Leverage and the Oil Industry

Analysis on the Firm and Production Level

Johannes Lips

September 5, 2017

Department of Economics

Justus-Liebig University Gießen

Outline

Research Questions and Motivation

Price Development on Energy Markets

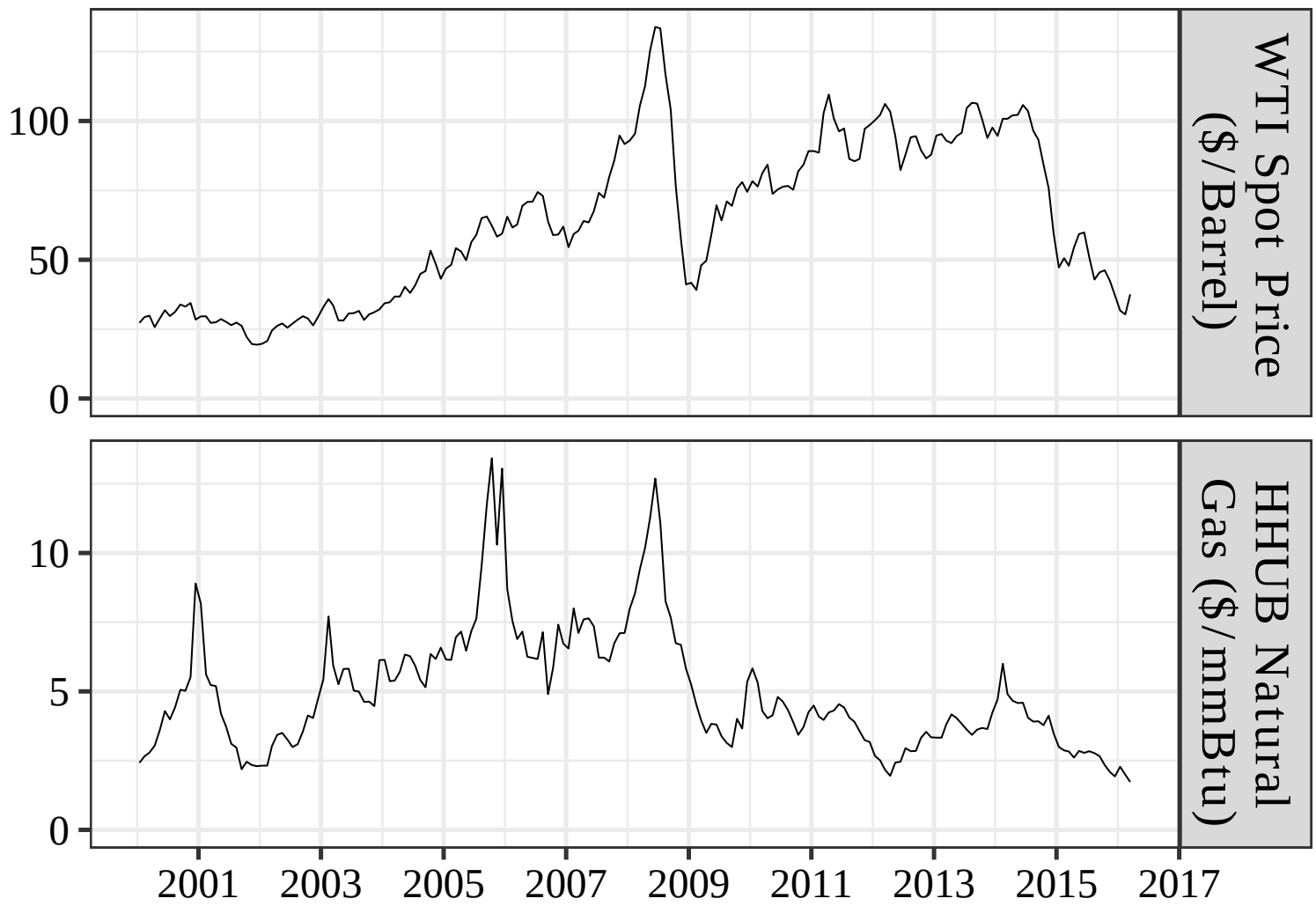

Figure 1: Development of WTI crude oil and Henry Hub natural gas spot prices

Development of aggregate oil production in the US

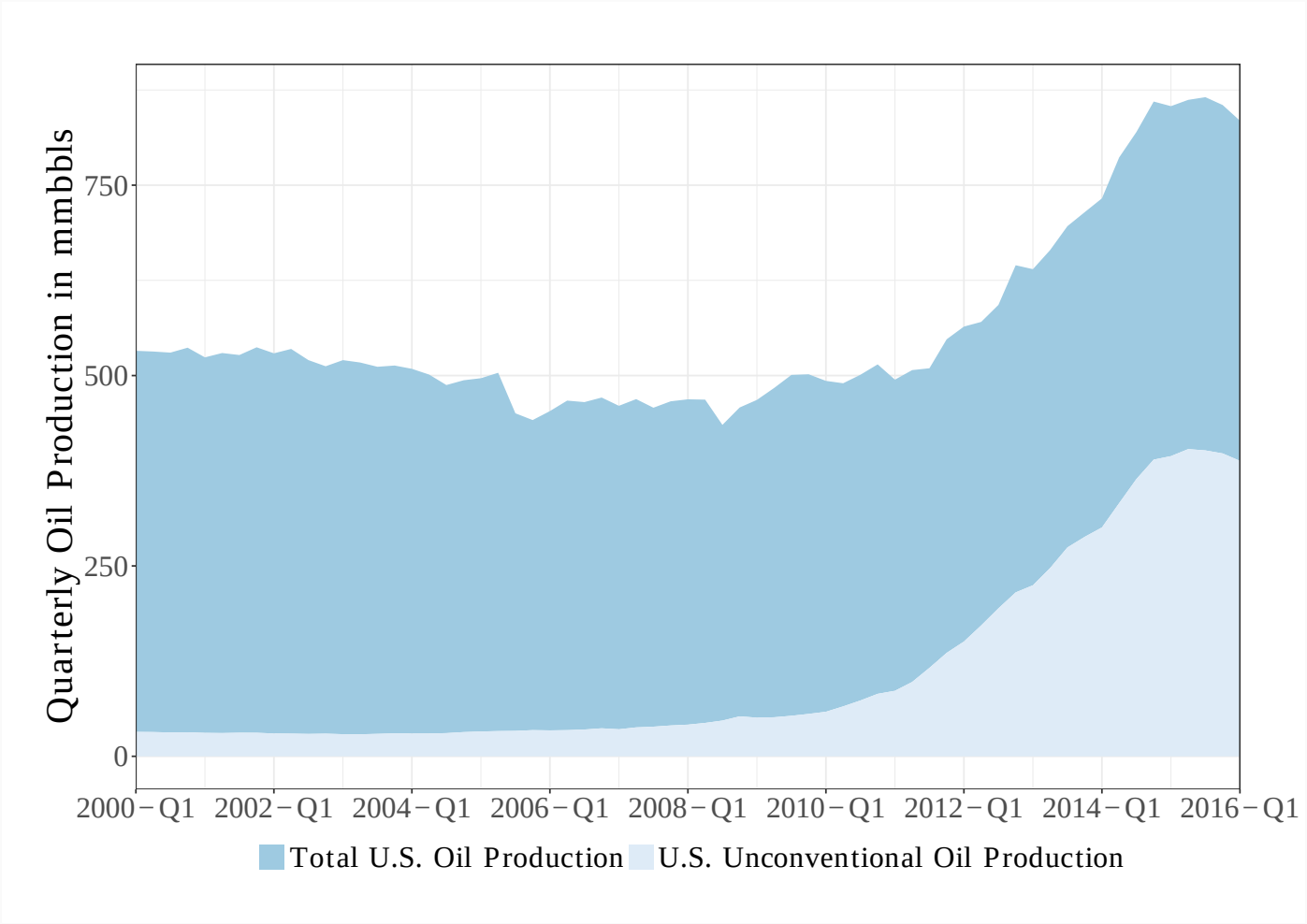

Figure 2: Development of conventional and unconventional US oil production.
Source: EIA (2017a,c)

