Energy Economics 55 (2016) 266–271

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Oil reserve life and the influence of crude oil prices: An analysis of Texas reserves

Nicholas Apergis [a], Bradley T. Ewing [b], James E. Payne [c,*]

[a] Department of Banking & Finance, University of Piraeus, Greece
[b] Rawls College of Business, Texas Tech University, Lubbock, TX, United States
[c] J. Whitney Bunting College of Business, Georgia College & State University, Milledgeville, GA 31061, United States

ARTICLE INFO

Article history:
Received 25 October 2015
Received in revised form 27 January 2016
Accepted 2 February 2016
Available online 27 February 2016

JEL classification:
Q35
C01

Keywords:
Oil reserves
Oil production
Crude oil prices
Reserve life
Time series analysis
Persistence

ABSTRACT

Oil producing exploration and production companies generate revenue from reserves which, from any given well, are depleting over time. The reserve life index measures how long reserves would last at the current production rate if there were no additions to reserves. In this study, we examine the time series behavior of the reserve life index for each of the twelve onshore oil producing districts in Texas. Specifically, we model the relationship between reserve life and the real price of oil within a nonlinear ARDL framework. Among the results, we find evidence of both long-run and short-run asymmetries in the response of reserve life to increases/decreases in real oil prices. Further, the magnitude of the effect is greater for positive changes in real oil prices than for negative changes in real oil prices. The findings are important to operators, investors and policymakers interested in sustainability.

1. Introduction

The value of an oil producing Exploration and Production (E&P) company depends on the amount of proved reserves it has available for production.[1] While the current production of oil from reserves generates revenues, it is the reserves available to sustain future production that allows an oil company to generate future revenue. The reserve life index is the ratio of (proved) reserves to production and "provides an indication of how long reserves would last at the current production rate if there were no additions to reserves."[2] (Simkins and Simkins, 2013) As such, the reserve life index is an important component in financial analysis and economic valuation of oil producing firms.[3] In fact, some companies explicitly report their reserve life index to investors while others do not. For example, Linn Energy refers to their reserve life index in the overview of business (Item 1) of their annual Form 10-K report for fiscal year ended December 31, 2014.

Surprisingly, no study to date has examined the time series relationship between reserve life indexes and real oil prices, as such a study is relevant for E&P companies and policymakers in the design of optimal strategies to manage the behavior of reserve life to ensure both profitability and sustainability. The current study focuses on reserve life indexes in the oil-producing state of Texas. Moreover, examining reserve life indexes in various onshore oil producing areas in the state[4] provides evidence as to (1) the behavior of reserve life indexes over time, thus acting as benchmark information for the companies that operate in Texas, and (2) allows for identification of regional differences in the reserve life index. Moreover, as both production and reserve development may be influenced by oil prices and expectations, the reserve life index may change over time, as well. In this regard, we also explore the short-run and long-run dynamics between the reserve life indexes and crude oil prices for each of the oil-producing districts in Texas.

* Corresponding author.
E-mail addresses: napergis@unipi.gr (N. Apergis), bradley.ewing@ttu.edu (B.T. Ewing), james.payne@gcsu.edu (J.E. Payne).

[1] The Society of Petroleum Engineers notes that "proved reserves are those quantities of petroleum which, by analysis of geological and engineering data, can be estimated with reasonable certainty to be commercially recoverable, from a given date forward, from known reservoirs and under current economic conditions, operating methods and government regulations." (www.spe.org).

[2] In fact, the Form 10-K of all publicly traded E&P companies provides the necessary information to compute the RL index in the detailed disclosures or "notes" of Item 8, whether or not a company chooses to report that the actual value is a management choice.

[3] The value of reserves is also an important factor in valuing E&P companies. Proved reserves are valued at year end (per Securities and Exchange Commission requirements) using the average price of the first day of each month in the year of just past.

[4] In Texas, the oil producing areas are referred to as Districts by the Railroad Commission.

http://dx.doi.org/10.1016/j.eneco.2016.02.009
0140-9883/

The remainder of the paper proceeds as follows. Section 2 provides background on the role of the oil reserve-production ratio. Section 3 presents the data, methodology, and results while concluding remarks are given in Section 4.

2. Background

It is the inventory nature of oil reserves that is valued by E&P companies as well as their investors (Kaiser, 2013). Maximizing the current net present value of an oil producing company requires striking a balance between current and future production out of current reserves under current economic conditions, technologies, operating methods and regulatory environment. The reserve life index provides information to help accomplish this goal. Specifically, higher reserve life index values effectively give more weight to future oil production and, therefore, profits of oil producing companies. On the one hand, with above-ground and below-ground uncertainties regarding future prices, government regulations, and ultimate recovery, a higher reserve life index may be viewed negatively, that is, as a signal that production problems may exist. On the other hand, higher reserve life index values suggest large inventories which may indicate sustainable production going forward. Knowledge of how reserves-to-production ratios behave over time may assist companies and policymakers in formulating optimal strategies to balance short and long reserve lives for both profits and sustainability.[5]

While the energy industry and its investors focus on the use of the reserve life index in valuation and planning, the focus of most related academic studies is on peak energy (or peak oil), energy security and independence, economic sustainability, and climate change. Bentley (2002) discusses political and physical risks of world conventional oil supply and resource limits, leading to shortages in the supply of conventional oil. However, he also argues that non-conventional oil can work to mitigate the shortages. Turton and Barreto (2006) approach the peak oil issue in terms of diminishing oil supply in the context of climate change. Along the same lines, Hallock et al. (2004) model resource availability and future demand for oil and predict an irreversible decline between 2004 and 2037. Kaufman and Shiers (2008) attempt to estimate peak oil allowing for uncertainty in the remaining supply of oil (i.e., reserves) relative to the production path of oil.

