House Price Risks in Oil-Producing States: Repeat of the 1980s?

August 27, 2015

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Introduction

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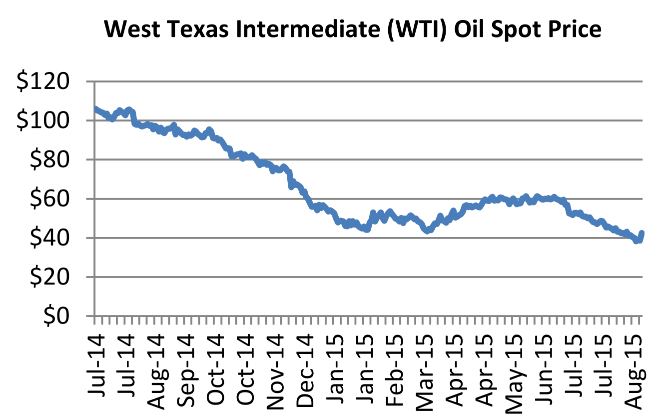
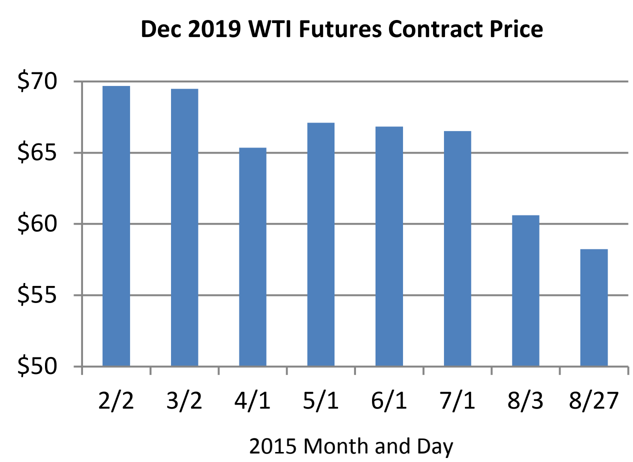
With oil price declines resuming the past two months, a quick rebound appears increasingly unlikely. Futures markets now anticipate "lower for longer" prices (Fig. 1). The prospect of a protracted bust prompts comparisons to the oil price slump of the 1980s. While most Americans enjoyed lower gas prices at the time, others felt a negative impact as large employment losses occurred in the oil industry followed by a general economic slowdown in many oil-producing states. This often led to house price declines. Prices in Texas, for example, fell 11% from 1983-1988 during a time when national home prices rose by 32%.[1]

In this edition of *Housing Insights*, we project a five-year cumulative "drag" on future house price growth caused by the oil price decline for 10 oil-producing states under the assumption of sustained lower prices. We do this by examining the historical relationship in the 1980s between oil prices, oil industry employment, and house price growth.[2] Adjustments are made accounting for a number of differences between then and now, and given uncertainty over the resilience of new oil production technologies, multiple scenarios are presented. To illustrate potential new house price growth paths, the estimated "drag" values are applied to a baseline, publicly available, five-year house price forecast.[3]

In the case of the approximate current oil price futures curve ($60 by 2019), we project that the negative effect on house prices is likely to be less severe for most oil-producing states than in the 1980s. Most are likely to experience only a deceleration in house price growth. However, three states (AK, ND, and WY) are at risk of experiencing significant cumulative declines, and, in a worst-case scenario, other states could be, as well.

Figure 1: The Past Year's Decline in Oil Spot Prices and the More Recent Decline in Futures Prices





Sources: Energy Information Administration, CME Group

[1] Price changes reported are measured by the FHFA's all transactions house price index, the index used throughout this analysis.
[2] While the 1980s is used as a reference period in order to capture comparable "bust" conditions, we also examined the relationship between oil price, employment, and house prices over a broader time range to confirm that it remains currently relevant.
[3] While the ESR group publishes a two-year house price forecast based on the FHFA index, Fannie Mae does not disclose five-year or state-level house price forecasts. Therefore, this note reports the publicly available IHS five-year state level house price forecast, as of Q2 2015, as a baseline from which to measure possible house price growth effects.

The 1980s Oil Price Slump and House Price Decline

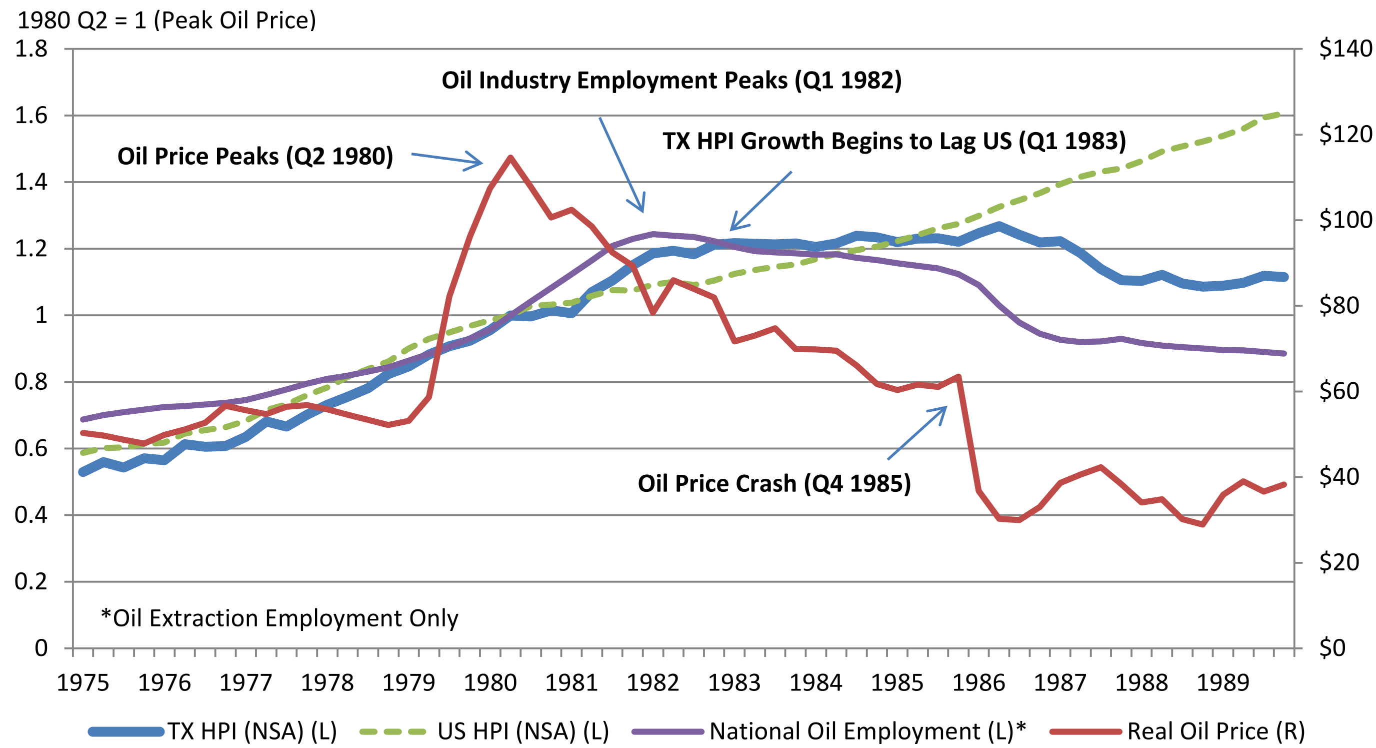
During the 1980s oil bust, home price growth in states with high oil production significantly lagged behind the trend of the country as a whole (Fig. 2). In six of those states, as measured by the Federal Housing Finance Agency (FHFA) index, prices experienced cumulative declines, including 11% in Texas. This compares to cumulative home price growth of 32% for the US.

