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In Search of the "Just" U.S. Oil Policy: A Review of Arrow and Kalt and More

U.S. oil policy has sought a Faustian bargain of benefiting U.S. consumers at the expense of increasing U.S. crude-oil imports. United States consumer benefits are financed from a portion of U.S. producer gains from OPEC cartelization, an income transfer justified by "equity considerations." Arrow and Kalt stress that U.S. oil policy has also created deadweight losses from the misallocation of U.S. resources. They develop a method of trading off the equity and efficiency aspects of oil policy and conclude that deregulation of the industry is the best U.S. policy option. I derive the optimum price control policy indicated by their analysis. I also extend the economic analysis to consider how U.S. oil policy has affected OPEC pricing strategy, the cornerstone of the case for decontrol. I also consider the wisdom of neoclassical optimum tariff policies.

Gosh, justly redistributing income is tricky business. [MONTY PYTHON]

In December 1979, the Carter administration and the Congress were embroiled in debate about the administration's "new energy policy." To reduce U.S. imports of foreign oil, President Carter was invoking his statutory authority to remove gradually existing price control regulations on U.S. crude oil. To lessen the perceived "equity" problems of decontrol, the administration submitted to Congress legislation that politically tied the gradual elimination of price controls to the levying of a "windfall profits" tax. Within this political environment, the American Enterprise Institute released a pamphlet by Kenneth Arrow and Joseph Kalt (December 1979) entitled "Petroleum Price Regulation: Should We Decontrol?" (p. 47). Given the political issues at that time, the authors mysteriously addressed only the economic wisdom of either reversing the presidential intention of decontrolling the industry or pursuing immediate decontrol. Comparing the cases for immediate instead of gradual decontrol was not explicitly undertaken. Most ironic was the authors' complete silence on what their economic analysis implied for the wisdom of levying the then-contemplated and now-implemented windfall profits tax.

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Notwithstanding the poor focus on the extant policy issues, the Arrow and Kalt study is an excellent summary of the key economic issues surrounding petroleum price regulation. As much of new energy policy revolves around the wisdom of dismantling old policies, their study correctly concentrates on the economic effects of past price controls. The authors elegantly identify the efficiency and popularly viewed equity aspects of petroleum price regulation and highlight how standard cost-benefit analysis can indeed combine efficiency and distribution considerations of a policy choice in developing a logically consistent policy recommendation. Their discussion concludes that immediate decontrol generates efficiency gains larger than the equity losses suffered by virtually any of the usual standards of social justice. To the extent that a windfall profits tax could further ameliorate the equity problems (without unduly sacrificing the efficiency gains of decontrol), the authors conclude that coupling immediate decontrol with such a windfall profits tax would be the most preferable policy option of all. The least desirable policy action would be the reversal of the president's current deregulation plans.

The authors' most novel and important contribution is their attempt to balance the efficiency and equity dimensions of petroleum price regulation. In defining the efficiency and equity issues, they first characterize the effect of existing regulation on market forces by deriving the equivalent taxes and subsidies summarizing how the various regulations have influenced May 1979 U.S. demand-and-supply conditions. Using standard applied welfare analysis, the authors then estimate the efficiency effects of these taxes and subsidies by assigning values to the key demand-and-supply elasticities. Finally, the distributive effects of regulation are computed by employing assumptions on how the taxes and subsidies influenced uncontrolled U.S. prices for crude oil and refined products. As their methodology follows an earlier paper by Hall and Pindyck (1977), my comments on this portion of the study will be confined to discussing technical issues. I also extend the analytical exercise to include the key issue of regulation which the authors choose not to include in their systematic analysis: the relationship between U.S. petroleum regulation and OPEC pricing policies. Below I show that the effect of U.S. regulation on OPEC pricing strategy must dominate the economic analysis of optimal U.S. policy from virtually any viewpoint of the goals of U.S. energy policy.

Armed with estimates of the dimensions of the efficiency and equity aspects of regulation, the authors then successfully show how various viewpoints on social justice would logically view the choice on decontrolling oil prices. Five standards are discussed: efficiency-based standards, voluntarism in exchange, horizontal equity, regional equity, and vertical equity according to the neoclassical tradition of relating optimal income redistribution to diminishing marginal utility of income. As

I argue below, the most interesting and relevant social standard is the discussion relating to vertical equity. I show that the authors' weighting of equity versus efficiency considerations is remarkably robust to empirically relevant variations in the assigned value to the key parameter: the rate at which the marginal utility of income declines with income.

I also will show that the implicit standard of policymaking when considering vertical equity leads to a much different ranking of policy options than the authors themselves argued if the economic effects of controls are as assumed by the authors. Given their methodology, the following list ranks the various options in descending order of desirability: (1) extensive modification but continuation of controls; (2) immediate decontrol without the actual windfall profits tax; (3) gradual decontrol without the actual windfall profits tax; (4) reversal of President Carter's decontrol plans, thereby keeping existing controls intact; (5) immediate decontrol with the actual windfall profits tax; and (6) gradual decontrol with the actual windfall profits tax. The authors mistakenly concluded that their economic analysis supports decontrolling the U.S. oil industry. Note that recent political developments have forsaken the fourth best policy in favor of the worst policy option from the viewpoint of a standard of social justice based upon vertical equity, given the assumptions used by Arrow and Kalt in summarizing the economic effects of existing controls. My concluding section (V) offers some comments on why the political process continues to spurn the "just" solution to petroleum price regulation.

The first four sections of this essay contain the core of the analysis. Sections I and II, respectively, discuss the estimates of the effect of regulation on national income and its distribution. Section III considers the ranking of policy options according to the methods employed by Arrow and Kalt. Section IV shows that the case for decontrol ultimately revolves around the interaction between OPEC pricing policies and U.S. oil policy. I also apply standard optimum tariff theory to the U.S. petroleum situation. Despite potentially significant U.S. monopsony power, the U.S. importing position in refined products greatly diminishes the extent to which the U.S. can beneficially exploit its monopsony power in world crude-oil markets. As the Arrow and Kalt study contains virtually no empirical work, my comments primarily consider the logical and analytical tools employed by the authors.

I. Oil Regulation and U.S. National Income

Crude-oil price controls, of course, levy a shadow tax on U.S. crude-oil production. The magnitude of the tax is the difference between uncontrolled and controlled prices. Ignoring intertemporal considerations in petroleum supply, the authors apparently estimate the effects of price controls on the crude-oil supply sector by assuming a linear supply curve. Taking into account the variety of price ceilings operating under existing price control regulation, the authors compute that price controls reduced U.S. oil output in May 1979 by an annual rate of 650 million barrels per year. This reduced output was replaced by increased oil imports. The deadweight loss from this output loss was about $2.0 billion per year. While not discussed by Arrow and Kalt, this income loss includes the inefficiency in even producing the nation's current rate of output. The multiple tier price ceiling policy does not minimize the costs of production for any given aggregate level of industry output. Production from the most stringently controlled properties (called lower tier) had marginal costs around $6.50/barrel, and production from less stringently controlled properties (called upper tier) had marginal costs of around $14/barrel. Section III shows that overcoming this inefficiency is a key aspect of "optimal reform." In that the authors' estimation procedure ignores existing distortions from state government severance taxation and the corporation income tax, the estimated income loss can be reasonably viewed as a lower bound on the true loss—given their assumptions about U.S. oil supply and constant uncontrolled oil prices.

