0.0075)	(0.0130)	(0.0152)	(0.0134	(0.0112)	(0.0075)	(0.0059)
Overall R-square	0.61	0.6	0.75	0.74	0.86	0.9	0.92	0.91	0.93	0.94	0.93	0.86
Root MSE	3.17	4.15	10.12	4.63	9.28	11.68	19.09	15.92	18.72	15.58	9.7	6.35
Observations	45979	47807	49826	49425	49357	49436	49668	50043	50131	50166	49634	46733

Panel B: 2SLS with applications exogenous

	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSE purchases	0.06053	−0.08109	−0.27523	−0.06539	−0.02275	−0.13586	−0.23188	−0.25946	−0.4176	−0.32899	0.25021	0.03597
	(0.0536)	(0.0353)	(0.0586)	(0.0896)	(0.0529)	(0.0660)	(0.0661)	(0.0779)	(0.1090)	(0.1280)	(0.0802)	(0.3597)
Applications	0.10779	0.13527	0.27157	0.12631	0.17003	0.24394	0.33225	0.32654	0.4005	0.38311	0.19917	0.16598
	(0.0144)	(0.0090)	(0.0212)	(0.0115)	(0.0183)	(0.0260)	(0.0312)	(0.0210)	(0.0269)	(0.0193)	(0.0160)	(0.1071)
1st stage: underserved	−1.5019	−2.3566	−4.8054	−1.1853	−4.5358	−5.4125	−10.647	−7.6801	−5.9606	−3.7336	−2.9616	−0.83751
	(−9.25)	(−13.08)	(−6.96)	(−10.81)	(−7.06)	(−6.49)	(−7.36)	(−13.80)	(−13.86)	(−14.47)	(−11.42)	(−2.68)
Kleibergen–Paap	85.51	171.10	48.41	116.94	49.82	42.14	54.23	190.43	192.12	209.29	130.45	7.16

Panel C: 2SLS with applications endogenous

	1994	1996	1998	2000	2001	2002	2003	2004	2005	2006	2007	2008
GSE purchases	−0.01681	−0.27947	−0.18186	−0.13933	0.04826	−0.02948	−0.11676	−0.12729	−0.11648	−0.00586	0.18477	0.0121
	(0.0841)	(0.0597)	(0.0422)	(0.0968)	(0.0402)	(0.0526)	(0.0631)	(0.1079)	(0.1339)	(0.1953)	(0.1169)	(0.1729)
Applications	0.14137	0.21756	0.22631	0.14282	0.13731	0.19082	0.26972	0.27974	0.31573	0.3141	0.21584	0.17386
	(0.0281)	(0.0162)	(0.0151)	(0.0112)	(0.0126)	(0.0207)	(0.0297)	(0.0291)	(0.0274)	(0.0292)	(0.0252)	(0.0522)
1st stage GSE: underserved	−2.4439	−3.12732	−11.709	−1.04619	−11.0425	−16.3203	−38.0626	−10.646	−8.17885	−5.11607	−5.31965	−5.6064
	(0.2080)	(0.1907)	(0.9898)	(0.1410)	(1.1211)	(1.7682)	(2.5240)	(0.9413)	(0.7277)	(0.5291)	(0.5293)	(0.4637)
1st stage GSE: ownership	15.45288	15.51417	58.46146	10.29623	75.67446	115.1653	203.5256	60.86241	44.897	32.82312	36.64883	35.51461
	(0.8672)	(0.7010)	(2.4761)	(0.4070)	(2.7904)	(4.0409)	(7.3369)	(2.8886)	(2.4929)	(1.6544)	(1.8071)	(1.4099)
Kleibergen–Paap	24.72	50.68	36.61	47.61	36.48	33.84	42.34	80.87	76.98	63.26	51.84	9.73

[a] Model controls include census tract attributes of the loans and loan applicants for each year from the HMDA files, and socioeconomic (SES) attributes of the tract population from the decennial census. SES controls are drawn from the 1990 census for years prior to 2000, and from the 2000 census from 1998 on. HMDA controls include tract median size loan requested, median applicant income, percent of applicants minority (Hispanic or African American), and percent of applicants female. Census SES controls include tract percent Hispanic, percent African American, average age of the tract population, percent of adults with high school degree, percent with some college, percent with college or more, population density, median income, and the ratio of tract median income to MSA median income (AMI). All models include county fixed effects and standard errors are clustered at the county level.

clustering at the county level. All of the models also include an extensive array of socioeconomic controls along with county fixed effects. Although these additional controls are important, Tables 2a and 2b present only the coefficients on GSE loan purchases and applications, partly to conserve space and partly to focus first on the primary coefficients of interest. For three sample years for the home purchase sector, Table 3 presents the complete set of model coefficients for both the first and second stage equations when both GSE purchases and applications are treated as endogenous.