The Texas experience (Fig. 3) illustrates the dynamics in play during the period. Real oil prices peaked in 1980, followed by a near-decade-long decline. This included a crash in late 1985. A clear pattern exists. Real oil prices first fell, then with a time lag, oil industry employment declined (along with royalties and state and local tax receipts). This in turn weakened the broader labor market and eventually drove house prices downward as demand fell.

Figure 2: 1980s State HPI Change

State	Cumulative FHFA HPI Change (1983-1988)
OK	-22%
WY	-19%
LA	-15%
TX	-11%
AK	-10%
ND	-5%
UT	0%
CO	1%
NM	3%
KS	10%
U.S.	32%

Figure 3: 1980s Texas Experience – Oil Prices, Oil Industry Employment[4], and House Prices



Sources: Energy Information Administration, Bureau of Labor Statistics, Federal Housing Finance Agency

[4] Shown here is a national measure of oil industry payrolls related to extraction activates, only a subset of total direct oil industry employment. A more comprehensive measure (only available annually for this time period) illustrates a decline of greater magnitude, and is the measure used in later analysis at both state and national levels.

Key Differences: 1980s vs. the Present

The 1980s experience suggests that today's fall in oil prices could lead to a similar house price decline in oil-producing states. However, a number of key factors differ between the current situation and that of the 1980s.

Major differences include:

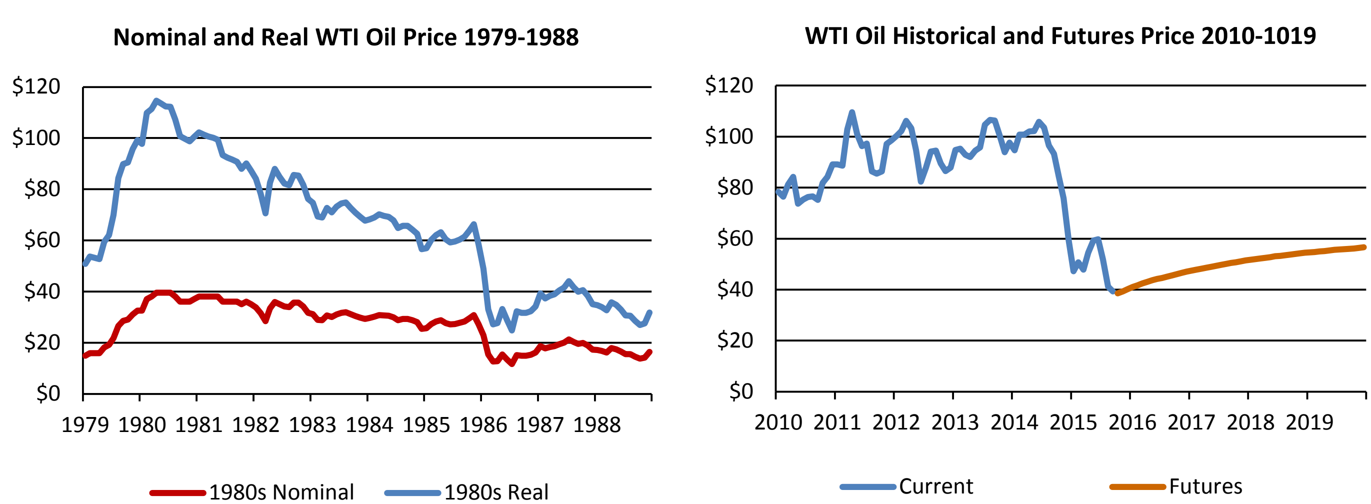
- **Oil Price Behavior**: Prices fell continuously for eight years in the 1980s and by a greater magnitude than that which has occurred presently to date.
- **State Economies are More Diversified**: Most oil-producing states' economies rely less heavily on the oil industry today.
- **Technology Advancements**: Advancements in production technologies have changed how the industry responds to oil prices, potentially reducing the price sensitivity of oil industry activity, but also increasing the level of uncertainty.

Oil Price Behavior: Current Decline is Less Severe

While the 1980s peak-to-trough oil price percentage decline is somewhat similar to the present (70% in the 1980s, 63% currently), our analysis finds that the real price level is more indicative of oil industry activity than the nominal percentage change. In this perspective, the 1980s decline appears considerably more severe. After adjusting for inflation, 1980s' oil prices fell as low as $24 per barrel in today's dollars, and largely remained below $40 dollars per barrel for approximately three years. While recent prices have breached the latter figure, current futures contracts anticipate them to trend upward going forward.

And while the sudden price collapse in late 1985 is similar to what occurred last year (and similarly triggered in part by an OPEC decision to not cut production), the years leading up to the events fundamentally differ. In 1985, prices had already been falling for years previously, along with declining industry employment and weak or even negative house price growth. No such weakness existed prior to entering the current episode.

Figure 4: 1980s and Current Period West Texas Intermediate (WTI) Crude Oil Prices

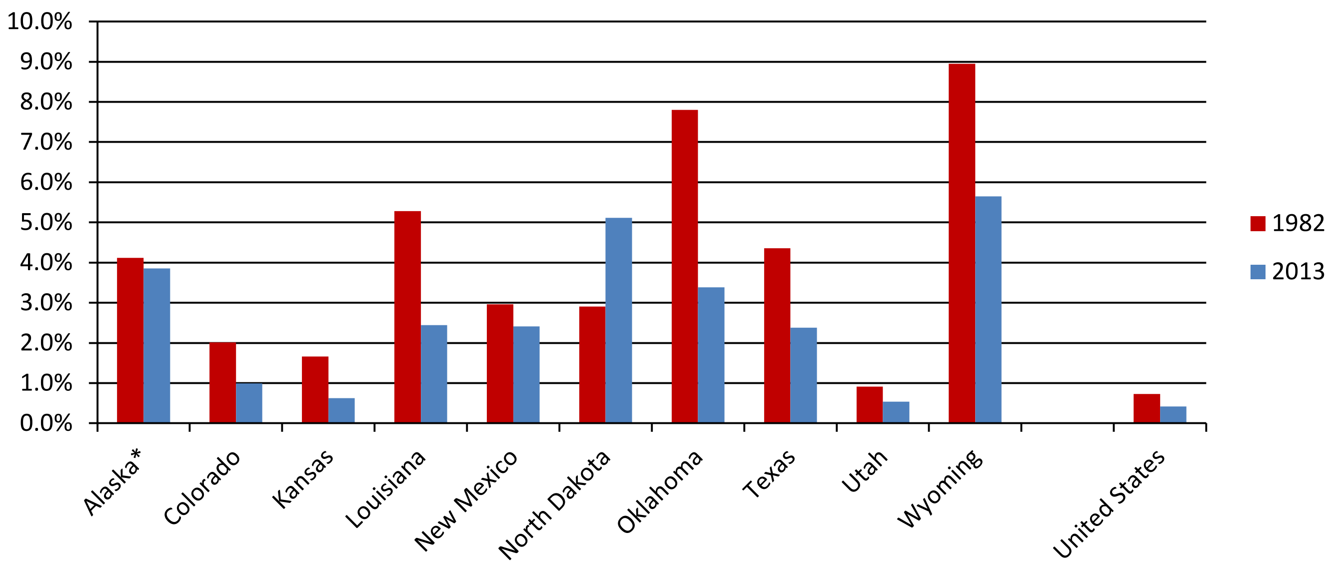


Sources: Energy Information Administration, Bureau of Labor Statistics, CME Group

