ornl

OAK RIDGE
NATIONAL
LABORATORY

MARTIN MARIETTA

Oil Vulnerability and Intermediate Price Fluctuations: A Preliminary Assessment and Proposal

T. R. Curlee
D. B. Reister

OAK RIDGE NATIONAL LABORATORY
CENTRAL RESEARCH LIBRARY
CIRCULATION SECTION
4500N ROOM 175
LIBRARY LOAN COPY
DO NOT TRANSFER TO ANOTHER PERSON
If you wish someone else to see this
report, send in name with report and
the library will arrange a loan.

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (615) 576-8401, FTS 626-8401.

Available to the public from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.
NTIS price codes—Printed Copy: A03 Microfiche A01

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

ORNL/TM-11259

OIL VULNERABILITY AND INTERMEDIATE PRICE FLUCTUATIONS: A PRELIMINARY ASSESSMENT AND PROPOSAL

T. Randall Curlee
and
David B. Reister

Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831-6205

Date Published - September 1989

Prepared by the
Oak Ridge National Laboratory
Oak Ridge, Tennessee 37831-6205
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U.S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

MARTIN MARIETTA ENERGY SYSTEMS LIBRARIES

3 4456 0318990 2

TABLE OF CONTENTS

1. INTRODUCTION 1

2. A BRIEF REVIEW OF THE LITERATURE 3

3. THE POSSIBILITIES FOR INTERMEDIATE PRICE SWINGS 7

4. POSSIBLE IMPACTS OF INTERMEDIATE PRICE FLUCTUATIONS 15

5. MITIGATION MEASURES AND INTERMEDIATE PRICE FLUCTUATIONS 17

6. SUGGESTED FUTURE RESEARCH 19

REFERENCES 23

ABSTRACT

Most of the work on oil vulnerability has focused on the implications and appropriate public and private responses to short-term oil price spikes. This report focuses on the possibility that the world oil market is inherently more prone to large intermediate price fluctuations that are often triggered by short-term disturbances.

The purposes of this report are to (1) pose the question of whether large and repeated intermediate price swings are a likely outcome, given our knowledge of the world oil market, (2) address how the effectiveness of policy instruments designed to mitigate the impacts of oil vulnerability may change in a world in which large intermediate oil price fluctuations are expected, and (3) propose future research that would address in greater detail the potential for, and appropriate responses to, large intermediate price swings on the world and domestic oil markets.

The report concludes that there are plausible conceptualizations under which oil prices may fluctuate over the intermediate term. It is suggested that a major focus of future work should be on how the structure of the oil market may itself change over time, causing oil prices to go up and down. The report also concludes that the implications of such price swings may be significant for both the types and quantities of mitigation measures held by the public and private sectors. Finally, it is argued that the current world oil market provides a valuable opportunity for studying how oil prices may fluctuate over the intermediate term and how U.S. energy policies can best be structured to cope with oil vulnerability.

1. INTRODUCTION

The once urgent problem of oil vulnerability has received little attention in recent months due to tumbling world oil prices and a lack of cohesiveness in the Organization of Petroleum Exporting Countries (OPEC). That trend is now reversing, however, as policy makers realize that the resurgence of oil vulnerability is inevitable. Not only are there continued threats of large price increases, but there are potentially serious effects of sudden and large price reductions.

A significant amount of research has been done to assess different public and private responses to large and sudden swings in the price of world oil. And it can be argued that many of the conceptual and empirical questions related to short-term oil price spikes have been answered. However, little attention has been given to the notion -- either conceptually or empirically -- that the world oil market is inherently subject to large intermediate price swings. By intermediate we mean the price swings that occur over a 5 to 10 year period and refer specifically to the oil price changes that have occurred during the past decade.

The purposes of this report are to (1) pose the question of whether large and repeated intermediate price swings are a likely outcome, given our knowledge of the world oil market, (2) address how the effectiveness of policy instruments designed to mitigate the impacts of short-term oil disruptions may change in a world in which large intermediate oil price fluctuations are expected, and (3) propose future research that would address in greater detail the potential for, and appropriate responses to, large intermediate price swings on the world and domestic oil markets.

2. A BRIEF REVIEW OF THE LITERATURE

As a prelude to our discussion of intermediate-term oil price fluctuations, a brief review of the literature on oil vulnerability is in order. For the most part, previous studies of oil vulnerability have focused on the impacts and appropriate responses to short-term oil price spikes. Major emphasis has been given to oil stockpiles.[1] In simple terms, stockpile models have attempted to balance the expected costs of accumulating and maintaining a reserve in non-disruption time periods against the expected benefits of releasing the stockpile during a disruption. The costs and benefits have usually been measured in terms of producer and consumer surplus, and the disruptions themselves have been viewed as short-term, exogenous events. More recently, work has been done to assess the optimal drawdown of oil from the Strategic Petroleum Reserve (SPR) during a disruption.[2] That work, however, has not led to a consensus of opinion, as has generally been the case with the optimal size of the SPR.[3]

A major focus has also been on oil import tariffs or equivalent quotas. Some have argued for a short-term tariff or quota during a disruption that would limit the transfer of wealth to oil exporters by increasing the domestic disruption price above the world market level.[4] These proposals have been criticized, however, on the basis of their political feasibility and their macroeconomic implications.[5] Others have proposed a tariff or quota during normal time periods to in essence force the domestic oil market to prepare for higher oil prices during a disturbance.[6] By forcing the domestic oil market to operate along short-run supply and demand curves that intersect the long-run supply and demand curves at a higher price, much of the surplus losses that occur during a disruption can be avoided by removing the tariff during periods of price spikes. In other words, the imposition of the tariff during normal time periods and the removal of the tariff during price spikes would help to "level out" domestic oil prices over time. The disruption

---

[1]See, for example, Teisberg (1981), Chao and Manne (1982), Kuenne et al., (1975), and Nichols and Zeckhauser (1976).