Regulation also generated a distortion on U.S. oil demand. Refiners were allocated rights to price-controlled oil in proportion to their total use of crude oil. So each refiner found that using an extra barrel of crude oil increased his rights to price-controlled crude oil. In May 1979, this aspect of regulation generated a shadow subsidy of $2.44/barrel on the use of uncontrolled crude oil. Under the authors' assumption about the elasticity of U.S. refiners' demand for crude oil, this aspect of regulation was estimated to increase U.S. demand (at the initial uncontrolled crude oil price) by 375 million barrels per year. This increased U.S. oil demand would be satisfied by additional crude-oil imports. The deadweight annual loss from this overuse of crude oil was a modest $500 million.

The above demand-and-supply distortions represent the key effects of regulation on U.S. national income identified by the authors' analysis. The estimated effects are dominated by the standard supply-side effects of price controls, which accounted for 80% and 63% of the estimated total national income loss and increased imports of foreign oil, respectively. These analytical exercises certainly provide large estimated effects of regulation. The annual rate of oil imports in May 1979 was just over 3.1 billion barrels, so the authors imply that regulation has increased U.S. oil imports by about 50%.

While the authors note that regulation has undoubtedly benefited OPEC, they did not attempt to quantify the effect of regulation on OPEC pricing policy. Instead, their analysis assumed that uncontrolled oil prices were unaffected by price controls. Given that the authors

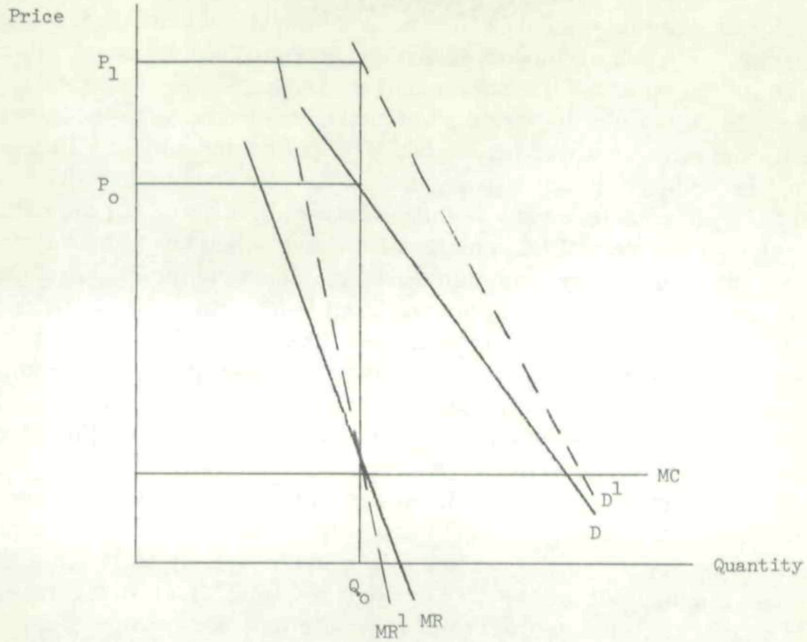

FIG. 1.—U.S. regulation and OPEC pricing policy. D, D^1 = pre- and post-U.S. regulation demand for OPEC oil; MR, MR^1 = pre- and post-U.S. regulation marginal revenue schedule; MC = OPEC marginal cost schedule; P_o, P_1 = pre- and post-U.S. regulation world oil price; and Q_o = OPEC output.

repeatedly stress analytical exercises in their pamphlet, I found their reluctance on this issue difficult to understand. I present my own analytical exercise, in an effort to show the reader the economic importance of regulation's effect on OPEC incentives to further increase world oil prices. As shown in Section IV, resolving the relationship between U.S. regulation and OPEC oil pricing occupies the cornerstone in determining the optimum oil policy from the viewpoint of various standards of social justice.

Figure 1 presents the effect of U.S. regulation on world crude-oil prices. There were two economic effects on OPEC crude-oil pricing strategy, both implying higher oil prices. As shown in Section IV, both of these forces critically influence the design of optimal U.S. oil policy. First, an increased U.S. import demand would likewise increase the market demand facing OPEC. According to the authors' estimate, the magnitude of the shift at the preregulation price, P_o, was just over 1 billion barrels per year. Second, U.S. regulation reduced the elasticity of the demand for OPEC oil. Oil price controls reduced the supply response of the U.S. production sector because higher world market prices were not allowed to stimulate additional U.S. production activity.[1] Furthermore, regulation also reduced the elasticity of U.S. refiner demand for crude oil because higher uncontrolled crude-oil prices increase the benefits U.S. refiners enjoy from expanding their total use of crude oil in order to obtain additional rights to the larger economic rent from price-controlled crude oil.[2] The shift in demand for OPEC oil and the reduced price responsiveness had an ambiguous effect on OPEC's marginal revenue schedule. Smith and Phelps (1980) show that regulation reduced OPEC's marginal revenue schedule, as long as the (absolute value of) preregulation elasticity of demand for OPEC oil was less than 2.2. Under the authors' assumption about U.S. elasticities, OPEC demand elasticity was -1.1 (see Appendix). Thus U.S. regulation would be expected to have actually lowered OPEC's marginal revenue schedule. For simplicity, the figure shows that the marginal revenue of preregulation output is the same before and after the imposition of U.S. price controls.

The key issue is whether OPEC is operating as an effective dominant firm in world crude-oil markets or as some other organizational form. For simplicity, I use the dominant-firm model merely to indicate the possible magnitude of the OPEC price response to U.S. regulation. Other models could be used to provide alternative estimates. Figure 1 depicts the solution. Using the authors' assumption about the elasticity of crude-oil demand and supply and their estimated increase in quantity demanded for OPEC oil at preregulation crude-oil prices, the dominant-firm model predicts that U.S. regulation increased world crude-oil prices by about $2.23 per barrel (see Appendix).[3] Thus without U.S. oil price regulation, foreign crude-oil prices would have averaged $16.73/barrel instead of their actual level of $18.96/barrel in May 1979. Given actual U.S. import levels of crude oil, regulation's adverse effect on the oil import price generated at least an additional $4.9 billion per year loss in national income.[4] So Arrow and Kalt certainly underestimated the national income loss from regulation by only concentrating on the deadweight losses from the misallocation of resources. Analytical exercises indicate that the income loss from higher world oil

1. The possibility of deferring production to future periods of higher prices from deregulation actually generates a negative supply elasticity for price-controlled crude oil. See Smith and Phelps (1978) for a theoretical discussion and empirical evidence. So assuming that regulation reduces the supply elasticity to zero is a conservative assumption.

2. U.S. refiner demand for crude oil becomes less elastic by a factor of 50%–70% (see Smith and Phelps 1980).

3. This analytical exercise yields a conclusion comparable with results of direct statistical analysis of the relationship between regulation and uncontrolled U.S. oil prices. Smith and Phelps (1980) estimate that U.S. regulation increased U.S. oil prices by about $0.90/barrel (1967 dollars) during 1976–77.

