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CHAPTER 5

U.S. PETROLEUM DEPENDENCY AND OIL PRICE DECONTROL

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INTRODUCTION

DURING THE PAST DECADE, dependency on foreign sources of petroleum has become one of the most salient problems for governments in industrial societies. In the United States, concern over the level of petroleum imports and increased petroleum prices has contributed to intense political debates over energy policies. Two concrete examples of changes resulting from this debate are the establishment of a cabinet-level department for energy matters and the initiation of a stockpiling program called the "strategic petroleum reserve." A third example, the deregulation of domestic petroleum prices, is the subject of this study.

Deregulation of petroleum prices is important not only because of its intended effect on imports of petroleum, but also because it is an item in the debate over the desirability of the use of government regulation in regard to energy. While many citizens accept the need for government regulation to protect against market failures, or against the normal operation of the market where endowments are highly unequal, there is still plenty of controversy over the type and extent of regulation that is really necessary or desirable. One characteristic of the recent debate has been to focus on the potential benefits of deregulation, especially in industries where regulation may have been imposed in such a way as to reduce competition or innovation. Thus, in the late 1970s, a number of proposals for deregulation were put

forth for airlines, trucking, telecommunications, and, not least in importance, the domestic prices of petroleum and natural gas.

While there is a growing literature of the effects of deregulation, there are not many rigorous quantitative studies in the energy field of this topic. Part of the problem, of course, is the difficulty of establishing quantitative measures of variables which adequately reflect energy policy and program outcomes. This study will focus only on the effects of the deregulation of petroleum prices on dependency on imported petroleum. The authors might also have examined the effects of deregulation on competitiveness in the petroleum industry or on prices of petroleum products. However, for this article, it is intended simply to present empirical evidence on the relationship between government oil price deregulation and petroleum dependency in the United States.

ENERGY PROBLEMS, ENERGY POLICY, AND PETROLEUM DEPENDENCY

Prior to the 1970s, little attention was paid in the United States to energy problems. America, with approximately one-twentieth of the world's population, was consuming about one-third of the world's energy production. The first significant message on energy by a president of the United States was delivered in 1971 when Richard M. Nixon warned that the energy supply could no longer be taken for granted. At that time there was no comprehensive official energy policy and not many individuals felt the need for one. Certainly there was no widespread perception before the 1970s that the country had a serious problem of dependency on foreign oil.

Things began to change in 1973. The oil embargo by Arab members of the Organization of Petroleum Exporting Countries in October of 1973 forced Americans to pay more attention to energy problems. In November 1973 President Nixon proposed Project Independence, which was intended to make the United States self-sufficient in energy by 1980. He asked for

> authority to restrict public and private energy consumption, a national 50-mph speed limit, loosening of environmental protection laws, quick temporary licensing for nuclear power plants, emergency energy allocation and rationing powers, construction of an Alaskan oil pipeline, decontrol of natural gas prices, mass transit improvements, deepwater ports for oil supertankers, increased production from the Naval Petroleum Reserves, a Cabinet-level Department of Energy and Natural Reserves, and a $10 billion research and development program aimed at achieving energy self-sufficiency (Pelham, 1980).

Congress did not give the President most of what he wanted. But it did pass the Emergency Petroleum Allocation Act in 1973, mandating price controls on domestic oil. In January 1974 President Nixon called for a windfall profit tax on energy-producing companies. The Nixon proposals of 1973 and 1974 have provided the basis for most subsequent U.S. energy policy.

American dependence on foreign petroleum increased during the mid-1970s, but Americans were protected from the full cost of imported oil by the price controls. President Gerald R. Ford offered his own energy plan in 1975. He wanted to lift controls on domestic oil, initiate a windfall profit tax on oil companies, establish an Energy Independence Authority with a $100 billion allocation, and create incentives for synthetic fuel production. While Congress would not go along with such strong actions, it did pass the Energy Policy and Conservation Act of 1975.