Development of aggregate natural gas production in the US

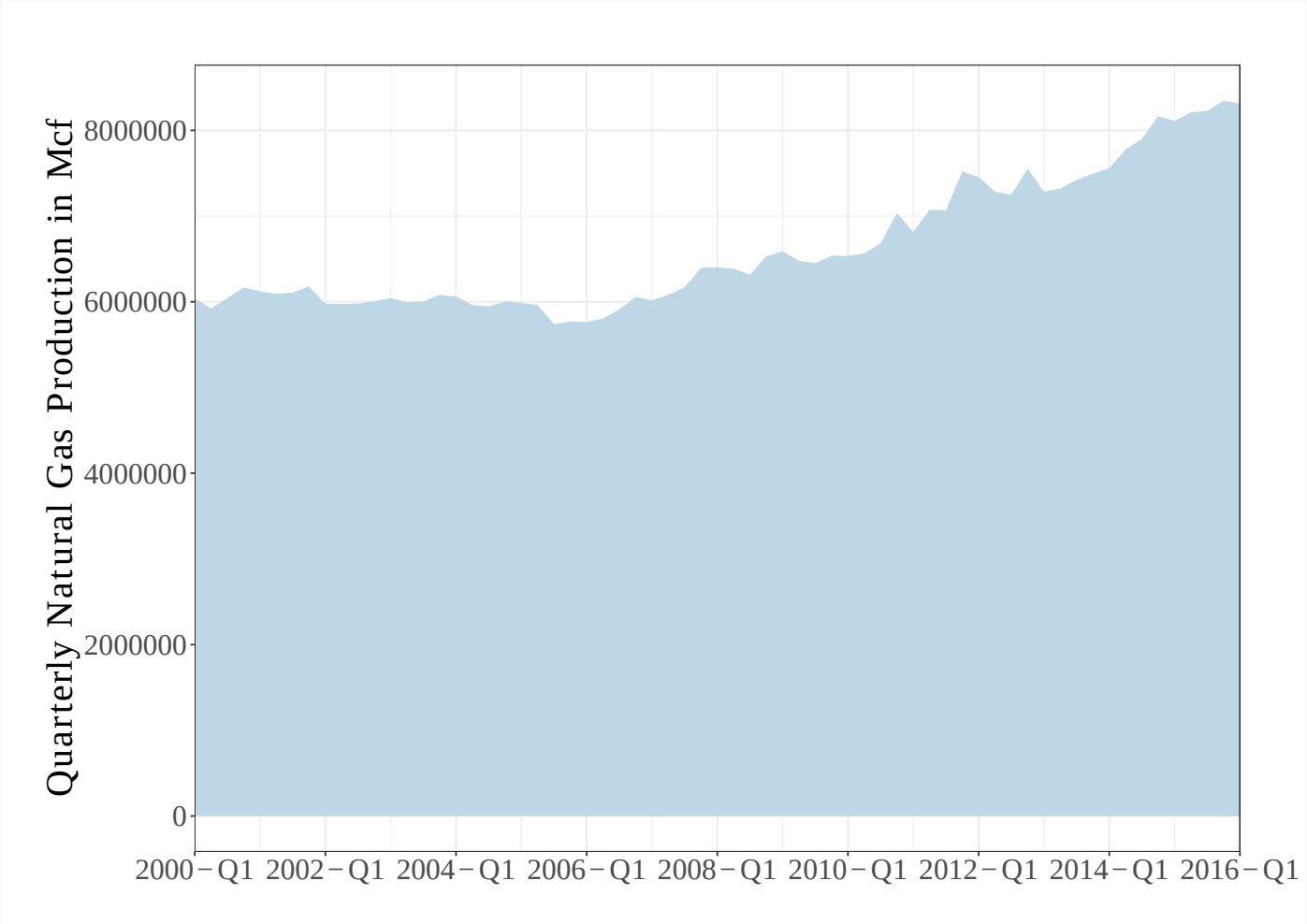

Figure 3: Development of US natural gas production.
Source: EIA (2017b)

Related Literature

- Domanski et al. (2015) raise the hypothesis that high debt may prevent producers from reducing production
- Lehn and Zhu (2016) empirically analyze the relationship – focus on period between 2011 and 2014
- Gilje et al. (2017) focus on project completion and investment decisions of firms

Development of Debt in the US E&P Industry (Sample)