Assessing energy production and use patterns, Vera and Langlois (2007) include the reserves-to-production ratio as an indicator of the economic dimension of sustainable growth. Addressing economic sustainability and energy security, Cavallo (2002) predicted that non-OPEC countries would experience a reserve decline between 2015 and 2020 and that by that time the OPEC countries would “completely control” the world oil market. The use and depletion process of conventional oil reserves for sustainable growth is also addressed by Neumayer (2000a) who emphasizes the need for proper resource accounting. Clearly, the concept of resource depletion and thus reserve life is found to be a component in many important energy-related issues. With this in mind, Feygin and Satkin (2004) discuss the proper interpretation of the reserve life index (i.e., the reserves-to-production ratio) specifically with respect to stage of oil-field development and other geological factors. Additionally, they note the need for replenishment (that is, additions to reserves) over time, perhaps through analysis of probable and possible reserves. Finally, Neumayer (2000b) considers natural resource availability in the context of a neoclassical economic growth model to argue a more optimistic case than peak oil. Specifically, the model suggests that any shortages will drive up the price of oil which, in turn, provides an incentive for more exploration and development and improvements in technology to improve estimated ultimate recovery. Overall, Neumayer (2000b) contends that future constraints put forth by many of the peak oil theory proponents are overstated.

In terms of our analysis, Texas is a particularly good case to examine the relationship between reserve life and oil prices given its long history and role in U.S. energy production. The Texas oil industry dates back over 100 years. In 1901, oil began producing at Spindletop in East Texas and at the end of 2013 Texas accounted for nearly one-third of all total proved reserves in the U.S. and most recently Texas oil production is almost three times that of North Dakota, the second leading state.[6]

3. Data, methodology, and results

Texas is the nation's leading producer of oil and contains several major oil and gas formations such as Barnett Shale, Eagle Ford, Granite Wash, Haynesville/Bossier Shale, and the Permian Basin.[7] The Railroad Commission of Texas divides the state into natural resource districts for data reporting and administrative purposes that span these formations.[8] There are twelve onshore oil-producing districts (in what follows we refer to these as D1, D2, D3, D4, D5, D6, D7B, D7C, D8, D8A, D9, and D10).

Data for the analyses cover the annual period 1977–2013. Oil reserves are district's proved oil reserves at year end given in millions of barrels. Oil production is district's total oil extracted over the year given in millions of barrels. The reserve life (RL) index is given as the ratio of oil reserves-to-oil production. The real price of oil is the Cushing spot price for West Texas Intermediate (WTI) deflated by the consumer price index (CPI). Price data were obtained from the Federal Reserve Bank of St. Louis from 1977–1985 and from the Energy Information Administration from 1986 to 2013.[9] Production and reserves data are from the Railroad Commission of Texas.[10] Fig. 1 displays the time series graphs for the respective oil-producing districts in Texas.

An overview of the RL index graphs reveals that index values have generally grown over the sample period, though some districts have experienced greater increases than others. Notable exceptions are Districts 4 and 6, both predominately natural gas producing areas in Texas. District 4 is located in South Texas (near Corpus Christi) and had an RL index that was relatively flat and low until late entry into the oil boom of 2008–2009 and the subsequent bust, never fully recovering over time. District 6 (which includes Haynesville) had relatively high RL index values (about 12) at the beginning of the sample period then dropped off as this area switched from primarily oil producing wells to a greater emphasis on natural gas, then since 2000 the RL index has moved upward much like the other districts in Texas.

Each district's RL index has experienced a great deal of fluctuation, the source of which may come from exploration and development which works only to add reserve volumes (increasing the RL index) or from production which drains reserves (decreasing the RL index). Unlike individual companies whose reserves may also change through sales and acquisitions, in any given district the net effect of reserve changes due to sales and acquisitions must sum to zero. Thus, reserve volume in the districts we are examining is due to additions from exploration and development, engineer's revisions (if any), and production. Our analysis also allows for oil prices to influence reserve volume. Clearly, E&P companies may change their rate of production, up or down in response to higher or lower oil prices, thus directly affecting the RL index. However, E&P companies also make investment decisions regarding capital expenditures to locate and develop new reserves based upon price forecasts, but the process is typically time consuming as there is a period of time before the reserves are proved. To summarize,

[5] Reserve life index is somewhat akin to net asset value which measures the value of an E&P company by taking the net present value of cash flows in the absence of future reserve additions.

[6] See http://www.eia.gov.

[7] See http://www.eia.gov/state/rankings.

[8] See http://www.rrc.state.tx.us.

[9] For these data see http://research.stlouisfed.org/fred2 and http://www.eia.gov.

[10] For these data see http://www.rrc.state.tx.us.