Measuring Fiscal Effects Based on Changes in Deepwater Off-Shore Drilling Activities

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Introduction

The Deepwater Horizon oil spill has brought to the forefront the negative physical externalities related to off-shore drilling. These costs have included damages to marine habitat, the oiling of pristine beaches and wetlands, and the negative economic impacts these physical changes have had on service based sectors such as tourism.

However, the deepwater offshore oil industry has brought positive economic benefits to areas that have supplied its labor and served its on-shore infrastructure (Fannin et al 2008). Benefits in terms of jobs, income and value-added are created in many of the coastal communities around ports and fabrication facilities that supply the inputs for this industry.

At the same time this industry provides these benefits, there are both benefits and costs to local governments from their operations. They receive sales tax and property taxes from the deepwater support businesses as well as income taxes and sales taxes from employees who earn and spend their wages and salaries. On the other hand, the industry places pressures on critical local infrastructure (roads, schools, water, sewer, etc.) from its existence. Understanding the net fiscal effects in both local fiscal revenue received as well as costs are important to know how much better or worse off local governments are from the existence and expansion or contraction of this industry.

This paper accomplishes two objectives. First, this paper estimates a model for oils wells drilled in the Gulf of Mexico using specific time series models. In the second objective, the number of wells drilled are applied to the COMPAS model for Louisiana based on Adhikari and Fannin (2009). In that model, wells drilled are treated as final demand in an input-output model framework to estimate exogenous changes in employment demand. This demand is then applied to a block recursive labor force module that measures changes in key labor market variables. These variables then serve as exogenous variables in revenue capacity equations. These revenue capacity variables are finally applied to local government expenditure demand equations. Per capita demand changes for key local government variables are then estimated. The results from this paper will better inform local and national policymakers of the benefits and costs that the deepwater oil and gas industry has on local communities in which they reside.

Literature Review

Oil and Gas Drilling Forecasting

Several studies have been done previously to forecast oil and gas drilling or production activities. A study by Walls (1992) provides a very extensive review of the existing approaches used in modeling and forecasting oil and gas supply. These include play analysis models that require detailed geological information for the Monte Carlo simulation approach to generate a distribution of total volume of oil and gas. This approach is most suitably used in undeveloped areas where detailed geologic data and technical expertise are available. The discovery process models require historical data on drilling and discovery in order to generate forecast for future discoveries. This approach is most suitably used in widely developed areas, in which information about exploration activities along with oil and gas discovery size are available. Econometric models apply historical data to test the relationships between economic variables and drilling activities. The forecasts generated by this model are consistent with economic relationships. Based on the strengths and weaknesses of each method, the study suggests the use of a hybrid approach. The hybrid approach is viewed to adopt the best features from both econometric and discovery process models.

Another study by Walls (1994) uses a hybrid approach to forecast the number of oil and gas wells in Gulf of Mexico OCS. This hybrid approach tackles the problems often faced in modeling and forecasting offshore oil and gas supply. Some of the problems are the government leasing behavior, environmental considerations in offshore drillings, and delays between development and production. The study analyzes data from the 1971 – 1988 period and then combines the econometric model with the discovery process model. The econometric model applies historical data to estimate relationships between exploration activity and (economic) variables such as prices. The econometric section of exploratory and development wells drilled is specified as a function of economic variables, government leasing behavior, and engineering component (new discoveries). The result from the estimation is then used to generate forecasts for future discoveries or exploration activities to the year of 2000.

Iledare (2000) assesses the petroleum exploration and reserve development effort in Nigeria Niger Delta basin. The study incorporates three main components into the model. The components include the drilling success rate, crude oil finding rate, and the number of oil wells drilled. The study also uses a hybrid approach in which it considers profit maximization (economic variables) and diminishing discovery rates to determine exploration and production rates.

Fiscal Impact Modeling

The Community Policy Analysis System (COMPAS) modeling framework has become a very efficient tool applied across the country to address labor market and fiscal impacts from initial changes in economic activity (Johnson, Otto and Deller 2006). At its foundation, COMPAS is an employment driven model. Employment demand is generated by changes in local product demand. The definition of employment demand may vary but the exogenous shock that appears from the changes in employment demand is the basis of the modeling system in COMPAS based models (Adhikari and Fannin, 2010). In many cases, this product is converted to employment demand through the use of input-output models. The Input-output (I/O) model is a case where the final demand is exogenous and the labor market supply is perfectly elastic to meet the labor demands generated by the product demands (Beaumont, 1990). In this I/O framework, an exogenous change in demand for the product and services interact with the rest of the economy through linkages of industrial material goods and services in an economy, its local labor market, and ultimately, its fiscal sector.