Oil State Economies Are Now More Diversified

The economies of oil-producing states, including Texas, are less reliant on the oil industry today than in the 1980s. As measured by the share of state-level payrolls attributed to the oil and gas industry, with the exception of North Dakota, every major oil-producing state's economy is less reliant today (Fig. 5).[5] In Texas, the share of oil and gas payrolls in 2013 was almost half of that of 1982 (2.2% vs 4.2%).[6] Though there are certainly localized areas that are more heavily concentrated, at the state level, the lower dependence on oil industry activities for employment should make oil-producing states' economies comparatively more resilient.

Figure 5: Oil and Gas Industry Direct Payroll Employment as Share of Total Payrolls



*The 1982 figure for Alaska is imputed using total mining payroll data as oil industry payrolls are not available in this series.

Source: Bureau of Economic Analysis

Technological Advances Have Changed Oil Industry Dynamics

Advancements in horizontal drilling and hydraulic fracturing ("fracking") techniques, applied to shale oil deposits, have fundamentally changed the oil industry's production with relationship to price. US oil production had previously been in a decades-long decline (Fig. 6). The rise and fall of prices in the 1970s and 1980s caused only a modest oscillation around this production trend. Despite real oil prices rising from about $20 in 1973 to a peak of $108 in 1980, annual production increased by only approximately 10%. In contrast, recent period production has increased over 70% since 2008, and has clearly broken out of the previous pattern. This is largely due to new shale oil development, with nearly 50% of US oil now produced via "fracking."[7]

New technologies made previously unobtainable sources economically feasible to develop. Therefore, at price levels greater than the minimum required to keep shale production viable, a greater quantity of oil will be produced going forward than the old price relationship would predict.[8] And if these new methods are still

[5] Payrolls included are those involved in extraction activities and industry support services, which tend to include drilling activity.

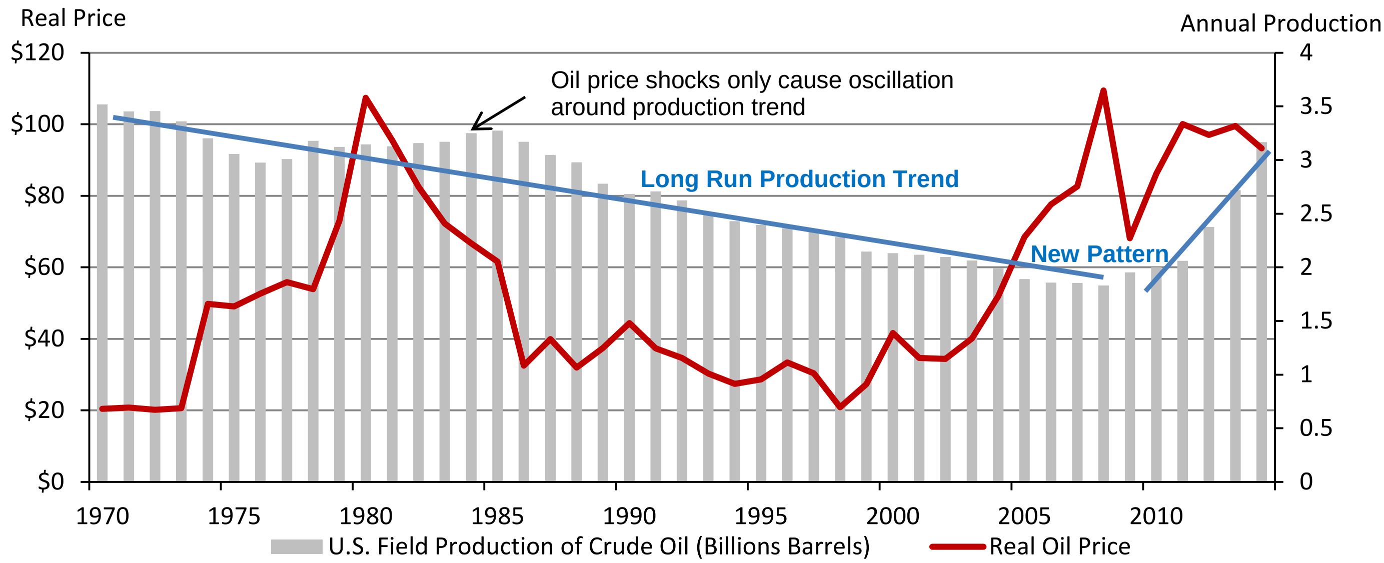
[6] This measure is for direct oil industry payrolls only. It should be noted that the entirety of oil industry supported employment is higher. Not included are independent contractors, sole proprietors, or any of the "pick and shovel" jobs elsewhere in the supply chain, such as manufacturing of drilling equipment, or pipeline construction. Economic gains via royalties for land owners or taxes for governments and second order benefits to area businesses are also not included. Still, these values can be used as comparative measures of oil industry intensity/importance for the state economies.

[7] Source: Energy Information Administration.

[8] See Appendix A for a more detailed analysis of the old vs. new industry activity/ oil price relationships.

becoming more efficient as technology advances, it is possible that output will continue to expand (or at least not decline) despite the fall in oil price. If this occurs, industry employment losses would likely be comparatively modest. However, if shale oil proves to be unviable at these prices, output declines could be severe.

