A SIMULATION OF PRICE EFFECTS ON CRUDE OIL PRODUCTION FROM STRIPPER WELLS IN TEXAS

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ABSTRACT

A brief discussion of the stripper well industry and the economic and regulatory enviornments in which it operates are given. Certain very simple models of the stripper well industry are estimated and critically analyzed. A set of data requirements are identified that are considered necessary to adequately model the stripper well industry. A program is outlined to obtain the necessary information and to construct a simulation model of the industry.

INTRODUCTION

One facet of government policy that has had a large effect on the U.S. economy is the attempts by the various state and federal governments to control the production of fossil fuels. With regard to crude oil, the regulation was originally intended to prevent a glut and to prevent destructive price declines due to over supply. These efforts at controlling crude oil production and prices were largely due to the Texas Railroad Commission and were quite successful in maintaining stable prices and production volumes over a long period of time. The U.S. government became involved in price maintenance of crude oil primarily through its efforts to limit the inflow of cheaper foreign crude oil and by its withholding from production certain strategic reserves, notably the Naval Petroleum Reserves.

Partially as consequence of the regulatory efforts by the various governments involved, the ability and willingness of the oil industry to change crude oil reserves and production in reaction to changes in prices are unknown. There is little historical information available from which to estimate such a response due to the past stability of crude oil prices.

Since the dramatic increase in world oil prices caused by the OPEC cartel, the U.S. government has been searching frantically for methods and procedures to increase the domestic production of crude oil or to reduce the demands for the products from crude oil. The obvious approach of allowing the marketplace to respond to the changed circumstances does not seem to be attractive to the policymakers in government. Perhaps their antipathy is due to a lack of information about the probable effects of allowing the markets to perform the function of determining prices and volumes.

Many attempts have been made to model the response of the oil industry to changes in price incentives. These efforts have resulted in a plethora of supply models for crude oil. They all share the same problem of a lack of adequate data and to a large extent compensate for the lack of data by making assumptions. This is true regardless of the apparent simplicity or complexity of the model involved. The resources involved in the modeling range from one or two researchers working for a short period of time to develop an aggregate model [5,7] to large teams of researchers building on extensive past research to develop reasonably comprehensive sets of models [3,4]. In addition to being based on a concatenation of assumptions and poor data, most of the models share another characteristic. Their results tend to be somewhat similar.

In the domestic crude oil supply, one source that has largely not been subject to production constraints or price regulation is oil from stripper wells; oil wells capable of producing ten or less barrels of oil per day.

In the past the exemption of stripper wells from price and production regulation has been justified on intuitive grounds. The actual behavior of the stripper well segment of the oil industry had not been adequately studied and the effects of its exemption from regulation were unknown. The situation has not changed and the research described here is an attempt at reducing the uncertainty about the effects of changing the conditions in which the stripper well industry operates.

This source of supply has been largely ignored by the modelers. Most of the crude oil supply studies have not explicitly treated the contribution to the crude oil supply that is made by stripper wells even-though the wells have been treated differently legally and differ in economic and physical characteristics from the general population of oil wells. Analysis of the supply response from stripper wells to price incentives can give a reasonable approximation to the larger question about the supply response of the oil industry. Since the stripper well industry has been and is largely unregulated it is a segment that may reflect the response of the oil industry as a

whole to deregulation.

The project being discussed here is an initial attempt to model the economics of the stripper well industry in Texas and concurrently to define the data limitations that need resolution in order to adequately model the stripper well industry for the United States. Essentially this study is intended to be a pilot project for a more extensive study.

The first phase of the study involves the acquisition of available published and unpublished data on the characteristics of the population of stripper wells in Texas. This data is largely maintained by the National Stripper Well Association. This data will help define the gaps in knowledge about stripper wells that need to be filled. Additionally, the data will be utilized to estimate a supply function for oil from stripper wells. This first model will necessarily be crude but will allow the testing of the hypothesis that stripper well production is sensitive to price incentives. It should motivate the development of better data and models that are more reflective of reality.

The second phase of the study involves the acquisition of primary data about economic and physical characteristics of the population of stripper wells. A survey is currently being designed to obtain the desired information from the stripper well operators. The survey results will be used to estimate the correlation between characteristics in the population and will subsequently be used to simulate the behavior of the population over time.

PRELIMINARY RESULTS

In order to obtain some quick and dirty results, a set of very simple models were estimated utilizing published aggregate time series data on the stripper well population. These models are very simple minded and ignore much of known reality but do allow certain interesting conclusions to be drawn. Using the available data only three measures of the stripper well population seem reasonable. These are: 1) the number of stripper wells, 2) the average daily production per well and, 3) the total production from stripper wells.

