

Federal Housing Finance Agency
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Shale Oil Boom and Bust: Implications for the Mortgage Market

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Executive Summary

Beginning in 2005, rising oil prices together with technological developments—horizontal drilling and hydraulic fracturing, also known as fracking—drove an increase in U.S. oil production. These technologies made drilling economically feasible in parts of the country that were not traditional oil producers, particularly “shale” areas. Most U.S. shale oil production has come from three regions: Bakken, primarily in western North Dakota; Permian Basin, primarily in western Texas; and Eagle Ford, primarily in southern Texas.

The shale oil production boom bolstered the growth of employment and population in these regions, which put pressure on local housing markets. Widespread use of nontraditional and temporary housing emerged. Single-family home prices in North Dakota and Texas increased substantially, especially in counties with higher oil and gas industry employment, compared to a decline nationwide. Demand for multifamily rental housing also strengthened, with rents in some places rising rapidly.

Since 2014, oil prices have dropped and currently stand at levels below which new shale oil production is generally economically viable. These three shale oil regions have witnessed a decline in new shale drilling activity over this period. Some areas have seen a rise in unemployment. In some of the regions, the housing markets have slowed, accompanied by early signs of stress. As a result, there is an emerging risk that the shale oil areas could face a further slowdown in their housing markets, which has the potential to adversely impact Fannie Mae and Freddie Mac (collectively, the Enterprises).

In light of concerns about the potential impact of the oil bust on housing raised by Fannie Mae and Freddie Mac, financial and industry entities, and media outlets, we assessed the Enterprises’ business activities in core shale regions during the 2005 to 2015 boom and bust cycle to better understand their potential exposure. We found that less than one-tenth of 1% of the Enterprises’ single-family mortgage acquisitions and less than 1% of their multifamily acquisitions from 2005 to 2015 were concentrated in these regions. From the materials we reviewed, we believe that, as matters now stand, the Enterprises’ potential exposure from this emerging risk is quite small as a proportion of their overall acquisitions.

This whitepaper makes no recommendations.

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ABBREVIATIONS

DSCR	Debt Service Coverage Ratio
Enterprises	Fannie Mae and Freddie Mac, collectively
Fannie Mae	Federal National Mortgage Association
FHFA or Agency	Federal Housing Finance Agency
Freddie Mac	Federal Home Loan Mortgage Corporation
LTV	Loan-to-Value
OIG	Federal Housing Finance Agency Office of Inspector General

BACKGROUND.....

Over the last 100 years, the history of the oil industry in the United States has been one of frequent boom and bust cycles. At the bottom of a cycle, excess oil supply results in low oil prices, which acts to constrain investment in oil exploration (and development of alternative energy ventures). Low oil prices, over time, increase demand, which leads to a tightening supply/demand balance and increase in oil prices. Rising oil prices create an appetite by oil companies to invest in new sources of oil and/or new technologies in certain regions, which gives rise to increased employment and housing demands in those regions. As those new projects come online and supply outstrips demand, prices begin to fall, setting off a bust in oil-related employment in the once booming regions.

In an effort to understand the possible impact on housing in the current cycle for shale oil, we looked to lessons that could be learned from the 1980s oil boom and bust cycle.

1980s Oil Boom and Bust Cycle

In 1979, the overthrow of the Shah of Iran and ensuing revolution in Iran resulted in the loss of 2.0 to 2.5 million barrels per day of oil production. At one point, production almost halted, resulting in a worldwide shortage of oil and a rise in oil prices. Responding to growing energy shortages, President Carter announced a national energy supply shortage and decontrolled oil prices in the United States. He also proposed an \$88 billion effort to enhance production of synthetic fuels from coal and shale oil reserves. In September 1980, Iran was invaded by Iraq, which led to a significant reduction in oil production by both countries. The loss of production from the combined effects of the Iranian revolution and the Iraq-Iran War caused crude oil prices to more than double by 1981. According to Fannie Mae, real oil prices rose more than five-fold from 1973 to 1980, with much of the increase occurring in 1979 to 1980.

The demand for oil, coupled with increases in the cost of oil from an average price of approximately \$13 per barrel in 1979 to \$34 per barrel in 1980, led to increased oil exploration in Texas. For example, drilling rig counts in Texas jumped from a yearly average of 770 in 1979 to 1,318 in 1981 and demands for state leases escalated significantly. Then-record prices for oil also led to drilling in other areas in the Southwest with known oil reserves and new exploration in off-shore areas. Strong demand for oil and concomitantly high prices brought economic prosperity to the Southwest, along with growth in overall employment and population and booming levels of construction for single-family and multifamily housing.

Oil-producing states experienced a regional recession when oil prices collapsed, even though the U.S. economy overall grew at a strong pace. In Texas, the state economy went into a deep recession. According to one estimate, each \$1 drop in the price of oil resulted in the loss of 25,000 jobs and \$100 million in state and local tax revenue in Texas. By September 1986, more than 750,000 Texans were unemployed. The unemployment rate in Houston climbed from 7.4% in January 1986 to 10.5% in September, according to a Federal Deposit Insurance Corporation publication, while the national unemployment rate fell from 7.3% to 6.8% over the same period.

The 1980s oil bust weakened the housing market. Home prices fell in many oil producing states.¹ For example, Texas home prices fell 11% from 1983 to 1988, while prices rose 32% nationwide. In Houston, overbuilding had continued even at the end of the oil boom and then the local residential real estate market collapsed. Nationally, single-family housing starts increased 73% from 1982 to 1987, while housing starts in Houston fell 75% during the same period. Multifamily construction in Houston was almost completely halted. Multifamily vacancy rates reached 18% and rents dropped 14% in total, according to Freddie Mac. In 1987, one in six homes and apartments in the Houston metropolitan area stood vacant. In some communities tied to oil production, foreclosure rates exceeded 60%.

Overall, the 1980s oil bust produced one of the most difficult times for the U.S. mortgage market. FHFA's predecessor, the Office of Federal Housing Enterprise Oversight, was required to identify the region that had experienced the worst single-family mortgage defaults and severity to use in setting the risk-based capital standard for the Enterprises. In 2001, it identified mortgages originated in 1983 and 1984 in Arkansas, Louisiana, Mississippi, and Oklahoma as sustaining the highest mortgage loss rates. The region had been hard hit by the oil bust.

