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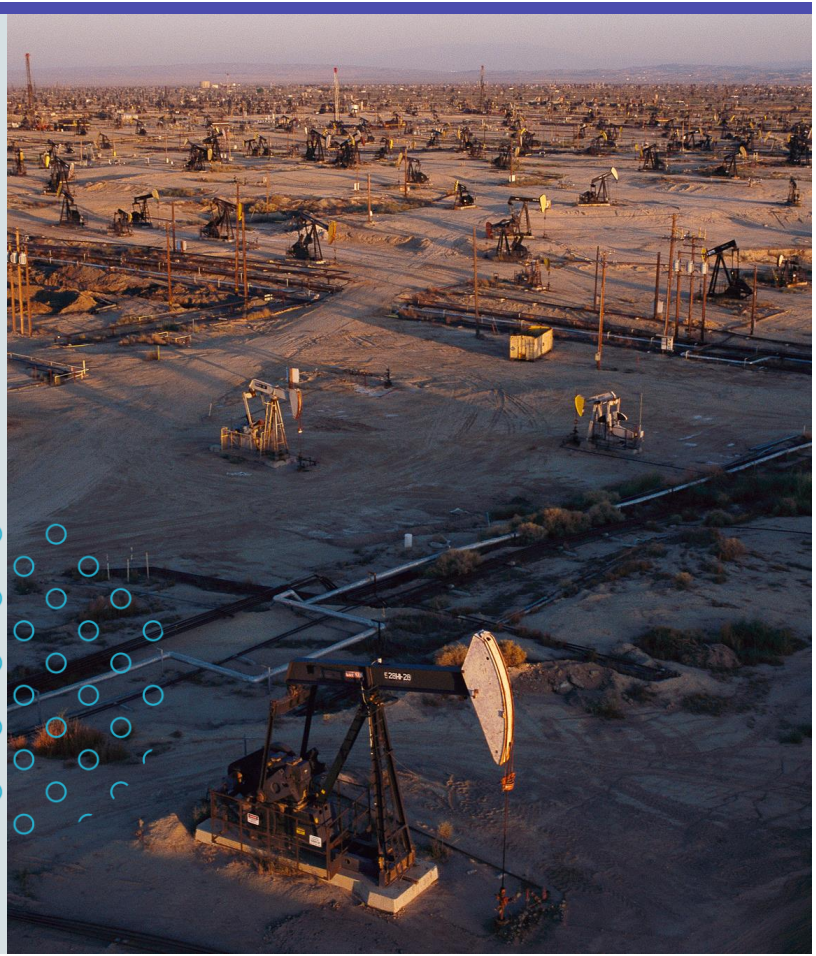
Survival of the fittest: US oil productivity during business cycles