4. This income loss is an understatement because it ignores two sources of additional loss: (1) second-order income loss from higher oil prices, and (2) ignores the national income loss from the higher world prices paid for U.S. imports of refined products.

prices could easily exceed their deadweight losses. One view of this conclusion is that if Arrow and Kalt can make their case for decontrol without considering regulation's adverse effect on OPEC pricing strategy, then they would have a conservative case for decontrol. Section III shows that the policy discussion (on their terms of analysis) does not enjoy this luxury.

Given the prospect that regulation has significantly increased uncontrolled crude-oil prices, the Arrow/Kalt estimates of the deadweight losses from regulation are likely to be "too high." The estimates of deadweight losses are based upon the difference between prevailing uncontrolled and controlled oil prices. That wedge exceeds the difference between uncontrolled prices without regulation and controlled oil prices by the amount regulation increased crude-oil prices.

I conclude this section with some observations on policy issues not explicitly addressed by the authors, even though these are key considerations in addressing petroleum regulation. I discuss the sacrificed efficiency in the U.S. oil production sector from the standpoint of coupling the actual windfall profits tax with decontrol and the adoption of gradual instead of immediate decontrol.

My discussion of the windfall profits tax will adopt the assumption that regulation has not affected world oil prices (a popular assumption among analysts). Despite its myriad of exemptions and special categories, the windfall profits tax is best viewed as an ad valorem excise tax (T_i) on the price increases allowed under decontrol. Decontrol without the tax would allow producers to receive the uncontrolled price, P_m, instead of the controlled price, P_c. The windfall profits tax mutes the price increase to be $(P_m - P_c)(1 - T_i)$. So the gain in national income (G) from decontrol, removing the supply distortions, falls from the quantity in equation (1) to the quantity given by equation (2).

$$G(\text{no tax}) = .5b_s(P_m - P_c)^2, \tag{1}$$

$$G(\text{with tax}) = .5b_s(P_m - P_c)^2(1 - T_i)^2, \tag{2}$$

where b_s is the price slope of the U.S. oil supply curve. Thus the imposition of the windfall tax reduces the efficiency gains from decontrol to only a fraction, $(1 - T_i)^2$, of the benefits of decontrol without the tax. While the actual magnitude of the tax depends upon the category of property (with rates ranging from 30% to 70%), I assume that the average effective tax rate will be the most common rate: 50%. The windfall profits tax reduces by 75% the Arrow/Kalt estimate of how decontrol improves the efficiency of the U.S. oil production sector.

Meanwhile, the adoption of gradual instead of immediate decontrol produces a double whammy in terms of reduced efficiency of the U.S. crude-oil production sector. First, gradual decontrol defers the gains from immediate decontrol. Second, gradual decontrol influences the extraction path from U.S. reserves. Given the current disparity between uncontrolled and controlled oil prices, there is a substantial economic incentive for withholding production until prices are deregulated by mid-1981 (if indeed the president follows his plan). Assuming that real uncontrolled prices remain constant, the annual real rate of return from withholding production would easily exceed 30%.[5] To the extent that crude-oil producers respond to this attractive investment prospect, there will be inefficient production paths from U.S. reserves. This inefficiency would be further aggravated if deregulation indeed reduced uncontrolled crude-oil prices. Individually profitable withholding activity would reduce production during regulation's remaining years, when prices would be higher, for increased production in future years when prices would be lower. I personally have no way of assessing the quantitative importance of this consequence from gradual decontrol.

II. Regulation and Equity

As stressed by Arrow and Kalt, equity considerations also play a role in the political economy of decontrol. Certainly U.S. crude-oil producers and any specific labor employed by that sector are losers from existing regulation. So those interests would number among the significant beneficiaries from removing price controls. However, equity considerations imply that the plight of beneficiaries from existing regulation should also be considered.

Arrow and Kalt identify two basic groups benefiting from price controls—U.S. refiners and U.S. consumers. The authors stress two regulatory periods. Under the early days of regulation, U.S. refiners were the sole beneficiaries from price controls as the property rights to controlled crude oil were assigned according to historical contracts. This procedure made the rent received from price-controlled oil a lump-sum transfer. With the introduction of the (entitlement) program reallocating property rights to controlled oil according to use of total crude oil, U.S. consumers were made patrons of the regulatory trough. The same subsidy that generated the excessive use of crude oil by U.S. refiners also increased the U.S. supply of refined products. This in-

5. In May 1979, full deregulation in September 1981 was 2⅓ years in the future. The return from withholding production in May 1979 for sale in September 1981 (r), is $P_m = P_c(1 + r)^{2.33}$ (P_m = uncontrolled price, P_c = controlled price). Assuming that the real uncontrolled price remains constant at $18.96/barrel, then lower and upper tier oils enjoyed a real return of 64% and 14% (per year), respectively, from waiting for decontrol. By fall 1979, the uncontrolled price was in the low, $30/barrel range. The new annual returns from withholding oil and awaiting decontrol became 124% and 46%, respectively, for lower and upper tier oil.

creased supply, in turn, placed downward pressure on U.S. refined-product prices.

Different types of analyses have arrived at different conclusions concerning the relationship between the Entitlement Program and U.S. refined-product prices. Each position emphasizes different relationships between U.S. and world market conditions. Arrow and Kalt are members of the school who argue that U.S. product markets are separated from foreign product competition, so that the increase in U.S. refined-product supply reduced U.S. product prices.[6] A different position has been advocated by Phelps and Smith (1977). United States markets are dominated by foreign competition, as reflected by both the presence (though small in magnitude at times) of U.S. product imports and the absence of declines in U.S. refined-product prices with the introduction of the Entitlement Program.[7] Another varient on the relationship between U.S. and world market themes is advanced by Smith and Phelps (1980). Any analysis of U.S. monopsony power in world markets must balance both crude-oil and refined-product market conditions. Regulation's effect on crude-oil markets implies directly higher uncontrolled crude-oil prices and, indirectly, higher U.S. refined-product prices. In conflict, regulation's direct effect on refined-product markets (the subsidy of U.S. refining) implies lower refined-product prices. Regulation's net effect on U.S. product prices balances these two forces.[8]

As Arrow and Kalt do not want to minimize deregulation's conflict between efficiency and equity considerations, it is indeed wise to consider the policy implications of assigning to consumers at least a portion of the benefits from existing regulation. Certainly, if decontrol can survive this analysis, then decontrol could also survive the analysis if consumers would be either unaffected or benefited by decontrol. The

6. The evidence in support of their proposition is that wholesale European product prices plus estimated transportation charges imply a landed cost of foreign products into the United States exceeding U.S. wholesale prices. As international trade patterns show that the U.S. trades with Caribbean (not European) refineries, the data does not speak to the relevant issue. Nevertheless, even if the relevant international price comparisons showed that regulation reduced U.S. prices relative to foreign product prices, it does not follow that U.S. prices were necessarily reduced by U.S. regulation (see n. 8).

