

A REVIEW OF THE SHELL STUDY OF NATURAL GAS DECONTROL

Staff Working Paper

**The Congress of the United States
Congressional Budget Office
June 1983**

A REVIEW OF THE SHELL STUDY OF NATURAL GAS DECONTROL

This CBO review was prepared in response to a request by the House Subcommittee on Fossil and Synthetic Fuels for comments on a study prepared by Shell Oil Company. The Shell study contains two major parts: "Increase in United States 'Old Gas' Reserves Due to Deregulation" and "Economic Analysis of Alternative Natural Gas Regulatory Policies."

SUMMARY

The principal finding of the Shell study is that there would be significant additions to "old gas" reserves if old gas prices are decontrolled. The first part of the Shell study estimates the effects of wellhead price decontrol on natural gas produced under the old gas sections of the Natural Gas Policy Act (NGPA). The second part examines the economic effects of three natural gas policy options: continuing current law (NGPA), enacting the Administration's decontrol proposal (H.R. 1760), and extending price controls under the Gephardt proposal (H.R. 2154). The central focus of the Shell study is the response of owners of old gas reserves to decontrol. This emphasis is appropriate because the pricing of old gas is one of the most important issues in the current natural gas debate. This review, therefore, focuses on the analytical, measurement, and methodological issues related to estimating the costs and benefits of decontrolling old gas. In addition, this review also examines the economic analysis of the three proposals.

CBO's principal observation is that the Shell study does not discuss the sensitivity of its results to different assumptions concerning oil prices, gas contracting practices, and the geological features of old gas reserves. A sensitivity analysis would be helpful to determine how the ranking of the policy options is affected by different contingencies. This observation applies equally to the two parts of the study reviewed here: old gas reserves and the economic analysis.

Old Gas Reserves

CBO has four major concerns about the study's section on old gas reserves:

- Random sampling procedures were not used in the selection of the old gas fields for the Shell study. This could bias the esti-

mates of reserve growth, although the direction of bias caused by this problem cannot be determined, based on available information.

- The estimates of additions to the old gas reserve base after decontrol may include quantities of gas that would be added anyway by the price incentive provisions under current law.
- The estimates of additions to old gas reserves that would result from deregulation appear to depend on key parameters that were based on engineering judgments. There is no independent way to validate these judgments, although they are central to the conclusions of the study.
- The Shell estimates of old gas reserve additions from infill drilling (drilling in fields currently under production) assumes that price incentives under current law for infill drilling are very small. If this is not the case, then Shell's estimates of the price responsiveness of reserve additions under decontrol are much larger than that found under current market conditions.

Economic Analysis

The Shell economic analysis focuses on supply-side effects and does not consider other, equally important, economic factors. For example:

- The price responsiveness of natural gas consumption is not considered. The omission of this factor may result in overestimates of production response, because consumption may fall as prices eventually rise under decontrol. This could subsequently lead to reduced drilling and smaller reserve additions.
- Interfuel substitutions are not estimated. Omission of these relationships may overstate oil import savings because higher gas prices relative to oil would encourage some amount of switching to oil.
- The macroeconomic effects of decontrol are not estimated. The Shell study only estimates the changes in government revenues from income taxes, royalties, and production taxes and does not estimate revenue losses incurred elsewhere in the economy. Furthermore, any evaluation of the budgetary consequences of

natural gas policy should be based on the net change in revenues less outlays rather than solely on revenue changes. 1/

THE SHELL STUDY OF OLD GAS RESERVES

The first part of the study, "Increase in United States 'Old Gas' Reserves Due to Deregulation," represents one of the first analyses of this topic. Using a sample of the 14 largest old gas producing fields in the United States, the study finds that 52 trillion cubic feet (TCF) of gas could be added to the country's reserves upon decontrol, assuming a market clearing price of \$3.50 per thousand cubic feet. These reserve additions result from three sources: prolonging the life of wells that would have been abandoned at controlled NGPA prices (27 TCF), drilling additional wells in old gas fields (18 TCF), and stimulating production from existing wells through enhanced recovery methods (7 TCF). There are four sources of concern with this part of the study: sampling techniques, estimation of the reserve base, estimates of reserve additions, and assumptions regarding infill drilling.

The Sampling Problem

The selection of a representative sample of old gas fields is very important. The study claims that the sample used is representative of all U.S. fields in terms of depth, age, and geological features. Another important characteristic, however, is the size of the remaining proved reserves in each field. A random sample would include a collection of fields that represent the distribution of old gas reserves. The selection of the 14 largest old gas fields, therefore, may be a biased sample. The direction of this bias, however, cannot be determined until a true random sample is collected. As a result, the extrapolation of the estimated reserve response from these fields to the total old gas reserve base may not be valid.

