



United States Department of Agriculture

Oil and Gas Development on Agricultural Lands

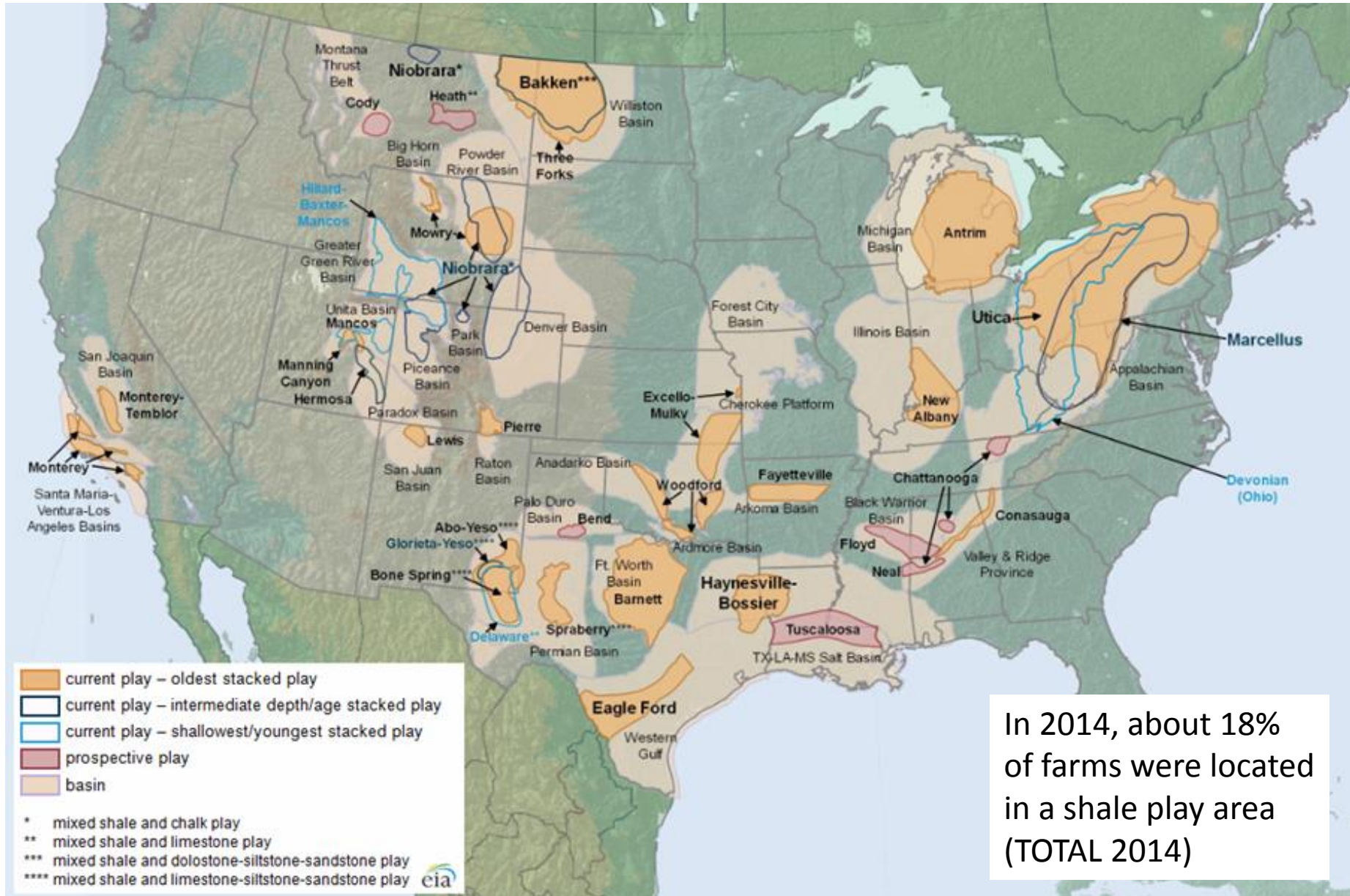
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*The views are those of the authors and should not be attributed to the USDA or the
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Shale Plays in the Lower 48 States



Drilling on Agricultural Land (1/2)

- Land for drilling pad, access roads, wastewater impoundment pit is taken (temporarily/ permanently) out of agricultural production
 - 5 acre multi-well drillpad can drain gas/oil from 500-1,000 acres (NETL 2013)
 - Vegetation removal due to oil and gas development from 2000-2012 affected about 7.4 million acres of land (47% rangeland, 37% cropland, 13% forestland) (Allred et al. 2015)
 - Agricultural production can continue, but disturbing of soil can lower crop yields
- Labor and transportation costs may increase
 - In the Bakken shale, farmers had difficulty finding seasonal workers (Deede 2014)
 - Rail shipment delays caused a loss of \$66.6 million in North Dakota's farm-level revenue for crops that were sold from Jan-Apr 2014 (Olson 2014)



Drilling on Agricultural Land (2/2)

Risk of air pollution, soil and water contamination

- Exposure to dust from truck traffic in dry areas
- Exposure to drilling chemicals from a blowout
- Exposure to wastewater through leakage or improper fencing of impoundments, direct application of wastewater to roads, and dumping of water on creeks and land

Impacts on livestock (Bamberger and Oswald 2012)

- Dust pneumonia
- Sudden death
- Difficulty breeding
- Increased incidence of stillborn offspring and offspring with congenital abnormalities