7. The empirical tests were based on a plotting of the relevant time series. No formal statistical tests were used.

8. Econometric analysis of monthly time series data (1972–77) related U.S. real refined-product prices to U.S. real income, real OPEC posted prices, monthly dummy variables, and U.S. regulation variables. The results indicated that U.S. regulation increased U.S. refined-product prices by less than $0.01/gallon (1967 dollars), except for industrial fuel which received an import subsidy. As the econometric evidence includes both the crude-oil price effect and the expansion of U.S. refining, this finding can be reconciled with a finding that the Entitlement Program increased the difference between foreign and U.S. product prices (by 45% of the entitlement subsidy as cited by Arrow and Kalt). The international price comparisons netted out how U.S. regulation increased foreign and U.S. product prices.

authors argue that U.S. consumers have benefited, at most, \$8.0 billion per year from price control regulation.[9] Refiners in turn have received benefits totaling \$8.5 billion per year. The equity concerns about deregulation, then, ultimately revolve around one's view of transferring income from U.S. consumers and U.S. refiners to the U.S. crude-oil production sector. These transfers are distinct from the gains in national income discussed in the previous section.

We now enter the issues which are the strength of the Arrow and Kalt study. They cleverly trace in great detail the identity of the various interests affected by deregulation of crude-oil prices. The transfers between refiners and oil producers are a within-corporate-sector affair. Given the degree of vertical integration in the industry, almost 70% of these transfers will be even a within-firm transfer! Thus only the transfer from U.S. consumers to U.S. producers would be the object of any equity concern. Yet in place state severance taxes, usual corporate income taxation, and private royalty arrangements will allow the production sector to enjoy only \$3.8 billion of the "transfer" from consumers. Thus any standard of social justice must specify how it weights gains by the corporate sector of the petroleum industry against the gains of the government sector through taxation and royalty arrangements[10] against the losses of U.S. consumers.

Arrow and Kalt make some useful simplifying assumptions in order to concentrate the equity discussion on the key issues of "social justice." As total energy consumption is about proportional to income, the consumer losses from deregulation would be distributed in proportion to personal income.[11] As the bulk of the crude-oil–producing firms

9. Even if Arrow and Kalt are correct in assuming that refined-product prices were reduced by U.S. regulation, their methodology may overstate consumer gains from the price reduction. Arrow and Kalt apparently estimate consumer gains (G) by multiplying the (absolute value of the) assumed product price reduction ($-dp$) by the quantity (Q_1) of products consumed by U.S. consumers: $G = -dpQ_1$. This procedure ignores, however, the fact that the equivalent variation of income (how much consumers' incomes must increase for them to be as equally well off under deregulation as they are under regulation) falls short of $-dpQ_1$. Consumers do not value their increased product consumption by as much as the preregulation price. The equivalent variation of income, of course, falls short of G by $\frac{1}{2}dpdQ$. Rewriting $dp = p_0 p^*$, $dQ = Q_0 Q^*$ (* indicates proportional change in the variable due to regulation, and the subscripted variables pertain to preregulation values), the ratio of overstatement of actual consumer benefits to $-dpQ_1$ equals $.5Q^*/(1 + Q^*)$. As Arrow and Kalt's analysis implies that $Q^* = .062$, consumer benefits would be 97% of the stated \$8.0 billion. The overstatement of gains, though a minor \$233 million/year, looms importantly, given their inability to give a strong case for decontrol (see Section III).

10. The government's proceeds from the corporation income tax need not represent a net gain in government tax revenue. U.S. refiners and U.S. consumers undoubtedly had increased tax liabilities on their gains from price control regulations. Probably government royalty interests represent the major net revenue gains from deregulation for the government sector.

11. While direct energy consumption shows an income elasticity below unity, indirect energy consumption (via manufactured products consumed) shows a sufficiently high

are publicly owned companies, the production sector's gains from decontrol would be distributed in proportion to stock ownership. The ultimate beneficiaries of the governments' gains from decontrol depend on how the governments spend their increased tax proceeds. Lacking any information on the likely government response, the authors assume that the governmental benefits will also be distributed roughly in proportion to income.[12] Thus the key equity issue can be further narrowed to addressing how various standards of social justice view distributing at most $3.8 billion per year according to the distribution of stock ownership or personal income.

The authors argue that the only uneasy cases for decontrol are encountered if one's standard of social justice involves concern for horizontal or vertical equity. Three other standards of social justice would not support existing price control regulation.

An *efficiency-based* standard would obviously support decontrol because it would only be interested in the gains in national income garnered from the deregulation of oil prices. This standard balances efficiency against equity by ignoring the latter.

Similarly, a standard based upon *voluntarism in exchange* would likewise favor decontrol because price controls interfere with the freedom of contract. This standard, as the former one, solves the efficiency-versus-equity problem by ignoring equity. The authors argue that "the voluntarist's general approach to what is proper in the realm of government policy is, of course, embodied in . . . our civil, criminal, and contract law" (Arrow and Kalt 1979, p. 36). Certainly such an argument for this standard cannot be conclusive, as the Supreme Court itself has paved the way over the years for defining the murky area when "public interest" dictates interference with the freedom to contract.[13] As the authors point out, the most common objection to this standard is its neglect of disputes about the "just" distribution of income: an issue considered by vertical equity. The authors also show how regional equity standards are also ultimately related to vertical equity.

A *horizontal standard* of equity places a stone wall in front of further analysis. This standard "holds that those who were alike before a change would be alike after a change" (Arrow and Kalt 1979, p. 36). Proponents of this view would have a difficult time making a decision, as they must balance their equity goals advanced by price controls

income elasticity to render the Arrow and Kalt assumption a reasonable working hypothesis (see Arrow and Kalt 1979).

12. As total federal income tax revenues are probably not greatly increased by deregulation, the major revenue interest would be state government severance tax interests. Thus, ultimately issues of regional equity must be considered.

13. For the economist, the most concise discussion of this evolution in the law can be found in Kahn (1970), vol. 1, chap. 2.

against their presumed interest in reducing inefficiencies in the economy. Existing controls further their standard of equity because the individual relatively hurt by the quadrupling in world oil prices (energy-intensive and less price elastic consumers) is relatively favored by controls if regulation has indeed reduced U.S. refined-product prices. The theoretical potential for beneficiaries of decontrol to compensate losers would probably shipwreck on the reef of difficulties in designing compensation schemes.

The *vertical equity* standard provides the most promise for analyzing the conflict between efficiency and equity. Following Harberger (1978), Arrow and Kalt introduce distribution weights into standard cost-benefit analysis. Where Harberger suggested no systematic way of assigning weights, Arrow and Kalt follow the lead of Fisher (1927) in relating the distribution weights to the neoclassical proposition of diminishing marginal utility of income. While this exercise has resurrected cardinal utility and interpersonal utility comparisons, I think that this is a defensible strategy. Let no analyst cast stones against cardinal utility who studies decision making under uncertainty with the expected utility hypothesis or bargaining games with Nash's theory of bargaining. Interpersonal utility comparison, of course, is indeed the grist of equity considerations, so those who do not desire making such comparisons must forever withdraw from public policy debates whenever equity issues are raised. Furthermore, standard cost-benefit analysis makes interpersonal comparisons by giving equal weights to all individuals. Given that so much cost-benefit analysis is disregarded because of its insensitivity to distribution questions, I am surprised that more analysts have not attempted systematically to trade off efficiency and equity. Arrow and Kalt are to be congratulated for advancing the debate in this area, and this reviewer hopes that other analysts discussing other issues also avail themselves of similar methods. Such attempts will at least make critics of cost-benefit analysis sharpen their own concepts of equity and, optimistically, improve the dissemination of systematic analysis of policy issues. Given the methodological importance of their discussion of vertical equity, I offer some detailed comments on this part of the analysis.