One of the objectives of this study is to examine the potential economic (basically fiscal) impacts of oil and gas activities of the Gulf of Mexico region by applying a MAG-PLAN model which provides us the changes in the final demand for various sectors that will act as an exogenous variable in the Louisiana Community Impact Model (LCIM). An early iteration of similar study was carried out by Fannin et al., (2008). They applied COMPAS model in the sector of oil and gas industries, where they demonstrated the economic impacts of developing the deepwater energy industry (DEI) on the local economy of Lafourche parish.[1] Results showed that the expansion of DEI led to the growth in both local government revenues and expenditures.

Methodological approach

A hybrid approach somewhat similar to Walls (1994) is used to generate forecast for oil and gas wells drilled in the deepwater Gulf of Mexico region. Formulas (2), (3), (4), (5), and (6) used in this study follow formulas (14), (12), (13), (2), and (3) respectively stated in Walls (1994). All prices are adjusted for inflation using the Producer Price Index (PPI) with 2007 as the base year (PPI = 100 for 2007).

The total number of oil and gas wells drilled at period t (W_t) is as following:

$$W_t = \alpha_0 + \alpha_1 W_{t-1} + \alpha_2 V_{t-1} + \alpha_3 l_t + \alpha_4 D_t l_t + \varepsilon_t \qquad (1)$$

where V_{t-1} is the expected discounted present value of profits per well at period $t-1$. The argument for using a lag of expected discounted present value of profits is that expected discounted present value of profits in previous year (period $t-1$) affects drilling decision at period t. W_t is the summation of exploratory wells at time t and development wells at time $t+1$. W_{t-1} is the lag value of W_t signifying that last period drilling activities might affect drilling activities at period t. Variable l_t is the weighted average number of leased tracts in the Gulf of Mexico for five consecutive periods (period $t-4$, $t-3$, $t-2$, $t-1$ and t). The weights (summing to one) for each year are as following: .5000 for period t, .2600 for period $t-1$, .1352 for period $t-2$, .0703 for period $t-3$, and .0345 for period $t-4$. Walls' study (1994) describes the weights as the impact of leasing on drilling activities that takes place over five-year period. The study mentions that half of the impact occurs in the first year. D_t is dummy variable that equals to zero prior to 1995 and equals to one otherwise. In 1995, the Deep Water Royalty Relief Act (DWRRA) was enacted to provide royalties relief to eligible leases for certain amounts of deepwater production. After its expiration

[1] Lafourche parish is a parish in South Louisiana that accounts for major on-shore support base and the growth of DEI in the Gulf of Mexico has centered around this place

in 2000, the DWRRA was then redefined and extended to promote deepwater exploration.[2] Variable $D_t l_t$ is incorporated into the model to capture any influence from the DWRRA on the deepwater drilling.

The expected present value profit per well (V_t) consists of four components: The after tax discounted present value of net operating profit for oil (in barrel) and gas (in thousand cubic feet/mcf), success ratio in finding oil or gas, expected size of new discoveries, and after tax drilling costs. The formula is given as following:

$$V_t = \pi_t^o S_t^o a_t^o + \pi_t^g (S_t^o a_t^{ag} + S_t^g a_t^{ng}) - [C_{dry} (1 - \tau_t) + C_{wet} (1-\tau_t (exp + i (1 - exp))] \quad (2)$$

where π_t^o and π_t^g represent discounted present value net operating profit per barrel of oil and gas, respectively. S_t^o and S_t^g represent the success ratio of finding oil or gas, respectively. C_{dry} represents exploratory and development drilling cost for dry hole per total well drilled, while C_{wet} is for the successful wells drilled. Variable *i* shows the delays between drilling and production while variable *exp* is the proportion of successful well drilling costs. Variable a_t^o represents additional oil discovered per successful well drilled, a_t^{ag} represents additional mcf associated-dissolved gas discovered per successful oil well drilled, and a_t^{ng} represents additional mcf non associated gas discovered per successful gas well drilled.