5.2. Home purchase loans

We focus first on the home purchase sector and begin with the OLS estimates in Panel A. As discussed in the Introduction, we anticipate a positive OLS bias to the extent that local unobserved factors attract both GSE and non-GSE loan purchases. For that reason, recall that OLS likely understates the degree of GSE crowd out. A comparison of the coefficients on GSE loan purchases in the three panels is consistent with this prior. For each sample year, the OLS coefficient in Panel A is a more positive number, sometimes substantially so. Bearing this in mind, observe that for the sample years from 1994 through 2001 the OLS coefficients in Panel A are positive and relatively small (less than 0.1).[22] Between 2002 and 2006, the OLS coefficients are negative and reach a peak in 2004 and 2005 of −0.25. The coefficients then diminish to −0.06 in 2006 and further rise to positive 0.3 (roughly) and are highly significant in 2007 and 2008. As lower bound estimates, these measures provide compelling evidence that GSE crowd out of private secondary market activity was substantial during the housing finance boom of 2003 to 2006. They do not reveal much about the extent of crowd out prior to that time, or since the onset of the financial crash in 2007.

Turning to Panels B and C, in which GSE purchases are treated as endogenous, a similar qualitative temporal pattern is present. Notice, however, that in both of these latter panels there are few years in which the GSE purchase coefficient is positive, and no years in which the coefficient is positive and significantly different from zero. This reflects again the OLS bias and the importance of instrumenting for GSE loan purchases.

Focusing next on Panel B – for which applications are treated as exogenous – evidence of GSE crowd out is very limited from 1994 through 2001, with coefficients negative but mostly small (below 0.1 in magnitude) and insignificant.[23] Beginning in 2002, however, crowd out effects increase, with the GSE purchase coefficient rising in magnitude from −0.125 in 2002 (with a t-ratio of −1.69) to a peak of −0.518 in 2005 (with a t-ratio of −4.23). Crowd out remains high and significant in 2006 (a coefficient of −0.26 with a t-ratio of −2.83), but then falls sharply with the onset of the financial crisis. In 2007, the GSE purchase coefficient is just −0.056 and in 2008 the coefficient is positive 0.327. Overall, the qualitative pattern is as before: little evidence of crowd out prior to the lending boom of 2003–2006, substantial crowd out during the boom, and no evidence of crowd out once the financial crash took hold.

[22] The only exception is for 2000 for which the coefficient is positive 0.188.

[23] The exception is for 1994 for which the crowd out coefficient is −0.14, but the estimate is not precise enough to be confident of a crowd out effect.

Table 3
Selected complete 1st and 2nd stage regressions dependent variable: private sector purchases of home purchase loans (standard errors clustered at the county level in parentheses).