Technological Developments in Oil Extraction

Technological developments have changed oil industry dynamics significantly since the 1980s, making previously unobtainable sources more economically feasible and faster to develop. Over the past decade, the use of horizontal drilling, in conjunction with hydraulic fracturing, has greatly expanded the ability to gainfully recover oil and natural gas from low-permeability geologic regions—particularly from shale areas.² Horizontal drilling is

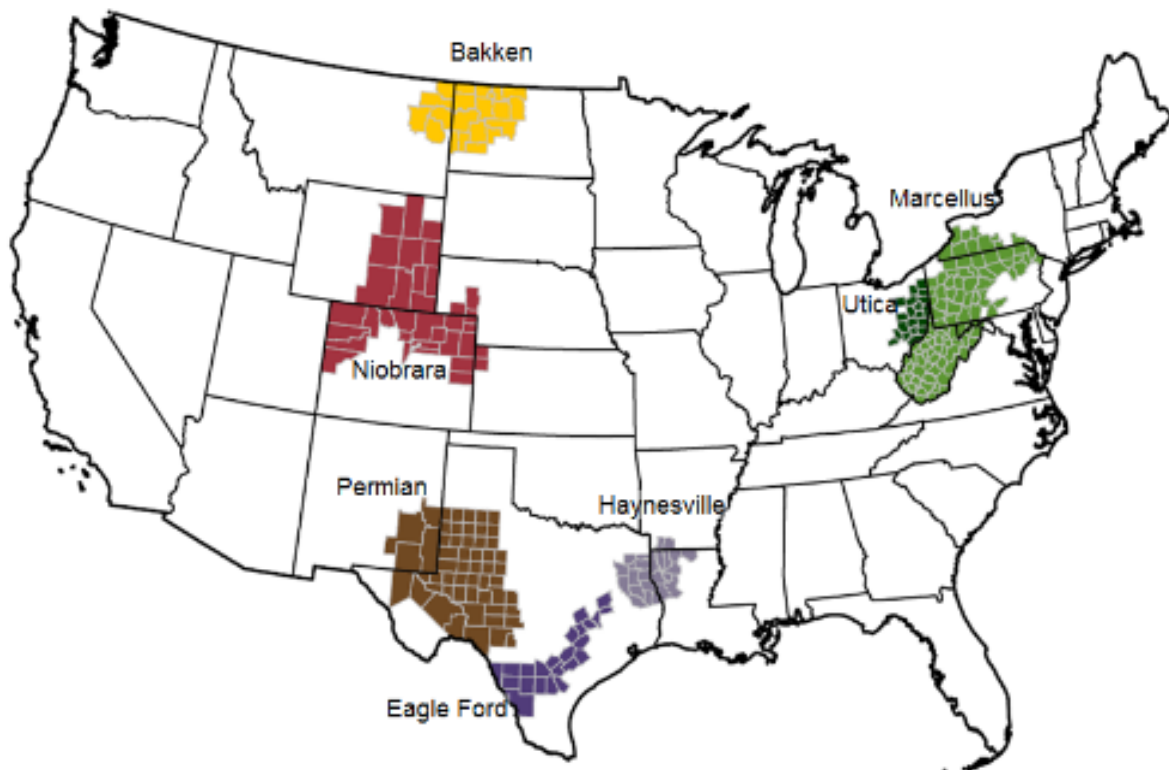
¹ Based on Fannie Mae analysis of FHFA's home price index for homes with mortgages sold to Fannie Mae or Freddie Mac.

² This whitepaper uses the term "shale" to refer to oil from shale and other tight formations like low-permeability sandstone, the recovery of which was made easier by hydraulic fracturing and horizontal drilling. Some shale regions have also produced large volumes of natural gas. We include discussion of the implications of the boom/bust cycle for shale oil and the corresponding geographic areas, but we do not cover shale gas.

conducted by slowly angling a well drill bit until it is drilling horizontally. Hydraulic fracturing, commonly known as “fracking,” involves pumping water, sand, and chemical additives into oil and gas wells at pressure sufficient to fracture underground formations, allowing oil or gas to flow.

The use of these technologies has been clustered in geographic areas, also known as shale plays. There are multiple shale plays across the United States. See Figure 1.

FIGURE 1. KEY SHALE REGIONS IN THE UNITED STATES



Source: U.S. Energy Information Administration.

Since 2006, more than 80% of U.S. shale oil production has come from three regions:

- **Bakken:**³ The Bakken region is where shale oil production got its start. Drilling is concentrated in counties in western North Dakota and across the border in eastern Montana. Williams County, North Dakota, home to the City of Williston, is at the center of shale oil drilling activity in this region.

³ This whitepaper uses the term Bakken region to include both the Bakken and underlying Three Forks formation that span parts of North Dakota and Montana. The joined formations are sometimes referred to as the Williston Basin.

- **Permian:** The Permian Basin was a prolific producer of oil and gas utilizing traditional technology for nearly 100 years, peaking in 1973. It has experienced an oil production resurgence since 2010 with the application of technological advancements to the old reservoirs. The region spans a large portion of West Texas, crossing into areas of southeast New Mexico. Midland-Odessa, Texas, is a key shale oil drilling hub in the Permian Basin.
- **Eagle Ford:** The Eagle Ford field was unknown as recently as 2007 and is now a top shale oil producer in the United States. It includes largely rural counties in southern Texas, stretching to the Mexican border.

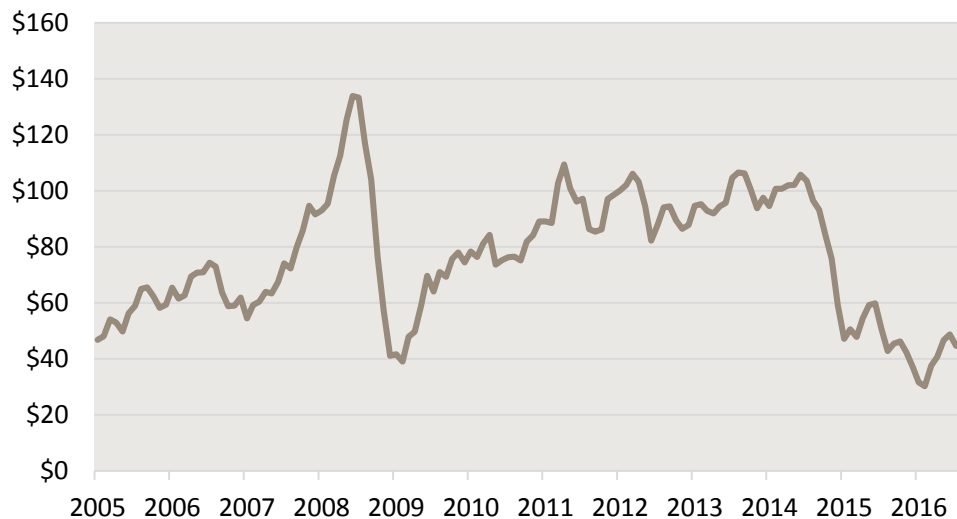
The technological developments in oil drilling enabled the United States to increase its domestic oil production faster than at any time in its history according to the U.S. Energy Information Administration.