> Price controls on domestic oil were continued by this major law, with higher price allowed for new discoveries—an incentive to encourage drilling. But the law also gave the President authority to remove or modify oil price controls after June 1, 1979. . . . Other presidential powers also were strengthened: in an emergency, he was authorized to ration gasoline or mandate other conservation steps. Automobiles were required to meet fuel economy standards set in the law. Also required was establishment of a national stockpile of petroleum, called a strategic petroleum reserve (Pelham, 1980).

However, President Ford left office without obtaining approval of the right to create higher fuel prices through import fees and price decontrol, matters that were at the heart of his energy plan.

President Jimmy Carter assigned a high priority to energy policy when he assumed office in 1977. Nevertheless, dependence on foreign petroleum hit new highs in 1977, reaching 53 percent during two different months. In April 1977, three months after taking office, President Carter sent a tough energy plan to Congress that would "raise gasoline taxes, increase the price of domestic crude oil through taxes and revamp electric rate making" (Pelham, 1978a). A major concern was the need to cut back oil imports. The Congress again failed to give a president the requested strong measures. When a bill did get through Congress in 1978, it gradually decontrolled prices of natural gas and attempted to stimulate conversion to coal. However, the President's idea of raising petroleum prices was not approved. Dependency on foreign petroleum continued to be a major problem for the United States.

The Carter Administration had long believed in "raising domestic oil prices to world market levels as a way of curbing oil imports" (Pelham, 1978b). Indeed the President promised world leaders at the Bonn economic summit in July of 1978 that he was committed to such action to help alleviate the U.S. trade problem. Accordingly, in April 1979, President Carter indicated that he was trying a market solution through a gradual end to controls on domestic oil prices. He decided to implement the controversial price decontrol strategy not with new congressional legislation, but with pricing authority he was to inherit on June 1, 1979 under the Energy Policy and Conservation Act of 1975. The major goal of his action was to reduce U.S. dependence on foreign petroleum. The decision meant that U.S. oil

price controls were being lifted gradually, with full decontrol taking effect on October 1, 1981. The new policy was being implemented gradually over a 28-month period in an attempt to avoid shocking the market.

Control of domestic oil prices had begun in 1971 when President Nixon imposed general wage and price controls. Congress had continued domestic oil price controls with the Emergency Petroleum Allocation Act of 1973. In various ways Presidents Nixon, Ford, and Carter had attempted subsequently to convince Congress to raise domestic oil prices. All efforts were to no avail. Now President Carter was trying a market solution. He believed that low oil prices encouraged consumption instead of conservation. According to the President, letting the market force up oil prices would encourage conservation and domestic oil production and reduce U.S. petroleum dependency.

American dependence on foreign oil began to decline as the Carter gradual price decontrol plan went into effect. On January 28, 1981, eight days after taking office and twenty months after the start of the Carter gradual oil price decontrol program, President Ronald Reagan abolished all petroleum price controls by executive order. He reasoned that immediate oil price decontrol would stimulate both energy production and conservation and reduce the importation of foreign oil. The oil price controls would have expired on October 1, 1981 without Reagan's action. Less than 25 percent of domestically produced oil remained under government regulation at the time of the decision by Reagan. The President believed that, among other things, immediate total decontrol of domestic oil prices would alleviate industry fears that price controls would not be phased out.

OIL PRICE DECONTROL HYPOTHESES

Did the decontrol of oil prices result in a reduction of U.S. dependency on foreign oil? In an attempt to answer this question, the analysis will focus on the impact on petroleum dependency of President Carter's gradual decontrol of oil prices, which began on June 1, 1979, and President Reagan's total decontrol of oil prices, which took place on January 28, 1981.

With regard to Carter's action, the expectation is that over time the dependency of the United States on foreign petroleum will decrease if the decontrol of oil prices had an impact. Accordingly, the first hypothesis is:

H_1: The oil price decontrol program initiated by President Jimmy Carter on July 1, 1979 (I_1) resulted in a decrease in the dependency of the United States on foreign petroleum (Y).

Hence the independent variable (I_1) is the Carter oil price decontrol program initiated on June 1, 1979, and the dependent variable (Y) is United States dependency on foreign oil.