Arrow and Kalt develop their distribution weights by assuming that the marginal utility of income is inversely proportional to the level of income. They then show that, normalizing as unity the equity of distributing a dollar in proportion to income, transferring income from U.S. consumers to U.S. producers generates an equity loss of 50% of the income transfer. While the authors caution their readers that this result is sensitive to their assumption about the nature of the diminishing marginal utility of income, their results are remarkably robust to this parameter.

Given their implicit specification of the equation relating the marginal utility of income to the level of income, the key parameter is the "marginal flexibility of money" (ϕ) (see Frisch 1959).[14] Arrow and Kalt assume ϕ to be -1. Alternative and independent methods of estimating ϕ have yielded identical conclusions: $\phi = -1.5$ (Maital 1973). Thus Arrow and Kalt understate the rate at which marginal utility diminishes with income and would apparently underestimate the equity issues of decontrol. Evaluating the more general formulas used by Arrow and Kalt at $\phi = -1.5$, the equity cost of decontrol would be 52% of the income transfer between U.S. consumers and U.S. producers instead of the 50% assumed by the authors.[15]

Using the neoclassical arguments on diminishing marginal utility actually involves the authors in a more fundamental policy position than simply trading off the equity and efficiency aspects when choosing between decontrol and maintaining existing petroleum price regulation. As noted by Pigou, the vertical equity standard would imply taxation and subsidization until everyone received the same income if there were no efficiency losses from government policy. Even in the presence of real-world efficiency costs of redistribution, the optimal policy would still involve Robin Hood taking from the rich and subsidizing the poor but not until incomes were equalized. This fundamental force lurking behind the shadows of the neoclassical vertical equity standard resurrects a new case for petroleum price controls. I pursue this point in the next section. This conclusion reflects discussions by Harberger (1978), where inequality in distribution weights can yield significant inefficiencies being justified by equity considerations.

14. The authors' implicit equation for the marginal utility of income, MU, is: MU = $F(I) = \mathrm{KI}^{\Phi}$. So Φ is the elasticity of MU with respect to income (I).

15. The equity weight received by income class i is proportional to the marginal utility of income: $W_i \sim \mathrm{MU}(I_i) = \mathrm{KI}_i^{\Phi}$. Price controls distribute an income transfer (S) to each income group i in proportion to the share of national income (α_i) received by that group. Thus the per-family gain under controls is: $G_i^c = S\alpha_i^i/N_i$, where N_i = the number of families in the ith income class. Thus the equity of distributing S dollars under price controls, E_c, is:

$$E_c \sim \sum_i W_i N_i G_i^c = \frac{S}{I_u} \sum_i n_i I_i^{(\Phi+1)},$$

where I_u is national per family income and n_i = fraction of families in the ith income class. In contrast, decontrol distributes S so that the per family gain for income class i is: $G_i^d = Sq_i/N_i$, where q_i is the fraction of stocks owned by income class i. So the equity of distributing S dollars by decontrol, Ed, is:

$$Ed \sim \sum_i W_i N_i G_i^d = \frac{S}{I_u} \sum_i \frac{n_i q_i}{\alpha_i} I_i^{(\Phi+1)}.$$

Using the Arrow and Kalt data on the distribution of families and stock ownership by income class, $E_c \sim .01137$ and $E_d \sim .005471$. Thus distributing S by decontrol generates equity equal to 48% of the equity enjoyed by using price controls. Thus the equity cost of decontrol is 52% of S.

III. Ranking Policy Options under the Arrow-Kalt Standard of Justice

Bringing together their estimates of efficiency and equity aspects of decontrol, Arrow and Kalt conclude that decontrol would be consistent with vertical equity. Equations (3) and (4), respectively, show how they estimated the equity and efficiency considerations:[16]

$$\text{equity loss: } (\delta_c - \delta_p)(-3.8 \text{ billion}) = -\$1.9 \text{ billion}, \quad (3)$$

$$\text{efficiency gains: } [t\delta_c + (1 - t)\delta_p](2.5 \text{ billion}) = \$1.9 \text{ billion}, \quad (4)$$

where δ_c is the equity weight given to consumer benefits from regulation (= 1), δ_p is the equity weight given to stockholders' benefits from decontrol (= 0.5), and t is fraction of increased production sector income from eliminating inefficiencies that are captured by governmental sectors (= 0.48). Obviously, the efficiency gains cancel the equity losses, but the authors argue that they have overestimated the equity losses. So their case for decontrol rests on the following addenda to the computation.

Three adjustments are advanced, although I do indeed have difficulty accepting them as significant. First, the computation of the equity losses ignores the royalty interests of governments and individual parties. However, the quantitative significance of this omission is small, even if one assumes that the distribution of private royalty interests is proportional to income. As royalty rates never exceed 20% (and are tax deductible in any event), the omission of royalty payments would overstate the equity costs of decontrol by at most \$220 million.[17] Second, Arrow and Kalt also believe that the equity costs of decontrol are overstated because some of the refining losses are from privately held corporations who undoubtedly are owned by wealthy individuals. But their argument here ignores the large amount of the net transfers to the production sector accruing to independent crude-oil production firms, themselves privately held corporations. The independent refiners account for less than 5% of U.S. refining activity, and independent producers may account for as much as 30% of U.S. crude-oil production. It is, then, difficult to understand how noncorporate interests on balance generate an overstatement of the equity losses from decontrol.[18] Finally, Arrow and Kalt conclude that the equity losses

16. These equations depend critically on the authors' assumption that giving governments money is just as equitable as giving individuals money in proportion to their income.

17. The reduced equity cost equals $(1 - t)(\delta^c - \delta^p)(3.8)r$, where r = royalty rate. So if t = .42, $\delta^c = 1$, $\delta^p = .5$, and $r = .20$, then the equity cost would be reduced by \$0.220 billion.

18. The size of the "corporate sector" of the petroleum industry was based upon the operating characteristics of the top 24 vertically integrated firms listed on either the New York or American stock exchanges. More extensive search of publicly traded firms

are also underestimated because decontrol will reduce compliance costs suffered by firms. Lower compliance costs, they assert, would slightly reduce U.S. refined-product prices. As compliance costs are not directly related to operating activity, I suspect that the regulation would have increased overhead costs, which need not have been passed on to consumers as higher prices in the short run. So at best, the case for decontrol presented by the authors is marginal from the viewpoint of vertical equity.

The vertical equity criterion used by Arrow and Kalt also does not bode well for the combination of decontrol with the actual windfall profits tax (the administration's policy). Equation (5) presents the sum of efficiency gains and equity losses (called justice) from jointly deregulating and imposing a windfall profits tax T_i.[19] The "justice" provided by a previously controlled but untaxed oil market has been normalized at zero.

$$J = 2.5[t\delta_c + (1 - t)\delta_p](1 - T_i)^2 - 3.8(\delta_c - \delta_p)(1 - T_i) + .5[t\delta_c + (1 - t)\delta_p]. \quad (5)$$

Equating the first-order condition to zero yields an "optimum" tax of 49%. While this rate corresponds with the actual statutory rate, examination of the second-order derivative shows that this tax rate is a global minimum![20] The computed loss in justice is about \$490 million annually from selecting $T_i = .49$ instead of zero. Thus if this vertical equity criterion was the guide in the formulation of the administration's new energy policy, some White House staffer failed to examine the second-order conditions. The administration could have done better by choosing between decontrol and maintaining existing price controls.