THE SHALE OIL BOOM.....

Although new technologies made the extraction of shale oil possible, oil drilled in shale formations is more expensive to produce than traditional oil. As a consequence, drilling for shale oil has proven to be economically viable generally when oil prices reach approximately \$60 to \$65 per

barrel. Between 2005 and 2006, oil prices increased moderately. At year-end 2006, prices began to rise sharply, with a June 2008 peak of about \$134 per barrel. After a short-lived decline, prices rebounded in 2009 and continued to generally rise until mid-2014, as shown in Figure 2. Between January 2009 and June 2014, prices more than doubled, rising from approximately \$42 to \$106 per barrel.

**FIGURE 2. WEST TEXAS INTERMEDIATE CRUDE OIL PRICES
(DOLLARS PER BARREL THROUGH JULY 2016)**



Source: U.S. Energy Information Administration.

As prices increased, so did domestic crude oil production. Between January 2009 and June 2014, overall U.S. oil production increased nearly 70%, driven in large measure by the increasing extraction of shale oil.

Growth of Employment in Shale Oil Regions

The boom in shale oil production bolstered the growth of employment in shale oil regions. While U.S. employment declined slightly between 2006 and 2012, the shale-intensive states of North Dakota and Texas experienced brisk employment growth (3.4% and 1.5%, respectively). During these years, energy-related employment experienced large increases. Texas witnessed a 33% increase in oil and natural gas employment between 2007 and 2012. In Williams County, North Dakota, the Bakken drilling focal point, employment more than doubled from 2007 to 2011, with almost half of the increase due to the mining, quarrying, and oil and gas extraction industry.

Surge in Housing Demand

As employment in shale oil areas grew rapidly, so did the demand for housing, and widespread use of nontraditional and temporary housing emerged. Many workers settled in temporary housing, including recreational vehicles, tents, shipping containers, hotels, and frequently “man camps”—temporary housing compounds supporting the influx of workers in the region. In 2011, Williams County, North Dakota, commissioners approved man camp beds for 12,000—about half the size of the county’s population at that time. The use of such nontraditional housing options was considered an interim solution until subdivisions and apartment complexes could be built.

In 2013, North Dakota’s governor called the supply of housing a great challenge facing the state. Despite more than 16,000 housing units that had been built or started during the previous two years, he said that demand for all types of housing in some communities was rising faster than builders could complete their projects.

From third quarter 2006 to third quarter 2011, single-family home prices in the shale oil states of North Dakota and Texas increased significantly, compared to a decline nationwide. In 2011, FHFA reported that in North Dakota and Texas counties with substantial employment in mining, quarrying, and oil and gas extraction, house prices increased 40% and 9% over this period, respectively. House prices in the other counties of these states increased at a slower rate—12% and 5%. By contrast, house prices nationwide decreased by 19% during the same period.⁴

⁴ For more information, see FHFA, *U.S. House Price Index Report – 3Q 2011 / September 2011* (Nov. 29, 2011) (online at www.fhfa.gov/AboutUs/Reports/ReportDocuments/2011-Q3-September_HPI_508.pdf).

The demand for multifamily housing—typically rental properties with five or more units or apartments—also strengthened during the shale oil boom. Fannie Mae reported that rents in Midland-Odessa, Texas, were estimated to have grown more than 20% in both 2011 and 2012. In 2012, the U.S. Department of Housing and Urban Development reported that rents in the Williston, North Dakota, area were comparable to rents in larger U.S. metropolitan areas. By the end of 2013, Williston had some of the nation’s highest multifamily rents for basic entry-level apartments at over \$2,300 per month—more expensive than the San Francisco or New York areas. Williston added more than 5,750 apartments since 2008, a sizeable increase given its population of approximately 32,000.

THE SHALE OIL BUST

Oil is a volatile market. As we previously explained, the steep decline in oil prices in the 1980s drove a significant loss of jobs and weakened the housing market in oil producing states.

In the current cycle, oil reached a high of \$106 per barrel in June 2014, before oil prices dropped precipitously. Prices fluctuated through the first six months of 2016, from a low point of less than \$30 per barrel during February to more than \$50 per barrel in June. In June 2016, the U.S. Energy Information Administration forecasted a 2016 annual average of about \$43 per barrel—a 60% drop from its 2014 peak. Further, the U.S. Energy Information Administration expects prices to remain low, forecasting crude oil prices to average approximately \$52 per barrel in 2017.

According to industry experts, the drop in oil prices hit shale oil operations especially hard because oil in shale formations is more expensive to produce than traditional oil. As noted above, shale producers generally have found that shale oil cannot be profitably produced unless oil prices exceed approximately \$60 to \$65 per barrel.

As the price of oil declined from 2014 to 2016, new shale drilling activity diminished. According to information published on the website of oilfield services company Baker Hughes, the number of active oil drilling rigs in the United States dropped dramatically since oil prices fell. In the Bakken region, the rig count declined almost 90% since reaching its June 2012 peak. In the Permian region, the rig count declined almost 75% since its October

2014 peak. And in the Eagle Ford region, rig count declined more than 85% since its April 2014 peak.⁵

Fewer active rigs combined with productivity enhancements (such as improvements in the number of wells a rig can drill each month) reduced the demand for workers, and employment related to shale oil production started to decline. According to data from the U.S. Bureau of Labor Statistics, about 170,000 jobs (26%) were cut in the oil and gas extraction industry and their supporting services between October 2014 and April 2016, compared to a 3% gain in jobs across all U.S. industries in the same time period. In 2015, the number of jobs in North Dakota contracted by 1.6%, and the Bakken region lost at least 20,000 jobs since employment peaked in late 2014. In Williams County, North Dakota, the unemployment rate tripled, increasing from 1.4% in January 2014 to 4.5% in April 2016. However, the state's overall unemployment rate remains one of the lowest in the nation at 3.2%. In the Midland-Odessa, Texas, area, employment fell 8.9% from December 2014 to December 2015. For the wider Permian Basin, in December 2015 the unemployment rate stood at 4.2%, up from 2.7% a year earlier, although still lower than the Texas statewide unemployment rate or U.S. unemployment rate. In McMullen County, Texas, a key Eagle Ford shale oil production area that has one of the highest relative concentrations of employment in the oil and gas extraction industry, employment decreased by 18% between December 2014 and 2015.

According to an International Monetary Fund working paper, bringing a drilling rig online can immediately create 37 jobs and, longer term, may create an additional 224 jobs in other local industries. When new shale drilling activity is reduced, there is likely to be a ripple effect on employment in other local industries, although that ripple effect may take longer to manifest.