[2]See, for example, Davarajan and Hubbard (1984), Horwich and Weimer (1984). For assessments of oil drawdowns in an international context, see Hubbard and Weiner (1984), Bohi and Toman (1985 and 1986), and Hubbard, Marquez, and Weiner (1985).

[3]Studies suggest that the optimal SPR size is somewhere in the neighborhood of two billion barrels.

[4]See, for example, Chao and Manne (1982), Hogan (1982 and 1983), Rowen and Weyant (1982), Eckstein and Eichembaum (1985), and Verleger (1982).

[5]The objections are raised in Gilbert and Mork (1982) and Bohi and Montgomery (1982).

[6]See, for example, Nordhaus (1974), Tyner and Wright (1978), Cox and Wright (1975), and Curlee (1981).

benefits must, of course, be balanced against the surplus losses that occur during non-disruption time periods due to the higher domestic oil price. Tariff policies, as well as government stockpiles, have also been considered within a game-theory context, where the imposition and the withdrawal of a tariff or the buildup or drawdown of a stockpile can have strategic implications for oil producers and consumers in their quest for market control.[7]

Some analysts have attempted to examine the interdependencies of different policy instruments.[8] It has been shown, for example, that there are tradeoffs between tariffs, stockpiles, fuel-switching capacity, and surge production capacity; and the optimal set of policies or measures depends on the expected marginal benefits and costs of the different policy instruments over time. Conceptually, fuel-switching and surge production capacity provide benefits by allowing domestic oil suppliers and demanders to adjust to price spikes more quickly than they otherwise could.[9] In addition, adjustments can be made more quickly if new technologies to produce and consume energy are "on the shelf" and available to take advantage of the relative price changes that accompany oil disturbances. Producer and consumer surplus losses, and thus the major costs of oil vulnerability, can be reduced by any mechanism that facilitates adjustments to price changes.

Finally, work has been done to assess the macroeconomic implications of sudden oil price jumps, and policies have been recommended to respond to those jumps.[10] Policies considered include temporary tax reductions, revenue recycling, and monetary changes.

An underlying assumption of many microeconomic and macroeconomic analyses is that the market will not respond to oil price spikes or the threat of those spikes optimally. Externalities in the forms of excessive rents to oil producers due to monopoly power and potentially severe macroeconomic costs have been argued most often as the reason for government intervention. A less used argument has been the lack of contingent commodity markets -- or insurance markets -- that would allow domestic firms and individuals to insure themselves against oil price spikes. This later argument is less persuasive today, given the success of futures markets in oil.

---

[7]Examples include Lantzke (1984) and Hubbard and Weiner 1984).

[8]See, for example, Murphy, Toman, and Weiss (1986). Curlee (1981) examines the tradeoffs between tariffs, stockpiles, fuel-switching capacity, and surge production capacity.

[9]See, for example, Curlee (1981, and 1984a).

[10]For a good review of how various policy instruments may impact on macroeconomic parameters, see Gilbert and Mork (1984). Other works include Pindyck and Rotemberg (1984), Hubbard (1984), Barth and Berk (1984), and Kelman (1984). Mork (1981) contains several papers on the macroeconomic effects and responses to sudden oil price spikes.

The work of the past decade in the study of oil price spikes has therefore been broad. Gaps do, however, exist in the conceptualizations of the problem. More needs to be known about the interrelationships of the different mitigation measures, especially within the constraints imposed by domestic and international political and institutional realities. The costs and benefits of international cooperation among oil importing nations needs further attention, especially with respect to the political feasibility of abiding by agreements such as those of the International Energy Agency.[11] More emphasis needs to be placed on how events in the world and domestic oil markets impact on the expectations of suppliers and demanders in future time periods.[12] Altered price expectations may have significant impacts on domestic exploration and drilling activities and on capital investments in conservation technologies.[13] The appropriate mechanism to draw down oil stocks from the SPR remains a conceptual concern; and the integration of the microeconomic assessments of the problem with the macroeconomic implications of price spikes and the different mitigation measures is not yet complete.[14]

From an empirical perspective, the analysis of oil price spikes continues to be plagued by a severe lack of data -- especially in the areas of fuel-switching capacity, surge production capacity, and the relevant political and institutional constraints at the domestic and international levels.[15] The historical response of private-sector stockpiles of oil to various market conditions has been examined, but the results of those studies vary significantly.[16] The institutional flexibility of the domestic and international markets to price spikes has been largely ignored; and transportation and refining constraints have been examined in only a cursory way.[17] Empirical estimates of short and long-run supply

---

[11]See, for example, Krapels (1980) for a discussion of International Energy Agency Agreements.

[12]Sargent (1985) contains several papers that apply rational expectations theory to several problems related to oil vulnerability.

[13]As discussed further below, the current depressed prices in the oil market offer an excellent opportunity for empirical research in this and other areas.

[14]The most recent attempt at this integration can be found in Murphy, Toman, and Weiss (1986).

[15]Curlee (1984) discusses the lack of information that currently hampers the assessment of our oil vulnerability.

[16]See, for example, Verleger (1982).

[17]See, for example, Hinkle et al. (1983) for an examination of transportation and refining constraints and the crude mix of the SPR. That question is supposedly being reexamined in a current study by the National Petroleum Council. Curlee, Turhollow, and Das (1986) address the general implications of these types of constraints and how different modeling methodologies can be used to address their implications for oil vulnerability.

and demand elasticities and the speed at which markets adjust to oil price changes -- i.e., parameters that are key to the expected costs of price spikes -- remain controversial.[18] Finally, the implications of oil vulnerability for key macroeconomic parameters remains an elusive target for both the domestic and international markets. The macroeconomic implications for developing, oil-importing countries may be particularly important, given the growing percentage of oil going to those countries. The macroeconomic implications for developing oil-exporting countries may also be severe, given those countries' economic and political dependence on oil revenues.

Identifying which and how much of the possible mitigation measures should be "purchased" by our public sector to respond to future oil price spikes is a question that must be reviewed continually. Unfortunately, our current conceptual and empirical inadequacies limit our capabilities to meet this important goal.