Actually, the vertical equity standard analyzed by Arrow and Kalt can be easily solved for an optimum price control policy. This optimum policy radically differs with existing policy in that there should be a common price for all U.S. crude oil. As stated in Section I, the multiple-tier price ceilings do not minimize the cost of producing any given level of output. So the multiple-tier pricing policy actually increases the efficiency cost of achieving any desired level of transfer between U.S. oil producers and U.S. consumers. Using the common

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would further reduce the market shares of the independent oil production and refining sectors, but such an exercise would not reverse the key assertion in the text: the noncorporate sector is relatively larger in crude-oil production than refining.

19. As stated in Section I, the efficiency gains under decontrol *and* the windfall profits tax equal $(1 - T_i)^2$ the inefficiency in the production sector under regulation plus the elimination of the inefficiency in the refining sector. The tax, of course, reduces the equity cost of decontrol by the amount government tax collections reduce the transfer from U.S. consumers to U.S. producers.

20. This is a global minimum as indicated on the second-order condition: $(\partial^2 J)/(\partial T_i^2) = 5[t\delta_c + (1 - t)\delta_p] > 0$.

price ceiling, the Arrow and Kalt vertical equity justice function ($\hat{J}$) becomes:[21]

$$\hat{J} = (\delta_c - \delta_p)(1 - t)\{\lambda_\epsilon k(p_m - p_c)Q_1 - .5b_c k^2\lambda\epsilon^2(p_m - p_c)^2\} - [t\delta_c + (1 - t)\delta_p](.5b^s - .5k^2bd)(p_m - p_c)^2. \quad (6)$$

The function normalizes at zero the "justice" provided by an unregulated petroleum industry.

The first term in equation (6) measures the assumed equity gains from reducing prices paid by U.S. consumers when subsidizing U.S. crude-oil use by the Entitlement Program. Within the brackets, the terms are the first- and second-order income effects of the computed price reductions: $K\lambda_\epsilon(p_m - p_c)$. This consumer gain is weighted by the differences in equity weights assigned to consumer and producer interests $(\delta_c - \delta_p)$ adjusted by the fraction of the industry's reduction in profitability shared with the government through taxes other than the windfall profits tax (t). The adjustment in equation (6) for the government revenue interest reflects the Arrow and Kalt assumption that the equity weight for government revenues equals the equity weight for U.S. consumers.

The second term in equation (6) measures the assumed efficiency losses from the optimal price control policy. The portions involving b^s and b^d measure the second-order income losses from the oil-supply and oil-demand distortions from regulation. The equity weight term $[t\delta^c + (1 - t)\delta_p]$ is the same term used in equation (4), with the same interpretation.

The optimal price control policy under the Arrow and Kalt assumptions can be derived by maximizing the justice function with respect to the price ceiling, p_c. The first-order equilibrium condition yields (after transforming into elasticities):

$$\frac{P_m - P_c}{P_m} = \frac{(\delta_c - \delta_p)(1 - t)\lambda_\epsilon k}{[t\delta_c + (1 + t)\delta_p](\epsilon^s w_s - k\eta^d wd) + (1 - t)(\delta_c - \delta_p)\eta_c k^2\lambda_\epsilon^2 r_p}. \quad (7)$$

21. The new symbols are: λ_ϵ = fraction of entitlement subsidy passed onto U.S. consumers as lower product prices (.5); K = fraction of deprived revenue from price controls entering Entitlement Program (.7) multiplied by fraction of total crude-oil input subsidized by the Entitlement Program (.5): k = .35; Q_1 = U.S. annual consumption of refined product (6.46 billion barrels, May 1979); P_m = uncontrolled and assumed constant market price of crude oil ($18.96/barrel); w_d = ratio of U.S. crude-oil input to U.S. total product consumption (.9); r_p = ratio of P_m to refined-product price P (.9); W_s = ratio of U.S. oil output to U.S. product consumption (.54); P_c = controlled price (to be determined); and b_s, b_d, and b_c are, respectively, the price slopes of U.S. oil supply, U.S. refiner demand for oil, and U.S. consumer demand for products.

Using the values for the parameters assumed by Arrow and Kalt, the optimal difference between the uncontrolled market price and the U.S. domestic price is 58.6% of the uncontrolled price.[22] So the U.S. price would be optimally set at \$11.11/barrel below the world price, that is, at \$7.85 per barrel. Evaluating the "justice function" at the optimal price ceiling, the gains from choosing the optimal policy in preference to deregulation equals about \$1.6 billion annually.[23]

The large optimal price control policy reflects Pigou's interpretations of the neoclassical equity standard: Large inefficiencies can be justified by distributive considerations. On the margin of the Arrow and Kalt model, any policy transfering 50 cents to U.S. consumers can be justified so long as U.S. producers do not sacrifice income of more than \$1.00. This large implied "demand" for reducing U.S. producer income for the benefit of U.S. consumers sustains the large optimum price control policy. Only the rapidly rising inefficiencies from lower price ceilings prevent even more stringent price control policies from being optimal.

Once one considers the optimum policy, instead of comparisons between only two policy alternatives, it is clear that the case for decontrol cannot be based on the economic analysis and vertical equity standard advocated by Arrow and Kalt. They can only show a marginal preference for decontrol over an "inefficient" price control policy. Given that the optimal domestic oil price (\$11.11/barrel) is below the actual May 1979 average domestic price (\$15.40/barrel), this result illustrates the importance of reducing the efficiency cost of transfering income. By the Arrow and Kalt hypothesis concerning the beneficiaries of price controls, the rollback in U.S. oil prices would further benefit U.S. consumers. This optimal price control policy would entail placing controls on the 40-odd percent of U.S. oil production exempted from price ceilings by then-existing legislation.

Collecting the results of my analysis, the following ranking of policy options in descending order of desirability is suggested by the Arrow and Kalt vertical equity criterion. Obviously, the optimal price control policy is the first best solution. Notwithstanding my reservations on the addenda to the authors' computation, immediate decontrol without the windfall profits tax may possess a moderate advantage over reversing

22. ϵ^s, η^d, and η^c are, respectively, elasticities of U.S. oil supply (.1), U.S. refiner demand for oil (−.5), and U.S. consumer demand for products (−.5).

23. This solution is indeed a maximum. $(\partial^2\hat{J})/(\partial P_c^2) = (\delta^c - \delta^p)(1 - t)K^2\lambda_\epsilon^2 b_c - [t\delta^c + (1 - t)\delta^p](b_s - K^2 b_d)$. Converting into elasticities: $(\partial^2\hat{J})/(\partial P_c^2) = Q_1/P_m\{-(\delta_c - \delta_p)(1 - t)k^2\lambda_\epsilon^2\eta_c P_m/cP - t[\delta_c + (1 - t)\delta_p](\epsilon^s w_s - k^2\eta^d w_d)\}$, where P = refined product price. Evaluating the expression at the assumed values of the parameters (see nn. 19 and 20), $(\partial^2 J)/(\partial P_c^2) = (Q_1/P_m)(.008\ P_m/P - .0808) < 0$, as refined-product prices (P) exceed uncontrolled crude-oil prices (P_m).