Slowdown in Demand for Housing

Both Fannie Mae and Trulia report that home prices in oil producing areas tend to follow oil prices, with roughly a two-year lag period. In the 1980s oil cycle, the decline in oil prices drove a decline in oil-related employment, a decline in housing prices and housing starts, and a significant increase in multifamily vacancy rates in affected areas. The 1980s oil bust produced one of the most difficult times for the U.S. mortgage market. In the current cycle, single-family housing in some shale oil areas is starting to weaken from prior levels. Between the fourth quarter of 2014 and the fourth quarter of 2015, single-family housing starts declined 60% in North Dakota and 10% in Texas from their prior levels. House prices in North Dakota fell by almost 1% in the first quarter of 2016, according to FHFA's expanded

⁵ The decline in new drilling activity did not necessarily translate to immediate production declines because existing oil wells continued to produce. Compared to June 2014, when oil prices reached their recent high point, production in the Bakken region is relatively flat, production in the Permian region is up, and production in the Eagle Ford region is down.

house price data. By contrast, house prices rose 1.5% nationwide in the first quarter of 2016. In Midland, Texas, median home prices were down 1.2% since the first quarter of 2015 compared to a 5.4% median price increase for the state.

Mortgage delinquencies may be showing early signs of trouble. A *Wall Street Journal* article noted the share of borrowers in oil-focused areas falling 30 days behind on a pool of Freddie Mac mortgages, while low at 0.38% in December 2015, had exceeded the national average for approximately six months. More broadly, for the fourth quarter of 2015, TransUnion reported that year-over-year mortgage delinquencies fell 28% for the country as a whole, but not in energy states where they held relatively steady. Further, the *Wall Street Journal* reported that some large banks have tightened selected mortgage standards, for example, requiring larger down payments on home loans in oil-reliant areas or restricting cash-out refinances. Foreclosures are also on the rise. In Midland, Texas, foreclosures have increased by over 30%. And although North Dakota still has one of the lowest foreclosure rates in the nation, foreclosure filings in the state have increased since oil prices fell.

Shale region multifamily markets are also slowing down from recent levels. According to Morningstar Credit Ratings LLC, many properties built to house oilfield employees had to drastically cut rents. By one estimate, asking rents in Williston, North Dakota, fell by more than 34% in 2015. At one Williston complex, rent for a two-bedroom apartment reportedly fell from nearly \$4,000 a month at the peak of the boom to about \$1,600 in January 2016. In the Midland-Odessa, Texas, area, rents have been volatile but have not declined as dramatically, contracting by 5% in 2015, according to one estimate. Further, vacancy rates at local multifamily properties are up. In Midland-Odessa, vacancy rates went from 3% in 2012 to just over 10% at the end of 2015, while the vacancy rate in Williston increased from 6% to 16% in 2015. A property management firm conducted a survey of 20 developments in Williston and estimated the average vacancy rate of newly constructed units as high as 50% in March 2016.

Cash flow has suffered at many multifamily properties built during the employment boom. Insufficient cash flow at a multifamily property could jeopardize the owner's ability to service the mortgage and the value of the property. According to one report, investors in several apartment projects told Williston, North Dakota, city commissioners that they are struggling with cash flow and talking to their banks about reworking their loans. Some multifamily properties in the former boom areas have taken a hit to their underlying values. For example, a multifamily development in the heart of the Bakken region saw its appraised value fall 65% between its initial boom-era appraisal in 2013 and an updated appraisal in November 2015.

Regarding whether the experience from the 1980s oil bust will be replicated in this cycle, some observe that oil state economies today are more diversified than they had been and financial markets are more robust, which may lessen the adverse impact on the housing

sector. It remains to be seen whether the significant declines in oil prices since 2014 will result in a drop in home prices and increased single-family and multifamily mortgage delinquencies in affected areas over the next two years.

EMERGING RISK

Following the plunge in oil prices, shale regions experienced a downturn in employment and began to exhibit early signs of stress in their housing markets. The expectation that oil prices will not rise significantly in the near future suggests a slowdown in the economies of shale oil regions until a more sustainable level is reached. Where the economy of a shale oil region is tied in large measure to production of shale oil, that region is likely to sustain a greater adverse impact from the decline in shale oil production than other areas with more diversified economies. According to Fannie Mae, states with a higher oil industry concentration are likely to face greater downward home price pressure when oil prices drop. For example, industry experts anticipate that shale oil regions of North Dakota may sustain a significant impact from the shale oil bust. In a Summer 2016 report, Arch Mortgage Insurance Company deemed North Dakota to have the highest risk index of any state, with a 52% chance of experiencing a house price decline over the next two years. It projected that home prices in North Dakota are 21% overvalued. According to Fannie Mae, “[w]ithout a significant recovery in oil prices, it is likely that Williston—along with most of North Dakota—will continue to languish for the next several years.” Midland-Odessa, Texas, has the highest concentration of oil and gas industry jobs in the country, with at least 65% of the economic activity in Midland tied to energy. Freddie Mac deemed that area to have the highest risk exposure due to its reliance on oil and gas jobs and low diversification index ratings.

Although not located in a shale oil area, Houston, Texas, called the nation’s “energy capital,” has been identified by Fannie Mae and Freddie Mac as particularly vulnerable in the event of prolonged low oil prices. Fannie Mae called Houston the only primary metropolitan area in the United States that would be expected to experience a notable negative impact. Freddie Mac said that Houston could have risk exposure tied to multifamily housing because it has witnessed a multifamily housing boom in recent years and has relatively large energy-related employment. The Enterprises noted, however, that Houston’s economy is more diversified than it had been during the oil bust in the 1980s and should be better able to weather a storm.

In August 2015, Fannie Mae projected a five-year cumulative drag on future house price growth for ten oil-producing states, including Texas and North Dakota, assuming oil prices remained low and the 1980s relationship between oil prices, employment, and home prices held true.

THE ENTERPRISES' ACTIVITY IN CORE SHALE REGIONS.....

As low oil prices lingered, Fannie Mae and Freddie Mac, financial and industry entities, and media outlets noted concerns about the impact of the oil bust on housing. In the core shale regions, this risk to the housing sector presents a potential increased risk to the Enterprises, depending on the type and degree of their activities in these regions and the extent to which they have transferred risk to third parties. In light of the concerns raised by numerous parties, we assessed the Enterprises' single-family and multifamily business activities in the core shale oil areas during the 2005 to 2015 boom and bust cycle to better understand their possible exposure.