Tract attribute controls	1998			2004			2008		
	1st stage GSE purchase	1st stage applications	Private purchase	1st stage GSE purchase	1st stage applications	Private purchase	1st stage GSE purchase	1st stage applications	Private purchase
GSE purchases	–	–	−0.077	–	–	−0.439	–	–	0.117
	–	–	(0.075)	–	–	(0.120)	–	–	(0.198)
Applications	–	–	0.281	–	–	0.610	–	–	0.258
	–	–	(0.029)	–	–	(0.038)	–	–	(0.098)
Underserved tract	−4.447	−4.601	–	−9.665	−17.270	–	−4.286	−7.471	–
	(0.793)	(1.484)	–	(0.860)	(2.399)	–	(0.465)	(0.987)	–
Homeownership rate (lagged)	31.06	82.64	–	38.18	141.6	–	23.71	50.70	–
	(1.414)	(3.500)	–	(3.280)	(11.83)	–	(2.036)	(4.374)	–
Median loan size requested ($1000s)	0.300	0.285	0.016	0.166	0.421	0.054	0.071	0.082	0.020
	(0.044)	(0.068)	(0.018)	(0.037)	(0.123)	(0.013)	(0.015)	(0.035)	(0.008)
Median Loan Applicant Inc. ($1000s)	−0.087	−0.163	−0.030	0.013	−0.058	−0.043	0.063	0.315	−0.049
	(0.051)	(0.099)	(0.014)	(0.043)	(0.141)	(0.028)	(0.026)	(0.083)	(0.026)
% of applicants Af. Amer.	−20.09	−17.77	−6.946	14.03	168.7	−22.14	5.417	27.68	−6.206
or Hispanic Hispanic	(3.755)	(8.668)	(2.347)	(6.911)	(26.31)	(5.426)	(4.794)	(11.53)	(2.630)
% of applicants female	−12.96	28.430	−1.850	7.032	67.01	7.490	−7.436	−17.40	1.757
	(3.101)	(7.143)	(2.011)	(5.096)	(19.59)	(2.539)	(2.331)	(5.305)	(0.732)
Average age of resident	−0.561	−2.145	0.051	−1.112	−5.303	−0.146	−0.764	−1.747	−0.007
	(0.094)	(0.231)	(0.029)	(0.154)	(0.470)	(0.085)	(0.096)	(0.194)	(0.023)
% African American residents	−0.804	−36.64	5.139	−23.04	−110.81	3.583	−10.28	−26.39	1.727
	(2.062)	(6.383)	(1.567)	(4.132)	(16.71)	(2.405)	(3.349)	(7.830)	(1.016)
% Hispanic residents	2.263	−33.01	2.387	−1.437	16.88	−11.75	−3.447	−4.990	−2.673
	(3.772)	(9.093)	(1.646)	(5.322)	(17.95)	(2.966)	(3.517)	(7.797)	(1.477)
% of age 25+ residents high school deg.	−17.42	7.631	−4.268	−0.082	45.88	−15.14	−12.01	−6.419	−5.649
	(5.478)	(11.74)	(2.052)	(8.200)	(25.21)	(4.074)	(4.099)	(9.875)	(2.927)
% of age 25+ residents some college	43.35	76.41	7.024	80.17	316.8	0.636	42.26	86.01	−3.483
	(5.659)	(12.91)	(1.792)	(8.781)	(26.03)	(3.975)	(4.554)	(10.88)	(1.824)
% of age 25+ residents college deg	36.30	31.19	5.197	40.62	70.33	−8.438	19.53	31.63	3.493
	(4.721)	(11.061)	(2.071)	(6.458)	(21.31)	(4.906)	(3.501)	(8.412)	(1.973)
Unemployment rate	0.304	−53.88	4.779	−19.61	−105.8	8.079	−15.36	−44.25	1.679
	(3.800)	(10.32)	(2.213)	(5.523)	(19.44)	(2.720)	(4.000)	(8.608)	(2.181)
Population density	1.40E−04	2.40E−04	0.50E−04	1.60E−04	4.90E−04	−0.30E−04	0.80E−04	3.00E−04	−0.10E−04
	(0.2E−04)	(0.9E−04)	(0.2E−04)	(0.4E−04)	(1.5E−04)	(0.2E−04)	(0.4E−04)	(1.8E−04)	(0.05E−04)
Tract median household income	−0.636	−0.941	−0.006	−0.924	−2.778	0.147	−0.639	−1.392	0.037
	(0.080)	(0.154)	(0.032)	(0.105)	(0.305)	(0.039)	(0.073)	(0.148)	(0.028)
Tract median household income /AMI	24.85	39.44	−0.062	33.65	107.9	−6.705	25.19	53.77	−1.734
	(4.204)	(7.732)	(1.550)	(6.279)	(18.80)	(2.026)	(4.420)	(9.303)	(1.324)
Constant	4.607	83.50	–	17.53	102.0	–	20.34	52.82	–
	(6.677)	(13.71)	–	(9.687)	(30.82)	–	(4.675)	(10.16)	–
Kleibergen–Paap Weak Inst. test	–	–	18.90	–	–	25.14	–	–	10.14
County fixed effects and county clustering	854	854	848	854	854	849	854	854	847
R-square	0.29	0.16	0.75	0.12	0.09	0.93	0.10	0.08	0.85
Observations	49776	49776	49770	50010	50010	50005	46720	46720	46713

The patterns thus far provide clear evidence of substantial crowd out during the housing/finance boom years of the mid-2000s. However, the large positive and significant 2008 coefficient on GSE purchases requires further comment since the sign is the opposite of what would be predicted with crowd out. One possible explanation outside of our model developed earlier is that agglomeration economies arising from the local presence of the GSEs could enhance opportunities for private sector entities to purchase loans (e.g. Rosenthal and Strange, 2004), causing the coefficient on GSE loan purchases to be positive. This might occur if GSE activity helped to establish and/or maintain information and business networks 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. Indeed, one of the original motives behind the government's expanded mandate for the GSEs in the 1992 GSE Act was to help nurture the development of a robust secondary market for mortgage loans. The positive 2008 coefficient on GSE purchases, therefore, may be correct.[24]