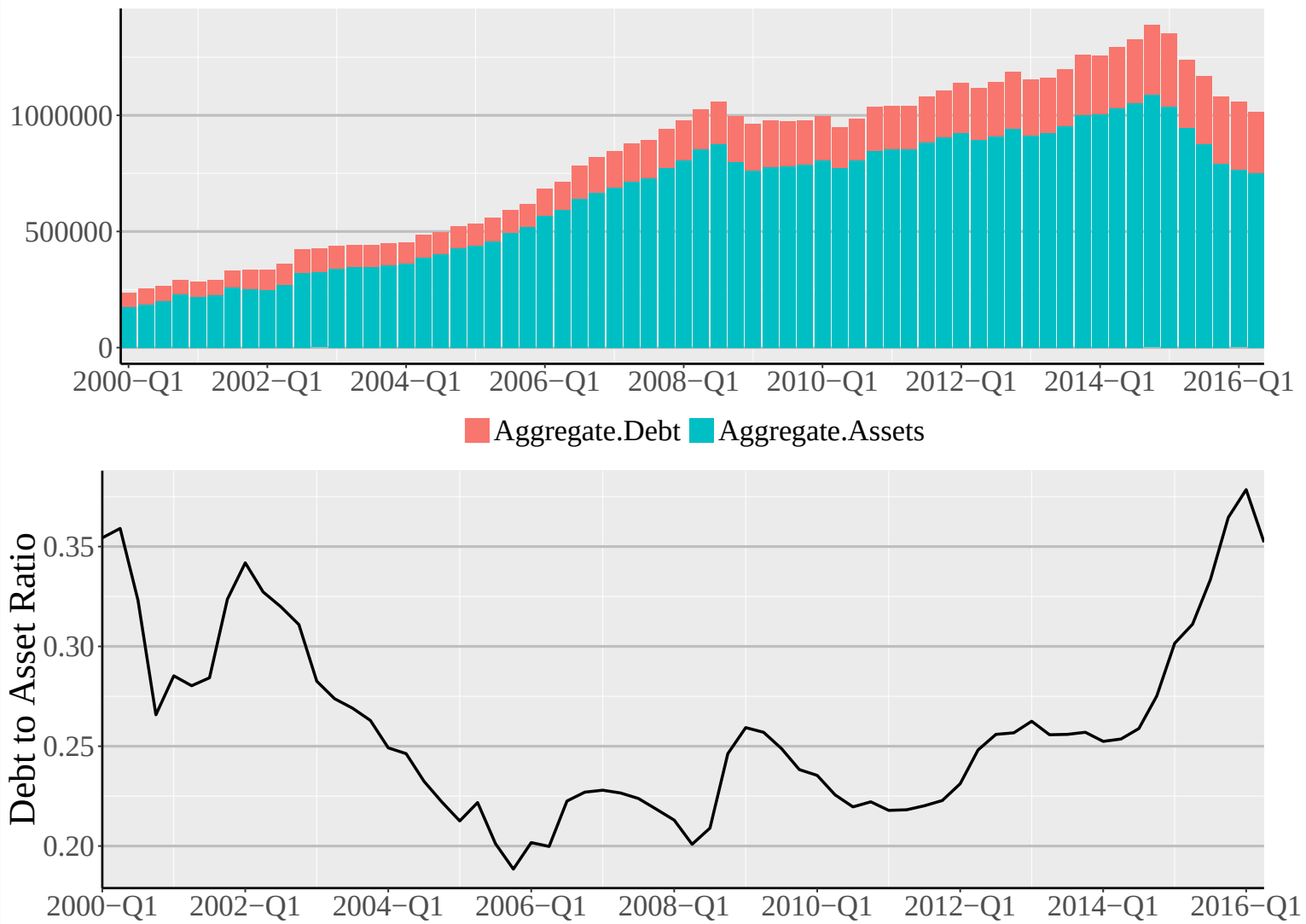

Figure 4: Development of Debt and Assets

Creating the Dataset

Company Data

- Companies active in E&P of Crude Oil and Natural Gas (SIC 1311)
- Quarterly financial data from CapitalIQ
- Initially 1018 companies in the financial data set

Production Data – Drillinginfo

- Data obtained based on the companies in the financial data set
- Monthly production data on oil and gas wells
- 18.5 million rows in the database
- Information on the technology and additional data