Associated-dissolved natural gas is natural gas that occurs in crude oil reservoirs either as free gas (associates) or as gas in solution with crude oil (dissolved gas). Non-associated natural gas is natural gas that is not in contact with significant quantities of crude oil in the reservoir.[3] Variables a_t^o, a_t^{ag}, and a_t^{ng} are defined as three-year moving averages. Additional oil discovered per successful well drilled (a_t^o) is obtained by dividing three year moving average of total discoveries with three year moving average of successful well drilled lagged one period. The same procedure is applied to compute for a_t^{ag} and a_t^{ng}.

The discounted present value net operating profit per barrel of oil (π_t^o) is obtained as following:

[2] The US Energy Information Administration website http://www.eia.doe.gov
[3] Definitions taken from the US Energy Information Administration website http://www.eia.doe.gov.

$$\pi_t^o = \beta^2 \, b \, P_t^o \, / \, (1 - \beta \, e^{-b}) \qquad (3)$$

The discounted present value net operating profit per mcf of gas (π_t^g) is obtained as following:

$$\pi_t^g = \beta^2 \, c \, P_t^g \, / \, (1 - \beta \, e^{-c}) \qquad (4)$$

where β is the discount factor ($\beta = 1/(1 + r)$; r = discount rate). Variable b is the average crude oil production decline rate obtained by dividing total production (barrel) with total reserves (barrel). Variable c is the average gas production decline rate obtained by dividing total production (mcf) with total reserves (mcf). The lag between drilling and production is also shown through the square of β. P_t^o is the net operating profit per barrel of oil. P^t_g is the net operating profit per mcf of gas.

The net operating profit per barrel of oil (P_t^o) is as following:

$$P_t^o = \Phi_t^o \, (1 - \tau_t \, (1 - \delta_t - \omega_t - \rho_t) - \omega_t - \rho_t) + \omega_t \, P_t^b - OC_t^o \, (1 - \tau_t) \qquad (5)$$

where Φ_t^o is the wellhead oil price, τ_t is the corporate income tax rate, ρ_t is the royalty rate, δ_t is the depletion allowance rate, and ω_t is the windfall profits tax rate. P_t^b is the spot market price of oil (West Texas Intermediate). OC_t^o is the operating cost per barrel of oil.

The net operating profit per mcf of gas (P^t_g) is as following:

$$P_t^g = \Phi_t^g \, (1 - \tau_t \, (1 - \delta_t - \rho_t) - \rho_t) - OC_t^g \, (1 - \tau_t) \qquad (6)$$

where Φ_t^g is the wellhead gas price, τ_t is the corporate income tax rate, ρ_t is the royalty rate, and δ_t is the depletion allowance rate. OC_t^g is the operating cost per mcf of gas.

An Autoregressive Distributed Lags (ADL) model is used to estimate model (1). Hill et al (2008) describes that Autoregressive Distributed Lags model overcomes two problems found in finite distributed lag model. First is the problem of choosing how many lags to be put into the model and second is the auto correlated error problem. The inclusion of lagged values of the dependent variable eliminates this correlation. An ADL (1,1) is applied to model (1) where there are lag of both dependent and independent variables in the model. The coefficient estimates obtained shown on Table 1 are then used to generate forecast for the number of wells drilled to the year of 2050.

Data

The values for royalty rate (ρ_t), corporate income tax rate (τ_t), delays between drilling and production (i), proportion of successful well drilling costs (*exp*), windfall profit tax rate (ω_t), and the success rate for oil and gas (S_t^o and S_t^g) used in this study follow the values mentioned in the study by Walls (1994). The value for depletion rate (δ_t) used in this study refers to a publication by the Independent Petroleum Association of America (2009).

Operating costs (OC_t^o and OC_t^g) for 1984 – 1989 and 1994 – 2007 are obtained from DOE/EIA-0185 publications (*Costs and Indexes for Domestic Oil and Gas Field Equipment and Production Operations*). Operating costs (OC_t^o and OC_t^g) for 1990 – 1993 are obtained from DOE/EIA-TR-0568 publication (*Cost and Indices for Domestic Oil and Gas Field Equipment and Production Operations 1990 through 1993*). The amount of additional oil and gas discovered from new field discoveries, new reservoir discoveries in old fields, and extensions are obtained from DOE/EIA-0216 publications (*US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves Annual Report*).