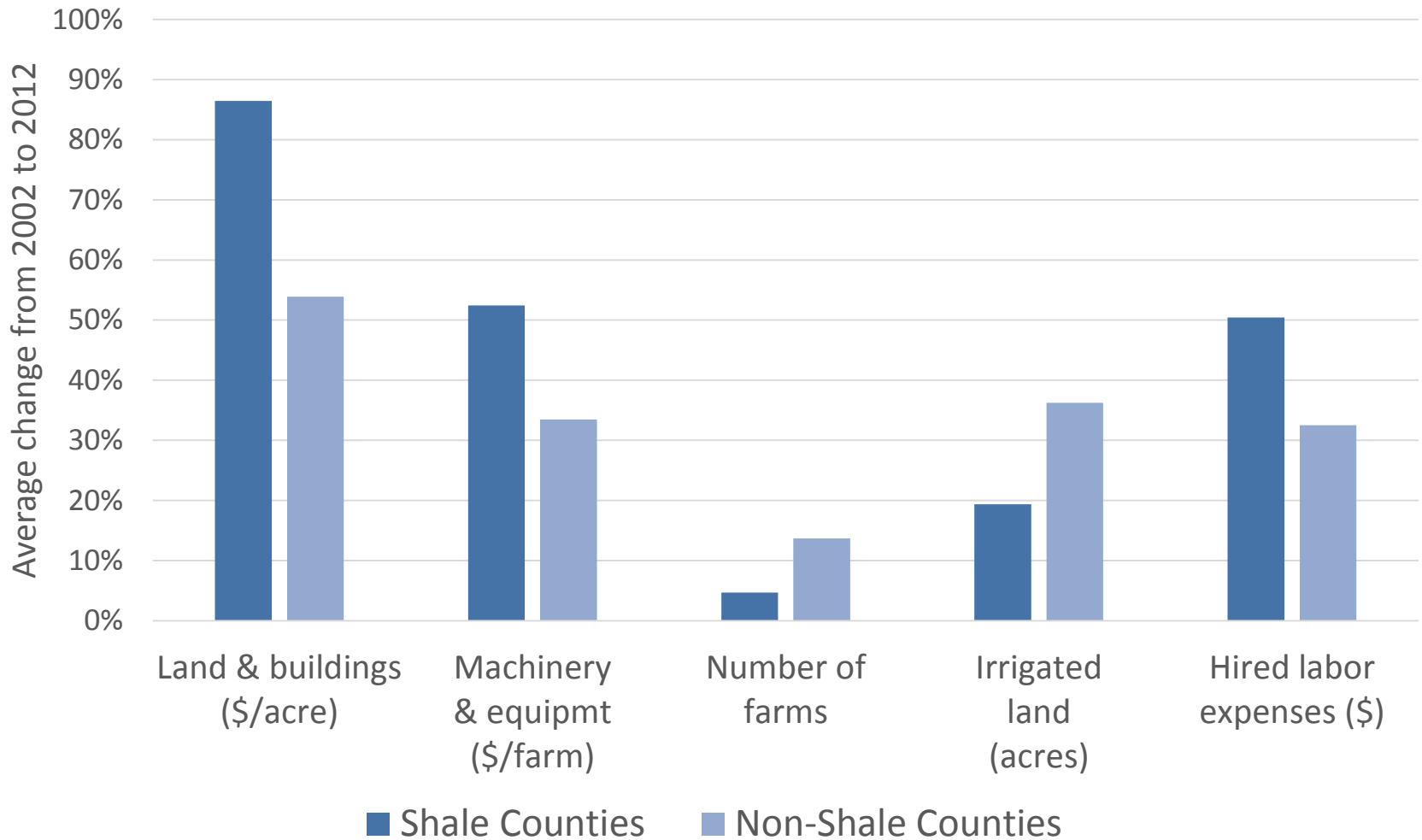
Lease and Royalty Income

Can affect level and type of agricultural production

- Switching primary output (e.g. from dairy to beef)
- Investing in machinery
- Buying land
- Increasing leisure time
- Exiting/entering conservation programs