---

[18]For an assessment of methodological and empirical issues concerning oil demand elasticities, see Bohi (1981). A good assessment of oil supply elasticities is given in MacAvoy (1982).

3. THE POSSIBILITIES FOR INTERMEDIATE PRICE SWINGS

The work that is reviewed briefly in the above section focuses for the most part on oil price spikes of short duration, usually, but not always, brought on by temporary supply disruptions. And that work has led to some significant -- although not totally complete -- findings about the ways we can prepare for and respond to price spikes.

That work does not, however, consider that world oil prices may be subject to large intermediate price swings, as well as relatively short-term jumps. In fact, if we examine the historical record on oil price changes, we find that past disruptions -- or what may more appropriately be called disturbances, given the rather minor disruptions that occurred -- did not lead to price spikes, but rather led to price jumps that were sustained over the intermediate term. We can refer specifically to the initial 1973-74 price hike that occurred at the time of the so called Arab Oil Embargo and the 1979 Iranian Revolution. The Iran-Iraq War, which led to a disruption of equal or greater size, however, had few implications for world oil prices and therefore oil vulnerability.[19] And the recent declines in oil prices have occurred despite the continued Iran-Iraq War and the attacks on tankers in the Persian Gulf.

The notion thus comes to mind that oil vulnerability is not just a short-term problem, but is also an intermediate problem that has historically been "triggered" by short-term events. When intermediate oil prices are on an upswing, short-term disruptions may accelerate that upswing; and when intermediate oil prices are on a downturn, short-term disruptions may result in few problems.

To discuss this notion more fully, consider oil price changes over three time periods -- the long term, the short term, and the intermediate term. And let us postulate that oil prices are determined by the following sets of factors -- the supply of and demand for oil, which are determined in part by the particular oil market structure; political forces; and institutional factors.[20] While these factors are not mutually exclusive, they represent a convenient parameterization of the forces that influence oil prices in different time periods.

By market structure we mean the degree to which the market is competitive, oligopolistic, or monopolistic. In a competitive market we have many buyers and sellers, none of which is large enough to individually exert any control over market prices. In a monopolistic-monopsonistic market, we have only one buyer and one seller, each of which having control over prices. In an oligopolistic-oligopsonistic market, we have a few buyers and a few sellers, some of which having some, but often varying, control over prices. For

---

[19]See Curlee (1983) for a discussion of the impacts of past disturbances on world oil production and the oil price increases that occurred during those time periods.

[20]Curlee (1985) reviews specific methodologies to forecast oil prices, which are based on these determining factors either singularly or in combination.

each market structure, there will be some corresponding supply and demand structure, which in turn will determine some market price. In the case of a competitive market, the quantity produced and consumed and the equilibrium price are uniquely determined. By contrast, in a bilateral monopoly -- i.e., a monopolist and a monopsonist -- the two sides bargain over quantity and price. The equilibrium price for a particular agreed upon quantity is, however, not uniquely determined and will depend on the bargaining power of the two sides. A movement from one market structure to another, which may simply be a change in bargaining power within a noncompetitive market structure, can result in altered market prices. And in the case of some commodities -- especially those in which there is a potentially large rent component -- the differences in prices can be severe.[21] (The economic rents -- i.e. profits in excess of those provided by alternative investments -- from the production of oil in some countries, such as Saudi Arabia, are very high because of low relative costs of production.)

Political forces include the objectives of both oil producers and consumers that may cause their actions to deviate from what they would be under purely economic criteria. While economists have generally viewed political factors as exogenously determined constraints on the economic objectives of suppliers and demanders, work has been done by other disciplines to directly address these important factors and their impacts on oil prices. For example, Moran (1982) and Satty and Gholamnezhad (1981) have constructed political models of how oil prices are formed. Moran models the political objectives of Saudi Arabia, the assumed OPEC leader. Satty and Gholamnezhad consider the political stability of the Persian Gulf region, the intensity of the Arab-Israeli conflict, and the increased influence of the Soviet Union in the Middle East.

By institutional factors we mean the organization by which oil is traded, transported, refined, and so forth. Two institutional changes currently taking place that have received little attention but could have significant impacts for future oil prices are (1) the transition from an oil market dominated by long-term contracts to one dominated by spot-market sales and (2) the additional control of the world oil market being gained by OPEC countries through vertical integration and evolving sales agreements.[22] Most OPEC oil is currently sold on the spot market or through new sales arrangements, such as the recent "netback deals." And it is estimated that foreign oil producers will soon control about one million barrels per day of refinery capacity in the United States.[23]

---

[21]One of the first papers to consider the different oil price trajectories under varying market structures was Pindyck (1978). That paper did not, however, consider that the structure of the oil market may be inherently unstable.

[22]See Curlee, Turhollow, and Das (1986) for a discussion of these institutional changes and how they may impact on oil vulnerability. Hubbard (1986) reviews and puts forth his own notions about how spot and long-term contract prices impact on the overall world oil price.

[23]See Frazier and Tanner (1986).

Consider the factors that may lead to price changes within the short, intermediate and long terms and the implications of those potential changes for oil vulnerability. Oil vulnerability is really a question of the risk or uncertainty about future oil prices. If suppliers and demanders anticipate price changes correctly and respond accordingly, costs may be incurred when prices change, but those costs will not be preventable. An oil vulnerability problem occurs when suppliers and demanders are faced with price changes grossly outside the range of their expectations or when suppliers and demanders do not or can not prepare for and respond to their price expectations in a way that is optimal for themselves or society. A primary focus of an assessment of oil vulnerability within different time frames must therefore be on the factors that may cause price changes, the potential range of those changes, and the probabilities of those price movements.

