Survival of the fittest: US oil productivity during business cycles

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Overview

With the shale oil revolution, US crude oil supply almost doubled from about 5 million bbl/d in 2008 to peak supply in March 2015 at 9.6 million bbl/d, and its effect on US and global economy has been studied in several papers (Kilian, 2016; Manescu and Nuno, 2015). The production growth ended more than two decades of declining oil production, as the introduction of new technology coincided with high oil prices. Although considered a costly oil production, supply from shale oil continued to increase until the recent turn in oil prices. In this paper, we study production behavior and examine how recent oil price and business cycles have affected the supply of US crude oil production, and if it has affected conventional oil and shale oil production differently?

Methods

In contrast to previous supply studies in the oil industry, which traditionally focuses on supply differences between regions (mainly OPEC vs non-OPEC countries), our data is separated into production of conventional oil and shale oil to examine to what degree supply response differs between these.

The paper considers 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. The tight oil fields consists of Bakken, Eagle Ford, Niobrara, Permian and Utica region. For the analyses, address the problem by investigating the relationship between WTI oil price and activity of US conventional oil and shale oil sector. For the analysis, we assess the activity as the total production levels of conventional crude oil and shale oil during the business cycles, the productivity of conventional crude oil and shale oil during the business cycles, and finally the rig count for conventional sector and shale oil during the business cycles. To explore the relationship between WTI crude oil prices and production, productivity and sector size, we first perform visual analyses where plots of productivity, production and number of rigs together with WTI crude oil price will be conducted. Second, we apply a multivariable regression model to the data. A supply function based on a modification of Griffin's (1985) model, is estimated using data from the major shale oil regions and for US production in total from January 2007 to December 2016, and supply elastiseties for conventional oil- and shale oil are conducted.

Results

Figure 1 presents the development of WTI and production (1000 bbl/d) of conventional oil and shale oil over time. The large increase in shale oil is particular visible from 2012 to 2015, where the production of shale oil approximately doubled. With the relatively stable production of conventional oil over this time frame, the production of shale oil surpassed the conventional oil production August 2013, and has since then been higher for shale oil. However, we observe a falling trend in supply of shale oil following the price decrease in 2014. Since the top month of April 2015 the supply of shale oil has been steadily declining, and are now approaching the level of conventional oil. This is supported by the result for the regression model; the supply elasticity is positive and significant for the shale oil supply, but negative and significant for conventional oil supply. Hence, for the shale oil sector the competitive hypothesis is supported, but for the conventional oil sector the hypotheses of TRT is supported.

The development in productivity and WTI are presented in figure 2. Our results on productivity point to an increase in productivity during downturns, when oil price is reduced. This effect is also visible for conventional oil production during both periods of oil price decline (2008 and 2014). The opposite relationship between productivity and state of the economy is also visible for periods of economic boom. This is particularly noticeable of the price

increase in 2007 and 2009 but also for the relatively smaller price increase in 2016. These results are also by the result from the estimated regression model, where the price elastisity is found to be 1-.38 for the conventional sector and -1.20 for the shale oil.

As expected, we also found a positive relationship between economic cycle and sector size. An oil price drop will result in a general downscaling of new fields and drilling operations, creating better opportunities to exploit current fields at a higher level.

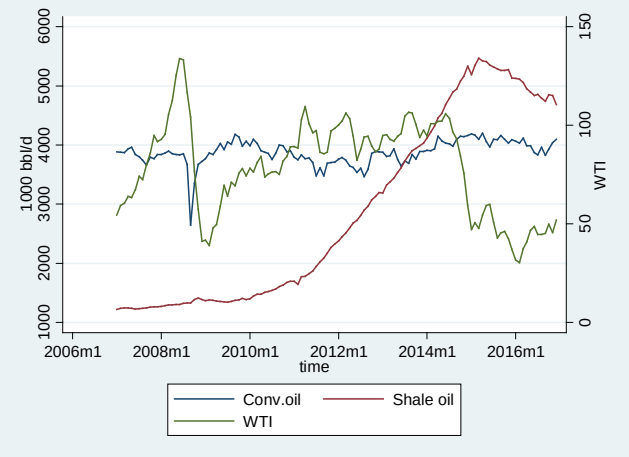

Figure 1. WTI and production (1000 bbl/d) of conventional oil and shale oil over time

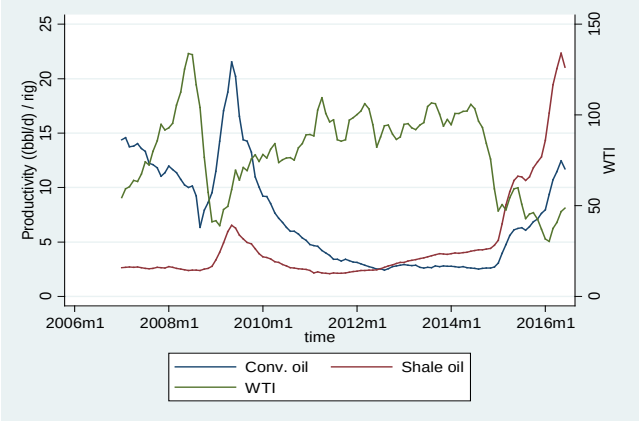

Figure 2. WTI and productivity (bbl/d per rig) over time for conventional oil and shale oil.

Conclusions

Applying new technology in tight oil formations provided a revolution with the utilization of shale oil. However, productivity was relatively low from shale oil production for many years, thus requiring a high break-even oil price. With the drop in oil prices, the oil producers were pushed for increased efficiency and utilization. At the same time the number of new fields and drilling operations in general was reduced, creating better opportunities to exploit current fields at a higher level. Our results indicate an increase in productivity during periods with low oil prices, indicating a selection of the most efficient and profitable oil fields. In addition, improved technology with horizontal drilling and hydraulic fracturing, together with more experienced workers may also increase productivity. For other oil production, productivity has increased, although not at the same rate. This can be partially explained by the mature technology applied on conventional oil fields and a higher participation by established and integrated oil companies, which combined provides a lower exposure to oil price levels for conventional oil field productions. We also find that while the supply elasticity for conventional oil is negative and significant the supply elasticity of shale oil is positive and significant, indicating that the shale oil sector are competitive compared to the conventional sector. The supply of conventional oil is hence less vulnerable to the business cycles, and will therefore insure that a stable supply persist by operating as a buffer. Finally, the results show an industry with the ability to adjust, and equally important, the ability to make profits at a lower oil price regime as their marginal cost is reduced.

References

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