- Matching of both data sets on available company information

Unbalanced quarterly data set – Q1 2000 to Q2 2016

- Panel data set ranging from Q1 2000 to Q2 2016
- Initially 153 companies
- 172 drop out and 190 enter into the sample
- 53 are present throughout the whole sample period
- 146 on average in each quarter
- 343 different companies in total

Key Figures of the Quarterly Oil Production Dataset

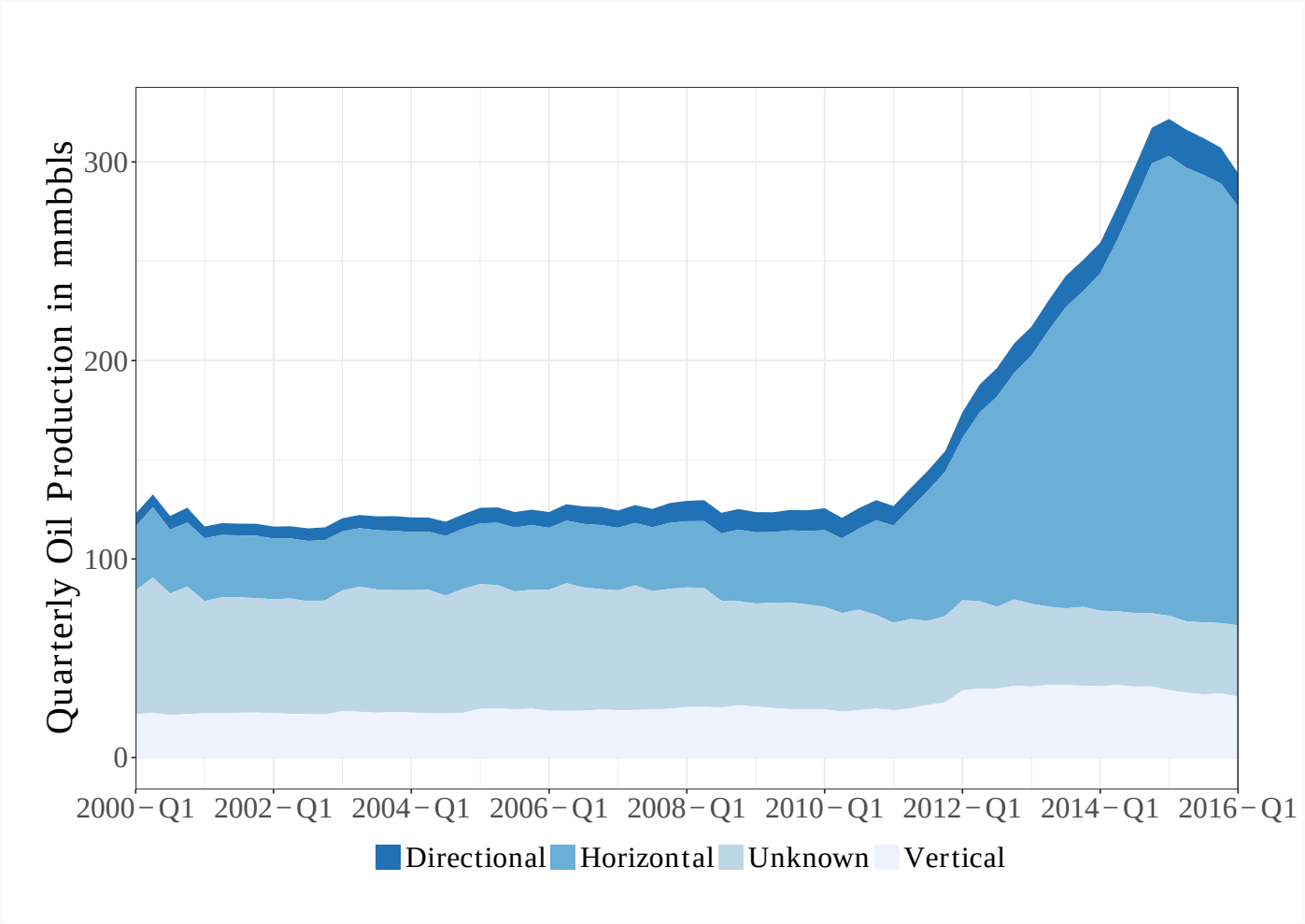

Figure 5: Development of aggregated oil production for different drilling technologies