Over the long term it is generally argued and accepted that oil prices will increase as resources are depleted. We can fairly safely conclude that 40 years from now real oil prices will be higher than they are today, not because of the political objectives of producers or consumers or institutional factors, but because over the long term purely economic forces will force the real price of any depletable resource to increase. Political and institutional factors will, of course, impact on which market structure will prevail over the long term and therefore which long-term price path will be followed; and the projection of a particular path is an empirical issue. But it can be argued that market structure, political power, and institutional factors are of lesser importance in determining oil prices in the long term as compared to the short or intermediate terms. The results of Pindyck (1978) and Alsmiller et al. (1985) lend support to this argument. In both of these papers long-run price projections are made under different market structures. And in both cases it is shown that for very different market structures -- i.e. OPEC as a cartel and as a competitive producer -- the price of oil converges over the long term of 30 to 40 years. An argument can therefore be made that long-term oil price changes are robust to changes in market structure, political power, and institutional factors. While the uncertainty about how long run oil prices will differ from current prices is great, the sources of that uncertainty are more limited than, as we will see, in the cases of the short and intermediate terms.

In the short term -- by definition a few months to about one year -- the most likely reason for a price spike is some unexpected and sudden change in oil supply or demand that results from a source other than altered market structure, political forces, or institutional factors. A truly temporary supply disruption caused by, for example, a natural disaster at a major transportation center, could result in severe bottlenecks and a temporary price spike. Alternatively, an extremely severe winter could lead to a significant temporary shift in oil demand and thus a price spike. Once the supply bottleneck is corrected or demand subsides, the price of oil should, however, decrease to the old supply-demand balance if none of the other determinants of price are altered. While changes in market structure, political forces, and institutional factors could be short term, history suggests such changes are not likely.

Changes in market structure, political forces, and institutional factors, which in turn impact on world oil supply and demand and on bargaining power, do not usually manifest themselves in the short term, but rather occur over the intermediate term. Consider the

price changes that have occurred during the past two decades. One explanation for those intermediate real price swings is that the underlying market structure of the world oil market -- which is dependent in part on political and institutional variables -- has changed and those changes have persisted over the intermediate term. Political power can help promote the dominance of one or a group of countries within OPEC, as well as coordination and cooperation among the consuming countries. Institutional changes that may make the trading, transportation, and refining of oil less flexible to change may alter the power of producers and consumers and thus pose a vulnerability threat.[24] In this conceptualization, past oil disturbances did not in themselves cause the price changes -- at least in the intermediate term -- but simply triggered and escalated a price movement that was inevitable, given the underlying structural changes that were occurring in the world oil market.[25]

Pindyck (1978) and Alsmiller et al. (1985) have shown that in the intermediate term the world oil price is very sensitive to market structure. For example, Alsmiller et al. project the world oil price in 1983 dollars to be about $41 per barrel in 1990 with OPEC acting as a cartel versus about $32 per barrel with OPEC as a competitive producer. A movement from one market structure to the other over the intermediate term could obviously result in large intermediate price swings. Figure 1 depicts the movement of oil prices in the intermediate term due to movements in market structure from OPEC acting as a cartel to a structure in which OPEC countries act as competitive producers. The figure should be considered illustrative and not representative of any particular price projections.

Structural changes of lesser magnitude are also possible and could result in large price fluctuations. The movement, for example, from a market structure in which Saudi Arabia, with huge oil reserves, is the core of an oligopoly to a structure where Iran, with much smaller reserves, is the core could lead to major production changes and thus significant price fluctuations. Further, collusive market arrangements are inherently unstable over the intermediate term because of the complicated side payments and policing actions that must be made among and taken by colluding producers. The benefits provided by OPEC cooperation must be constantly balanced against the incentives for individual members to cheat.

At a more fundamental level, simple models of the world oil market can be constructed that examine the price impacts of a small but unexpected shift in the world supply of oil. For example, the models included in the Energy Modeling Forum's EMF-6 study and a more recent model by Reister (1987) show that the resulting oil price changes can be both severe and intermediate in duration. These results are based on the assumption that short-run oil supply and demand are significantly more price inelastic than their long-run counterparts and that reaction times of oil suppliers and demanders are

---

[24]See, for example, Curlee, Turhollow, and Das (1986).

[25]Curlee (1983) argues that market structural changes nad a major impact on the severe price changes of the past two decades.