While the above explanation for the positive 2008 coefficient is certainly plausible, a different possible explanation is that our model may not be adequately specified to deal with the turmoil in mortgage markets following the onset of the 2007 financial crisis. Summary measures in Table 1a for home purchase loans, for example, show that applications fell precipitously between 2006 and 2008, averaging 160 per census tract in 2006, 104 per tract in 2007, but just 52.7 in 2008. A third possible explanation, also related to model specification, is motivated by the upward shifted pattern of applications in underserved census tracts in Fig. 1, including for 2008. As noted earlier, that shift is suggestive that increased local GSE activity may encourage lenders in the primary market to solicit additional loan applications. These considerations suggest that applications may be endogenous, possibly in a way that might contaminate our 2008 estimate of the GSE purchase coefficient.

To allow for this later possibility, in Panel C we instrument for applications using lagged tract homeownership rates as described earlier.[25] As suggested above, increased local secondary market activity may result in some easing in local underwriting standards,

[24] From this perspective, in 2008 the benefits from agglomerative spillovers associated with GSE activity may have been especially important given the financial crisis, while at the same time competition for market share was limited, causing this 2008 coefficient be become positive.

[25] Recall that for sample years prior to 2002 we use the 1990 tract homeownership rate obtained from the census, while for the latter years we use the year-2000 homeownership rate.

causing local applications to increase. This would cause the non-IV estimate of the coefficient on applications to be upward biased. Comparing the coefficients on applications in Panels B and C, which treat applications as exogenous and endogenous, respectively, provides mixed support for this prior. In most sample years, there is little difference in the coefficients. In 2007, the coefficient on applications is noticeably smaller in Panel C than in Panel B, but the reverse is true in 2008. Thus, although the OLS bias goes in the anticipated direction in 2008, it does not in 2007. Based on these patterns, the possibility remains that applications may be exogenous and that local GSE activity in 2008 helped to prop up the private sector as suggested by the positive GSE purchase coefficient in Panel B.

Bearing this in mind, consider nevertheless the GSE purchase coefficients in Panel C. Once again, the qualitative temporal pattern described above persists: relatively little crowd out prior to 2002, substantial crowd out during the financial boom years, and no evidence of crowd out in 2007 and 2008. The estimates in Panel C are also suggestive of slightly more crowd out in the 1990s relative to estimates in Panel B, and slightly less thereafter. For example, crowd out estimates in Panel C peak in 2004 at −0.439, and decline thereafter to −0.35 in 2005 and −0.18 in 2006. In 2007 and 2008, the crowd out coefficients in Panel C are positive 0.12 and 0.11, respectively, and both are not distinguishable from zero (with t-ratios of 1.2 and 0.6, respectively).

Summarizing, the three different models in Panels A, B, and C all suggest a qualitatively similar humped shaped pattern to the evolution of GSE crowd out coefficients over time. It appears likely that GSE crowd out of private sector purchase activity was small prior to 2003, but jumped up to roughly 50% during the financial boom, peaking in roughly in 2005, and then disappeared with the crash in 2007. On balance, these patterns are consistent with the qualitative predictions from our simple model outlined in Fig. 2. In particular, the wholesale scaling back of private sector loan demand in 2007 and 2008 would have greatly reduced competition for secondary market purchases. That seemingly moved the secondary market loan demand function back to a more elastic portion of the supply curve, eliminating GSE crowd out. Importantly, this suggests that GSE purchases *did* help to maintain the flow of home purchase mortgage credit during the 2007–2008 financial crisis, consistent with arguments by Treasury Secretary Paulson and others who orchestrated the government's September 2008 takeover of the GSEs.[26]

5.3. Refinance Loans

Table 2b presents estimates of purchases of refinance loans using the same table format as for the home purchase segment (in Table 2a). Relative to Table 2a, notice that in each panel of Table 2b, estimates of the coefficients on GSE loan purchases are less negative, indicating diminished evidence of crowd out. In Panel A, which presents OLS estimates, the GSE purchase coefficient is positive in every year except for 1998. In Panel B, where GSE purchases are treated as exogenous, the qualitative pattern is similar to that of the home purchase market, but more muted. As an example, the GSE crowd out effect peaks at −0.42 in 2005 for the refinance sector (in Panel B) versus roughly −0.52 for the home purchase sector.