Source: Own calculations based on data provided by DrillingInfo

Comparison of Production in the US and the Sample

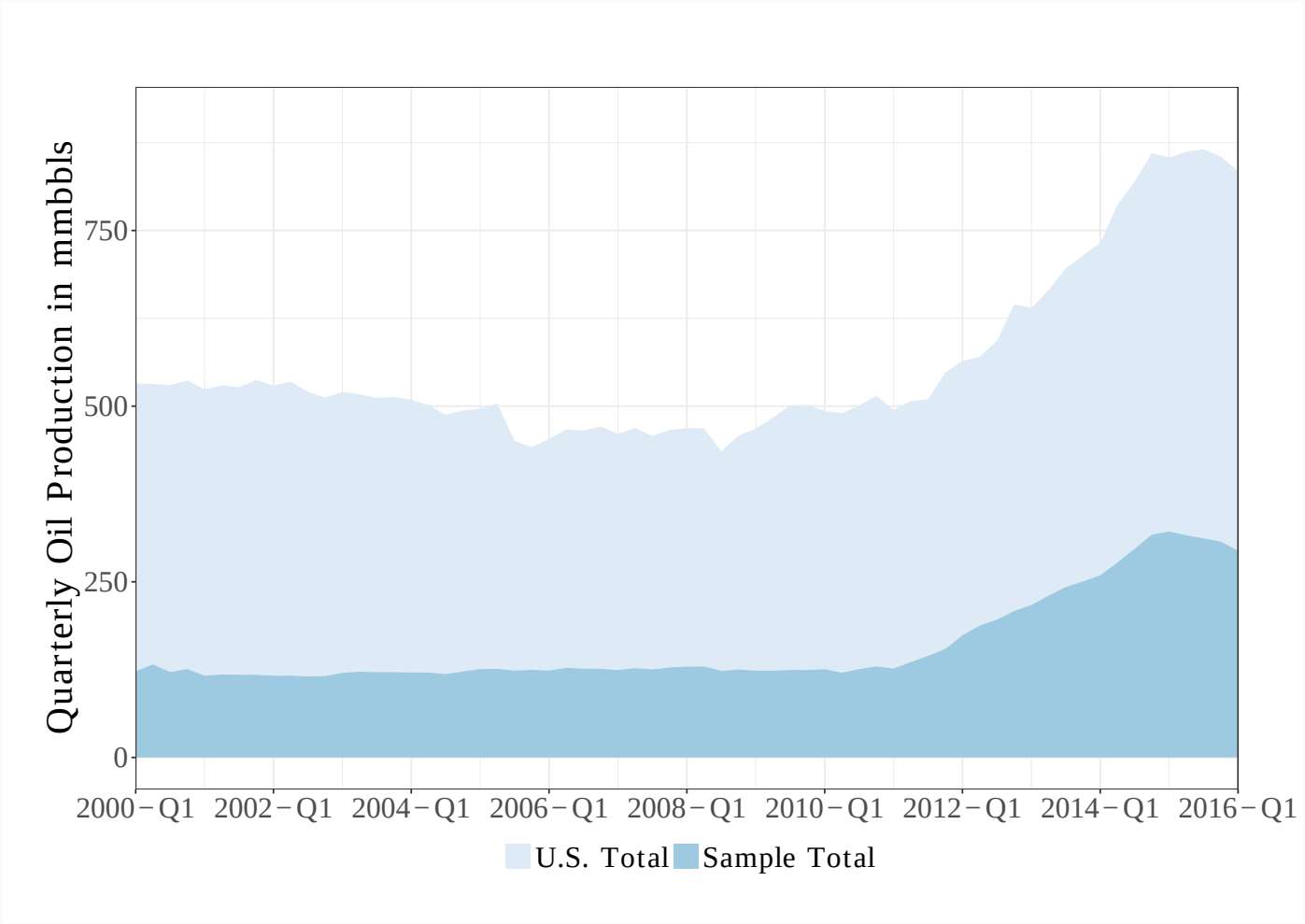

Figure 6: Total US oil production and oil production in sample
Source: Own calculations based on data provided by DrillingInfo