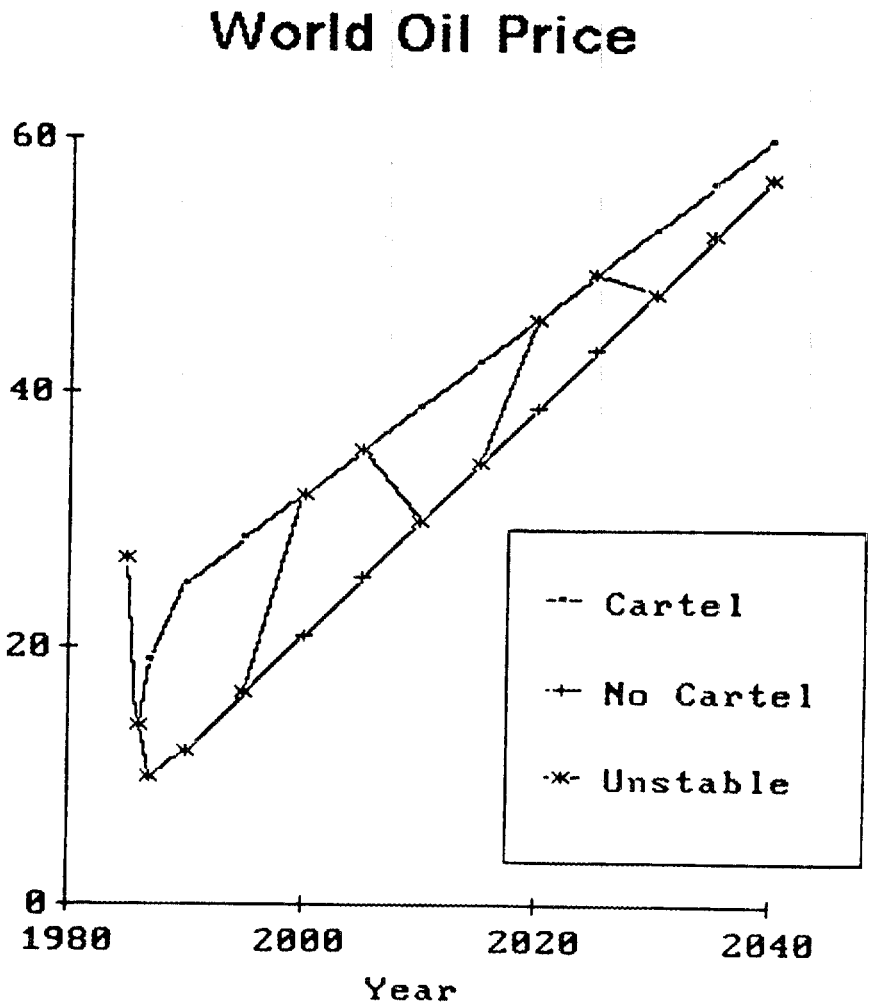

Fig. 1. Price fluctuations due to changes in market structure.

slow relative to other markets. In essence, this argument is based on the notion that any market, when moving from one long-run equilibrium point to another in which supply has been reduced unexpectedly, will first observe prices that are higher than the long-run price. The short-term price increase sparked by the reduction in oil supply -- which may in the case of oil markets become an intermediate price increase because adjustments take place slowly -- are higher because both suppliers and demanders have fixed capital stocks that cannot be adjusted instantaneously. Given an unexpected reduction in supply, suppliers cannot produce all that they want, and demanders must consume more than they otherwise would prefer, thus increasing prices above the long-run level. As demanders and suppliers of oil adjust their capital stocks over the intermediate and long terms, more oil is produced and less oil is consumed, thus resulting in lower oil prices. Figure 2 is taken from Reister (1987) and is a representative assessment of the impacts of oil production changes on real oil prices.

It is argued therefore that the main factors that can cause large oil price movements manifest themselves more in the intermediate term than in the short term. Further, over the long term, oil prices are robust to changes in factors that can promote large intermediate price swings. The problem of oil vulnerability is not simply one of short-term oil spikes, but also one of potential and even likely movements -- both up and down -- in the intermediate price of oil. Measures designed to mitigate the potential damages of oil vulnerability should therefore be designed to cope with severe price swings over the intermediate term, as well as the short term.

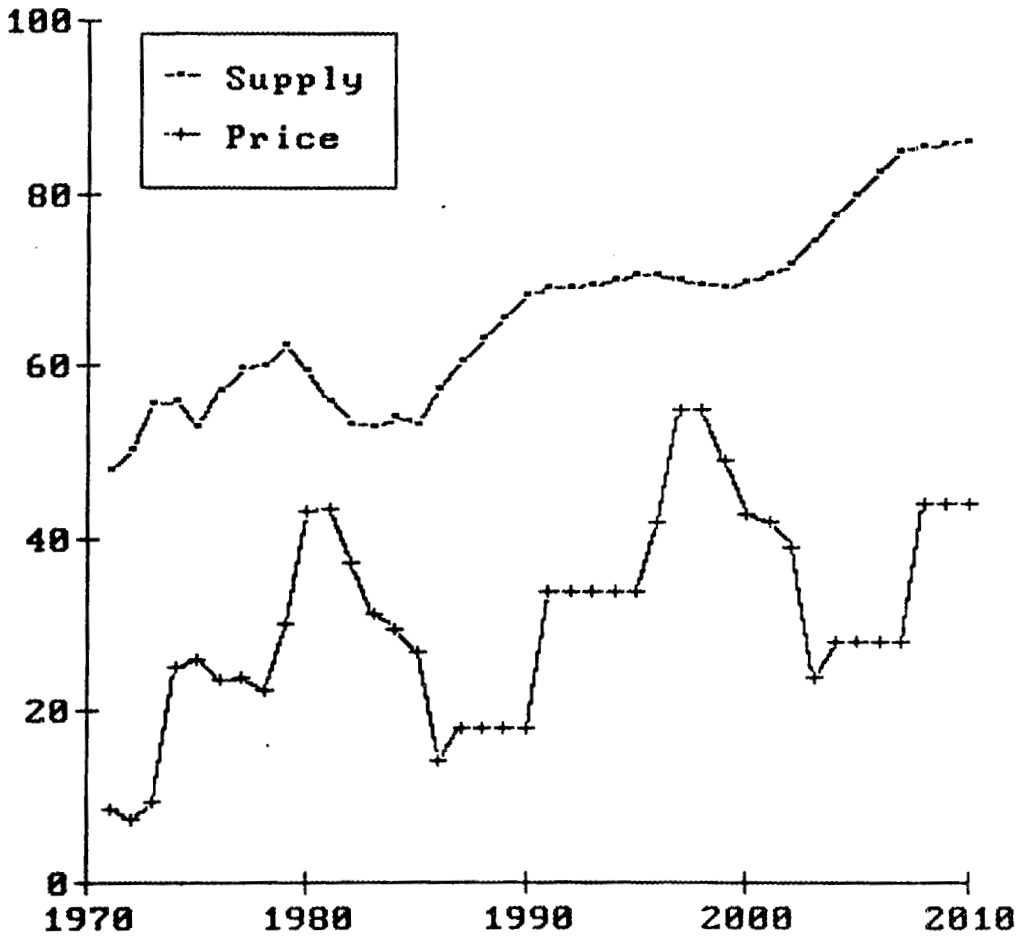

Fig. 2. Supply changes and oil price fluctuations.

Source: Reister (1987).

4. POSSIBLE IMPACTS OF INTERMEDIATE PRICE FLUCTUATIONS

The potential impacts of oil price jumps on microeconomic and macroeconomic parameters have been studied extensively and are discussed briefly in the second section of this paper. The impacts of oil price reductions have, however, received less attention.[26] Transition costs in the forms of depressed domestic energy sectors and the domestic and international financial markets have possibly been higher than many would have anticipated; and the impacts on the increasingly important developing nations remains unclear. While there are obviously winners and losers when oil prices go either up or down, conventional economic wisdom allows us to conclude that in the long run lower energy prices will be good for the domestic economy.