The expectation in regard to the Reagan action is that the dependency of the United States on foreign petroleum will decrease abruptly as a result of the sudden and total decontrol of oil prices. The second hypothesis is:

H_2: The oil price decontrol action by President Ronald Reagan on January 28, 1981 (I_2) resulted in a decrease in the dependency of the United States on foreign petroleum (Y).

The independent variable (I_2) is the Reagan oil price decontrol action on January 28, 1981, and the dependent variable (Y) is United States dependency on foreign oil.

HYPOTHESIS TESTING CONSIDERATIONS

The research orientation employed for empirical examination of the hypotheses falls within the tradition of the evaluation research approach (Hoole, 1978; Cook and Campbell, 1979; Rossi and Freeman, 1982). The most powerful and feasible quasi-experimental design for use in this study is the interrupted time series design. It is employed along with its well-established methodology.

The operational procedures for the variables are straightforward. The Carter oil price decontrol plan (I_1) went into effect on June 1, 1979. The time prior to June 1, 1979, is considered to be the no-treatment era and time periods falling in that era are given scores of zero for the I_1 variable. The time after that is considered to be the treatment era and time periods falling in it are given scores of one for I_1 variable. The Reagan oil price decontrol action (I_2) went into effect on January 28, 1981. The time prior to February 1, 1981, is considered to be the no-treatment era and time periods falling in it are given scores of zero for the I_2 variable. The era after that is considered to be the treatment era and time periods falling in it are given scores of one for the I_2 variable. The dependent variable, U.S. petroleum dependency (Y), was operationalized in terms of volume as:

$$\text{Petroleum Dependency}_t = \frac{\text{Crude Oil Imports} + \text{Net Imports of Refined Petroleum Products}_t}{\text{Petroleum Consumption}_t}$$

The data were collected from public sources on a monthly basis from January of 1976 through December of 1982.[1]

The Box-Jenkins approach (McCleary and Hay, 1980) was employed for the purpose of statistical analysis. Box-Jenkins techniques indicate whether a statistically significant change in the dependent variable takes place after a policy intervention. The orderly behavior of a time series is identified

through development of an ARIMA noise model, to which intervention components are added. We specified our general intervention model in the following manner:

$$Y_t = N_t + w_0 I_{1,t} + \delta_1 \hat{Y}_{t-1} + w_1 I_{2,t} + a_t \quad (1)$$

where: Y is petroleum dependency

N is the ARIMA noise model estimate

I_1 is the intervention time series for the Carter oil price decontrol action, where 0 represents periods before the intervention and 1 represents periods after the intervention

I_2 is the intervention time series for the Reagan oil price decontrol action, where 0 represents periods before the intervention and 1 represents periods after the intervention

$\hat{Y}$ is defined as $Y - N$

w_0 is the abrupt impact parameter for the Carter oil price decontrol action

δ_1 is the gradual impact parameter on the lagged input series Y_{t-1} for the Carter action