Using data from FHFA, we examined the Enterprises' business volume and analyzed trends in their single- and multifamily loans in certain shale areas for 2005 through 2015, the time period of the shale oil boom and subsequent rapid collapse of oil prices. Within each of the three primary shale oil areas, our analysis focused on the six core counties that produced the majority of each region's shale oil during the boom.⁶

Appendix A provides detailed analyses of Enterprise mortgage acquisitions, which are summarized below.

Single-Family Activity

Each year the Enterprises purchase millions of single-family mortgage loans. FHFA data revealed that Enterprise single-family acquisitions in the core shale regions represented less than

FIGURE 3. ENTERPRISE SINGLE-FAMILY ACQUISITIONS: CORE SHALE REGIONS RELATIVE TO NATIONWIDE, 2005-2015

Enterprise	Single-family Acquisitions in Core Shale Areas (\$Millions)	Percent of Nationwide Acquisitions
Fannie Mae	\$3,820	0.06%
Freddie Mac	\$2,280	0.05%
Total	\$6,100	0.06%

Source: OIG analysis of data provided by FHFA and public information.

⁶ For the Bakken region, the six core counties, accounting for over 87% of shale oil production, are: Divide, Dunn, McKenzie, Mountrail, and Williams counties in North Dakota and Richland County, Montana. For the Permian region, the six core counties, accounting for 81% of production, are: Glasscock, Martin, Midland, and Upton counties in Texas; and Eddy and Lea counties in New Mexico. For the Eagle Ford region, the six core counties, accounting for 62% of production, are: DeWitt, Dimmit, Gonzales, Karnes, La Salle, and McMullen counties in Texas.

one-tenth of 1% of the dollar amount of nationwide Enterprise acquisitions between 2005 and 2015.⁷ See Figure 3.

Our analysis found that certain loan quality measures—loan-to-value (LTV) ratio and credit score—for the acquired loans in these regions were slightly weaker than the same measures for loans acquired by the Enterprises nationwide. However, the serious delinquency and foreclosure trends for the acquisitions in these core areas did not differ significantly from nationwide trends.

For the single-family loans acquired in the core shale areas during 2005-2015, Figure 4 shows the loan balance remaining in the Enterprises' portfolios as of December 31, 2015.

FIGURE 4. REMAINING LOAN BALANCE OF ENTERPRISE SINGLE-FAMILY ACQUISITIONS IN CORE SHALE REGIONS, 2005-2015

Enterprise	Remaining Balance of Single-family Acquisitions in Core Shale Areas as of Dec. 31, 2015 (\$Millions)	Percent of Single-family Acquisitions in Core Shale Areas Remaining as of Dec. 31, 2015
Fannie Mae	\$1,776	46%
Freddie Mac	\$1,015	45%
Total	\$2,791	46%

Source: OIG analysis of data provided by FHFA.

Overall, 46% of the aggregate loan balance that the Enterprises acquired from the core shale regions over this period remained in their portfolios.

Multifamily Activity

Similar to single-family, the Enterprises' multifamily activity in the core shale oil areas was quite small relative to their overall activity. Together, the Enterprises acquired 67 multifamily loans with properties in the core shale oil areas between 2005 and 2015. The total loan balance of these acquisitions was less than 1% of the Enterprises' nationwide multifamily acquisitions during the same time period. See Figure 5.

⁷ The percent of acquisitions in the core shale areas may differ from the percent remaining in the current portfolios because the composition of the portfolios changes over time as loans pre-pay, default, or are removed for other reasons.

Our analysis found that multifamily quality measures—LTV ratio and debt service coverage ratio (DSCR)—for the loans were generally within Enterprise risk limits. With regard to performance, there were no multifamily delinquencies or foreclosures in the three core regions during this time period. All multifamily loans were either current or had previously prepaid or matured as of the end of 2015.

FIGURE 5. ENTERPRISE MULTIFAMILY ACQUISITIONS: CORE SHALE REGIONS RELATIVE TO NATIONWIDE, 2005-2015

Enterprise	Multifamily Acquisitions in Core Shale Areas (\$Millions)	Percent of Nationwide Acquisitions
Fannie Mae	\$4,062	1.29%
Freddie Mac	\$176	0.07%
Total	\$4,238	0.75%

Source: OIG analysis of data provided by FHFA and public information.

For the multifamily loans acquired in the core shale areas during 2005 to 2015, Figure 6 shows the loan balance remaining in the Enterprises' portfolios as of December 31, 2015.

FIGURE 6. REMAINING LOAN BALANCE OF ENTERPRISE MULTIFAMILY ACQUISITIONS IN CORE SHALE REGIONS, 2005-2015

Enterprise	Remaining Balance of Multifamily Acquisitions in Core Shale Areas as of Dec. 31, 2015 (\$Millions)	Percent of Multifamily Acquisitions in Core Shale Areas Remaining as of Dec. 31, 2015
Fannie Mae	\$201	5%
Freddie Mac	\$141	80%
Total	\$342	8%

Source: OIG analysis of data provided by FHFA.

Overall, 8% of the aggregate loan balance that the Enterprises acquired over this period remained in their portfolios.

CONCLUSIONS

Following the rise of shale oil extraction as a viable and lucrative industry, several regions experienced rapid growth as oil prices increased and new shale oil production surged. Growth in employment and population in these regions led to local housing crunches and price surges. Now, however, these regions face a new reality as oil prices have dropped and are not predicted to rise substantially in the near future. These regions have also experienced an increase in unemployment and, in some communities, a slowdown in their housing markets accompanied by early signs of stress. There is an emerging risk that the shale oil areas could face a further slowdown in their housing markets.

The scope of this emerging risk for the shale oil areas will be affected by how fast and how far oil prices rebound. In June 2016, spot oil prices climbed past \$50 per barrel on several days and drilling rig counts increased for three consecutive weeks after an extended period of decline. However, it is unclear if these are signals of a longer-term industry turnaround or simply a temporary minor rebound.

Although the Enterprises have acquired single-family and multifamily loans in the core shale regions, these acquisitions represent a small fraction of their overall portfolio. We found that less than one-tenth of 1% of the Enterprises' single-family acquisitions and less than 1% of their multifamily acquisitions from 2005 to 2015 were concentrated in these regions. Additionally, of those core shale area acquisitions, only 46% of the single-family loans and 8% of the multifamily loans remained in the Enterprises' portfolios at the end of 2015. Further, although low energy prices can have a detrimental effect in regions involved in production, other areas of the country may benefit from low prices. Therefore, we believe that, as matters now stand, the Enterprises' potential exposure from this emerging risk is quite small as a proportion of their overall acquisitions. We expect that FHFA, as conservator of the Enterprises, will appropriately monitor this emerging risk.