The more important question for our purposes concerns the transition costs of large price swings in the intermediate term. During the down part of the cycle, there may be little emphasis placed on oil exploration, domestic production, conservation technologies, and investments in fuel-switching capacity -- at the expense of potentially large longer-term gains. During the up part of the cycle, too much emphasis may be given to these measures. If the transition costs are large on both the up and down sides and the market does a poor job of anticipating the price fluctuations (which can be argued has been the case during the past two decades), it is conceivable that the overall costs of intermediate price fluctuations could be greater than those of short-term price spikes or a sudden price increase that is maintained over the long term.

The determination of the transition costs of those fluctuations depends on factors such as the short and long-term supply and demand elasticities for oil, the speed at which suppliers and demanders adjust along their long-run curves, and the ways suppliers and demanders form expectations about future prices. It also depends on how macroeconomic parameters are affected by what may continually be unexpected price swings. And while no firm conclusions are possible at this time, the potential impacts of intermediate price fluctuations are of sufficient severity to warrant additional research.

---

[26]The problems posed by lower oil prices have been discussed in several papers contained in Pearce (1983).

5. MITIGATION MEASURES AND INTERMEDIATE PRICE FLUCTUATIONS

If world oil prices are subject to intermediate price fluctuations more than to short-term price spikes, there could be significant implications for the types and quantities of mitigation measures maintained at public expense. Recall that possible mitigation measures include oil stockpiles, tariffs or quotas, surge production capacity, and fuel-switching capacity. Macroeconomic measures include tax revenue recycling, monetary changes, and changes in fiscal expenditures.

The benefits of stockpiles, for example, may be relatively less valuable for intermediate-term price changes than the benefits of surge production and fuel-switching capacities. The relative benefits of an import tariff and the mechanism by which the optimal size of the tariff is determined may also change.

While the conceptual benefits of different mitigation measures will be different in a world dominated by large intermediate price fluctuations rather than short-term price spikes (especially when considered in a game-theoretic framework), the more important implications may be for (1) the empirical estimate of the optimal set of measures to respond to oil vulnerability, and (2) the impacts that price fluctuations may have on private sector actions.

6. SUGGESTED FUTURE RESEARCH

In this section some specific suggestions are made for future research that would help identify (1) the likelihood of intermediate oil price fluctuations and (2) the impacts of those fluctuations on microeconomic and macroeconomic variables and on the mitigation measures that have been suggested, and to some extent, implemented to respond to the continued threat of oil vulnerability. Suggestions for future research can be divided into the further study of conceptual and empirical issues.

From a conceptual perspective, more work is needed to suggest the likelihood that the price of world oil will fluctuate over the intermediate term because of changes in market structure or changes in political or institutional factors. Do the political and institutional changes within and among oil exporting and importing countries cause the market structure, and thus the price, to be unstable over the intermediate term; or do we expect large price fluctuations even within a constant market structure?

Can we identify key parameters that would suggest when swings in price may occur or, alternatively, when the relative balance of power among the players in the world oil market is changing? What role do price expectations play on domestic supply and demand for oil and on privately held mitigation measures? Can we identify in a conceptual sense how price fluctuations may impact on key macroeconomic parameters and suggest ways to mitigate those impacts?

Finally, can we suggest how the relative costs and benefits of generally accepted mitigation measures change in a world in which intermediate price fluctuations are the expected outcome? Changes may occur not only in which and how much of the individual measures should be held, but also in how the mitigation measures should be used, given the point in the price cycle at which the measures are needed. In other words, do the relative marginal costs and benefits of the different measures depend significantly on key market parameters that may in turn suggest that the world oil market is poised for either an intermediate price increase or intermediate price decrease? The past research on oil vulnerability should be reexamined within the context of intermediate price fluctuations, in addition to short-term price spikes.

From an empirical perspective there are a host of interesting issues that warrant additional attention. First is an empirical assessment of the factors -- market, institutional, and political -- that have contributed to the recent price reduction. Do these factors appear to be unique, or do they appear to be more cyclical in nature? If we can identify these factors, can we track them over time, given our current data sources, to suggest the direction in which intermediate prices may be going?

Second, what are the impacts of the current price reduction on domestic and world oil supply and demand and on privately-held mitigation measures. The current price decrease offers a unique opportunity to study how markets respond on the down side. Information that could be collected and analyzed during this time period would be invaluable in terms of assessing short-term supply and demand elasticities and the speed

at which suppliers and demanders adjust along their long-run curves. Significant insights could also be gained into the private sector's stockpiling behavior and incentives to hold surge production capacity and fuel-switching capacity. The recent price reduction also offers unique opportunities for studying domestic and international exploration and drilling activities.

Third, additional work is needed to study the impacts of the recent price reductions on the long-term supply and demand for oil. In what ways will an intermediate price reduction impact on the expected date at which, for example, unconventional fuels will be available? Given that these sources of energy have a long startup time, how might intermediate price fluctuations affect the economic viability of these alternative fuels?

Fourth, how do the recent price reductions and possibilities for intermediate price swings impact on the economies of oil-importing and oil-exporting developing countries? These questions are not only important to the individual developing countries, but are also crucial to overall world oil market trends. Developing countries continue to claim an increasing share of world oil consumption, and the economic health of developing oil-exporting countries may place significant economic and political pressures on the major oil producers.

Fifth, the infrastructure and institutional factors that affect the flexibility of the market to price changes require continued attention. Little is known of the effects of new trading arrangements, such as netback deals, or the vertical integration of major producers into downstream processing. Infrastructure changes in terms of the transportation network and the capacities and capabilities of domestic and world oil refineries to process crudes of varying qualities into varying product slates may change the flexibility of the market to price changes. The degree to which future changes in the quality of crude oil and the end product mix could impact on oil vulnerability -- in themselves interesting questions -- may depend crucially on these institutional and infrastructure changes.