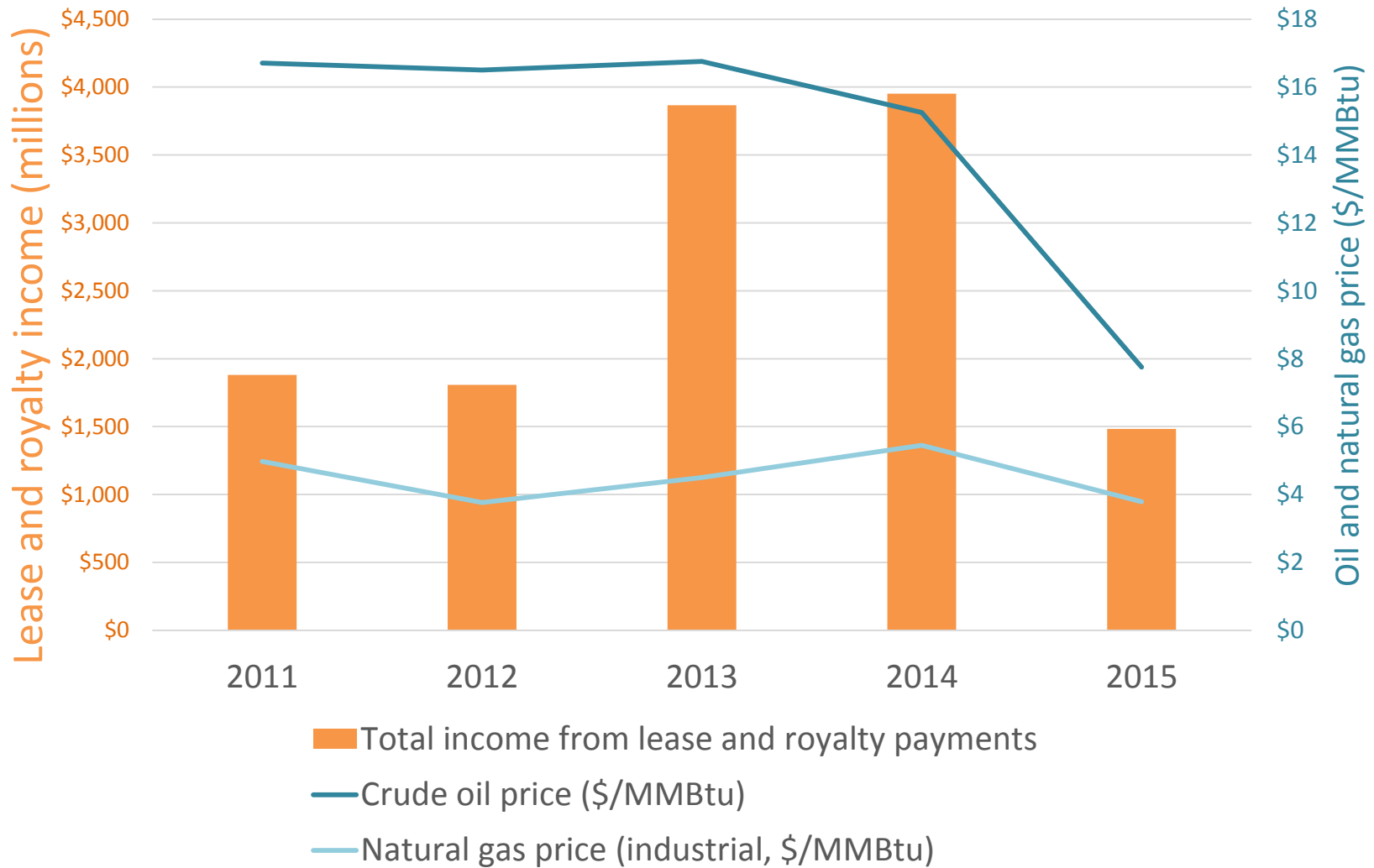
Change in Agricultural Variables from 2002 to 2012 across Shale and Non-Shale Counties



Source: Based on USDA, NASS, 2002 and 2012 Censuses of Agriculture. Includes counties with shale plays in AR, CO, LA, MO, NM, ND, OK, and TX.



Lease and royalty income to farm operators



2011-2015 Agricultural and Resource Management Surveys



Research Questions

Are non-operator landlords more likely than owner-operators to allow energy development on their land?

What is the prevalence of split estates?

What is the impact of shale development on **farm finances, agricultural production, and conservation programs** for different types of farmers who...

- Own the land and the mineral rights
- Own the land only (split estate)
- Rent the land and own neither [future work]



Data

Tenure, Ownership, and Transition of Agricultural Land (TOTAL) Survey for 2014 (USDA NASS and ERS)

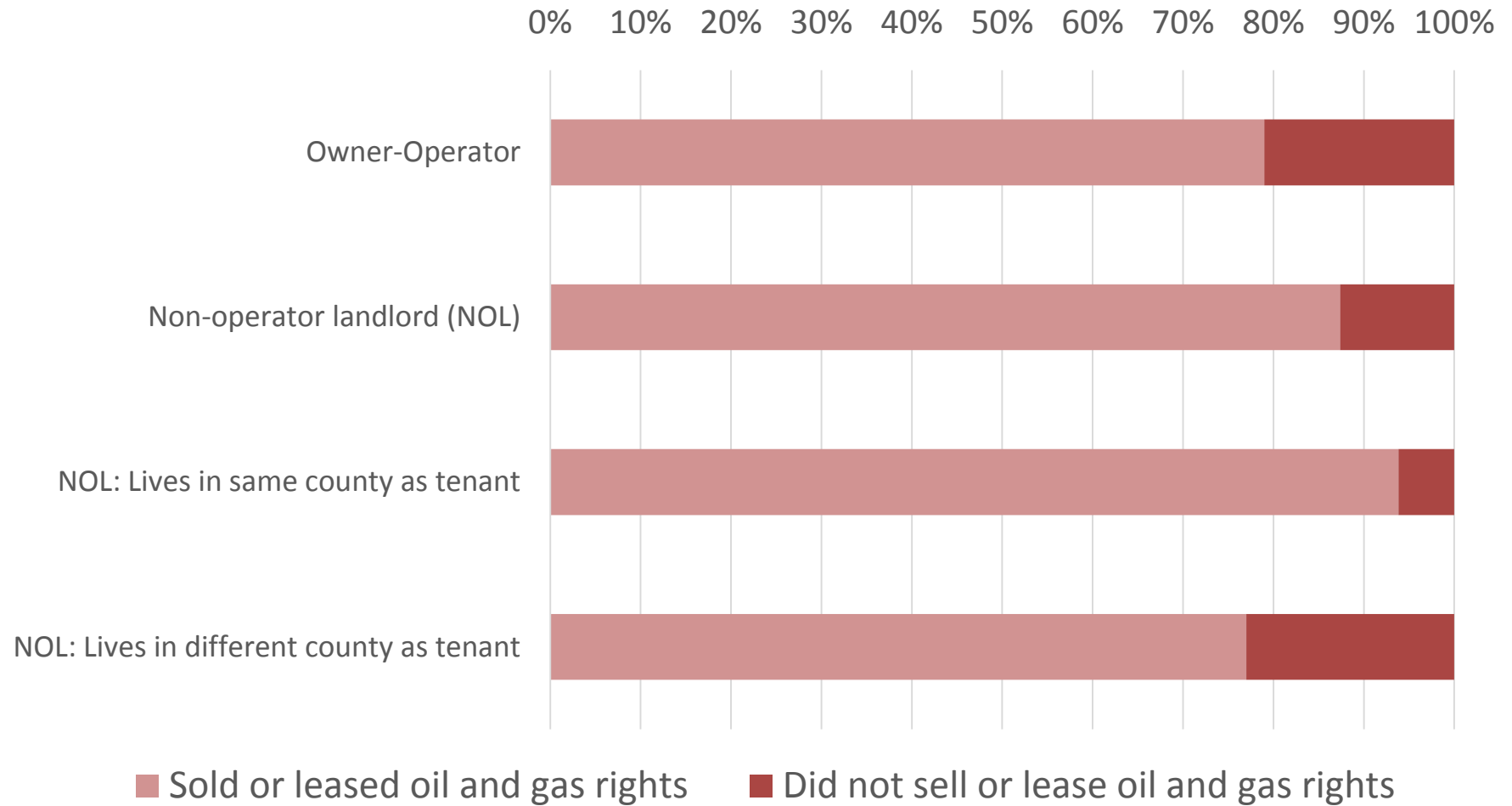
- Survey of farm operators AND non-operator landlords
- Mandatory (response is required by US law)
- Information on income, expense, debt, assets, transition plans, demographic and other landlord characteristics