w is the abrupt impact parameter for the Reagan oil price decontrol action

a is the error term

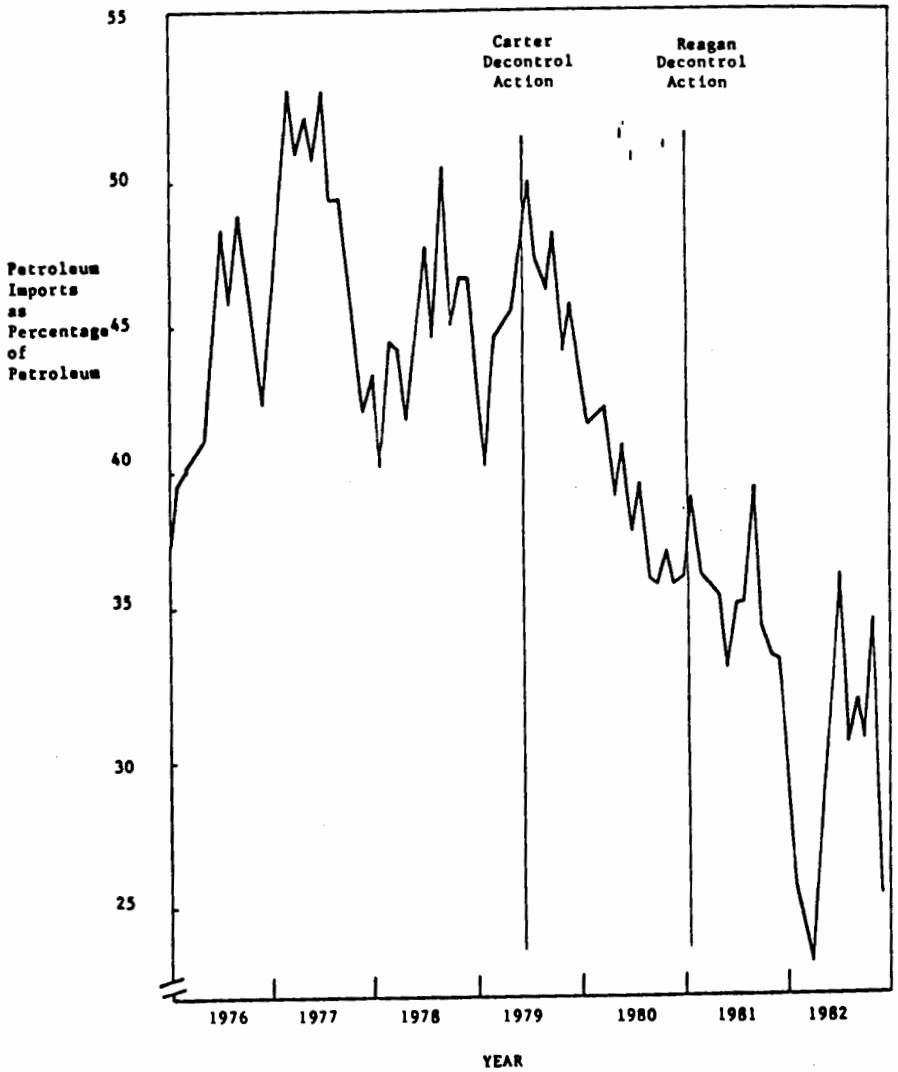
The appropriate ARIMA $(p,d,q)(P,D,Q)_s$ model is developed from data through use of the Box-Jenkins modeling process.

A nonlinear maximum likelihood estimation procedure was selected for use in the analysis.[2] The residuals from the estimated equation were analyzed for higher order autocorrelation using standard Box-Jenkins diagnostic checks and the Q statistic (McCleary and Hay, 1980). The tests of significance of the estimated parameters are based on t tests. The .05 level was used for all tests of significance and confidence limits. The $\bar{R}^2$ value and residual mean square are used as indicators of goodness of fit. The autocorrelation function and partial autocorrelation function and their correlograms are used for identification purposes.

EMPIRICAL FINDINGS

A plot of petroleum dependency data is presented in Figure 5-1. As can be seen, the trend was toward greater petroleum dependency throughout 1976, and a peak was hit in 1977. Furthermore, petroleum dependence remained high through mid-year 1979. A trend downward started soon after the Carter decontrol action, slowing down and almost leveling off for a few months, about the time of the election of Ronald Reagan, and then about a year after the Reagan oil price decontrol action the petroleum dependency data began a period of considerable fluctuation.

Figure 5–1
U.S. Petroleum Dependency



We estimated the autocorrelation and partial autocorrelation functions using the forty-one pre-intervention observations and identified and estimated without problems an ARIMA (1,0,0) model for the petroleum dependency time series. A variety of attempts at overfitting the model confirmed this analysis. Substituting the ARIMA (1,0,0) specification into equation (1) yields the following specific intervention model:

$$Y_t = m + \phi_1 Y_{t-1} + w_0 I_{1,t} + \delta_1 Y_{t-1} + w_1 I_{2,t} + a_t \qquad (2)$$

where: m is the mean
ϕ_1 is the first order autoregressive parameter
Other terms are as defined for equation (1)

This is the model used for empirical evaluation of our hypotheses.