Figure 6: Long-Run Downward U.S. Production Trend Ended Around 2008



Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, Energy Information Administration

Given the infancy of these methods, it is not known where this viability price cutoff is. Furthermore, the “full cycle cost” of acquiring and developing new sites is higher than the “lift cost” of producing from existing wells. And given firm heterogeneity, and the luxury of being able to afford inefficiencies in the boom period, viability price points vary by producer. Factors including geographic location and associated transportation costs, operational efficiencies, capital structures, price hedging strategies, and counterparty arrangements all affect the viability price level. Short term production for a firm may be viable at prices as low as $30 per barrel, while long term viability may require $85 per barrel or more.[9]

Estimating the Impact of Oil Prices on House Price Growth

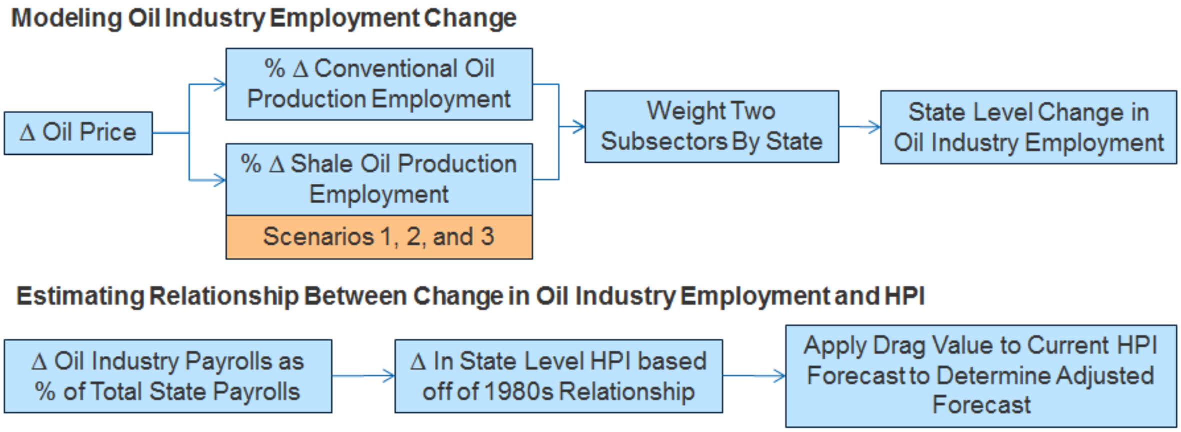
Taking into account the three differences discussed above, we project state-level home price drags due to the oil price shock utilizing the historical relationships between real oil price, oil industry employment, and house prices. We assume roughly current WTI oil futures prices (converging to $60 per barrel by 2019).[10] Due to uncertainty around the viability of shale oil production, multiple potential scenarios are analyzed:

1. Pessimistic: New shale oil projects are no longer viable and production from existing sources decays 90% over the next five years.[11]
2. Optimistic: The price level is sufficient to maintain 2014 annual levels of shale oil production.
3. Traditional: A scenario presented for comparison, where shale oil production behaves in the same manner as conventional oil production with regards to price.

[9] Estimates of break-even prices for both the marginal costs of production and full project development vary greatly. The range used here is from an amalgamation of figures made available from firms including WoodMacKenzie, Rystad Energy, and Barclays.
[10] For the purpose of this analysis, it is assumed that changes in royalties and taxes parallel changes in industry employment.
[11] 3-5 years is roughly the life estimate of new shale wells per the Energy Information Administration.

We follow a two-step process to estimate the effect of oil price declines on home prices.[12] First, the expected change in oil industry employment is forecast using the historical oil price/ industry employment relationship along with the future oil price and production assumptions in each scenario. Predictions are made for both the conventional and shale oil components of the industry. Then, using a state-level proxy for the shale share of production to weight the two subcomponents, an expected industry employment loss value is found for each state.[13] Represented as a share of total state employment, this serves as a measure of the shock felt due to the oil price decline.

Figure 7: Two-Step Process Used to Project House Price Growth Drag Values Due to Oil Price



Second, using cross-state variation during the 1980s, we estimate the relationship between industry payroll losses as a share of total employment and changes in house prices. This value is then applied to the state level employment loss measures projected in the first step to determine a cumulative five-year house price growth "drag," related to the oil price, under the various scenarios. Lastly, for illustration, this is applied to a baseline cumulative five-year house price forecast, to project a new house price path (Fig. 8).[14]

Figure 8: Projected State-Level Five-Year (2014-2019) House Price Drag Values at $60 Oil in 2019

				1.Pessimistic		2.Optimistic		3.Traditional	
State	**Oil Ind. Share of Payrolls**	**Shale Proxy Percent**	**Q2 2015 IHS Forecast**	**Drag**	**HPI Ch.**	**Drag**	**HPI Ch.**	**Drag**	**HPI Ch.**
Wyoming	5.6%	71%	18%	-30%	-12%	-11%	6%	-20%	-3%
North Dakota	5.1%	67%	9%	-29%	-20%	-11%	-2%	-19%	-10%
Alaska	3.9%	12%	8%	-17%	-9%	-14%	-6%	-15%	-7%
Oklahoma	3.4%	73%	15%	-23%	-8%	-7%	9%	-13%	2%
Louisiana	2.4%	4%	16%	-11%	5%	-10%	6%	-10%	6%
New Mexico	2.4%	64%	11%	-17%	-6%	-6%	6%	-10%	2%
Texas	2.4%	50%	16%	-16%	0%	-6%	9%	-10%	6%
Colorado	1.0%	70%	27%	-8%	19%	-2%	25%	-4%	23%
Kansas	0.6%	30%	17%	-4%	13%	-2%	15%	-3%	14%
Utah	0.5%	16%	23%	-3%	20%	-2%	21%	-2%	21%

[12] See Appendix B for more detailed explanation of the home price growth drag projection methodology.
[13] The shale proxy is approximate as some non-shale oil production via horizontal drilling techniques will also be represented.
[14] We use the Q2 2015 IHS cumulative FHFA index 2014-2019 HPI forecast. This predates the more recent oil price fallback. Upon examination of the forecast details, it appears to be consistent with an assumption of a shorter-term oil price recovery. Therefore, for a 5-year period, we believe it to represent a reasonable baseline HPI path without protracted oil price effects. For the 5-year period, it is also similar to earlier forecasts, but incorporates more recent data. Still, it is acknowledged that this is not a perfect baseline but is provided to put the "drag" effects into context.

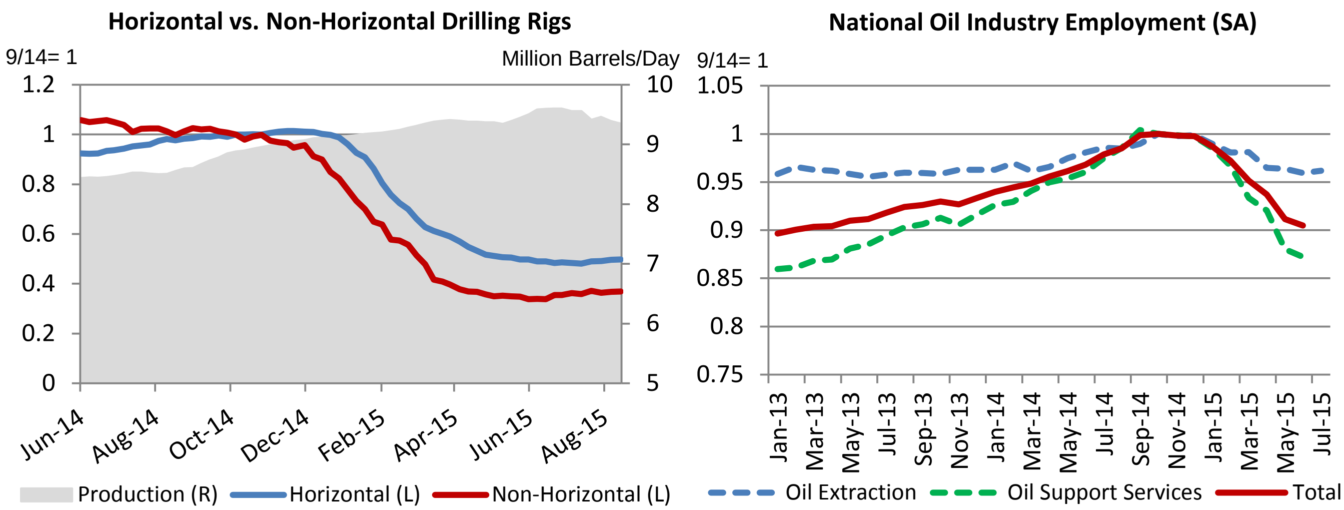
States with higher oil industry concentrations face greater downward home price pressure, while states with greater shale production face higher variation in estimates between the scenarios. Considering the three scenarios as a whole, three states (AK, ND, and WY) are projected to experience home price growth “drags” high enough to cause home prices to potentially decline under at least two of the three scenarios. If shale oil production proves to be sufficiently resilient, then the “drag” will be comparatively modest. However, if shale production decays severely, there may be significant house price declines in multiple states. Applying the pessimistic “drag” values to the baseline IHS forecast yields: AK: -9%, ND: -20%, NM: -6%, OK: -8%, and WY: -12%.[15] While some metro areas will bear greater stress, Texas as a whole is not expected to experience cumulative house price declines in any of the scenarios. Still, the “drag” is projected to significantly slow cumulative growth, approaching zero in the more severe case. Of course, larger house price “drags” would occur, including in Texas, if oil prices trend lower than current futures markets suggest.[16]