Shale play boundaries (EIA)

Number of wells drilled from DrillingInfo



Proportion of landowners (operators and non-operators) who sold or leased their mineral rights by type of landowner



2014 TOTAL Survey



Characteristics of operator landowners and non-operator landlords who own or used to own (since 2002) their mineral rights

		Operators	Non-operators	
			Same county as tenant	Different county as tenant
Operations	Total	141,673	63,510	46,042
Acres Owned	Acres/farm	646	199	222
Acres Rented to others	Acres/farm	78	199	222
Acres Operated	Acres/farm	826	NA	NA
Debt-to-Asset Ratio	Ratio/farm	10.0	10.6	1.9
Farm Income to Household	\$/farm	38,714	13,937	49,381
Total off-farm Income	\$/farm	104,789	78,429	92,908
Total Household Income	\$/farm	143,503	83,088	108,256
Household Net Worth	\$/farm	1,909,572	1,106,320	1,034,608
Landowner Age	Average years	61	68	67

2014 TOTAL Survey



Characteristics of farm operators who own their land and own or used to own (since 2002) their mineral rights

	Units	Oil and gas rights retained since 2002	Oil and gas rights leased or sold since 2002
Operations	Total	47,520	94,152
Acres operated	Acres/farm	606	868
Value of production	\$/farm	132,413	142,226
Farm income	\$/farm	28,951	43,645
Off-farm income	\$/farm	96,256	109,098
Household debt	\$/farm	175,439	198,004
Household assets	\$/farm	1,952,112	2,174,700
Debt to asset ratio	Ratio/farm	12.0	8.9
Enrollment in CRP	Share of farms	0.43	0.60

The 2002 cutoff marks start of the shale boom.