All eighty-four observations were used to estimate the fully specified intervention model. The following parameter estimates were obtained:

$M = 46.56$ with a t statistic of 42.19, which is significant at the .05 level for a two-tailed test

$\phi_1 = .62$ with a t statistic of 6.94, which is significant at the .05 level for a two-tailed test

$\delta_1 = .99$ with a t statistic of 60.54, which is significant at the .05 level for a one-tailed test; the upper and lower 95 percent confidence limits are .96 and 1.03

$w_0 = -.56$ with a t statistic of -2.89, which is significant at the .05 level for a one-tailed test

$w_1 = 2.20$ with a t statistic of 1.83, which is not significant at the .05 level for a one-tailed test

The value of the Q statistic is 27.25 (df = 23), which is not significant at the .05 level. Examination of the autocorrelation function revealed that for the first twenty-five lags only the seventh autocorrelation coefficient exceeds the 95 percent confidence limits. This could occur on the basis of chance and does not appear to be meaningful. Hence, the diagnostic checks on residuals indicate they are not different than white noise. A visual check of the plot of the residuals failed to reveal a problem of heteroscedasticity. The R^2 value is .86 and the residual mean square is 7.07. The bounds of stationarity for an ARIMA (1,0,0) model indicate ϕ_1 must be constrained to the interval $-1 < \phi_1 < +1$. Hence the bounds of stationarity are met. The value of the δ_1 parameter suggests there is no problem of system stability.[3] The diagnostic checks indicate it is appropriate to use the estimated model to test our policy impact hypotheses.

An analysis of the statistical significance of the intervention parameters indicates that both parameters associated with the Carter intervention (W_0 and δ_1) are significant at the .05 level. The Carter action had a statistically significant impact on petroleum dependency. Furthermore, the change is in the hypothesized downward direction. *There is strong support for the first impact hypothesis* (H_1). The w_1 parameter associated with the Reagan intervention is not statistically significant at the .05 level. Furthermore, the positive value of the parameter associated with the Reagan action suggests the statistically insignificant change that was brought about was not in the downward direction intended by President Reagan.[4] *There is lack of support for the second impact hypothesis* (H_2).

DISCUSSION

The evidence suggests that the Carter Administration began deregulation policies which were effective in reducing U.S. petroleum dependency. Indeed, the decision to decontrol petroleum prices was a decision to let the market provide signals to consumers to ration their use of petroleum. The effect of the deregulation of the market was limited somewhat by the reluctance of the Carter Administration to remove all price controls immediately, and by the imposition of a windfall profits tax to make sure that oil firms did not benefit excessively from the upward adjustment of prices. So it cannot be argued that the decontrol of oil prices was equivalent to letting an unregulated market distribute resources. Instead, one should come away from this study with the sense of the relative efficacy of *price signals* in raising or lowering levels of consumption. To the extent that government price controls artificially raised the level of petroleum consumption, they made the United States more dependent than was necessary on imported petroleum and their removal appears to have reversed the dependency trend.

Nevertheless, one should still be a bit tentative in accepting fully the observed results. The study does not argue that oil price decontrol was the only cause for the decline in petroleum dependence, but rather that, as in the case of many historical phenomena, at least part of the decline, and a statistically significant part at that, is attributable to decontrol. Of course, one must remain concerned with the possible impact of parallel forces occurring at the same time as the decontrol policy initiatives. Hence events such as OPEC price increases, supply interruptions such as the one caused by the Iranian revolution, and heightened dependency concerns such as those caused by the Soviet invasion of Afghanistan might also have had an impact on the reduction in U.S. petroleum dependency. Unfortunately, there is no foolproof way of sorting out a series of highly collinear factors such as the ones present in this case. Indeed, an argument can be made that the techniques used are among the most sophisticated currently available for tackling this problem. In this regard, it should be noted that the particular use of the interrupted time-series design allowed a considerable degree of faith in ruling out plausible rival hypotheses; it seems unlikely that without the policy change to deregulation the observed change in the trend would have occurred exactly when it did and have caused the exact observed impact. However, the accumulation of knowledge through additional empirical analyses should shed additional light on matters. It does seem clear that the deregulation explanation is a plausible one that should be retained at this time and used as an explanatory variable in subsequent empirical analyses which attempt to explain petroleum dependency.[5]