OBJECTIVE, SCOPE, AND METHODOLOGY

The objective of this whitepaper was to describe:

- The shale oil boom and bust;
- How local economies and housing markets, in particular, were affected by the shale oil boom and bust; and
- Fannie Mae and Freddie Mac's housing activity in key shale oil regions.

To achieve this objective, we interviewed personnel at FHFA with responsibilities for Enterprise loan data and single-family house price research. We also reviewed: publicly available documents, such as U.S. Energy Information Administration reports, FHFA reports, reports from other government agencies, and Fannie Mae and Freddie Mac research publications and financial disclosures; publicly available data, such as oil price and production data from the U.S. Energy Information Administration, population counts from the U.S. Census Bureau, drilling rig data from Baker Hughes, and employment data from the U.S. Bureau of Labor Statistics; and non-public oil production data from the U.S. Energy Information Administration and loan-level data provided by FHFA. We did not independently test the reliability of the U.S. Energy Information Administration's or FHFA's data.

Our work was conducted under the authority of the Inspector General Act of 1978 and in accordance with the Council of the Inspectors General on Integrity and Efficiency's *Quality Standards for Inspection and Evaluation* (January 2012). These standards require us to plan and perform a report based on evidence sufficient to provide reasonable bases to support its conclusions. We believe that this whitepaper meets these standards. The performance period for this whitepaper was from April 2016 to July 2016. We provided FHFA with the opportunity to respond to a draft of this whitepaper.

This whitepaper was led by Omolola Anderson, Senior Statistician, in collaboration with Christine Eldarrat, Senior Policy Advisor, and Beth Preiss, Senior Investigative Evaluator, with assistance from Bryan Saddler, Senior Policy Advisor. We appreciate the cooperation of FHFA staff, as well as the assistance of all those who contributed to the preparation of this whitepaper.

This whitepaper has been distributed to Congress, the Office of Management and Budget, and others and will be posted on our website, www.fhfaoig.gov.

APPENDIX A

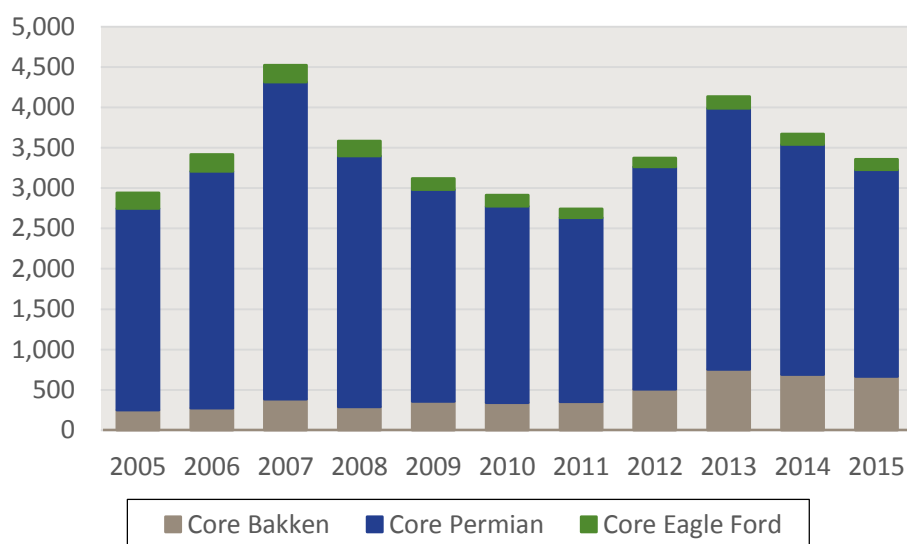
Enterprise Single-Family Acquisitions

Number of Loans

From 2005 through 2015, the Enterprises acquired an average of about 3,400 loans annually in the three core shale areas combined. The number of Enterprise single-family loan acquisitions in the three core shale oil areas peaked in 2007 and 2013. See Figure 7.

Looking at the three core shale areas individually, the core Permian region accounted for the bulk of Enterprise loans in these shale regions, driven in large measure by the fact that the population of the core Permian region generally was more than twice that of the core Bakken and Eagle Ford regions combined. The core Bakken region experienced notable growth in the number of loans, with the number of Enterprise acquisitions more than doubling between 2005 and 2015.

FIGURE 7. NUMBER OF ENTERPRISE SINGLE-FAMILY ACQUISITIONS IN CORE SHALE REGIONS 2005-2015



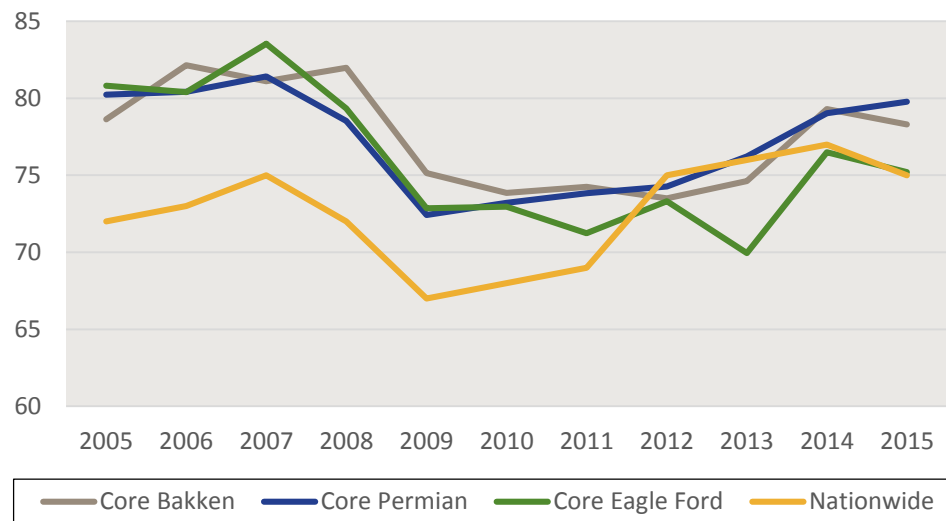
Source: OIG analysis of data provided by FHFA.

Loan Quality Measures

To assess the quality of loans acquired in the core shale areas, we examined the average weighted LTV ratio and borrower credit score (FICO score) on an annual basis. The LTV ratio is the unpaid principal amount of a mortgage loan as a percent of the value of the property that serves as collateral. In general, the Enterprises consider higher LTV ratios an indication of increased risk. When reporting on their annual acquisitions, the Enterprises report the average original LTV ratio, weighted by the unpaid principal balance of each loan, as one gauge of the loan quality for acquisitions in a given year.