It should be noted that viability prices may vary across states due to factors that include differences in transportation costs. It is therefore possible that some states like North Dakota, with a greater distance to refineries, could experience something closer to the pessimistic scenario while states like Texas, where refineries are more local, may experience the more optimistic case. For the full severity of the pessimistic scenario to occur widely, however, global oil demand will have to fall sufficiently and/or other nations must increase output enough to offset the decline in US production so that the oil price does not rebound. While this is certainly possible, given that other market participants face the same oil price, we believe this to be unlikely.

Oil Industry and General Employment Observations Thus Far

At this stage, we have not yet observed significant house price effects.[17] This is expected, however, as noticeable changes did not occur in the 1980s until at least a year or two after oil price movements. Rather, what can be observed at this point is how the oil industry is reacting, and any changes in general employment levels. Using the 1980s as a guide, any significant home price changes will likely be preceded by changes in these two areas, respectively.

Figure 9: Oil Industry Drilling Activity and Payroll Employment Changes Thus Far



Sources: Bureau of Labor Statistics, Energy Information Administration, Baker Hughes

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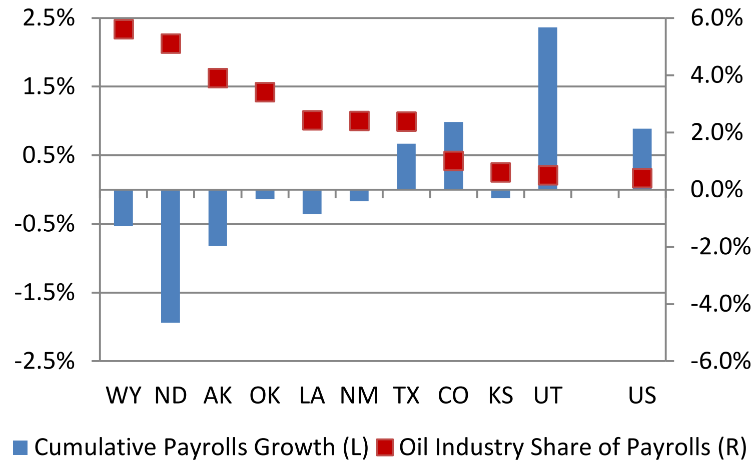
15 The absolute changes in this projection are subject to the values of the baseline forecast used. Applying a different baseline will yield different price change values.

16 See Appendix C for forecasts under the alternative oil price values of $40 to $70 by 2019.

17 The current FHFA HPI release is through Q1 2015. No conclusive changes in house price growth are observed through that point.

First, oil production has only recently begun to show modest declines (Fig. 9); however, seen in the same figure, active drilling rigs have declined by 56% since their peak last fall. Rigs reflect efforts to develop new oil wells. The slowdown in this measure suggests a future output deceleration. In turn, the rig measure is broken down by type, which approximates the drilling of conventional (non-horizontal) and shale (horizontal) oil wells. The smaller proportional decline in horizontal rigs is consistent with a view that shale oil technologies and applications are continuing to improve, allowing for greater supply at any given price point. However, the most recent oil price slide may cause the rig decline to resume and further test the viability of shale production.

Figure 10: 2015 Cumulative Total Non-Farm Payroll Change through July and Oil Industry Share



Sources: Bureau of Labor Statistics, Bureau of Economic Analysis

Second, industry employment is also now declining (Fig. 9), down as of June almost 10% from the peak, and will likely show additional declines in the following months. Employment involving oil extraction, which is more correlated with oil production, has fallen by less than the servicing component, which includes drilling crews and is correlated more with the active rig count measure. Though meaningful, the drop in industry employment thus far is modest relative to the 48% decline experienced in the 1980s.

Still, this weakness appears to be transmitting to the broader labor markets of the oil-producing states. Overall payroll growth in most of the oil-producing states' has lagged that of the country as a whole, with the six most heavily concentrated states (plus KS) experiencing cumulative declines through July of this year (Fig. 10). North Dakota's losses have surpassed what occurred during the past recession. Texas, the largest state in the list, continued to add payrolls. However, for the first time in many years, the pace underperformed that of the US, and growth is being driven primarily by the non-oil metro areas.

Conclusion

Futures markets now factor in a higher possibility that oil prices have only a modest recovery within the next five years. Examining how house prices were affected during the 1980s oil price bust allows for an estimate of the potential home price growth impact currently. However, even in a depressed oil price environment, after taking into account changing oil industry dynamics and how state economies have become more diversified, we expect that home price weakness will not be as severe in most oil patch areas as it was in the 1980s. Still, the three states with most risk of a decline are WY, ND, and AK. While there may be localized metro areas experiencing greater stress, short of a worst-case scenario, we do not expect Texas to see cumulative home price declines over the period.

The resilience of shale oil production will be key. Thus far, in the short run, it has remained relatively viable, and while industry employment has been declining, losses are still modest relative to the 1980s. States with higher oil industry concentrations are showing comparatively weaker general labor markets. Although there is no evidence yet of negative house price effects, given the historical time lags, we continue to monitor the situation.