Data was obtained on prices and the above measures for the years 1966 through 1976 [1,2,6]. Data is not yet published for 1977 but will become available in early fall, 1978. This data includes eight pre-embargo years in which prices were the same for all sources of domestic crude oil and includes three post-embargo years in which the prices for domestic crude oil depended on the history of the producing oil well. The results of these regressions are:

1) Number of Wells = 363,442 + 210(price per barrel in dollars)

2) Average Production per Well perday = -.171 -.054 (Price per barrel in dollars) + .000014(Number of Wells)

3) Total Annual Stripper Well Production = 470,883,487 6.575×10^6 (Price per barrel in dollars)

Of these simple models, number 1 is statistically insignificant while models 2 and 3 are both significant at the five percent level. In models 2 and 3 all coefficients are significant at less than the five percent level.

As mentioned before and as will be discussed in a later section of this paper these models have serious problems. However it appears that there is no strong historical correlation between the number of stripper wells and the prices received for oil from stripper wells (model 1). The average daily per well production appears to decrease as prices increase and increase as the number of wells increase. This can be due to higher prices' keeping wells in production longer before they are abandoned as the direct effect of prices. As the number of stripper wells increase, the increase partially comes from wells that were in the past more productive. As the wells drop into the stripper category, they naturally are the more productive segment of the stripper well population and hence increasing numbers of stripper wells seem highly correlated with higher average productivity.

Finally, model 3 illustrates the essential futility of attempting to model complex relationships using simplistic methods. Historically all domestic crude oil production, including stripper well production, has been declining. This is essentially true throughout the eleven year period used in this study. The prices received for crude oil have been increasing over this period with the result that prices and production are negatively correlated.

Two of the more serious problems associated with this simple approach are the use of average data instead of actual well data and the state of change in the regulatory enviornment in which the stripper well industry operates. The first problem and the steps being taken to solve it are discussed in the next section. The second problem is best illustrated by a short history of the more important changes in the federal regulatory environment over the past few years. [9,10]

* Prior to late 1973 prices for oil from stripper wells were unregulated
* November, 1973 - FEA created by the Emergency Petroleum Allocation Act of 1973. Two-tier pricing system installed. Stripper will oil in upper tier.
* November, 1973 - Trans-Alaska Pipe Line Authoritization Act of 1973 changes definition of stripper well from a single well basis to property basis. "A property whose average daily production of crude . . . per well did not exceed 10 barrels per day during the preceeding calendar month." The act deregulates price for stripper well production.
* June, 1975 - FEA decides that property that once qualifies as a stripper property will remain a stripper property regardless of changes in average per well productivity.

* December, 1975 - The Energy Policy and Conservation Act reinstates price controls on stripper well production effective February 1, 1976.
* September, 1976 - The Energy Conservation and Production Act deregulates prices on production from stripper well properties and also changes the definition of a stripper well property.

The effects of these regulations are not always what the policy makers desire and are surely impossible to detect using the simple models previously discussed. For example, at the current prices, a well producing 26 barrels of oil per day selling at "old oil" prices generates less revenue than the stripper well producing 10 barrels per day selling at unregulated prices. The "once a stripper, always a stripper" rule results in "stripper wells" producing large amounts of oil [8]. A well producing 50 barrels of oil per day that is classified by the federal government as a stripper well may not be picked up by the National Stripper Well Survey. In fact, whether or not it should be included in stripper well statistics is not immediately clear.

These and other changes in federal policy worsen the inadequacy of existing published data in measuring the effects of economic changes on the characteristics of the stripper well industry.

DATA REQUIREMENTS

The requirements of the model to simulate the behavior over time, of the industry determines the data required. The basic requirements of an adequate model are;

I. Define at a specific time the characteristics of the components of the industry (wells and properties) and of the industry in aggregate.
II. Project how the population characteristics change over time
   A. Abandonments of existing wells or properties
   B. Creation of new wells or properties
   C. Changes in the characteristics of existing stripper wells or properties

As these model requirements are defined, they imply that a simulation of the industry will require detailed information about the physical and economic characteristics of individual wells or properties. Information on the distribution and correlations of the characteristics is also needed.

At present, a survey form is being designed to obtain the desired information from a sample of the stripper well producers. The information will be broken into sections for wells that have been abandoned in the past year, existing wells, and new stripper wells. For each of the three types of wells, the following information will be requested on a per well and on a property basis.

* The quantity of petroleum produced
* The oil-water ratio
* The depth of the well
*The number of wells on the property
* The revenue generated
*The costs incurred - Cash flow basis
- Accounting basis
*The Royalty and Tax payments
* The depletion allowance utilized

The information will be requested for two sequential twelve month periods.

The data will be analyzed to obtain estimates of the average values of the stripper well industry's characteristics and to obtain measures of the correlation between the characteristics. The simulation model is being designed and details of its formulation are not yet available.

CONCLUSIONS

This paper presents some very preliminary results of an effort to model an important segment of the domestic energy supply. The direction in which futher research needs to go is reasonably clear. In particular, the published data is much too aggregated to be very useful in projecting the path of the industry into the future. The problem is compounded by rapid changes in the economic and regulatory environment in which the industry must operate. The process of defining a reasonable model is progressing and within the near future should contribute to an understanding of the consequences of federal and state regulation on the stripper well industry.

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