Estimation of the Reserve Base

The definition of old gas reserves is very important. Old gas is defined in the Shell study as gas that remains under NGPA price controls, "specifically, categories 104, 105, 106(a), 108, 109, and portions of 103 which are

-
1. Congressional Budget Office, Natural Gas Pricing Policies: Implications for the Federal Budget (January 1983).

never deregulated." 2/ This definition, however, cannot be used to estimate the old gas reserve base because data on reserves by NGPA section are not available. As a result, Shell estimated the old gas reserve base of 115 TCF in two steps. First, from total proved reserves of 206 TCF the study subtracted Alaskan North Slope reserves (33 TCF), dissolved gas reserves (20 TCF), and water drive reserves (20 TCF). Secondly, in order to correct for new gas reserve additions, Shell took 85 percent of the above remainder as the amount of old gas responsive to deregulation. This procedure may be an adequate first approximation; however, the limited public availability of data on old gas reserves does not permit verification.

One potential problem with the Shell definition of old gas is that it may not consider some of the incentives for reserve additions that already exist under current law. Thus, some of the additions to old gas reserves estimated in the Shell study may occur as a result of current law, not deregulation. For example, a portion of intrastate gas under Section 105 of NGPA is scheduled for decontrol in 1985. The amount of intrastate gas that reaches the market clearing price in 1985 under current law, however, is likely to be small for two reasons. First, only about 34 percent of intrastate gas will be deregulated in 1985. 3/ Second, the price increase under decontrol and the amount of intrastate gas that would be decontrolled are limited by long-term contracts with definite price escalators in the intrastate market. Thus, contract provisions as well as current law limit the near-term incentives for reserve additions from intrastate prices.

Another incentive under current law that is apparently overlooked in the Shell study is the price allowed for stripper gas under Section 108. The allowed maximum ceiling price was \$3.54 per million Btu on January 1983. Currently, wells may qualify as a stripper if production falls below 60 thousand cubic feet per day for a 90-day period. Although the amount of gas currently produced under this category is relatively small, production and, therefore, dedicated reserves under Section 108 may increase as output levels from old gas wells decline. Nonetheless, the definition of stripper gas may be too restrictive in terms of providing sufficient incentive to increase production at the margin. Finally, including NGPA section 109 in the old gas category does not consider the discretionary authority that the Federal

-
2. C.S. Matthews, Increase in U.S. Old Gas Reserves Due to Deregulation, (Shell Oil Company, April 1983), p. 1.
 3. U.S. Department of Energy, Energy Information Administration, Office of Oil and Gas, Natural Gas Producer/Purchaser Contracts and Their Potential Impacts on the Natural Gas Market (June 1982), p. 23.

Energy Regulatory Commission (FERC) has in setting prices for "other" reclassified gas.

Reserve Additions From Lowering Abandonment Pressures

As wells are depleted and their production rates decline, producers need higher prices to avoid declining revenues. The producer has to choose between continuing production or withdrawing his working capital to invest in another income-generating asset. The key decision variable in determining when to abandon a well, therefore, is the net rate of return on the marginal unit of production. If this return is less than that of an alternative investment, then the gas producer would shut down his well and invest in the other asset. Given the depletion of old gas reserves, the key question is, therefore: what price is necessary to provide a sufficient rate of return for producing an additional unit of old gas?

The Shell study asks a different question: given a \$3.50 price for old gas under decontrol, what is the addition to old gas reserves? This second approach assumes that the market clearing price is necessary for earning a sufficient rate of return from additions to old gas reserves. The problem with this assumption is that some producers could earn a rate of return that would provide adequate incentives for reserve additions at a price lower than the \$3.50 stipulated in the Shell study. Thus, the study may overstate the total cost of obtaining additional old gas reserves.

In order to estimate the old gas reserve response, Shell had to answer the following question: at what reservoir pressure would old gas fields be abandoned under controlled prices? The estimate of abandonment pressure is critical because most of the other parameters in the study depend on it. This estimate was determined on the basis of "considerable engineering judgment." 4/ The study presents no information or structured methodology for estimating this parameter.