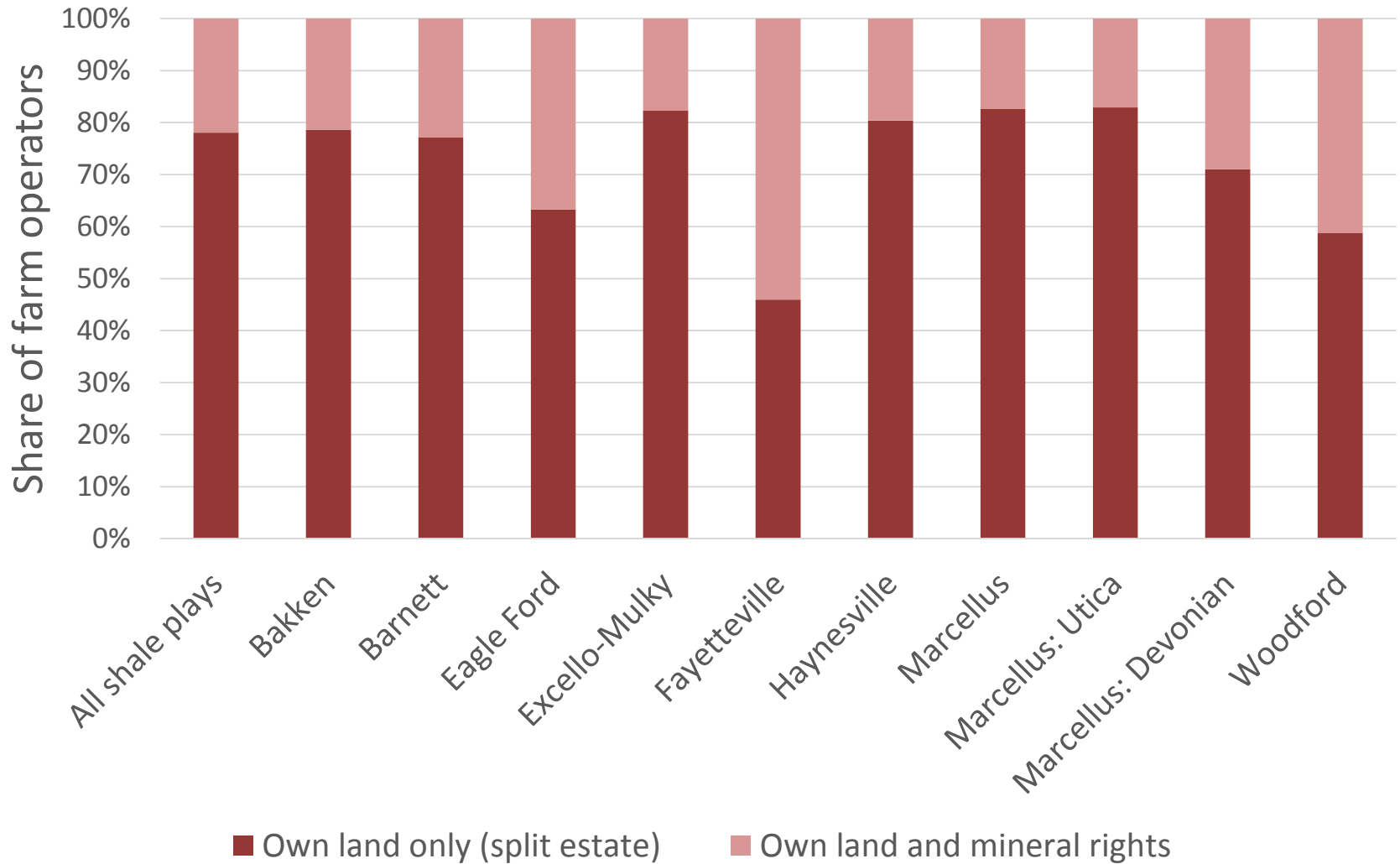
2014 TOTAL Survey



Determinants of allowing energy development
(Sample: Owner-operators in shale who own or
used to own (since 2002) their mineral rights)

Dependent variable	Energy development (0/1)	(continued)	
		Principal commodity (PC):	
Land owned (acres)	-0.0000336 (-1.52)	Crop	0.411** (2.35)
Land rented in (acres)	0.00000695 (0.18)	PC: Fruit, veg, greenhouse	-0.433** (-2.16)
Value of production (\$)	-0.000000135** (-2.09)	PC: Cattle	-0.0259 (-0.22)
Cash expenses	0.000000285** (2.25)	PC: Hogs	0.535 (1.01)
Off-farm income	0.000000307 (0.78)	PC: Poultry	0.730** (1.99)
Farm income to household	0.000000436* (1.72)	PC: Dairy	0.188 (0.95)
Debt to asset ratio	0.000448 (0.27)		
Observations	991		

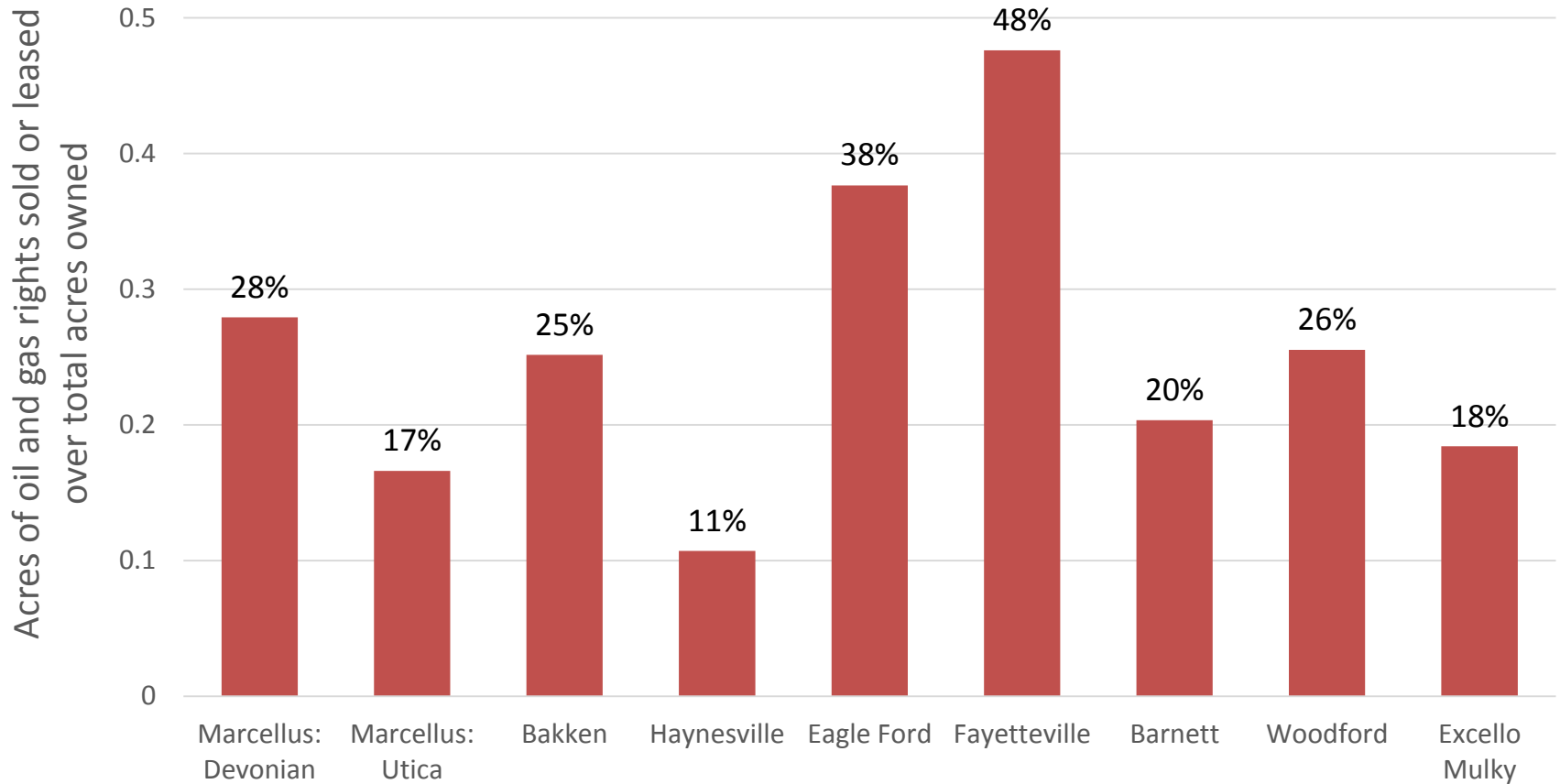
Prevalence of split estates across shale plays