The discount rate (r) is the federal funds rate obtained from Federal Reserve Statistical Release. The PPI index is obtained from the US Department of Labor, Bureau of Labor Statistics. The wellhead prices for oil and gas (Φ_t^o and Φ_t^g), total oil and gas productions, total oil and gas reserves are obtained from the US Energy Information Administration website (http://www.eia.doe.gov). The number of tracts leased (l_t) is obtained from the US Department of the Interior, Minerals Management Service. The number of exploratory and development wells (W_t) as well as the number for operating oil and gas wells is obtained from API Basic Petroleum Data Book (2009). The drilling costs (C_{wet} and C_{dry}) are obtained from the yearly Joint Association Survey (JAS) publication published by API. The market spot prices of crude oil (P_t^b) based on West Texas Intermediate (WTI) are obtained through the LSU Center for Energy Studies website (http://www.enrg.lsu.edu/).

Estimation Results

The coefficient estimate for W_{t-1} is positive implying that an increase in the number of wells drilled in the previous period (*t-1*) increases the number of wells drilled in period *t*. A positive coefficient on V_{t-1} implies that an increase in the previous period expected discounted present value of profit per well increases the number of wells drilled at period *t*. Variable l_t also has positive coefficient meaning that an increase in the number of leased tracts leads to an increase in wells drilling at period *t*. A positive coefficient on $D_t l_t$ implying that the 1995 DWRRA have a positive impact on the number of wells drilled. W_{t-1} was significant at the 90 percent level.

A joint significance test for all the right hand side (RHS) variables is conducted with the result that they are significant at 95 percent level. The Durbin-h test statistics is conducted to test for the null hypothesis of no serial correlation in the error term. The test fails to reject the null hypothesis at 95 percent level, implying that there is no serial correlation in the error term. Figure 1 shows the actual versus the fitted values for the total wells drilled.

Forecasting

Variables a_t^o, a_t^{ag}, and a_t^{ng} are generated with a three-year moving average as following:

$$a_t^o = [(a_{t-1}^o + a_{t-2}^o + a_{t-3}^o)/ (a_{t-2}^o + a_{t-3}^o + a_{t-4}^o)]\ \ a_{t-1}^o \qquad (7)$$

$$a_t^{ag} = [(a_{t-1}^{ag} + a_{t-2}^{ag} + a_{t-3}^{ag})/ (a_{t-2}^{ag} + a_{t-3}^{ag} + a_{t-4}^{ag})]\ \ a_{t-1}^{ag} \qquad (8)$$

$$a_t^{ng} = [(a_{t-1}^{ng} + a_{t-2}^{ng} + a_{t-3}^{ng})/ (a_{t-2}^{ng} + a_{t-3}^{ng} + a_{t-4}^{ng})]\ \ a_{t-1}^{ng} \qquad (9)$$

The success ratio for oil and gas (S_t^o and S_t^g) in the forecasting is much higher than the ones used in the model. A study published by MMS (2003) notes that due to advance technological progress in offshore drilling, this success rate has dramatically increased to about 50 percent. Forecasts for the crude oil and gas wellhead price (Φ_t^o and Φ_t^g) as well as crude oil spot market price (P_t^b) are obtained through the US Energy Information Administration website (http://www.eia.doe.gov).

The number of tracts leased (l_t), exploratory and development drilling costs for dry hole as well as for successful well (C_{dry} and C_{wet}) are the average values from the sample period. The operating cost for oil and gas (OC_t^o and OC_t^g) as well as the discount factor (β) are the values at the last year of sample period (in 2007). In 2005, the congress passed the Energy Policy Act that states the windfall profit tax rate (ω_t) to be 25 percent for oil and gas production (Lazzari and Pirog, 2008).

The variables and parameters used for the forecasting are shown on Table 2. The crude oil spot market price (P_t^b) combined with the crude oil and gas wellhead price (Φ_t^o and Φ_t^g) as well as operating cost for oil and gas (OC_t^o and OC_t^g) are applied to formula (5) and (6) yielding the net operating profit per barrel of oil (P_t^o) and per mcf of gas (P^t_g), respectively. These results are then applied to formula (3) and (4) to obtain the discounted present value net operating profit per barrel of oil (π_t^o) and per mcf of gas (π_t^g), respectively. The prediction for expected present value profit per well (V_t) following formula (2) is then generated by combining the discounted present value net operating profit per barrel of oil and per mcf of gas (π_t^o and π_t^g) with the predicted three-year moving average of additional reserves (a_t^o, a_t^{ag}, and a_t^{ng}) as well as the exploratory and development drilling costs for dry hole and for successful well (C_{dry} and C_{wet}).