Eric Brescia
Economist
Economic & Strategic Research Group

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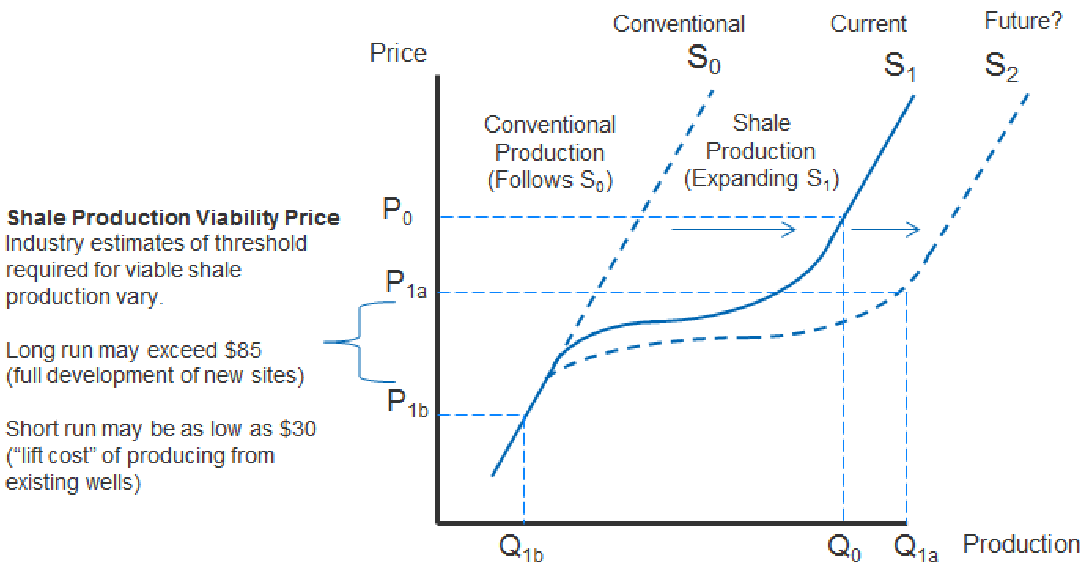
Appendix A: New vs. Old Industry Price Dynamics Due to Technology Change

New technologies applied to shale oil deposits have fundamentally changed the relationship between oil prices and industry output. Figure 11 presents a basic theoretical economic model of what has occurred in recent years. New production technologies have allowed the development of previously unobtainable shale oil sources to become economically viable. Therefore, the model represents the growth in recent shale oil production as the continual outward shifting of "$S_{1.}$" With each additional year, a greater quantity of production occurs for any given price point. The old curve, "$S_{0,}$" continues to explain conventional oil production – production changes linearly with price in the historical pattern.

Figure 11: Theoretical Model of Shifting Oil Industry Supply Function

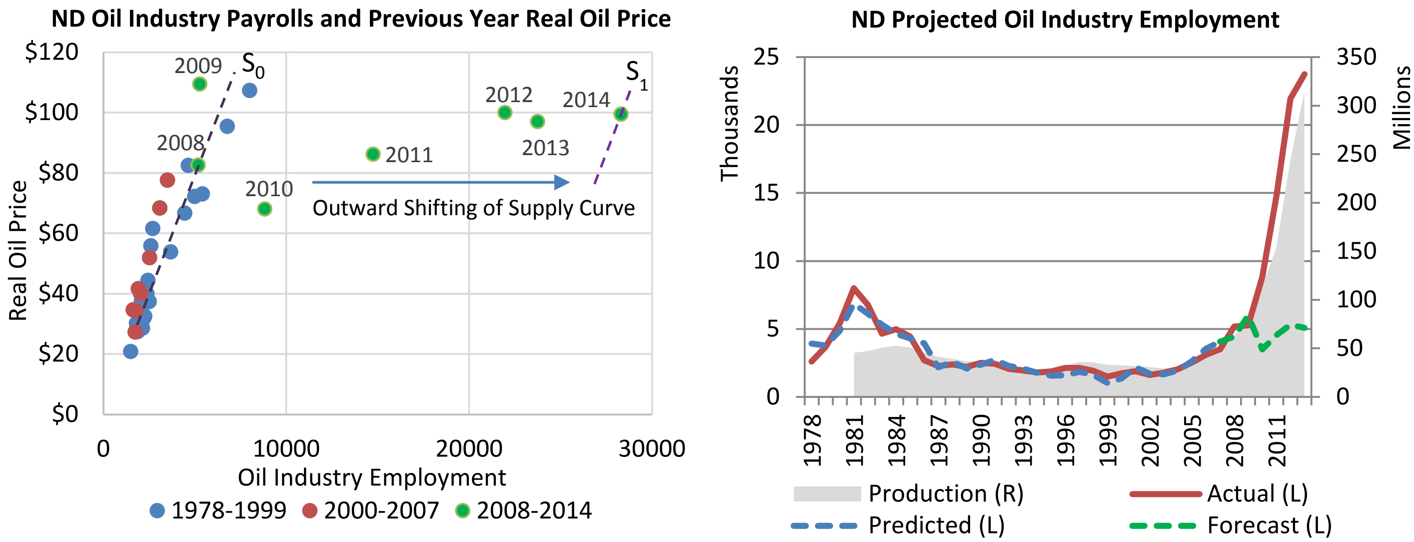


The changing supply function complicates predicting the industry's employment response to the current oil price decline. It is widely understood that shale oil production techniques have a higher minimal viability price than that of traditional sources. However, given that these new methods have not been historically tested by low oil prices, it is not precisely known what minimal level is required for production to remain viable. If the current price decline is represented by a shift from P_0 to P_{1a}, then shale production will continue and industry employment losses will likely be comparatively modest. If the price settles at P_{1b} however, shale activity will cease to be viable, output will revert to the old relationship (S_0), and industry employment losses will may be severe.

Figure 12 shows the case of North Dakota as an example of this new relationship. Around 2007, it became the first state to begin large scale shale oil development. The left portion of the figure displays annual oil industry employment in relation to the previous year's average real oil price. This is essentially the supply curve pattern shown in figure 11. As can be seen, for the years of 1978 to 2007, employment and price are related in a predictable linear manner (S_0). Higher prices induce greater production and industry employment.[18] However, beginning in 2008, payrolls begin to grow quickly and are no longer explained by the old price relationship.[19] Even without additional increases in oil price, employment continued to grow rapidly through 2014.[20] This is due to increased shale oil production made possible by continuing improvement of production technologies, represented by the previously discussed shifting outwards of the supply curve.

[18] Due to time lags in developing new sources, employment levels react more quickly to price changes than oil output measures.
[19] The year 2009 is likely an outlier to this relationship due to the financial crisis and the corresponding short term oil price crash.
[20] State level 2014 oil industry employment is not yet available via the utilized BEA series. The 2014 number is therefore imputed using the growth rate of total mining employment in the state over the period, of which oil industry payrolls are the largest part.

Figure 12: North Dakota Oil Industry Payrolls and Production in Relation to Real Oil Price[21]



Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, Energy Information Administration

To more formally explain this relationship change, we estimate the following model using annual data for the years 1978-2007, and then use the results to forecast employment for the years 2008-2013. Included is a linear time trend term to represent the depletion of oil sources and increases in labor productivity over time:[22]

$$ND\ Oil\ Industry\ Employment_t = \beta_0 + \beta_1 * Real\ Oil\ Price_{t-1} + \beta_2 * Time\ Trend_t$$

The results displayed in the right portion of figure 12 show that the oil price model explains industry employment well in the first period. However, when used to forecast payrolls through 2013, the model breaks down; the old supply curve relationship no longer holds. The forecast values are interpreted as what industry employment would have been in the absence of these new production technologies. In other words, this is an estimate for conventional oil production-related employment in the state. This intuition is used at the national level to project the change in oil industry payrolls related to conventional production, which is utilized in the projection of state-level house price growth "drags." This methodology is further discussed in Appendix B.