2014 TOTAL Survey



Acres of oil and gas rights sold or leased over total acres owned (Ratio)



2014 TOTAL Survey



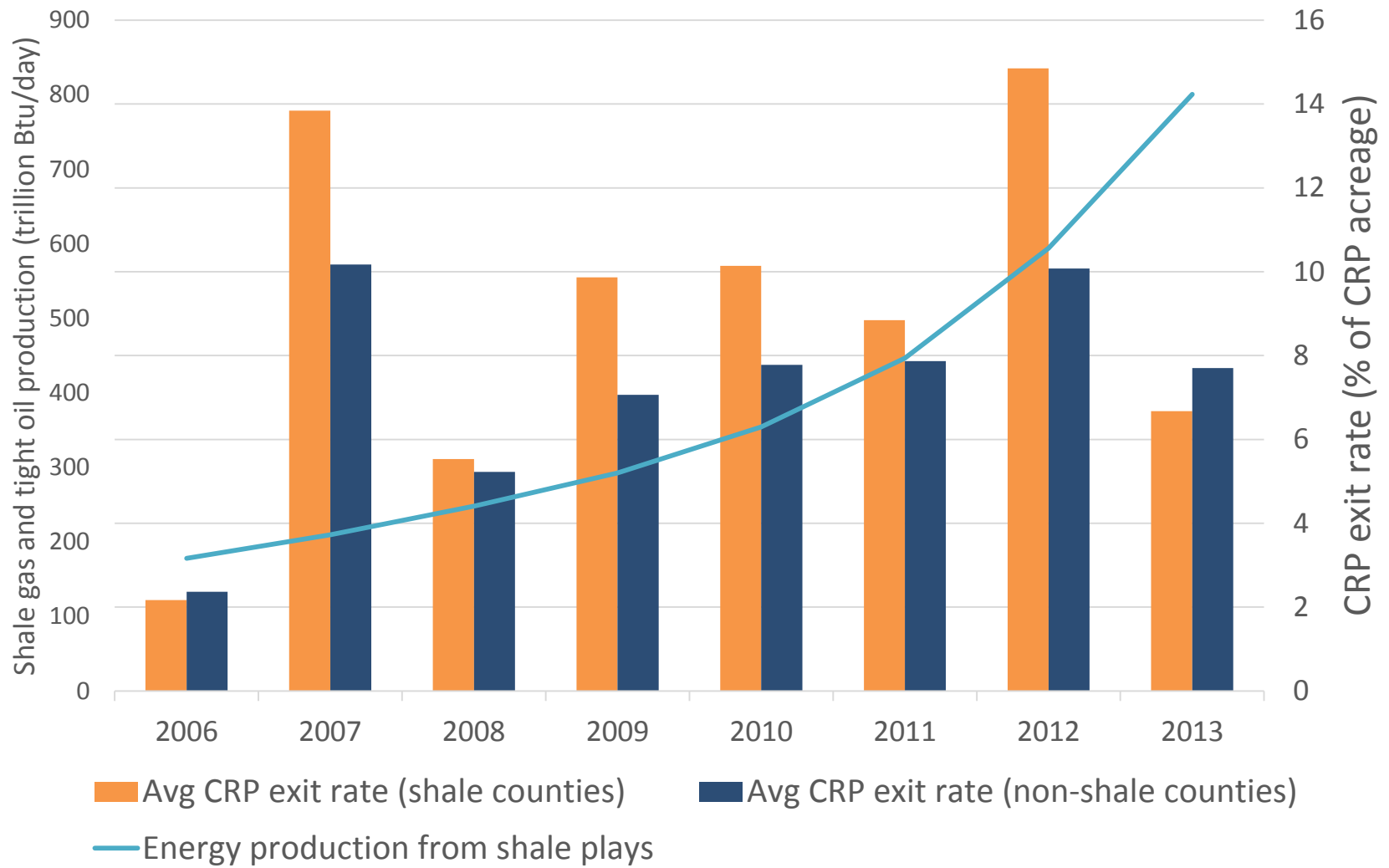
Characteristics of farm operators who own only their land