The predicted expected present value profit per well (V_t), the number of tracts leased (l_t), and variable $D_t l_t$ to capture any influence from the DWRRA on the deepwater drilling are then combined with the coefficient estimates obtained from the regression (Table 1) to generate prediction for the number of wells drilled (W_t).

The predicted number of oil and gas wells drilled to the year 2050 is shown on Table 3. This prediction of number of wells is also available in Figure 2.

The discovery process components in the model (a_t^o and a_t^{ag}) are showing decreasing discovery rates, except for a_t^{ng} that increases during the forecast period. The decreasing discovery rates effects of a_t^o and a_t^{ag} are much less than the increasing discovery rates effect from a_t^{ng}. These discovery process components are built into the computation for V_t. Due to this, V_t increases over the forecast period as well. Since V_t and W_t are positively correlated, hence W_t increases over the 2008 – 2050 period.

Fiscal Effects

Following the block recursive nature of the COMPAS model, demand for the final product, oil and gas, generates an employment demand. In our case, final demand is the number of wells to be drilled. Given that employment drives the COMPAS model, employment generated to drill the provided number of wells was derived by the MAGPLAN model (Saha and Phillips 205) that offers direct, indirect and induced impacts. This employment number was then plugged into the labor force module which ultimately fed into the fiscal module in the Louisiana Community Impact Model[4] for analyzing two specific parishes that are measurably impacted by deepwater oil and gas extraction.

Results indicate that the total number of wells (119) to be drilled in 2011 would generate around 3,643 jobs in the LA-2 region as defined by the Bureau of Ocean Energy Regulation and Enforcement (BOEMRE, formerly MMS).[5] For this paper, we have selected Lafayette Parish that makes up more than half of the total Mining jobs in the region. The fiscal impacts were generated based on two revenue capacity equations and four expenditure equations. Estimates of assessed value and retail sales make up the revenue capacity equations. Local government revenue is commonly generated by different tax revenues and transfer revenues and these tax revenues are based upon assessed value and retail sales respectively. On the other hand, expenditure equations are built up in such a way that the expenditures are explained by factors that measure the quantity of public services, quality of public services, demand conditions related to the public services, and input conditions related to public services (Johnson, 1996).

A closer inspection about the impacts provided by these number of wells to be drilled in 2011 could be observed by calculating the impacts if those wells would not have been drilled. The 119 wells that are to be drilled in 2011 are new wells; however, the people residing in the region are employed because of the wells that were drilled in previous years. What would be the impact in terms of expenditure if those 119 wells were not drilled? This would be a fundamental question that needs to be addressed in order to evaluate the marginal effects of losing the jobs in that region. In the short run, the

[4] See Appendix for the regression results.
[5] LA-2 region is described by MMS as few southern parishes of Louisiana that includes seven parishes, namely, Acadia, Evangeline, Iberia, Lafayette, St. landry, St. Martin and Vermillion.

demand for these expenditure categories would not change significantly, however, in long run the demand for these categories might increase or decrease depending on the preference and necessities of the people in the region. The people who are not employed after losing the jobs would be interested in these public services and thus the expenditure in any of these categories might increase. On, the other hand, because of the loss of jobs, people might not be able to afford these public services and the expenditure in any of these categories might decrease.

As could be seen from Table 4, there is about 11% percent change in the health and welfare expenditure when moving from 2009 to 2010 and around 15% change when moving from 2010 to 2011. Thus, there is a difference of about 4%, which accounts for the spending effects as evaluated by the difference in the growth rates between years. For other categories of expenditure, these effects are 1%, 2%, and 5% for general government, public safety and public works respectively. If we think of the wells drilled as wells that will not be drilled because of Deepwater Horizon, then the additional Health and Welfare spending effects above baseline growth would reduce Health and Welfare spending per capita back about halfway to 2009 levels. Similar effects occur in the other expenditure categories. It should also be noted that the per capita expenditure change is three to six times inflation. Much of this spending is due to spillover effect one-time spending from federal dollars from Hurricanes Katrina and Rita working through local governments. Since the dataset available to model parish government expenditures only starts in 2004, in the short term, these models are likely to have Katrina and Rita overestimations until additional data can be added to these panel models.

Conclusion

This paper attempts to model and project the number of wells to be drilled in the Gulf of Mexico as well as understand how the oil and gas industry activities impact the local regional on-shore economies the service off-shore drilling. An econometric model using an autoregressive distributed lag is used to estimate and forecast the number of wells drilled over the next forty years. Further, these results were applied to a community policy analysis modeling framework which projected changes in local government expenditure demands.