Comparison of Production in the US and the Sample

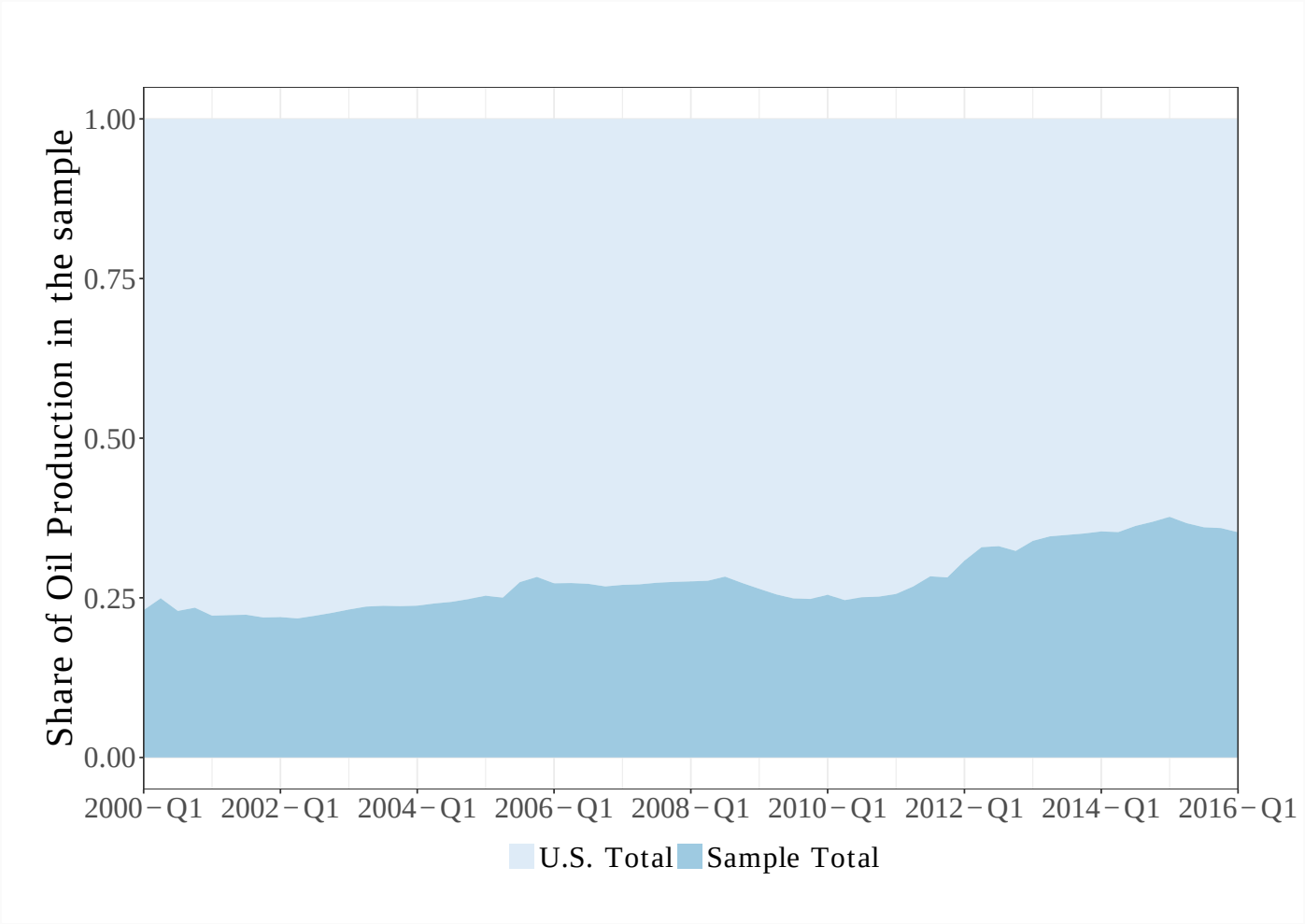

Figure 6: Total US oil production and oil production in sample
Source: Own calculations based on data provided by DrillingInfo

Exploratory Data Analysis

Distribution of Leverage prior to price decline in 2008 and 2014

Leverage Percentile	2008 Q2			2014 Q3		
	No.	Assets	Debt	No.	Assets	Debt
1^{st} *Quartile*	33	3094	493	33	5872	948
2^{nd} *Quartile*	36	11 869	2494	36	12 895	2749
3^{rd} *Quartile*	35	5018	1380	36	4279	1328
4^{th} *Quartile*	35	2845	1208	36	2002	885
Non-calculable Leverage	5	1172	339	7	1304	391

Table 1: Comparison of the number of companies for each leverage group prior to price declines in 2008 Q2 and 2014 Q3 and their average value of total assets and debt in million US-Dollar.