[21] Note that state-level oil production values are only reported by the Energy Information Administration starting in 1981.

[22] The tendency over time for industry payrolls to decline due to oil source depletion and labor productivity gains can be seen by contrasting the slope of years 1978-1999 with that of 2000-2007 in figure 12. Oil prices trended downwards in the first period and upwards in the later, so the movement in price within these periods is correlated with time. Therefore, the estimated employment decline due to price is overstated in the first period and growth in payrolls due to price is understated in the second period, resulting in different slopes. A time trend variable corrects for this, allowing for isolation of the oil price effect on industry employment.

Appendix B: House Price Growth Projection Methodology

Provided here is a more detailed discussion of the two-step methodology previously shown in figure 7.

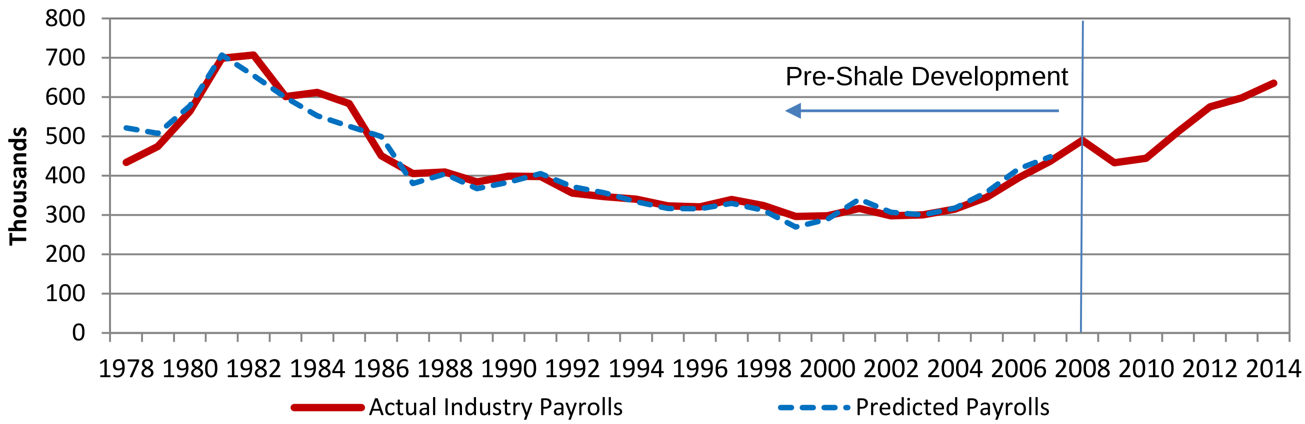
1. Forecasting Future Oil Industry Payroll Losses

As discussed previously, oil industry payroll losses historically trigger broader declines in states' labor markets, which in turn create downward house price pressure. Therefore, industry payroll losses are forecast given an expected oil price. Separate forecasts are made for the two industry components: one for the conventional oil component of the industry and one for the shale oil component of the industry.[23]

First, the conventional component is modelled nationally using the historical pre-shale industry oil price/employment relationship discussed in Appendix A. The following is estimated using annual average data for the years 1978-2007 with results shown in figure 13:

$$Conventional\ Industry\ Employment_t = \delta_0 + \delta_1 * Real\ Oil\ Price_{t-1} + \delta_2 * Time\ Trend_t$$

Figure 13: Predicted Oil Industry Employment as a Function of Real Oil Price



Sources: Bureau of Economic Analysis, Bureau of Labor Statistics, Energy Information Administration

The model explains industry payroll employment well prior to 2008. While this relationship no longer holds in the current shale production period, it continues to explain conventional oil production employment.[24] Therefore, the percentage change predicted at the national level between 2014 and 2019, given our oil price scenario, is used as a forecast for the proportional change in the conventional employment component.

Second, as it is unknown how the shale oil component will react to the oil price change, rather than estimating employment through a model, inputs for the stated scenarios are used (Optimistic, Pessimistic, Traditional). In the Optimistic, it is assumed that shale oil production decelerates but maintains the 2014 level over the time period, and corresponding employment declines by 10%. In the Pessimistic, it is assumed that shale oil is no longer viable, and related production decays over the five-year period, along with a corresponding 90% employment decline.[25] The Traditional case assumes shale production behaves in the old price relationship.

Next, we estimate state-level changes in industry employment by combining the two national-level industry component percentage change estimates. State-level weights are created via drilling rig type data used as a

[23] In actuality, industry employment between the two components is not fully discrete; however, as discussed previously, the two different production methods will respond differently, and each provide corresponding employment.

[24] See Appendix A for explanation.

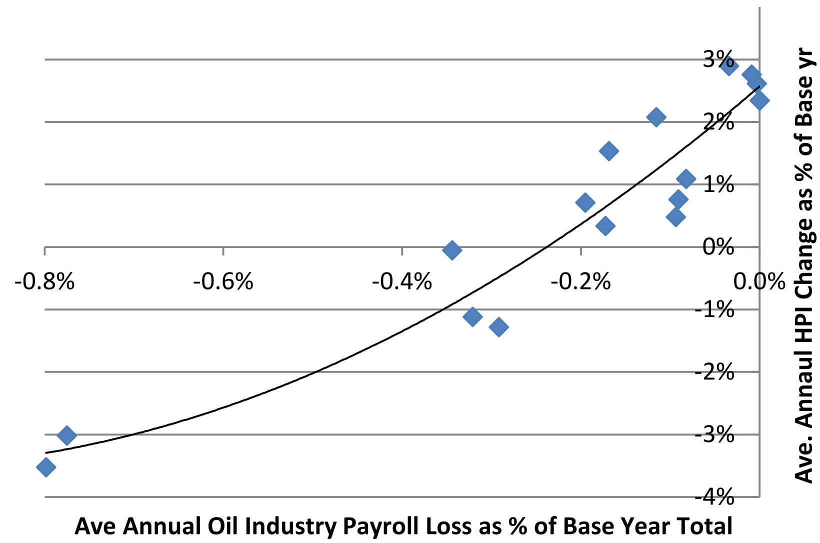
[25] Approximate life span of a new shale oil well per the Energy Information Administration.

proxy for the shale oil share of production.[26] The value is lastly converted to an expected decline in industry payrolls as a percent of total state employment in 2013.[27] This provides a comparable measure of the expected labor market impact that a state will experience due to oil industry employment declines.

2. Estimating the Historical Relationship between Changes in Oil Industry Payrolls and House Prices

The second step is to estimate the 1980s relationship between declines in oil industry employment as a percent of total payrolls and changes in house prices. This is done by exploiting cross-sectional variations between states in the historical period. First, both cumulative home price changes[28] and oil industry payroll declines in the 1980s are measured as a percent of the base-year home price and total payroll employment, respectively. The changes are measured from the year in which oil industry employment peaks for each state (either 1981 or 1982) and 1988 (the year house prices generally bottomed). This takes into account the longer period of weakness and not just the oil price crash in 1985. In order to map this relationship to the current time frame, these values are divided by the number of years measured for each state, resulting in an average annual change as a percent of the base year's value.