Since these results represent forecasts of oil and gas wells to be drilled based on characteristics of the Gulf of Mexico prior to the Deepwater Horizon explosion, they represent the impacts to not having the forecasted wells drilled. That is, compared to baseline growth rates, we would reduce growth rates of local government expenditure demands due to reduced revenue capacity to finance their delivery. Such a framework may provide insights into the slower approval of permitting by BOEMRE in future years as the agency tries to balance economic and environmental concerns.

There are a few limitations that should be noted. The COMPAS modeling framework is still in some of its early iterations and needs further refining and testing before providing greater confidence to final projections. Further, the oil and gas wells drilling model is somewhat limited to forecasting "what would have been" without the Deepwater horizon explosion.

Despite these shortcomings, this approach provides an opportunity to generate a meaningful understanding of the relationship between the deepwater oil and gas industry and the local fiscal sectors along the coast that are impacted by its activities. Its results should be considered as part of the larger portfolio of research evaluating the impact that the offshore drilling industry has on the economy and environment of the coastal zone.

References

Adhikari, Arun and J. Matthew Fannin. "Evaluating the relative performance of alternative local government revenue and expenditure estimates of community policy analysis models." A Poster presented at the Annual Meetings of the Southern Agricultural Economics Association, February 1-4, 2009, Atlanta, GA.

Adhikari, Arun and J. Matthew Fannin. "Comparative Analysis on Performances between Spatial and Non Spatial Estimators in Community Policy Analysis Model." A paper accepted in SRSA meetings and will be presented in Washington DC, March 26-29, 2010.

American Petroleum Institute (API), Statistics Department. *Joint Association Survey (JAS) on Drilling Costs*. Washington, DC. 1984-2007.

Beaumont, P.M. "Supply and Demand Interaction in Integrated Econometric and Input-Output Models." Internatioanl Regional Science Review, 1990, Vol 13, Nos. 1 and 2, pp. 167-181.

Energy API. *Petroleum Industry Statistics, API Basic Petroleum Data Book*. Volume 29, Number 2, August 2009. Washington, DC.

Fannin, J. Matthew, David W. Hughes, Walter Keithly, Williams Olatubi, and Jimine Guo. "Deepwater Energy Industry Impacts on Economic Growth and Public Service Provision in Lafourche Parish, Louisiana." *Socio-Economic Planning Sciences*. 42(September): 190-205. 2008.

Federal Reserve Statistical Release. "Selected Interest Rates Historical Data." Internet site: http://www.federalreserve.gov/releases/h15/data/Annual/H15_FF_O.txt (Accessed December 2010).

Hill, R. C., W. E. Griffiths, and G. C. Lim. *Principles of Econometrics*. 3rd ed. New Jersey: John Wiley & Sons, Inc., 2008.

Iledare, O. O. "An Analysis of the Rate of Crude Oil Reserve Additions in Nigeria's Niger Delta." Paper presented at Society of petroleum Engineers (SPE) Annual International Technical Conference and Exhibition, Abuja, Nigeria, 2000.

Independent Petroleum Association of America (IPAA). "Percentage Depletion." Washington, DC. 2009.

Johnson, T.G. "Federal Policy Analysis with Representing Rural Community Models." Presented at the Rural Policy Research Institute Modeling Conference, Kansas City, Missouri, Novemeber, 1996.

Johnson, T.G., D.M. Otto, and S.C. Deller. *Community Policy Analysis Modeling*. First Edition. Blackwell Publishing, 2006.

Lazzari, S. and R. Pirog. "Oil Industry Financial Performance and the Windfall Profits Tax." CRS report for Congress RL34689, 2008.

"Percentage Depletion." Independent Petroleum Association of America, Washington, DC (2009). www.ipaa.org.

Saha, B., J. Manik, and M. Phillips. (2005). "Upgrading the Outer Continental Shelf Economic Impact Models for the Gulf of Mexico and Alaska (MAG-PLAN Study Report)." OCS Report MMS 2005-048. Herndon, VA: USDOI/MMS.

US Department of Energy, Energy Information Administration (EIA). *Costs and Indexes for Domestic Oil and Gas Field Equipment and Production Operations.* DOE/EIA-0185 publications. Washington, DC. 1984-2007.