Finally, more research is needed on how past oil price increases and current oil price reductions have impacted, and are impacting, on the macroeconomy. Recall that a key argument for government intervention to reduce the threat of oil vulnerability is based on the macroeconomic externalities that can occur from oil price changes.

7. CONCLUSIONS

As policy makers and researchers are rediscovering, the issue of oil vulnerability is not dead. The threat of short and intermediate-term price swings remains a realistic possibility with potentially serious microeconomic and macroeconomic implications. The changes that are occurring with respect to the vulnerability threat are not necessarily in magnitude, but rather are in the ways oil prices can fluctuate and how those fluctuations can impose costs on suppliers and demanders of oil.

This report has focused on the possibility that oil prices may fluctuate over the intermediate term and the implications of such fluctuations for mitigation measures designed to respond to price swings. Although more research is needed, the paper concludes that there are plausible conceptualizations under which oil prices may fluctuate over the intermediate term. It is suggested that a major focus of future work should be on how the structure of the oil market may itself change over time, causing oil prices to go up and down. The paper also concludes that the implications for such price swings may be significant for both the types and quantities of mitigation measures held by the public sector. The effects on privately-held measures, such as stockpiles, surge production capacity, and fuel-switching capacity, may be equally great.

Additional work is warranted on both the conceptual and empirical fronts to study the likelihoods and implications of intermediate oil price fluctuations. The recent downturn in oil prices not only adds credence to the notion of intermediate swings, but also offers a unique opportunity to examine empirically the current and potential future implications of intermediate oil price changes.

REFERENCES

Alsmiller, R. G. Jr. 1985. "A Model of the World Oil Market with an OPEC Cartel." Energy 10(10): 1089-102.

Barth, Michael C. and Edwin Berk. 1984. "Economic Response: Administrative Options and Analytical Framework," in Oil Shock: Policy Response and Implementation, ed. by Alvin L. Alm and Robert J. Weiner, Cambridge, Mass.: Ballinger Publishing.

Bohi, Douglas R. 1981. Analyzing Demand Behavior: A Study of Energy Elasticities. Washington, D.C.: Resources for the Future.

Bohi, Douglas R. and W. D. Montgomery. 1982. Oil Prices, Energy Security, and Import Policy. Washington, D.C.: Resources for the Future.

Bohi, Douglas R. and Mike Toman. 1985. "How Might IEA Crisis-Management Programs be Restructured to Better Serve Member Country Interests?" paper presented at the International Association of Energy Economists International Conference, Bonn, Germany, June.

Bohi, Douglas R. and Mike Toman. 1986. "Oil Disruptions and the Role of the International Energy Agency." The Energy Journal 7(2): 211-24.

Chao, H. P. and Alan S. Manne. 1982. "An Integrated Analysis of U.S. Stockpiling Policies," in Energy Vulnerability, edited by James Plummer, 59-82. Cambridge, Mass.: Ballinger Publishing.

Cox, James C. and Arthur W. Wright. 1975. "A Tariff Policy for Independence from Oil Embargoes," National Tax Journal, 28(1): 29-42.

Curlee, T. Randall. 1981. "An Economic Analysis of Optimal Oil Independence," Ph.D. dissertation, Purdue University, West Lafayette, Indiana.

Curlee, T. Randall. 1983. The Impacts of Oil Disturbances: Lessons from Experience, ORNL/TM-8492, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Curlee, T. Randall. 1984a. "Strategic Stockpile Acquisitions and the Current World Oil Market," Energy Policy, 12(2): 216-19.

Curlee, T. Randall. 1984b. "Monitoring the Potential for Future Oil Supply Crises: The Lack of Information," The Journal of Energy and Development, 9(2): 289-97.

Curlee, T. Randall. 1985. "Forecasting World Oil Prices: The Evolution of Modeling Methodologies and Summary of Recent Projections," Materials and Society, 9(4): 413-42.

Curlee, T. Randall, Anthony F. Turhollow, Jr., and Sujit Das. 1988. "Oil Supply Disruption and Modeling Methodologies: The Role of LP Models," Energy Economics, 10(2): 147-54.

Devarajan, S. and R. G. Hubbard. 1984. "Drawing Down the Strategic Petroleum Reserve: The Case for Selling Futures Contracts," in Oil Shock: Policy Response and Implementation, ed. by Alvin L. Alm and Robert J. Weiner, Cambridge, MA.: Ballinger Publishing.

Eckstein, Zvi and Martin S. Eichembaum. 1985. "Oil Supply Disruptions and the Optimal Tariff in a Dynamic Stochastic Equilibrium Model," in Energy Foresight and Strategy, ed. by Thomas J. Sargent, 41-69. Washington, D.C.: Resources for the Future.

Energy Modeling Forum. 1982. "World Oil," EMF Report 6, Stanford University, February.

Frazier, Steve and James Tanner. 1986. "Foreign Oil Producers Buy Refineries in U.S. for Stake in Marketing," Wall Street Journal, April 4, 1.

Gilbert, Richard J. and Knut A. Mork. 1982. "Coping with Oil Supply Disruptions," in Energy Vulnerability, ed. by James Plummer, 149-98. Cambridge, Mass.: Ballinger Publishing.

Hinkle, Jerome, Joseph Tessmer, Arthur Roemer, and George Currie. 1983. "Strategic Petroleum Reserve Crude Mix Reevaluation Assessment," Washington, D.C.: U.S. Department of Energy, Strategic Petroleum Reserve.

Hogan, William W. 1982. "Policies for Oil Importers," in OPEC Behavior and World Oil Prices, ed. by James Griffin and David Teece, 186-203. London: George Allen & Unwin.

Hogan, William W. 1983. "Oil Stockpiling: Help thy Neighbor," The Energy Journal, 4(3): 49-72.

Horwich, George and David Leo Weimer. 1984. Oil Price Shocks, Market Response, and Contingency Planning, Washington, D.C.: American Enterprise Institute.