President Carter's intention of dismantling the regulatory structure inherited from previous Republican administrations. The ranking of gradual decontrol without the windfall profits tax is problematic but certainly would reside somewhere in the middle of the pack. Obviously, gradual decontrol defers the gains from immediate decontrol, but this effect alone would place gradual decontrol in the number three position. But the efficiency loss from gradual decontrol tilting U.S. production paths into the future could easily place gradual decontrol further down the list of policy options. Certainly coupling decontrol with the windfall profits tax was a masterpiece in moving further down the list. The imposition of gradual decontrol with the tax embraced the worst choice among the options considered by the president.

The above policy ranking is most sensitive to the validity of two assumptions, other than the acceptance of the neoclassical vertical equity standard. First, is controlling U.S. oil prices the least inefficient method of redistributing income? While consumption of refined products is correlated with income, there remains considerable noise in placing leverage on petroleum prices as a means of distributing governmental policy benefits proportional to income. This question raises much broader public finance issues than can be addressed here. Second, have Arrow and Kalt correctly identified the distribution of benefits and losses from regulation?

By assuming away any effect of regulation on OPEC oil prices, the authors have ignored the cornerstone of the case of decontrol that would even pass the neoclassical vertical equity standard. The U.S. was the free world's largest producer of oil in 1973–74, when regulation was introduced in the face of the rising market power of OPEC. Whenever the largest nonmember of a cartel handcuffs itself with price controls, it is reasonable to investigate the possibility (as in Section I) that this policy action adversely affected consumers of petroleum products. Furthermore, the magnitude of increased oil prices created by the price control policy may have been sufficient to overcome any differential advantage given by U.S. regulation to U.S. consumers over foreign consumers (see comments in Section II). Indeed, regulation may have worsened the plight of consumers worldwide but showed preferences to U.S. consumers by inflicting them with smaller losses.

Given the potential magnitude of the U.S. income loss from supporting OPEC, the optimum neoclassical oil price policy could easily encompass the abandonment of price controls. The estimated $4.9-billion-per-year income loss from higher oil prices contributes massively to the benefit side of the ledger for decontrol. The next section discusses optimum U.S. policy when the interaction with OPEC pricing policy is taken into account.

IV. Optimum U.S. Oil Policies with Due Consideration Given to the OPEC Response

This section investigates two disparate U.S. oil policy options. First, can *any* U.S. price control policy be justified under the Arrow and Kalt equity criterion, after considering that U.S. price control regulation induces OPEC to increase the world price for crude oil? Second, can U.S. policy harness U.S. monopsony power in world crude-oil markets and beneficially improve U.S. terms of trade? The key elements in answering both questions are the relationships between U.S. policy actions and the uncontrolled prices for crude oil and refined products, and the relationships among those price changes and the incomes of U.S. crude-oil producers, U.S. refiners, and U.S. consumers.

The discussion shall incorporate Section I's discussion of the effect of U.S. oil regulation on OPEC pricing strategy. In general, U.S. policies affect OPEC pricing in two ways: changing the quantity of OPEC crude oil demanded at any given price and changing the elasticity of demand for OPEC crude oil. Given the specifications of how various policy options influence these two elements of the demand for OPEC crude oil, I use the dominant-firm model to predict the resulting change in OPEC pricing of its crude oil. From a game theory viewpoint, the dominant-firm pricing strategy does not represent OPEC's best reply to the United States's using its oil policy for either "protecting" U.S. consumers from the cartel nor improving U.S. terms of trade. The Organization of Petroleum Exporting Countries can improve its own position by taking into account how the United States formulates its oil policy when adopting its pricing of OPEC crude oil. Thus the following discussion will overstate any gains from U.S. policy intervention. A complete analysis of the strategic interaction between OPEC and U.S. policy must await future game-theoretic analysis, whereby (among other issues) the threat capabilities of all sides are fully specified.

In describing changes in refined-product prices, I use the Arrow and Kalt assumption that 50% of every per unit subsidy of U.S. refiner use of crude oil is passed onto consumers as lower per-unit prices of refined products. I apply their assumption concerning the incidence of oil subsidies on refined-product prices to an analysis of the incidence of changes in uncontrolled crude-oil prices. My assumptions will generally understate the responsiveness of refined-product prices to changes in uncontrolled crude-oil prices, because subsidizing only a portion of the world market (U.S.) must have smaller leverage on refined-product prices than any worldwide reduction in the world price of crude oil (see Phelps and Smith 1977). I embrace my assumption to bias the case in favor of a moderate price control policy. Higher pass-throughs of increased crude-oil prices to higher refined-product prices inflict greater losses on consumers and reduce any potential equity gains from any given price control policy.

I use second-order approximations of profit functions for capturing how the regulatorily induced changes in crude-oil and refined-product prices affect the income earned by U.S. crude-oil producing and refining interests. For the U.S. crude-oil producing sector, the U.S. supply of crude oil is the relevant analytical tool.[24] For U.S. refining interests, the analysis becomes more cumbersome, as the implications of both crude-oil and refined-product prices must be taken into account simultaneously. In accounting for these considerations, I use results from duality theory (see Arrow and Hahn 1971) and some reasonably accurate but special assumptions about refining technology (see Smith and Phelps 1980). One can derive how refining profitability is affected by given changes in crude-oil and refined-product prices as functions solely of pre–price-change quantities of crude-oil and refined-product output and the elasticity of the U.S. refiner demand for crude oil.[25] Particular policies will have additional terms in the profit functions for measuring effects of forced income transfers or inefficiencies occurring even if regulation had no effect on uncontrolled market prices.

Finally, I use consumer surplus analysis for indicating the relationships between policy-induced changes in refined-product prices and U.S. consumer income.[26] Consumer surplus, of course, conceptually

24. Let I_p be the change in the income of the U.S. crude-oil production sector. Then $I_p = Q_s^o[\text{DPRM} + (\epsilon_s/2P_m^o)(\text{DPRM})^2]$, where Q_s^o = prepolicy level of crude-oil production, DPRM = change in price received for U.S. crude-oil output, ϵ_s = elasticity of U.S. crude-oil supply, and P_m^o = prepolicy price of U.S. crude-oil output.

25. Let I_R be the change in income of the U.S. refining sector, DP be the change in refined-product price, and DPRM be the change in the price paid by U.S. refiners for their crude oil. Arrow and Hahn (1971) show that to a second-order approximation,

$$I_R = Q^o\text{DP} - C^o\text{DPRM} + 1/2\Big[\frac{\partial Q}{\partial P}(\text{DP})^2 + \frac{\partial Q}{\partial\ \text{PRM}}(\text{DP})(\text{DPRM})$$

$$- \frac{\partial C}{\partial P}(\text{DP})(\text{DPRM}) - \frac{\partial C}{\partial\ \text{PRM}}(\text{DPRM})^2\Big],$$

where Q_o = prepolicy output of refined products, C^o = prepolicy use of crude oil, and the partial derivatives hold constant the other price. Using the production model assumed by Smith and Phelps (1980)—fixed properties and unity input/output coefficient—$Q = Q(P - \text{PRM})$, and $C = C(\text{PRM} - P)$ and $Q = C$. Linearizing the oil demand and product supply equations yields the following expression: $I_R = Q^oDP - C_o\text{DPRM} + .5\{[(\epsilon_R Q^o)/(P_o)]\ \text{DP}[\text{DP} - \text{DPRM}] - [(\eta_C C^o)/(\text{PRM}_o)]\ \text{DPRM}(\text{DPRM} - \text{DP})\}$, where ϵ_R = elasticity of U.S. supply of refined products, η_C = elasticity of U.S. refiner demand for crude oil, and $\epsilon_R = P_o/P_m^o\eta_C$ by virtue of the assumptions that $Q = C$ and both are linear functions of P − PRM.