US Department of Energy, Energy Information Administration (EIA). *Cost and Indices for Domestic Oil and Gas Field Equipment and Production Operations 1990 through 1993*. DOE/EIA-TR-0568 publication. Washington, DC. 1990-1993.

US Department of Energy, Energy Information Administration (EIA). *US Crude Oil, Natural Gas, and Natural Gas Liquids Reserves Annual Report.* DOE/EIA-0216 publications. Washington, DC. 1984-2007.

US Department of Interior, Minerals Management Service/Bureau of Ocean Energy Management, Regulation and Enforcement. "Gulf of Mexico Oil and Gas Lease Offerings." Internet site: http://www.gomr.boemre.gov/homepg/lsesale/swiler/swiler.html (Accessed December 2010).

US Department of Labor, Bureau of Labor Statistics. "PPI Index Commodity data." Internet site: ftp://ftp.bls.gov/pub/time.series/wp/wp.data.1.AllCommodities (Accessed December 2010).

Walls, M. A. "Modeling and Forecasting the Supply of Oil and Gas." *Resources and Energy* 14,3 (1992): 287-309.

__________ "Using a 'Hybrid' Approach to Model Oil and Gas Supply: A Case Study of the Gulf of Mexico Outer Continental Shelf." *Land Economics* 70,1 (1994): 1-19.

TABLE 1.
Coefficient Estimates of Model (1)

Number of obs =	23
F (4,18) =	8.62
Prob > F =	0.0005
R-squared =	0.6188
Root MSE =	40.68

W_t	Coef.	Robust Std. Err.	t	P > |t|	95% Conf. Interval	
W_{t-1}	0.6010751	0.1446838	4.15	0.001	0.2971058	0.9050445
V_{t-1}	0.000000198	0.000000131	1.51	0.149	-0.000000078	0.000000474
I_t	0.0433687	0.0581343	0.75	0.465	-0.078767	0.1655044
$D_t I_t$	0.0160005	0.0304841	0.52	0.606	-0.0480443	0.0800452
constant	0.5937841	38.11271	0.02	0.988	-79.47805	80.66562

TABLE 2.
Variables and Parameters for Forecasting

Variables	Values
τ_t	0.34
ρ_t	0.167
i	0.921
exp	0.3
ω_t	0.25
δ_t	0.15
S_t^o	0.5
S_t^g	0.5
OC_t^o	\$15.32/barrel
OC_t^g	\$1.48/mcf
β	0.9025
Φ_t^o	\$84.18/barrel
Φ_t^g	\$3.91/mcf
l_t	817 tracks
C_{wet}	\$7,442,658/well
C_{dry}	\$11,583,355/well
P_t^b	\$86.08/barrel
D_t	1
b	0.12
c	0.18

TABLE 3.
Predicted Number of Wells Drilled

Year	Number of Wells
2008	101
2009	110
2010	115
2011	118
2012	120
2013	121
2014	122
2015	123
2016	124
2017	124
2018	125
2019	126
2020	127
2021	128
2022	130
2023	131
2024	133
2025	135
2026	138
2027	141
2028	144
2029	148
2030	152
2031	158
2032	164
2033	171
2034	179
2035	188
2036	199
2037	212
2038	226
2039	243
2040	263
2041	285
2042	311
2043	341
2044	376
2045	416
2046	462
2047	516
2048	577
2049	649
2050	731

Table 4. Per Capita Fiscal Expenditure Effects on Lafayette Parish from Oil and Gas Wells Drilled in the Gulf of Mexico.

Year	Expenditure ($) Per Capita							
	General Government	% Change	Health and Welfare	% Change	Public Safety	% Change	Public Works	% Change
2009	149		76		90		483	
2010	175	17%	85	11%	107	19%	561	16%
2011	206	18%	98	15%	130	21%	680	21%

APPENDIX

Regressions Results for Labor Force Module

Independent Variable	Dependent Variable		
	Ln (Population)	(Ln)In-commuter Earnings	Ln (Out-commuter Earnings)
Ln (Labor force)		-1.03***	-0.15**
Ln (External labor force index)		0.41***	
Ln (External employment index)			0.69***
Ln (Place of work employment)	0.82***	2.10***	0.95***
Constant	2.48***	-0.78	0.94**
R^2	0.96	0.89	0.71