Figure 14: 1980s State Level Relationship Between Oil Industry Payroll Loss Measure and HPI Change



Sources: Bureau of Economic Analysis, Federal Housing Finance Agency

Sixteen states are used to estimate this relationship – nine of the 10 current "oil states" examined, plus seven additional interior states in proximity to the "oil states" that are hypothesized to be similar in other factors.[29] The house price value is regressed onto the payroll value (Fig. 14) to arrive at an estimated sensitivity.

Combining the Two Steps

The forecast industry payroll loss measures for the three scenarios determined in step 1 are then applied to the house price relationship estimate from step two. Using the calculated estimates for annual effect, a cumulative five-year house price "drag" value from the oil industry employment shock can be estimated for each state. This "drag" value is then applied to a baseline house price forecast for the period. In this case, the publicly available Q2 2015 IHS FHFA house price forecast is used.[30] The five-year period begins at the end of year 2014, when oil industry employment peaked.

[26] Not all horizontal drilling rigs are employed in shale oil production, so this measure should be understood to be approximate.
[27] The most recent year of state level oil industry employment data is 2013.
[28] As measured by the FHFA all transactions state level HPI.
[29] Alaska is not used due to industry employment data not being specifically reported by the BEA series for the time period. The additional states included are AR, IA, ID, MS, MT, NE, and SD.
[30] See previous footnotes #3 and #14 for explanation of choosing this forecast.

Appendix C: Projected Five-Year HPI Effects under Alternative Oil Price Scenarios

Five-year (2014-2019) cumulative, state-level house price drag effects are provided, given alternative assumptions about the future oil price in 2019. The presented baseline in the body of this note is $60 per barrel WTI. Outcomes closer to the Pessimistic scenario (shale production decays 90%) are more likely to occur at lower oil prices, while the Optimistic case (shale production holds at 2014 levels) projections are more likely at higher oil prices. Likelihoods may also vary across states for any given oil price level.

$40 Oil Price	State	Oil Ind. Share of Payrolls	Shale Proxy Percent	Q2 2015 IHS Forecast	1.Pessimistic		2.Optimistic		3.Traditional	
					Drag	HPI Ch.	Drag	HPI Ch.	Drag	HPI Ch.
	Wyoming	5.6%	71%	18%	-30%	-13%	-14%	4%	-26%	-8%
	North Dakota	5.1%	67%	9%	-29%	-21%	-13%	-5%	-24%	-15%
	Alaska	3.9%	12%	8%	-21%	-13%	-18%	-10%	-20%	-12%
	Oklahoma	3.4%	73%	15%	-24%	-9%	-8%	7%	-18%	-3%
	Louisiana	2.4%	4%	16%	-14%	2%	-13%	2%	-14%	2%
	New Mexico	2.4%	64%	11%	-18%	-7%	-7%	4%	-14%	-2%
	Texas	2.4%	50%	16%	-17%	-1%	-9%	7%	-13%	2%
	Colorado	1.0%	70%	27%	-9%	18%	-3%	24%	-6%	21%
	Kansas	0.6%	30%	17%	-5%	12%	-3%	14%	-4%	13%
	Utah	0.5%	16%	23%	-4%	19%	-3%	20%	-3%	20%

$50 Oil Price	State	Oil Ind. Share of Payrolls	Shale Proxy Percent	Q2 2015 IHS Forecast	1.Pessimistic		2.Optimistic		3.Traditional	
					Drag	HPI Ch.	Drag	HPI Ch.	Drag	HPI Ch.
	Wyoming	5.6%	71%	18%	-30%	-12%	-12%	5%	-23%	-6%
	North Dakota	5.1%	67%	9%	-29%	-20%	-12%	-3%	-22%	-13%
	Alaska	3.9%	12%	8%	-19%	-11%	-16%	-8%	-17%	-10%
	Oklahoma	3.4%	73%	15%	-24%	-8%	-8%	8%	-16%	0%
	Louisiana	2.4%	4%	16%	-12%	3%	-12%	4%	-12%	4%
	New Mexico	2.4%	64%	11%	-18%	-6%	-6%	5%	-12%	0%
	Texas	2.4%	50%	16%	-16%	-1%	-8%	8%	-12%	4%
	Colorado	1.0%	70%	27%	-9%	19%	-2%	25%	-5%	22%
	Kansas	0.6%	30%	17%	-4%	13%	-3%	15%	-3%	14%
	Utah	0.5%	16%	23%	-3%	20%	-3%	21%	-3%	20%

$60 Oil Price	State	Oil Ind. Share of Payrolls	Shale Proxy Percent	Q2 2015 IHS Forecast	1.Pessimistic		2.Optimistic		3.Traditional	
					Drag	HPI Ch.	Drag	HPI Ch.	Drag	HPI Ch.
	Wyoming	5.6%	71%	18%	-30%	-12%	-11%	6%	-20%	-3%
	North Dakota	5.1%	67%	9%	-29%	-20%	-11%	-2%	-19%	-10%
	Alaska	3.9%	12%	8%	-17%	-9%	-14%	-6%	-15%	-7%
	Oklahoma	3.4%	73%	15%	-23%	-8%	-7%	9%	-13%	2%
	Louisiana	2.4%	4%	16%	-11%	5%	-10%	6%	-10%	6%
	New Mexico	2.4%	64%	11%	-17%	-6%	-6%	6%	-10%	2%
	Texas	2.4%	50%	16%	-16%	0%	-6%	9%	-10%	6%
	Colorado	1.0%	70%	27%	-8%	19%	-2%	25%	-4%	23%
	Kansas	0.6%	30%	17%	-4%	13%	-2%	15%	-3%	14%
	Utah	0.5%	16%	23%	-3%	20%	-2%	21%	-2%	21%

$70 Oil Price	State	Oil Ind. Share of Payrolls	Shale Proxy Percent	Q2 2015 IHS Forecast	1.Pessimistic		2.Optimistic		3.Traditional	
					Drag	HPI Ch.	Drag	HPI Ch.	Drag	HPI Ch.
	Wyoming	5.6%	71%	18%	-30%	-12%	-10%	8%	-17%	1%
	North Dakota	5.1%	67%	9%	-28%	-20%	-9%	-1%	-15%	-7%
	Alaska	3.9%	12%	8%	-15%	-7%	-11%	-3%	-12%	-4%
	Oklahoma	3.4%	73%	15%	-23%	-7%	-6%	9%	-11%	5%
	Louisiana	2.4%	4%	16%	-9%	7%	-8%	8%	-8%	8%
	New Mexico	2.4%	64%	11%	-17%	-5%	-5%	7%	-8%	3%
	Texas	2.4%	50%	16%	-15%	1%	-5%	10%	-8%	8%
	Colorado	1.0%	70%	27%	-8%	19%	-2%	25%	-3%	24%
	Kansas	0.6%	30%	17%	-3%	14%	-2%	15%	-2%	15%
	Utah	0.5%	16%	23%	-2%	21%	-2%	21%	-2%	21%