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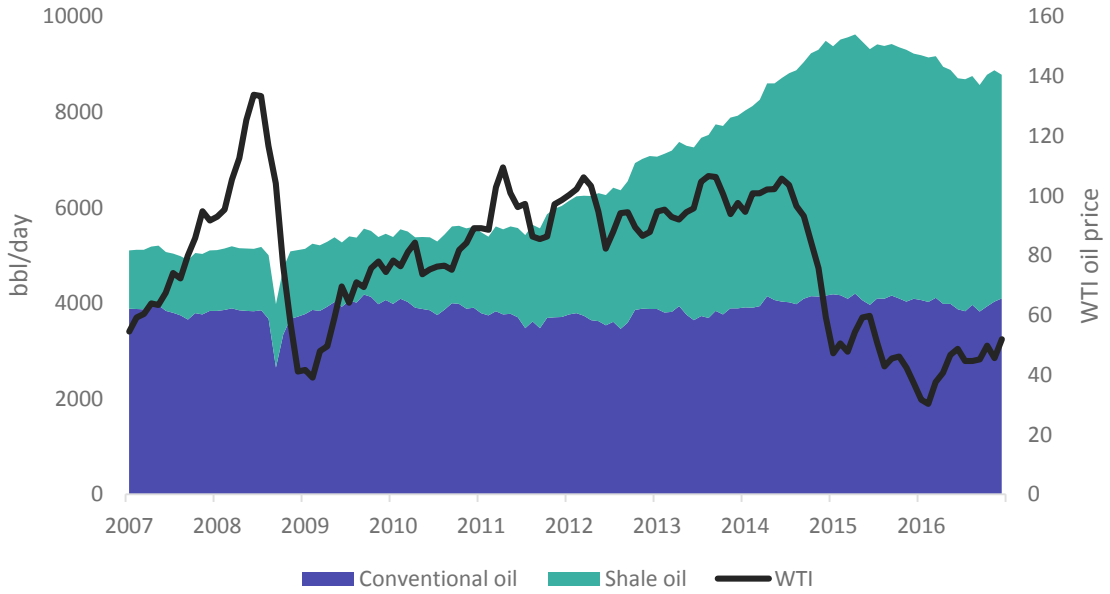
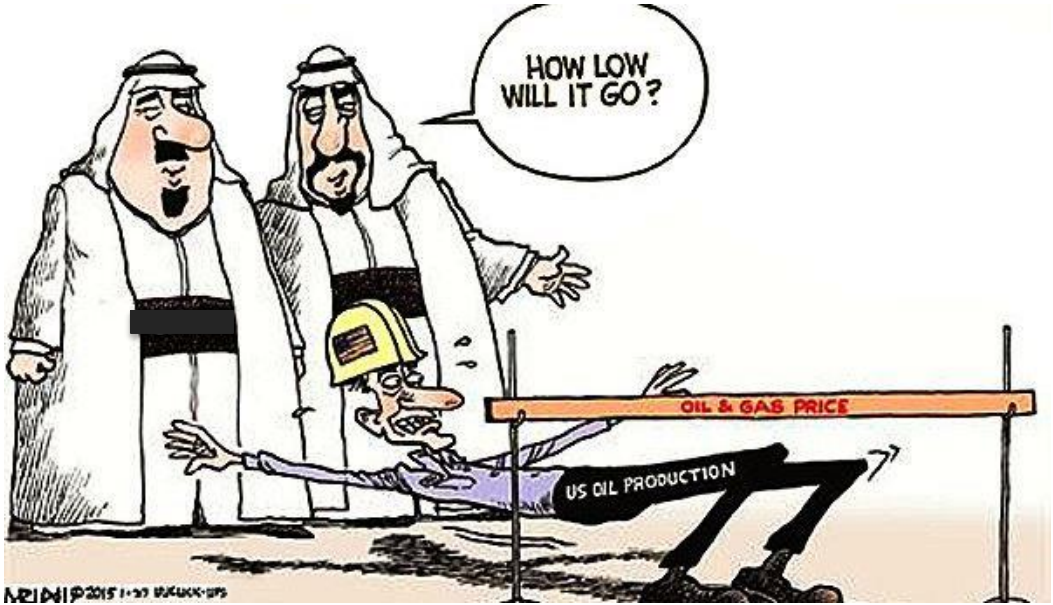
Objective

- Studying production behavior in US oil production
  - In which way has the business cycles (measured by oil price variability) affected the supply of oil, the productivity within the industry and the sector size?
  - Are there differences between conventional oil and shale oil?

Background


10000
8000
6000
4000
2000
0
bbl/day
160
140
120
100
80
60
40
20
0
WTI oil price
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Conventional oil
Shale oil
WTI