	Unit	In county with				
		Outside of shale plays	In shale play	>0-0.5 wells /1000 acres	0.5-1 wells /1000 acres	>1 well /1000 acres
Operations	Total	1,528,973	281,088	111,308	20,156	19,785
Acres operated	Acres/farm	409	368	396	804	370
Value of production	\$/farm	189,134	103,564	85,107	56,628	94,571
Farm household income	\$/farm	31,292	15,281	8,084	14,376	11,251
Off-farm income	\$/farm	102,925	111,589	135,262	108,806	161,104
Farm household debt	\$/farm	212,252	164,680	164,570	140,008	132,374
Farm household assets	\$/farm	1,742,303	1,397,723	1,442,068	1,062,907	1,254,622
Debt to asset ratio	Ratio/farm	8.1	7.0	6.9	3.8	5.2
Enrollment in CRP	Share of farms	0.56	0.45	0.36	0.42	0.37

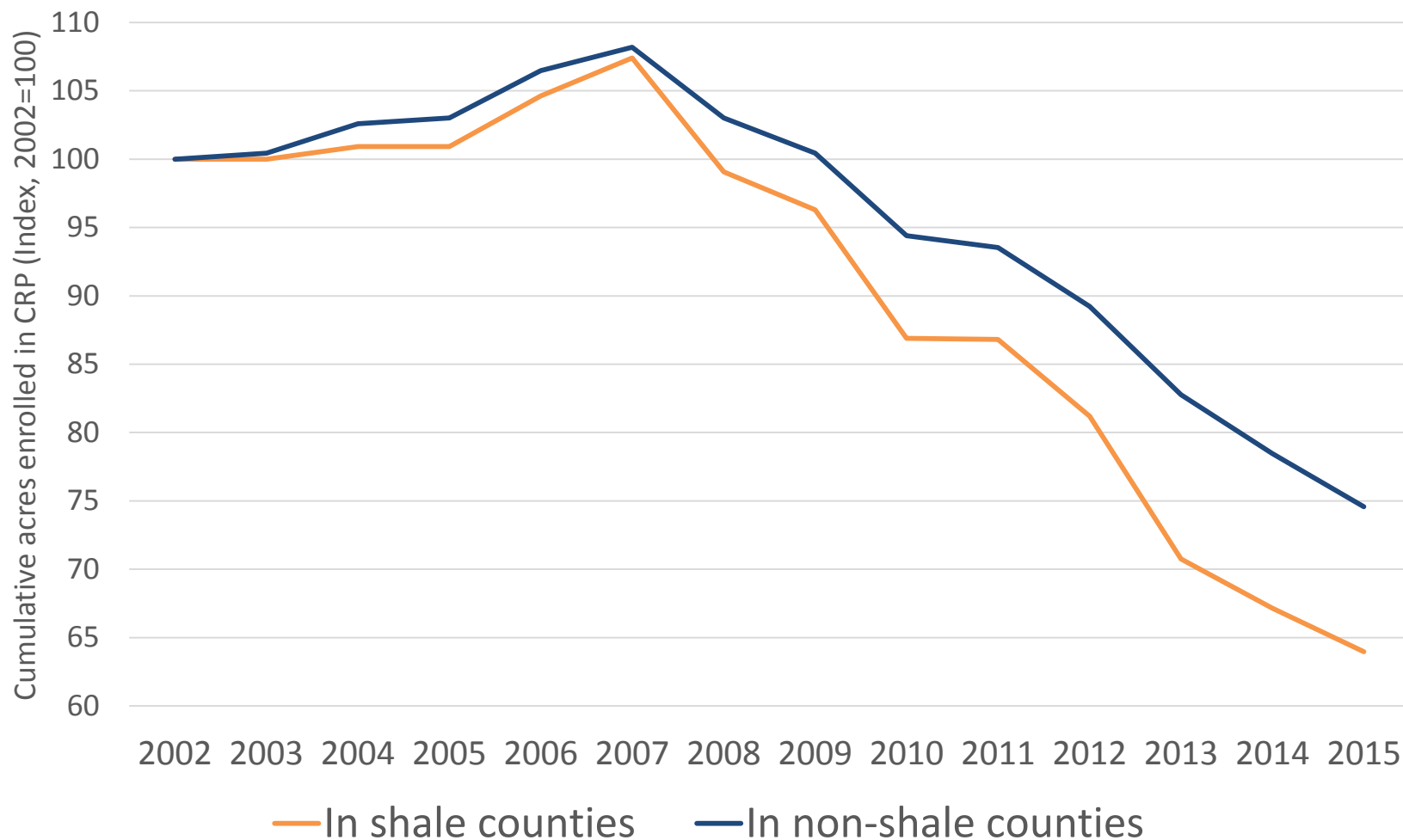
2014 TOTAL Survey



Average Exit Rates from the Conservation Reserve Program



Index of Cumulative Acres Enrolled in CRP



CRP enrollment data from
USDA, Farm Service Agency



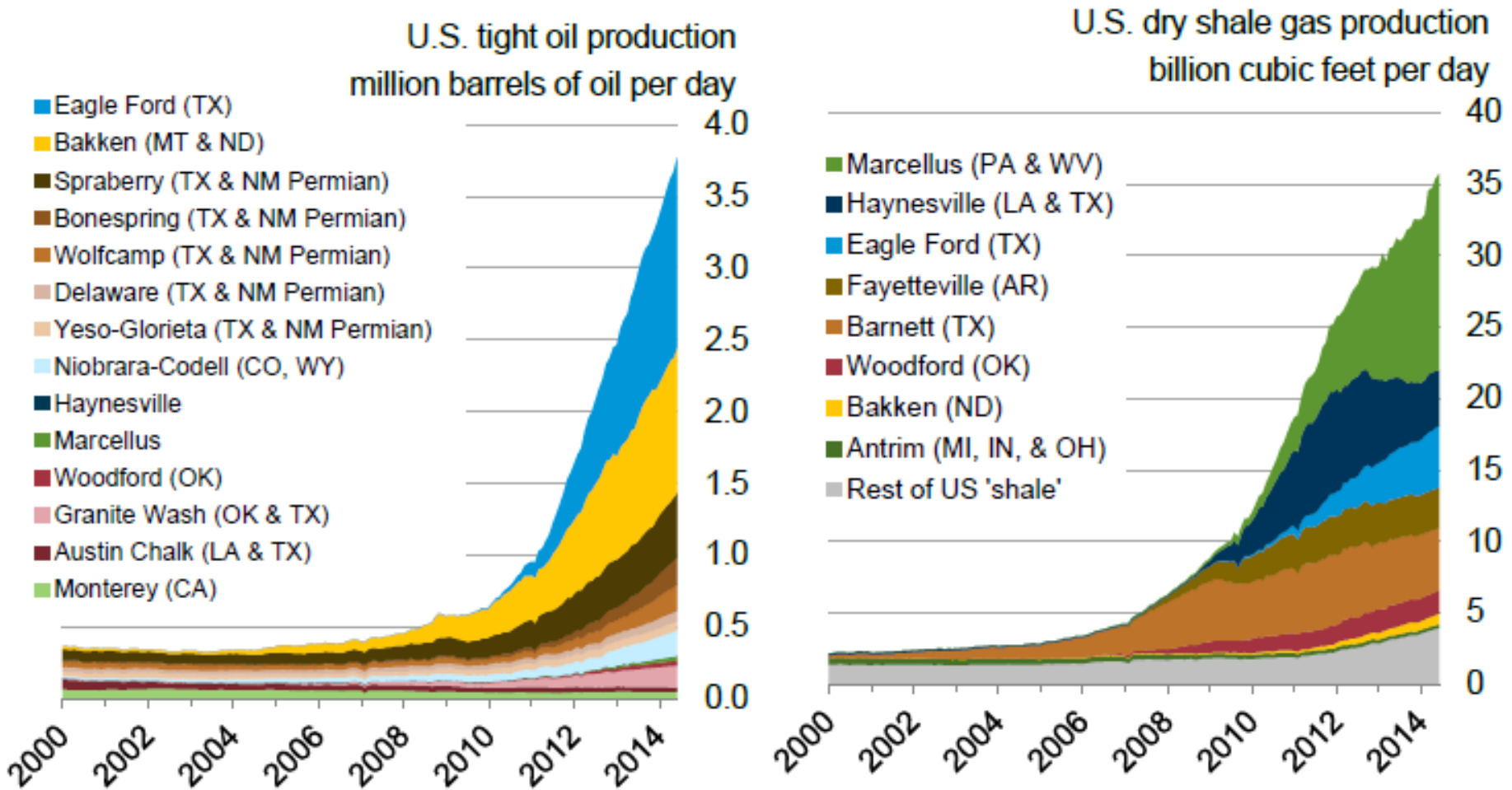
Dependent variable	CRP enrollment (0/1)
Land owned (acres)	0.00000364 (1.55)
Land rented in (acres)	0.0000225*** (3.95)
Value of production (\$)	-3.97e-08*** (-4.85)
Cash expenses	8.98e-09 (1.35)
Off-farm income	-2.60e-08 (-0.87)
Farm income to household	4.04e-08** (2.05)
Debt to asset ratio	-0.00271*** (-7.89)
In shale play (0/1)	-0.206*** (-7.53)
Own mineral rights (0/1)	-0.0904** (-2.05)
Sold or leased mineral rights (0/1)	0.282*** (7.77)
Observations (farm operators)	29,081

Conclusions

- Only about 1 in 5 farm operators who own their land also own or used to own (since 2002) the associated oil and gas rights
- Of those, many own or used to own only a portion of the oil and gas rights
- Split estates are less common in areas with no prior drilling history (eastern Fayetteville)
- Non-operator landlords who do not live in the same county as their tenant are less likely to lease or sell their oil and gas rights than those that live in the same county and than owner-operators
- Income from lease and royalty payments has declined along with the price of oil and gas
- Operators that retained their oil and gas rights tend to have smaller operations but produce higher-value crops or livestock, and off-farm income makes up a higher share of their total income. However, they have higher debt-to-asset ratios and a lower likelihood of being enrolled in the Conservation Reserve Program (CRP).
- Overall, land enrolled in the CRP declined 36% in shale counties from 2002-2015 compared with a 25% decline in non-shale counties.



Shale Production



Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through June 2014 and represent EIA's official tight oil & shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).

Roughly 200 tanker trucks deliver water for the fracturing process.

A pumper truck injects a mix of sand, water and chemicals into the well.

Natural gas flows out of well.

Recovered water is stored in open pits, then taken to a treatment plant.

Storage tanks

Natural gas is piped to market.