The authors make no claim that this study represents the last word on deregulation and energy policy. It is, among other things, an example of how the application of interrupted time-series analysis can help to confirm

or disconfirm hypothesized relationships between policy changes and outcomes. There is obviously room for further research of this general sort. A progression of studies could be developed in a flexible but rigorous fashion so that systematic empirical knowledge regarding the actual impact of government regulation in the energy field is developed in a cumulative fashion. Others would be encouraged to join in an effort to provide a more systematic empirical basis for the understanding of energy policy.

NOTES

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1. The data were collected from the U.S. Department of Energy, *Monthly Energy Review*: October, 1978: 4; December, 1978: 6; May, 1980: 6 and 8; December, 1980: 6 and 8; June, 1981: 6 and 8; May, 1982: 6 and 8; July, 1982: 6 and 8; and February, 1983: 8 and 10. December 1982 is the last month for which data were available when the statistical analyses were begun.

2. The Box-Jenkins computer program (Pack version) was used for the statistical analysis. The work was done at the Wrubel Computing Center of Indiana University.

3. The bounds of system stability dictate that the delta parameter must be greater than zero but less than one ($0 < \delta_1 < +1$). However,

> . . . when $\delta_1 = 1$, the level of the $\dot{Y}_t$ series changes by the quantity w_0 in each postintervention moment.
>
> Prior to the event, when $I_t = 0$, $\dot{Y}_t$ is an ARIMA (0,0,0) process, but when $I_t = 1$, Y_t becomes an ARIMA (0,1,0) process. The interpretation here is that, prior to intervention, the series is trendless, whereas postintervention, the series follows a trend with the parameter w_0 interpreted as the slope.
>
> In its simplest form, the model describes a fixed-level (or stationary) process which, at the moment of intervention, begins to grow [decrease] at a constant rate (McCleary and Hay, 1980).

The estimate of the value of δ_1 is .9944 and it falls between lower and upper 95 percent confidence limits of .96 and 1.03. It seems reasonable to view the δ_1 parameter as having a value of 1.0. It also makes substantive sense to observe a new downward trend in petroleum dependency which begins with the Carter oil price decontrol action.

4. In the interest of completeness additional analyses were conducted. We were worried because the interpretation of the δ_1 parameter is a somewhat rare one and we did not want the results to be a statistical artifact. Accordingly a large number of plausible alternative impact models were tried involving different types and combinations of impacts (abrupt permanent, gradual permanent, and pulse) as well as models employing logs, squares, and differences and different ARIMA specifications. These analyses confirmed the choice of the intervention model discussed above.

5. Increases in OPEC prices and the ensuing recession appear to have had a major impact on petroleum-conserving behaviors. Many Americans switched to more fuel-efficient automobiles, insulated their homes and workplaces, reduced passenger

mileage, and lowered their thermostats. And there was certainly greater anxiety about the potential for disruption in petroleum supplies after the Iranian revolution and after the public began to perceive the degree to which the industrial countries were dependent on the Persian Gulf for imported energy.

On the other hand, the recession, by reducing global demand for energy, also created downward pressures on petroleum prices, creating incentives to use more petroleum rather than less. Also, it is likely that only a small minority of Americans were aware or concerned about dependency on foreign sources of petroleum.

We appear to have here a problem of overdetermination. We would argue that decontrol of prices, because of the nature of our statistical findings, must be included in the list of causes of the reduction in U.S. petroleum imports. We do not deny that there are other possible candidates for that list. However, it should be noted that the methods that were used in establishing the effects of decontrol, notably the building of an ARIMA model for the dependent variable, do take into account systematic effects of other explanations as they manifest themselves in the orderly behavior of the dependent variable through time.

We would be the first to admit that, given our research design, it is difficult to evaluate the confounding events with specificity and it is not possible to estimate whether the decontrol action is effective only within a certain petroleum price range. In future work we hope to examine the multiple effects of decontrol and other variables that might test the durability of the decontrol cause.

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