Leverage and Unconventional Production

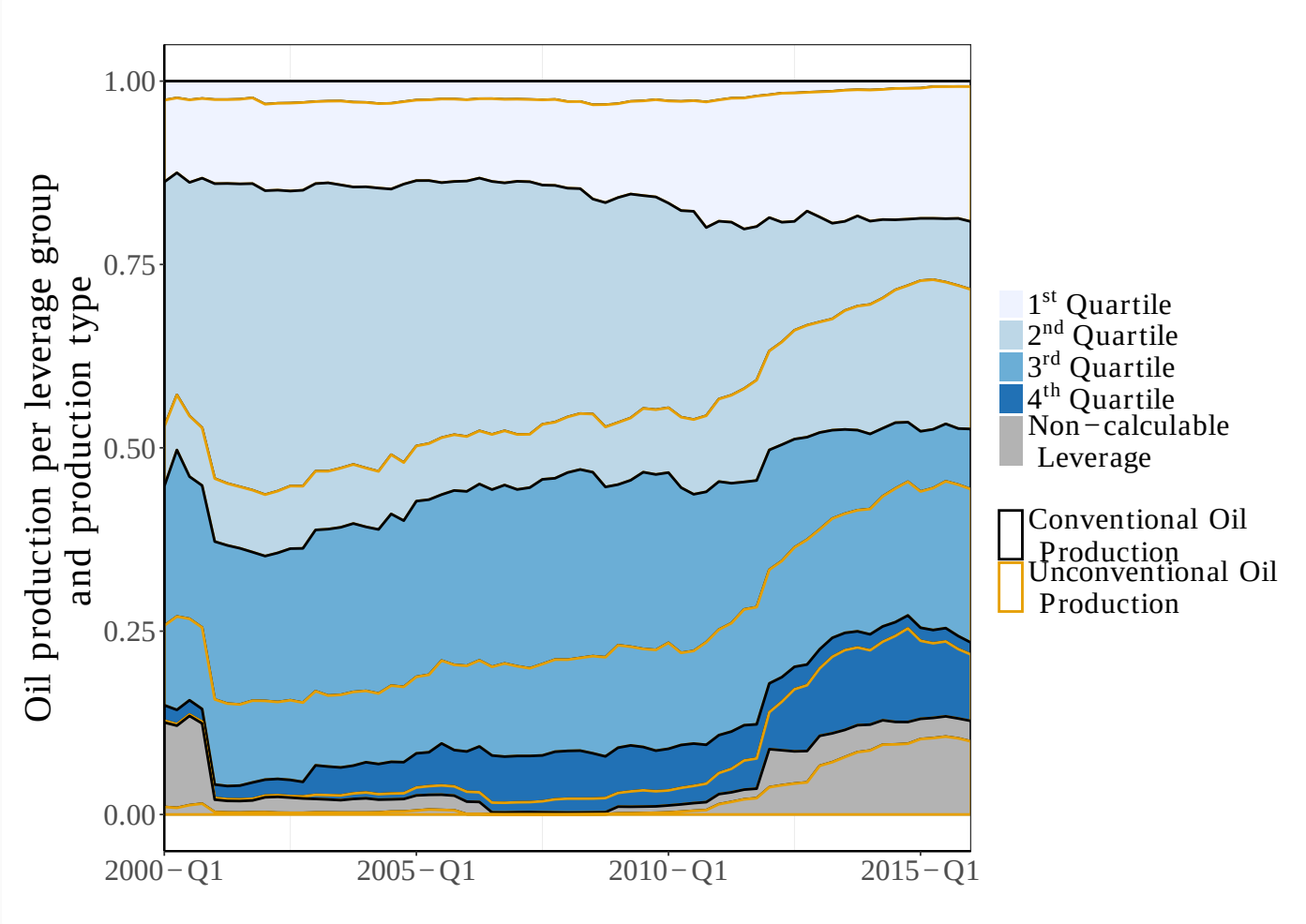

Figure 7: Total oil production differentiated by production type and leverage quartile of the companies in 2008. Yellow line separates the production types with conventional share above and unconventional share below.