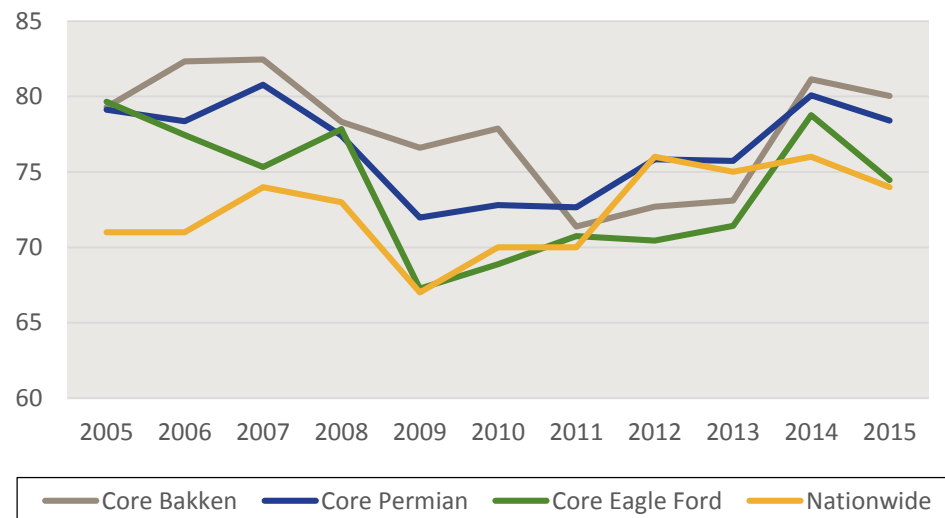
For acquisitions in all three core shale oil areas, the weighted average LTV ratio at acquisition⁸ generally dropped between 2008 and 2012 and began increasing in later years. Because the Enterprises generally consider higher LTV ratios as an indicator of increased risk, this means that loans acquired by the Enterprises in the three core regions generally exhibited less risk related to weighted average LTV during 2008 to 2012 and increasing LTV-related risk in 2013 to 2015. Except for 2012 and 2013, loans acquired in all core shale regions had a weighted average LTV higher than the national average of loans acquired by each Enterprise. This means that for most years the loans acquired from the core shale areas generally exhibited more weighted average LTV-related risk than the nationwide average. See Figures 8 and 9.

FIGURE 8. WEIGHTED AVERAGE LTV RATIO OF FANNIE MAE SINGLE-FAMILY ACQUISITIONS, 2005-2015



Source: OIG analysis of data provided by FHFA and Fannie Mae financial disclosures.

FIGURE 9. WEIGHTED AVERAGE LTV RATIO OF FREDDIE MAC SINGLE-FAMILY ACQUISITIONS, 2005-2015



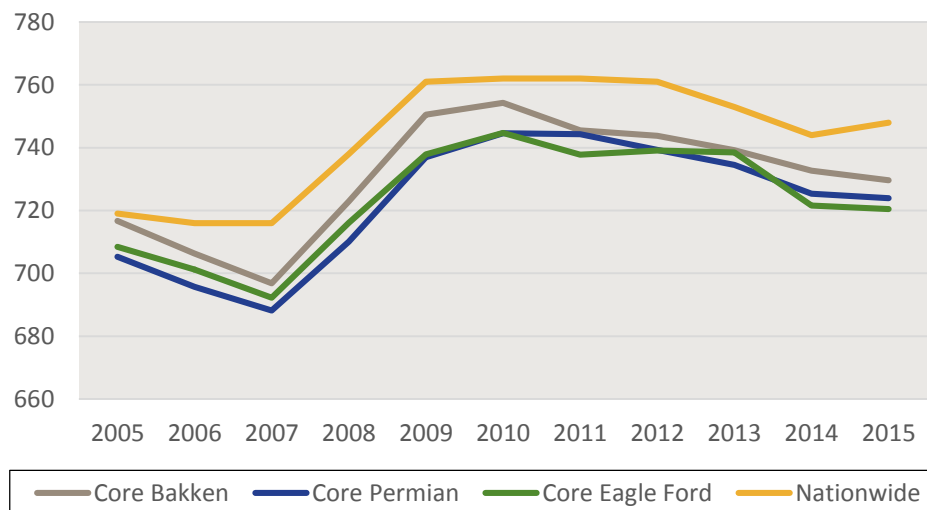
Source: OIG analysis of data provided by FHFA and Freddie Mac financial disclosures.

⁸ We analyzed the LTV ratio at the time the Enterprise acquired the loan and not at the time the loan was originated. Fannie Mae has noted that it generally acquires mortgage loans the month after origination.

Borrower credit scores are ranked on a scale of approximately 300 to 850 points with a higher value indicating the borrower has a lower likelihood of credit default. The Enterprises therefore consider loans with lower borrower credit scores as having higher risk. As with the LTV ratio, for annual acquisitions the Enterprises report an average credit score, weighted by the unpaid principal balance of each loan, as one gauge of the loan quality for acquisitions in a given year.

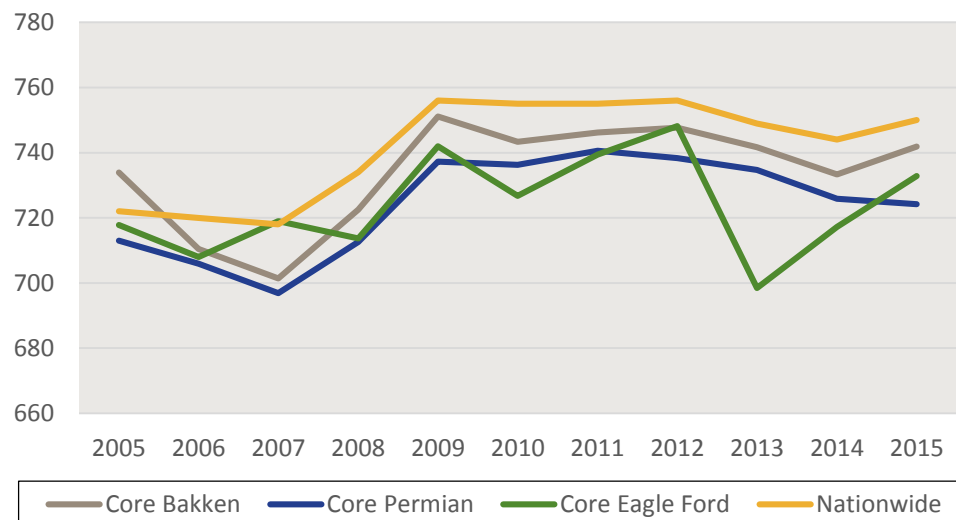
For acquisitions in each of the three core shale oil areas, the weighted average credit score was lower than the national average for all years except for Freddie Mac's 2005 acquisitions in the core Bakken region and its 2007 acquisitions in the core Bakken region and its 2007 acquisitions in the core Eagle Ford region. This means that Enterprise acquisitions from the three core shale areas generally exhibited more risk related to weighted average credit score than nationwide loans (except for the core Bakken region in 2005 and the core Eagle Ford region in 2007). See Figures 10 and 11.