The sensitivity of the Shell estimates based on CBO reestimates of reserve additions from lowering abandonment pressures is presented in Table 1. For example, if the estimated abandonment pressures under current prices were 10 percent lower than the Shell estimates, then the reserve additions would be 3 TCF lower (see Table 1). Similarly, the same reduction would occur if market clearing prices were \$3.00 per million Btu instead of the \$3.50 used in the Shell study. If the lower price scenario were combined

4. Matthews, p. 7.

with the lower estimates of abandonment pressures (that is, wells are abandoned earlier than the Shell estimates) then the reserve additions would be 6 TCF lower (see Table 1). The CBO high case presented in Table 1 is also within 6 TCF. Unfortunately, it is not clear whether the Shell estimates of additions to old gas reserves from lowering abandonment pressures represent the "mean," because the estimates were not derived from statistical procedures. In conclusion, the Shell estimates appear to be quite sensitive to assumptions concerning abandonment pressures under current prices and market clearing prices under decontrol.

TABLE 1. SENSITIVITY OF SHELL ESTIMATES OF RESERVE ADDITIONS FROM LOWERING ABANDONMENT PRESSURES TO ASSUMPTIONS ON ABANDONMENT PRESSURES UNDER CURRENT PRICES AND ON DECONTROLLED MARKET CLEARING PRICES (In trillions of cubic feet)

	Low CBO Case	Shell Case	High CBO Case
Abandonment Pressures <u>a/</u>	24	27	31
Market Clearing Prices <u>b/</u>	24	27	29
Combination <u>c/</u>	21	27	33

SOURCES: Shell study and CBO reestimates.

- a. The CBO low case is defined to include abandonment pressures under current prices that are 10 percent lower than the Shell estimates. Similarly, the high CBO case has pressures 10 percent higher.
- b. The low case is estimated with a \$3.00/MMBtu price under decontrol, and the high case is estimated with a \$4.00/MMBtu price.
- c. This is estimated with a combination of lines one and two.

The Shell methodology may also involve some problems. The procedure used to estimate the old gas reserve additions from increasing abandonment levels consists of the following four steps:

- (1) Current field pressures are estimated based on the estimate of abandonment pressures of current prices and measurements of initial field pressures (estimated if data were unavailable);
- (2) Abandonment pressures from new deregulated prices are then computed;
- (3) The percentage increases in reserves by field are computed by taking the ratio of the pressure increment resulting from decontrol to the pressure increment associated with controlled prices;
- (4) The percentage increases are then multiplied by proved reserves in each field to obtain the incremental reserves in trillion cubic feet.

The entire procedure is driven by data on current prices and reserves and, most importantly, assumptions on market clearing prices and abandonment pressures under current prices.

The Shell study also assumes that costs are constant as wells approach abandonment levels. The author notes that deregulation of gas prices would allow producers to spend more on well improvements and, as a result, "increase ultimate gas recovery significantly." 5/ The study does not indicate whether this additional spending is needed to attain its estimated reserve response or whether this spending would add even more reserves. If the wellhead gas market is competitive, producers charge market prices, and production costs rise as wells approach abandonment levels, then the reserve additions would be lower because the breakeven level is further reduced by higher costs, given the market clearing price.

Infill Drilling

Based on an examination of the 14 fields in its sample, Shell estimates that old gas reserves could be increased by 21 TCF from infill drilling under decontrol. Shell subsequently reduces this estimate by 15 percent to 18 TCF for infill drilling that would occur under the \$2.75/MMBTU allowed

5. Mitchell, p. 9, paragraph 3.

under NGPA section 103. The estimate of a 21 TCF increase in reserves from infill drilling appears to have been made from a technical evaluation of each field in the sample based on the assumed market price. This increase may be optimistic because the extent of infill drilling might also depend on its cost and whether market conditions would allow producers to sell their gas at the assumed decontrolled price.

The most important assumption in the Shell analysis of infill drilling is that 15 percent of the projected 21 TCF reserve addition from decontrol would occur under current law. This assumes that prices for gas that could be reclassified into Section 103 are quite close to the \$2.75/MMBTU currently allowed. This assumption also implies that cheaper gas cannot be reclassified into Section 103.

If these two assumptions are not valid, then the Shell results imply a large asymmetry in the price responsiveness of reserve additions under the two cases. For example, the 27 percent increase in wellhead prices (from \$2.75 to \$3.50 per MMBTU) under decontrol results in 18 TCF additional old gas reserves. This implies a reserve-price elasticity of 0.57 so that for a 10 percent change in price, old gas reserves added by infill drilling increase by 5.7 percent. 6/ On the other hand, if it is assumed that some gas priced at \$2.00/MCF can be reclassified into Section 103, the 3 TCF reserve addition estimated to occur under current law by Shell would imply a reserve-price elasticity of 0.10. 7/ This implies that for a 10 percent change in price, reserve additions per MMBTU from infill drilling under current law would increase by 1 percent. These large differences in the price responsiveness of reserve additions from infill drilling are largely attributed to assumptions concerning current prices for gas that could be reclassified into Section 103. The Shell results imply that gas that could be reclassified is currently being sold for \$2.62 per MMBTU, 13 cents lower than the \$2.75 per MMBTU price allowed under current law in NGPA. 8/

6. This elasticity is computed by dividing the percentage change in reserves by the percentage change in price. Thus, the 0.57 elasticity is equal to $(18/115)/(0.75/2.75)$.