More substantial differences arise when comparing estimates in Panel C of Tables 2a and 2b, where both GSE purchases and applications are treated as endogenous. For this specification, the GSE purchase coefficient is roughly −0.12 in 2003–2005, substantially smaller than for the home purchase sector for which the crowd out coefficient peaks at −0.44 in 2004.

Treating applications as endogenous also appears to have a larger impact on the applications coefficients in the refinance sector as compared to the home purchase market, and especially during the boom years in the mid-2000s. Notice that in the mid-2000s, the coefficients on applications in Panel C of Table 2b are roughly 25% smaller in magnitude than the corresponding estimates in Table 2a. These differences are consistent with the idea that in some market sectors primary lenders would have responded to heightened demand for loan purchases by offering incentives to attract additional mortgage applications. It seems plausible that such behavior would have been more pronounced in the refinance sector than the home purchase market, and especially given the concurrent decline in mortgage loan rates that occurred during much of the 2000s.[27] Regardless, overall these patterns suggest that it is more important to treat applications as endogenous when evaluating purchases of refinance loans as compared to purchases of home purchase loans.

5.4. Robustness

Our basic patterns have been established. In this subsection, we discuss additional features of our models that bear on robustness. To facilitate, as noted earlier, Table 3 presents the complete model estimates for 1998, 2004, and 2008 for the home purchase sector, including both the first and second stage regressions, treating both GSE purchases and applications as endogenous. For purposes of discussing questions related to robustness, estimates from these models are indicative of the other sample years and also those for the refinance sector, which are not shown to conserve space.

A quick review of the t-ratios on the first-stage instruments (underserved status and homeownership rates) in Table 3 indicates that the instruments are very strongly correlated with the endogenous variables. This is further confirmed in Tables 2a and 2b where Kleibergen–Paap test statistics for weak instrument bias are presented for each model. In all cases the Kleibergen–Paap test statistics are well beyond the benchmark 10 that is often used as a threshold for gauging potential bias arising from weak instruments (e.g. Murray, 2006; Stock and Yogo, 2005).[28] We conclude, therefore, that weak instrument bias is not a concern.

Instrument exogeneity is more difficult to assess. For this, we rely primarily on economic arguments noted earlier. We also rely on an extensive set of SES controls and county fixed effects to help control for possible spurious correlation between our instruments and local unobserved factors.[29] Consider first the SES controls.

Looking across the columns in Table 3, it is clear that loan applicant and census tract resident SES attributes have considerable explanatory power in the first-stage GSE purchase and applications regressions. Because of the reduced form nature of these models, it is difficult to interpret the individual coefficients. Nevertheless, towards the bottom of the table, two variables bear special attention. Notice that in the first-stage models, higher levels of median income are associated with reduced mortgage activity, all else equal. In addition, higher tract median income relative to AMI is associated with higher levels of applications and GSE purchases, although lesser levels of private sector purchases, all else equal. As emphasized in the

[26] The sharp increase in crowd out effects beginning in 2004 also coincides with an increasing tendency of the GSEs to purchase subprime loans. That purchase strategy mirrored purchase activity embraced by the non-GSEs a few years earlier. This also would have contributed to higher rates of crowd out during the 2004–2006 period.

[27] Nationwide, the average rate on a 30-year fixed rate mortgage fell from an average of 8.03 % in 2000 to a local bottom of 5.83 in 2008 (see http://www.freddiemac.com/pmms/pmms30.htm).

[28] The threshold of 10 as reported by Stock and Yogo (2005) corresponds to a model with homoscedastic errors whereas our models cluster the standard errors at the county level. We are unaware of benchmarks developed for models such as ours, but given that the test statistics are so much larger than 10 in nearly all instances this does not seem to be a substantive concern.

[29] Part of the challenge in assessing instrument exogeneity is that formal diagnostic tests of overidentifying restrictions (e.g. Sargan and Hansen-J tests) are very sensitive to model specification, including whether the standard errors are treated as homoscedastic or generated using robust/clustering methods. In addition, in Panel C our models are exactly identified, precluding calculation of the overidentification tests.

Introduction, these and the other model controls are included to help ensure that our estimates of GSE crowd out effects are identified off of the impact of a census tract's underserved status, conditional on the tract's level of economic status and its economic status relative to the MSA.[30]

Consider next the signs of the instruments in the first-stage equations in Table 3. For both the GSE purchase and applications regressions, the coefficients on the local homeownership rate are always positive, indicating that the presence of homeowners drives applications and contributes to GSE purchases conditional on the other model controls. This is as anticipated.