FIGURE 10. WEIGHTED AVERAGE CREDIT SCORE OF FANNIE MAE SINGLE-FAMILY ACQUISITIONS, 2005-2015



Source: OIG analysis of data provided by FHFA and Fannie Mae financial disclosures.

FIGURE 11. WEIGHTED AVERAGE CREDIT SCORE OF FREDDIE MAC SINGLE-FAMILY ACQUISITIONS, 2005-2015



Source: OIG analysis of data provided by FHFA and Freddie Mac financial disclosures.

Loan Performance

Even with increasing activity in the three core shale regions, Enterprise single-family acquisitions in those areas still represented less than one-tenth of 1% of nationwide Enterprise single-family acquisitions during the relevant time period. In particular, purchases in the core Bakken and Eagle Ford regions may have been only a few hundred loans each year. As a result, each delinquency or foreclosure can have a notable effect on the region's default or foreclosure rate, and results must be interpreted accordingly. We found no significant or concerning difference from the Enterprises' nationwide delinquency or foreclosure trends during this period.

For the loans acquired in the core shale oil regions during 2005 through 2015, the single-family loan status, as of December 31, 2015, and by region, was as follows:

- **Core Bakken Region:** 4,863 total single-family loans acquired by the Enterprises. Selected performance statuses, as of December 31, 2015:
 - 2,083 loans prepaid or matured
 - 8 loans seriously delinquent
 - 5 loans in or completed foreclosure
- **Core Permian Region:** 31,200 total single-family loans acquired by the Enterprises. Selected performance statuses, as of December 31, 2015:
 - 16,695 loans prepaid or matured
 - 65 loans seriously delinquent
 - 228 loans in or completed foreclosure
- **Core Eagle Ford Region:** 1,712 total single-family loans acquired by the Enterprises. Selected performance statuses, as of December 31, 2015:
 - 794 loans prepaid or matured
 - 11 loans seriously delinquent
 - 30 loans in or completed foreclosure

Enterprise Multifamily Acquisitions

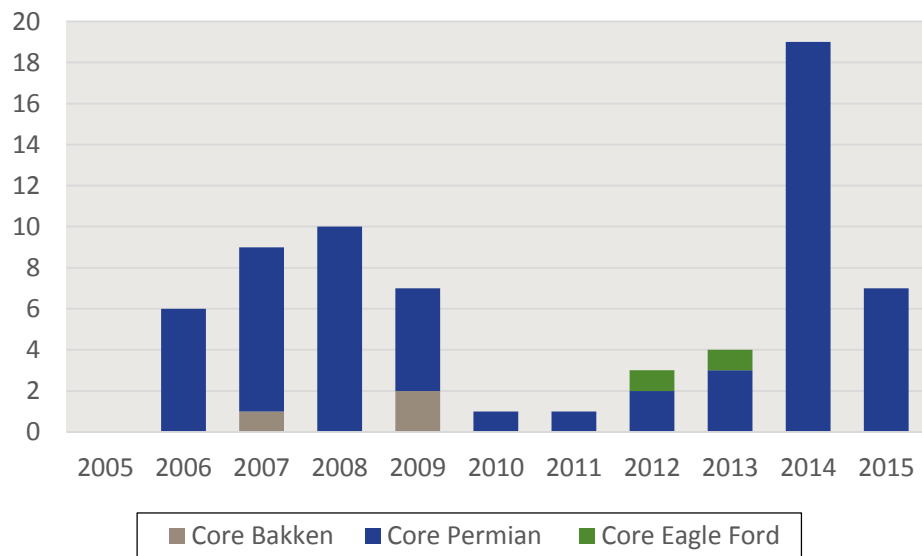
Enterprise multifamily loans help finance properties with five or more units. Multifamily loans have unique characteristics and differ from single-family loans in various ways:

- They are primarily for rental apartment communities, but also may include senior independent or assisted living properties, student housing, cooperative properties, and manufactured housing communities.
- A multifamily loan may have more than one property as collateral. Also, a multifamily property may be financed by multiple loans.
- The average multifamily loan size is significantly larger than that of a single-family loan.
- Multifamily loans typically have short terms (five, seven, or ten years) with a balloon payment at maturity, and they usually include a prepayment penalty.

Number of Loans

The number of multifamily loans acquired with properties in the three core shale regions is relatively small, totaling 67 loans for 2005 through 2015. Similar to the Enterprises' single-family activity, the majority of loans acquired with properties in the core shale areas were in the core Permian region; specifically, 62 loans were in the core

FIGURE 12. NUMBER OF ENTERPRISE MULTIFAMILY LOANS ACQUIRED IN CORE SHALE REGIONS, 2005-2015



Source: OIG analysis of data provided by FHFA.

Permian region, 3 in the core Bakken region, and 2 in the core Eagle Ford region. These 67 multifamily loans financed 74 properties with a total of about 11,000 units in the core shale areas. The number of Enterprise multifamily loan acquisitions with properties in the core shale areas peaked in 2014, when 19 loans were acquired for properties in the core Permian region. See Figure 12.

Loan Quality Measures

For multifamily acquisitions, the Enterprises, in general, consider DSCR and LTV ratio to be reliable indicators of risk level and future loan performance.

DSCR estimates a multifamily borrower's ability to service the mortgage obligation using the property's cash flow after deducting non-mortgage expenses from income. A higher DSCR indicates less risk in the multifamily mortgage. In general, the Enterprises report in their financial disclosures loan acquisitions with an original DSCR below 1.10 for increased risk. The lowest DSCR among all core shale region acquisitions was 1.15.⁹ Further, over 85% of the multifamily loans had a DSCR greater than or equal to 1.25.

As specified above, LTV is the ratio of the unpaid principal amount of a mortgage loan and the value of the property that serves as collateral. For multifamily loans, the Enterprises consider an original LTV ratio greater than 80% to have an increased level of risk. Of the 67 loans with properties in the core shale oil regions during the 2005 to 2015 time period, only one had an LTV ratio greater than 80%. This means that only one loan exhibited increased LTV-related risk.

Loan Performance

Regarding loan performance, as mentioned in the whitepaper, none of the multifamily loans with properties in all core shale regions were delinquent or had defaulted as of December 31, 2015, meaning performance as of this date does not reflect any concerns. Of the 67 loans, 16 were prepaid. Of the remaining 51 loans, all were current.

⁹ As with LTV ratio, the data included DSCR at acquisition, not at origination.

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