HOW LOW WILL IT GO?
OIL & GAS PRICE
US OIL PRODUCTION

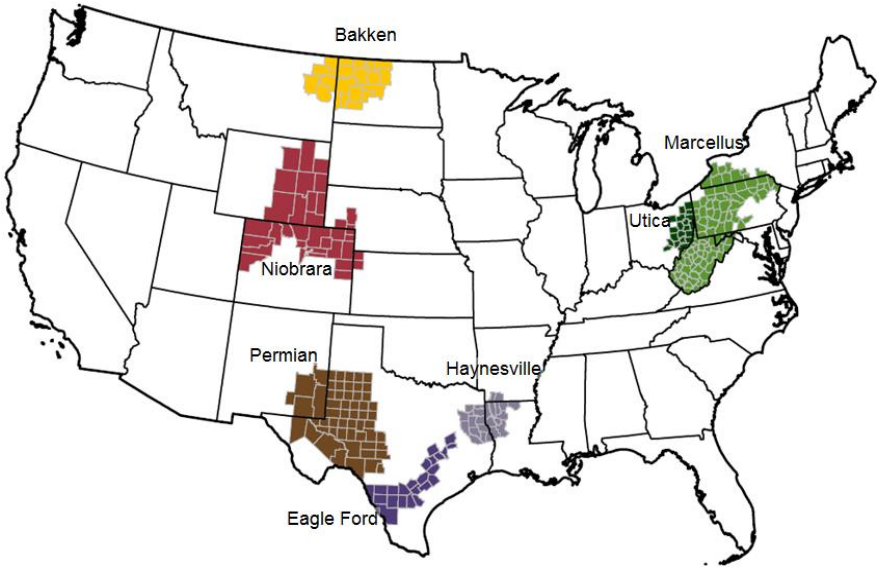
Litterature

- A number of studies has been conducted for explaining pricing and production behavior in the petroleum industry.
  - Griffin (1985)
  - Jones, (1990)
  - Mabro (1992)
  - Ramcharran (2001, 2002)
  - Dees et al. (2007)
  - Ringlund et al. (2008)
  - Hamilton (2013)
  - Güntner (2014)
  - Cologni and Manera (2014)
  - Gallo et al. (2010)

- The main focuses in previous litterateur:
  - *supply differences between OPEC and non OPEC members*

- This study focus on:
  - *differences between conventional oil and shale oil production*
  - WTI crude oil price influence on both production/supply, productivity and sector size

Data



The major US tight oil and shale oil regions (Source: EIA)

- Data:
  - monthly data from EIA on rigs and production in US oil fields from January 2007 until December 2016.
  - we differentiate between conventional oil fields and oil fields in tight oil formation where shale oil is a considerable part of the production
  - business cycle - WTI oil price

Production model

Production/supply model

$$lnQ_{ct} = \beta_0 + \beta_p lnP_{t-n} + \beta_t t + \beta_s lnQ_{st}$$
$$lnQ_{st} = \beta_0 + \beta_p lnP_{t-n} + \beta_t t + \beta_c lnQ_{ct}$$

Q_{ct}: the production in 1000 bbl/day of conventional oil in time period t.
Q_{st}: the production in 1000 bbl/day of shale oil in time period t.
P_{t-n}: the lagged WTI crude oil price
t: a time trend

β_p: measuring the supply elasticity,

If $\beta_p > 0$ the supply function is positively sloped and the competitive model is supported,
If $\beta_p < 0$ the supply-curve is backward bending and that the target-revenue theory (TRT) is supported

Productivity and sector size models

Productivity model:

$$lnq_{ct} = \beta_0 + \beta_p lnP_{t-n} + \beta_t t$$
$$lnq_{st} = \beta_0 + \beta_p lnP_{t-n} + \beta_t t$$

q_{ct} :production of conventional oil per rig in time period *t*
q_{st}: production of shale oil per rig in time period *t*

Sector size model

$$lnS_{ct} = \beta_0 + \beta_p lnP_{t-n} + \beta_t t$$
$$lnS_{st} = \beta_0 + \beta_p lnP_{t-n} + \beta_t t$$

S_{ct} :the number of rigs operated in conventional oil formations in time period *t*
S_{st}: the number of rigs operated in shale oil formations in time period *t*