Leverage and Unconventional Production

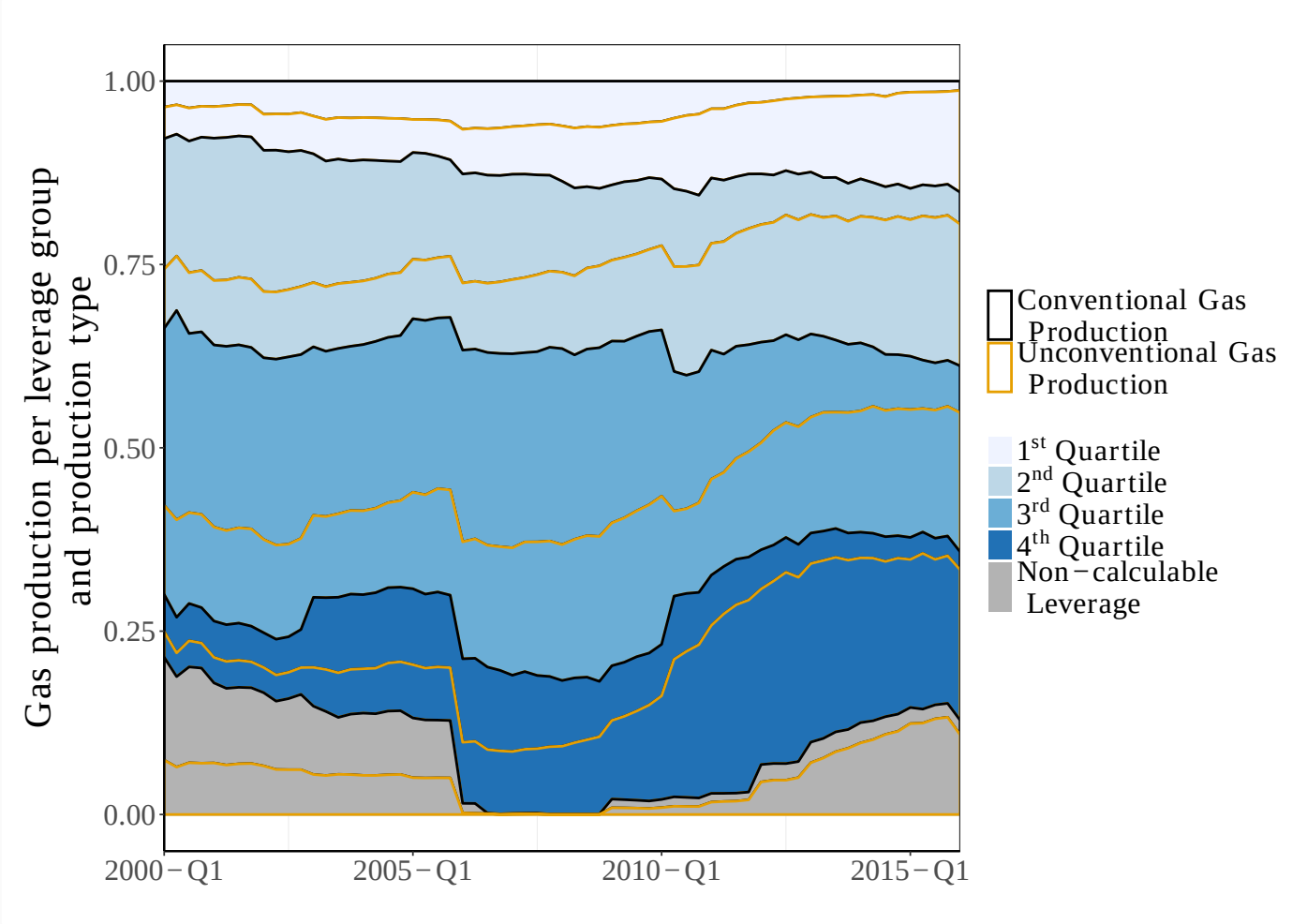

Figure 8: Total gas production differentiated by production type and leverage quartile of the companies in 2008. Yellow line separates the production types with conventional share above and unconventional share below.

Results Dynamic Panel Modelling

Pooled Estimation – Oil Production

	Coefficient	Standard error	t-stat	p-value
log(Total Oil Production)$_{t-1}$	0.948***	0.004	243.745	0.000
log(Total Assets)	0.032***	0.012	2.771	0.006
log(EBITDA)	0.022**	0.010	2.134	0.033
Leverage	0.002	0.004	0.425	0.671
log(WTI Spot Price)	0.025	0.021	1.209	0.227
constant	−0.533***	0.093	−5.721	0.000
R^2	0.934			
Observations	6327			
F statistic	17 968.161			

Note: *p<0.1; **p<0.05; ***p<0.01

LSDV Estimation – Oil Production

	Coefficient	Standard error	t-stat	p-value
log(Total Oil Production)$_{t-1}$	0.586***	0.044	13.424	0.000
log(Total Assets)	0.084***	0.032	2.660	0.008
log(EBITDA)	0.035***	0.012	2.906	0.004
Leverage	0.027*	0.015	1.810	0.071
log(WTI Spot Price)	−0.117**	0.055	−2.130	0.034
constant	−1.305***	0.269	−4.848	0.000
Observations	6327		σ_u	1.539
No. Companies	289		σ_e	0.657
F statistic	48.066		ρ	0.846
R^2-within	0.517			
R^2-between	0.895			
R^2-overall	0.928			

Note: *p<0.1; **p<0.05; ***p<0.01

Pooled Estimation – Gas Production

	Coefficient	Standard error	t-stat	p-value
log(Total Gas Production)$_{t-1}$	0.933***	0.004	217.170	0.000
log(Total Assets)	0.065***	0.013	4.908	0.000
log(EBITDA)	0.022*	0.011	1.931	0.054
Leverage	0.059*	0.036	1.653	0.098
log(WTI Spot Price)	−0.064***	0.024	−2.699	0.007
constant	0.182*	0.101	1.805	0.071
R^2	0.928			
Observations	6290			
F statistic	16 236.009			

Note: *p<0.1; **p<0.05; ***p<0.01

LSDV Estimation – Gas Production

	Coefficient	Standard error	t-stat	p-value
log(Total Gas Production)$_{t-1}$	0.514***	0.048	10.637	0.000
log(Total Assets)	0.094**	0.042	2.271	0.024
log(EBITDA)	0.027*	0.014	1.934	0.054
Leverage	0.093	0.150	0.622	0.535
log(WTI Spot Price)	−0.194***	0.066	−2.940	0.004
constant	3.371***	0.400	8.431	0.000
Observations	6290		σ_u	1.856
No. Companies	286		σ_e	0.707
F statistic	29.436		ρ	0.873
R^2-within	0.451			
R^2-between	0.954			
R^2-overall	0.924			

Note: *p<0.1; **p<0.05; ***p<0.01

Concluding Remarks and Outlook

Conclusion

- Leverage appears to have some impact on the production decision
- Relationship needs to be analyzed in more detail, with more appropriate methodology
- Endogeneity is one of the main issues in this context and needs to be addressed

Econometric Extensions

- GMM estimation Blundell and Bond (2000) to address the persistence and endogeneity
- Difference-in-Difference Estimation: Using the treatments of high and low leverage and contango or backwardation periods
- PanelVAR allows to explicitly model the endogeneity.

The End

Thank you for your attention!

For more details and current status, please see:

https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3026063