7. This elasticity equals $(3/115)/(0.75/2.75)$.

8. The 13 cents can be estimated by assuming the implied reserve-price elasticity under decontrol also applies to infill drilling under current law and solving for the price increment, or $(2.75/0.57) * (3/115)$.

THE SHELL ECONOMIC ANALYSIS

The economic analysis conducted by Shell compares the supply response, government revenues, and the cost of petroleum imports under the three policy options mentioned above. The results indicate that the Administration's bill (H.R. 1760) would generate higher natural gas production and government revenues and lower the cost of petroleum imports, compared to the NGPA and to the Gephardt bill (H.R. 2154).

These results are derived from an economic model that "considers only supply-side market forces." 9/ It is assumed in the model that domestic demand less imports will be large enough to absorb additional increases in production. The model was adjusted to account for the expected increase in production and reserve additions estimated in the first part of the Shell study. Additional production from new reserve additions was estimated by assuming a 7 percent extraction rate from old reserves as opposed to a 10 percent rate. Because the description of the Shell economic model and results are quite brief, the following comments are not as detailed as those presented above for the first section of the study on old gas reserves.

Budgetary Effects

Although the Shell economic analysis of various natural gas regulatory proposals is not intended to provide a forecast, there are several omitted factors that prevent the analysis from achieving even "order of magnitude" accuracy. First, the analysis does not consider how changes in the gas market affect the economy. This is particularly important for calculating changes in government revenues and outlays. The study does present estimates of changes in government revenues but does not consider any changes in government outlays. A previous CBO study has shown that the net effect of decontrol on the federal budget is quite small. 10/

Natural Gas Supply and Demand

The description of the Shell economic model indicates that production is simulated for 20 separate NGPA categories under a decontrol scenario.

-
9. Shell Oil Company, Economic Analysis of Alternative Natural Gas Regulatory Policies (April 1983), p. 3.
 10. Congressional Budget Office, Natural Gas Pricing Policies: Implications for the Federal Budget (January 1983).

Modeling production at this level of detail could involve large errors because the composition of the natural gas supply can only partially be constructed from a wide variety of disparate data sources. Hence, determining the composition of the gas supply is extremely difficult and modeling the production response of each NGPA section to changes in price incentives and contract terms is almost impossible.

The model also does not integrate supply and demand forces in the natural gas market and, therefore, does not indicate whether the assumed market clearing price is sustainable. Recent gas market behavior indicates that gas consumption (demand) may not support the production levels suggested in the Shell study. Price-induced changes in gas consumption (that is, the marketability of gas) are also important in determining the level of exploratory and development drilling and, therefore, the additions to proven reserves. Estimation of a market clearing price based on natural gas supply and demand is probably not possible given the nature of producer/purchaser contracts and the current regulatory structure that impedes demand adjustment feedbacks to wellhead markets. Nonetheless, econometric analysis of natural gas demand and drilling activities can be used to suggest whether estimated price levels under various policy options lead to any imbalances between supply and demand.

Oil Imports

The calculation of the cost of oil imports under each proposal in the Shell study does not consider interfuel substitutions and gas demand adjustments to changes in gas prices and accessibility. The net effect of decontrol on oil imports would be the result of two opposing factors--increased demand for oil (because gas is more expensive) and the reduced demand for oil because of improved accessibility to gas. CBO has found (in the previously mentioned CBO study) that the net effect is a very small increase in petroleum imports. Consequently, when considering the total trade in energy, lower gas imports resulting from increased domestic production under decontrol might be partially offset by higher oil imports.

Timing of the Economic Effects

The estimated increase in cumulative natural gas production from decontrol indicates that additional production from old gas reserves would not become significant until the early 1990s. If that is true, then the decontrol of old gas would not lead to significant additional production from relatively low-cost old gas reserves in the next five to seven years. This suggests that the time path of additional gas production and lower costs of

energy imports should be discounted and presented in real terms. Unfortunately, the Shell study estimates of changes in government revenues and the cost of oil imports are presented in nominal terms--thus, the results may overstate the benefits of decontrol. This is particularly important because most of the large benefits of decontrol are estimated to occur in the 1990s.