Correlation between production/productivity/rig count and lagged WTI oil price

	wti_t	wti_{t-1}	wti_{t-2}	wti_{t-3}	wti_{t-4}	wti_{t-5}	wti_{t-6}
Production Conv.oil (Q_{ct})	-0.4081	-0.4597	-0.5007	**-0.5191**	-0.4959	-0.4443	-0.3749
Production Shale oil (Q_{st})	**-0.3894**	-0.3548	-0.3163	-0.2772	-0.2341	-0.1902	-0.1452
Productivety Conv. oil (q_{ct})	-0.3920	-0.4667	-0.5318	-0.5742	**-0.5877**	-0.5705	-0.5226
Productivety Shale oil (q_{st})	-0.6807	-0.7043	**-0.7188**	-0.7154	-0.6899	-0.6398	-0.5719
Nr. rigs Conv. oil (S_{ct})	0.4135	0.4640	0.5072	0.5366	0.5528	**0.5560**	0.5486
Nr. rigs Shale oil (S_{st})	0.5558	0.6105	0.6553	0.6828	**0.6912**	0.6807	0.6515

Price-lag with the highest correlation in bold

Results from multivariable regression model

	Production		Productivity		Sector size	
	Q_{ct}	Q_{st}	q_{ct}	q_{st}	S_{ct}	S_{st}
β_0	7.9786	2.0787	8.6111	6.0376	-0.4267	-0.1194
	(0.000)	(0.331)	(0.000)	(0.000)	(0.332)	(0.708)
β_p	-0.0789	0.1553	-1.3844	-1.2032	1.4109	1.4176
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β_t	-0.0010	0.0161	-0.0147	0.0092	0.0135	0.0063
	(0.112)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
β_s	0.0875					
	(0.018)					
β_c		0.4945				
		(0.0500)				
R^2	0.2921	0.9446	0.7303	0.8448	0.7785	0.7891

p-values in parentheses

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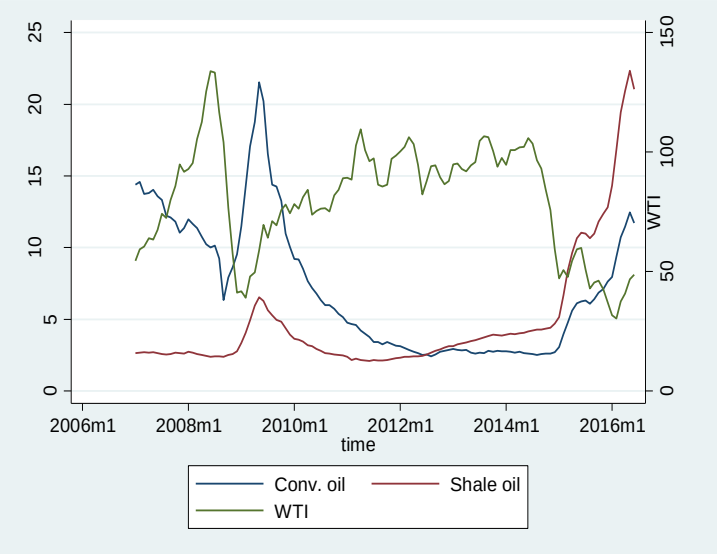
WTI and productivity (bbl/d per rig) over time for conventional oil and shale oil



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p-values in parentheses

Conclusion

- Increase in productivity during periods with low oil prices
  - selection of the most efficient and profitable oil fields and rigs

- Increased productivity for shale oil and deceased productivity for conventional oil
  - A more mature technology applied on conventional oil fields
  - A steeper learning curve for shale oil sector.
  - Different market structure.
    - Different cost structure

Conclusion

- Shale oil extraction is relative expensive compared to conventional oil production
- If the goal of the oil companies are a stable profit rather than a higher, but also more fluctuating profit
  - shale oil production should be conducted in periods of high oil price

- The shale oil sector has shorter response time to the economic cycles than conv. sector
  - technological leapfrogging

- The supply of conventional oil is less vulnerable to the business cycles, and will therefore insure that a stable supply persist by operating as a buffer

Conclusion

Thank you for your attention!

Question?