Hubbard, R. Glenn and Robert J. Weiner. 1984. "Government Stockpiles in a Multi-Country World: Coordination versus Competition," in Oil Shock: Policy Response and Implementation, ed. by Alvin L. Alm and Robert J. Weiner, 197-218. Cambridge, Mass.: Ballinger Publishing.

Hubbard, R. Glenn. 1986. "Supply Shocks and Price Adjustment in the World Oil Market," Quarterly Journal of Economics, 101(1): 85-102.

Hubbard, R. Glenn, J. Marquez, and Robert J. Weiner. 1985. "Oil and the OECD Economies: Measuring Stockpile Coordination Benefits." paper presented at the International Association of Energy Economist, Bonn. June.

Kelman, Steven. 1984. "Revenue Recycling Using Check Writing," in Oil Shock: Policy Response and Implementation, ed. by Alvin L. Alm and Robert J. Weiner, 145-66. Cambridge, Mass.: Ballinger Publishing.

Krapels, Edward N. 1980. Oil Crisis Management: Strategic Stockpiling for International Security, Baltimore: Johns Hopkins University Press.

Kuenne R. E. et al. 1975. "A Policy to Protect the U.S. Against Oil Embargoes," Policy Analysis, 1(2): 571-97.

Lantzke, Ulf. 1984. "The Role of International Cooperation," in Oil Shock: Policy Response and Implementation, ed. by Alvin L. Alm and Robert J. Weiner, 77-96, Cambridge, Mass.: Ballinger Publishing.

MacAvoy, Paul W. 1982. Crude Oil Prices As Determined by OPEC and Market Fundamentals, Cambridge, Mass.: Ballinger Publishing.

Manne, Alan S., Leo Schrattenholzer, and Jennifer L. Rowley. 1986. "International Energy Workshop: Oil Price Projections," The Energy Journal, 7(3): 109-14.

Moran, Theodore. 1982. "Modeling OPEC Behavior: Economic and Political Alternatives," in OPEC Behavior and World Oil Prices, ed. by James M Griffin and David J. Teese, George Allen and Urwin, London, 94-130.

Mork, Knut A. 1981. Energy Prices, Inflation, and Economic Activity, Cambridge, Mass.: Ballinger Publishing.

Murphy, Frederic H., Michael A. Toman, and Howard J. Weiss. 1986. "An Integrated Analysis of U.S. Oil Security Policies," The Energy Journal, 7(3): 67-82.

Nichols, Albert L. and Richard J. Zeckhauser. 1976. "Stockpiling Strategies and Cartel Prices," Bell Journal of Economics, 8(1): 66-96.

Nordhaus, William D. 1974. "The 1974 Report of the President's Council of Economic Advisers: Energy in the Economic Report," American Economic Review, 64(4): 556-65.

Pearce, Joan. 1983. The Third Oil Shock: The Effects of Lower Oil Prices, London: The Royal Institute of Economic Affairs.

Pindyck, Robert S. 1978. "Gains to Producers from the Cartelization of Exhaustible Resources," Review of Economics and Statistics, 60(2): 238-51.

Pindyck, Robert S. and Julio J. Rotemberg. 1984. "Energy Shocks and the Macroeconomy," in Oil Shock: Policy Response and Implementation, ed. by Alvin L. Alm and Robert J. Weiner, 97-120. Cambridge, Mass.: Ballinger Publishing.

Reister, David B. 1987. A Simple Model of Oil Supply Disruptions, draft ORNL-TM, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Rowen, H. and J. Weyant. 1981. "Oil and National Security: An Integrated Program for Surviving an Oil Crisis," Annual Review of Energy, (6): 171-98.

Sargent, Thomas J. 1985. Energy Foresight and Strategy, Washington, D.C.: Resources for the Future.

Satty, Thomas J. and A. H. Gholamnezhad. 1981. "Oil Prices: 1985 and 1990," Energy Systems and Policy, 5(4): 303-18.

Teisberg, Thomas J. 1981. "A Dynamic Programming Model of the U.S. Strategic Petroleum Reserve," The Bell Journal of Economics, 12(2): 526-46.

Tyner, Wallace E. and Arthur W. Wright. 1978. "U.S. Energy Policy and Oil Independence: A Critique and a Proposal," Materials and Society, 2(1/2): 15-22.

Verleger, Philip K., Jr. 1982. Oil Markets in Turmoil, Cambridge, Mass.: Ballinger Publishing.

INTERNAL DISTRIBUTION

1. D. J. Bjornstad
2. B. L. Bush
3. L. M. Cochran
4-18. T. R. Curlee
5. S. C. Davis
6. W. Fulkerson
7. M. Gettings
8. G. R. Hadder
9. E. L. Hillsman
10. R. B. Honea
11. D. W. Jones
12. R. Lee
13. P. N. Leiby
14. C. H. Petrich
15. D. E. Reichle
16-30. D. B. Reister
31. E. Rogers
32. M Schoepfle
33. D. P. Vogt
34. ORNL Patent Office
35. Central Research Library
36. Document Reference Section
37-39. Laboratory Records (3 copies)
40. Laboratory Records (Record copy)

EXTERNAL DISTRIBUTION

41. J. J. Cuttica, Vice President of Research and Development, Gas Research Institute, 8600 W. Bryn Mawr Avenue, Chicago, IL 60631
42. J. P. Kalt, Professor of Economics, Kennedy School of Government, Harvard University, 79 John F. Kennedy Street, Cambridge, MA 02138
43. D. E. Morrison, Professor of Sociology, Michigan State University, 201 Berkey Hall, East Lansing, MI 48824-1111
44. R. L. Perrine, Professor, Engineering and Applied Sciences, Civil Engineering Department, Engineering I, Room 2066, University of California, Los Angeles, CA 90024
45. Office of Assistant Manager for Energy Research and Development, DOE/ORO, P.O. Box 2001, Oak Ridge, TN 37831-8600.

46-55. OSTI, U.S. Department of Energy, P.O. Box 62, Oak Ridge, TN 37831