Notice also that the coefficient on census tract underserved status is always negative. On the surface, this would seem to echo the broad pattern in Fig. 1 which shows that applications increase with a census tract's income relative to AMI. But as noted above, tract median income relative to AMI is already included in the model and has a positive and highly significant coefficient in all of the first-stage regressions.[31] One must look elsewhere, therefore, for an explanation for the negative coefficient on underserved status.

One possibility is that, conditional on applicant pool and resident SES attributes, the GSEs may seek to *minimize* further exposure to relatively low income neighborhoods. This is because the GSEs are subject to two types of purchase goals: goals that target *borrower* income relative to AMI (the low–moderate and special affordable goals), and the *geographic* goal that targets underserved census tracts. The former have been much more demanding in each of our sample years except for 1994. In 2008, for example, the GSEs were obliged to obtain over 55% of their loans from low–moderate income borrowers, but only 39% from underserved tracts. Note also that a single loan purchase can count towards multiple goals, and many low–moderate income borrowers likely reside in underserved tracts. It is possible, therefore, that having satisfied the more stringent borrower income purchase goals, the GSEs are not obliged to purchase additional loans in underserved tracts and seek to minimize further exposure to those communities.

Regardless, we return to the economic arguments that motivate our instruments. Absent the 1992 GSE Act, and conditional on an extensive set of local socioeconomic controls, it is difficult to see why census tract underserved status should have any natural role in explaining private sector loan purchases. The same is true for the local homeownership rate. On the whole, therefore, conditional on the other model controls, we believe that tract underserved status and the local homeownership rate are valid instruments. Moreover, taking the full set of results discussed above into account, including GSE crowd out patterns from the OLS and 2SLS models, we believe that the key features of our results are robust: specifically, little crowd out prior to 2003, pronounced crowd out during 2003–2006 boom, and the absence of crowd out with the onset of the financial crisis.

6. Conclusion

The financial crisis that began in 2007 has been described as the most dramatic financial event in the United States since the Great Depression. At its peak, Fannie Mae and Freddie Mac, two giant government sponsored secondary mortgage market enterprises, teetered on the verge of bankruptcy and were placed in government conservatorship. Making good on longstanding implicit guarantees, the U.S. government provided an infusion of 200 billion dollars in support of the GSEs. The dramatic government takeover of the housing GSEs was based on arguments that those entities provided an essential flow of credit to the economy, and that mortgage lending would all but cease should the GSEs be allowed to fail. That argument hinges on the presumption that GSE loan purchases are not offset by crowding out of loan purchases by private, unsubsidized entities.

We examine this issue by estimating the crowd out effects of the GSEs for most years from 1994 to 2008, both for the home purchase market and also for refinance activity. In all instances, we restrict our attention to the conventional, conforming sized segment of the market, the sector targeted by the 1992 GSE Act as part of regulations that restrict the type of loans that the GSEs can purchase.

Instrumental variable estimates indicate that GSE crowd out effects were small prior to 2002, at a time when many primary lenders still held a noticeable share of loans in portfolio. However, with the boom in the private sector of the secondary market in the mid-2000s, along with the concurrent extreme reliance on the secondary market as a source of financing for mortgage credit, estimates of GSE crowd out jump to roughly 50% by 2005. Dramatically, with the onset of the 2007 financial crash, the private sector of the secondary market pulled back, and evidence of GSE crowd out virtually disappeared.

As a general characterization, these patterns confirm predictions from a simple conceptual model that crowd out effects from GSE purchases should vary with market conditions, and should be most pronounced when demand for loan purchases is high and loan originators hold few loans in portfolio. Of a more immediate nature, our findings also lend support to advocates of the 2008 GSE bailout. Specifically, the disappearance of any hint of GSE crowd out with the onset of the 2007 financial crisis suggests that loans purchased by the GSEs added substantively to the flow of mortgage credit in the U.S. economy. In that regard, the government takeover of Fannie Mae and Freddie Mac appears to have served its primary purpose of enhancing access to mortgage credit during a time of financial crisis.

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[30] Loan applicant median income is also included in the model for similar reasons to above; recall that GSE regulations also target individual borrower income.

[31] We also experimented with adding the square of tract median income to AMI to the models. This had no effect on any of the results of interest, including especially the second stage estimates of GSE crowd out effects. The same was true when we omitted tract median income and its value relative to AMI from the models.

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