***/**/* -- Significant at 1%/5%/10% levels.

Regression Results for Assessed Value and Retail Sales

Independent Variable	Dependent Variable	
	Ln (Assessed Value)	Ln (Retail Sales)
Ln (land density/sq mi)	0.02	0.04
Ln (Out-commuter earnings)	0.45***	0.18***
Ln (In-commuter earnings)		0.23***
Ln (Resident employed earnings)	0.49***	0.39***
Constant	7.22***	9.36***
R^2	0.85	0.92

***/**/* -- Significant at 1%/5%/10% levels.

Regression Results for Per Capita Expenditure Equations

Independent Variable	Dependent Variable			
	Ln (Per capita general government)	Ln (Per capita health and welfare)	Ln (Per capita public safety)	Ln (Per capita public works)
Ln (per capita assessed value)	0.18	0.65**	0.17	0.44
Ln (Per capita retail sales)	0.29	0.24	0.50	0.50**
Ln (Per capita income)	0.29	-0.49	0.37	0.33
Ln (% Urban)	0.46			-0.47
Ln (per capita arable land density)	1.02*		0.37**	0.78***
Ln (Per capita local road miles)	-0.35			-0.40
Ln (% African American)		-0.36	-0.10	
Constant	-1.99	1.19	-4.52	-3.55
R^2	0.38	0.05	0.19	0.36

***/**/* -- Significant at 1%/5%/10% levels.

FIGURE 1.
Actual Versus Fitted Values of Total Wells Drilled

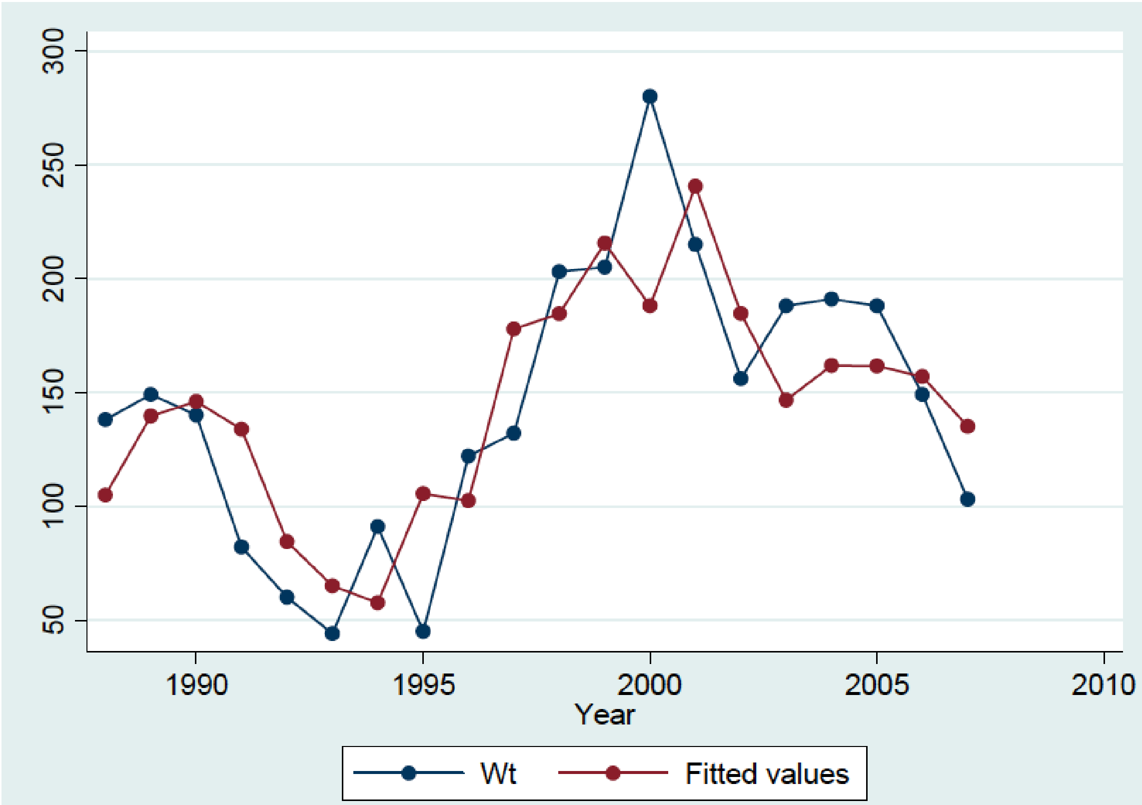

FIGURE 2.
Predicted Number of Wells Drilled