26. Let I_C be the change in consumer surplus from a given change in product price: DP.

$$I_C = -Q_C^o\Big[\text{DP} - \frac{\eta(\text{DP})^2}{2p_o}\Big],$$

where Q_C^o = prepolicy U.S. consumption of refined products.

misstates the change in income (at prepolicy prices) which makes consumers as well off as the actual change in prices generated by regulation. Yet the magnitude of the error is likely to be small because the misestimation of consumer surplus analysis relates to a small income effect from the change in the price of refined products.

The Optimum Price Control Policy: Decontrol

Conceptually, any oil price control policy can be separated into two parts: eliminating the U.S. oil supply elasticity and reducing the U.S. oil demand elasticity at precontrol prices, and reducing U.S. oil supply and increasing U.S. oil demand as domestic crude-oil prices are reduced from their unregulated levels. As stated in Section I, the first element (hereafter referred to as the elasticity-of-demand effect) of the price control policy, taken in isolation, increases the prices of crude oil and refined products. From the viewpoint of the Arrow and Kalt equity criterion, these price movements are not "just" because they transfer income from U.S. consumers toward the U.S. petroleum industry and foreign crude-oil producers. However, the rollback of domestic crude-oil prices, as the domestic price ceiling is placed below foreign crude-oil prices, may contribute toward "justice" as the refining subsidy places downward pressure on refined products. Whether the subsidy forces from price controls are sufficiently strong to justify a price control policy, of course, depends upon the rate at which OPEC increases its crude-oil prices as U.S. price control policy increases the demand for OPEC crude oil. Intuitively, the optimal design of price controls will balance the adverse consequences from reducing the elasticity of demand for OPEC crude oil against any net reduction to refined-product prices from increasing U.S. refined-product output and U.S. crude-oil demand.

Equation (8) presents the Arrow and Kalt justice function which enables the systematic analysis of the trade-off of these forces.[27] Justice (J) is

$$J = \delta_c I_c + [\delta_c t_R + (1 - t_R)\delta_p](I_R - I_\epsilon + T) + [t_p \delta_c + (1 - t_p)\delta_p]I_p, \quad (8)$$

a weighted average of the total effects of regulation on the incomes of U.S. consumers, U.S. refiners, and U.S. crude-oil producers. I have normalized justice to be zero at the unregulated equilibrium. The

27. I_p, I_R, and I_p were defined in nn. 24–26 to be the change in incomes due to the price effects of price control policy. The total effect of price controls in U.S. refining income must: (1) add the income transfer (T) received from U.S. oil producers: $Q_s^o[1 - \epsilon_s^R/P_m^o]$ [DPRM + R], where R = difference between the initial uncontrolled price of crude oil (P_m^o) and the domestic price ceiling (P_c) which must be determined and (2) subtract the inefficiency (I_E) in crude-oil subsidy use by domestic refiners from the crude-oil subsidy. This is financed from the profits of the refining industry (see Smith and Phelps 1980). $I_E = [(\eta_C C^o)/(2P_m^o)]k^2$ [DPRM + R], where k was defined in n. 21.

equity weights of the latter two categories are a mixture of consumer and industry equity weights, of course, because of the tax system discussed in Section II. I assume that the tax rate on refining (t_r) is the corporation income tax rate (0.42). The tax rate on U.S. crude-oil production (t_p) is the 48% discussed in Section II. Equation (9) completes the specification of the problem by relating the changes in uncontrolled crude-oil and refined-product prices to the domestic price ceiling (p_c):[28]

$$\begin{aligned} \text{DPRM} &= .075\, p^o_m + .1351\, (p^o_m - p_c) \\ \text{DP} &= .5[(1-k)\text{DPRM} - k(p^o_m - p_c)]. \end{aligned} \tag{9}$$

Using the definitions for I_c, I_r, I_e, T, and I_p, and substituting the equations in (9) for the changes in uncontrolled prices for crude oil and refined products, one obtains an expression for J which depends solely upon the difference between the original uncontrolled crude-oil price (p^0_m) and the domestic price ceiling (p_c). For brevity, I will not present the series of substitutions but simply present the results of the optimization problem.[29]

The justice function is a continuous function of the difference between the prepolicy uncontrolled oil price and the domestic price ceiling, but justice approaches −$2.8 billion as the price difference approaches zero. The $2.8 billion loss represents the quantitative magnitude of the adverse effect of price controls on the elasticity of demand for OPEC crude oil. As such, this loss represents a hurdle which price controls must clear by reducing the domestic price ceiling for offering a subsidy to U.S. refiner demand for crude oil.

The justice function reaches a local maximum at setting the domestic price ceiling $6.36/barrel below the precontrol uncontrolled price of crude oil ($16.73/barrel).[30] This rollback in prices equals only 57% of the rollback in prices called for under the optimal price control policy

28. The equation for the change in uncontrolled crude-oil prices is obtained from the earlier analysis in the Appendix, but noting that the increase in the quantity demanded for OPEC crude oil depends on the choice of the price ceiling. The equation for the change in uncontrolled refined product prices notes that the change in the marginal price of crude oil for U.S. refiners equals the increase in uncontrolled crude-oil prices, DPMR, minus the equilibrium oil subsidy $k[\text{DPRM} + p^o_m - p_c]$.

29. In parameterizing the justice function, a few judgments were required in assigning parameter values. I set p^o_m = $16.73 (the difference between the observed price in May 1979 and my estimate of the effect of U.S. regulation on crude-oil prices). Using $16.73/barrel instead of $18.96/barrel mitigates the adverse effects from price controls, reducing the elasticity of demand for OPEC crude oil (the first term in eq. [9] for DPRM). I set all the elasticities to the values used by Arrow and Kalt. The resulting justice function is: $J = -2.84 + .2636\,(P^o_m - P_c) - .0207\,(P^o_m - P_c)^2$.

30. $(P^o_m - P_c)$ = $6.36/barrel is indeed a local maximum: $(\partial^2 J)/(\partial P^2_c) = -.0414 < 0$.

dictated by the Arrow and Kalt analysis of the economic effects of U.S. price control legislation. The local optimum generates a smaller rollback of domestic prices because the severity of the price ceiling adversely affects U.S. terms of trade for crude oil.

Decontrol represents the globally optimal price control policy. Evaluating the justice function at p_c = \$10.37 (\$16.73 − \$6.36), the locally optimal policy generates a loss of equity equal to \$2.0 billion. If one were to weight equally the gains and losses of U.S. consumers and producers, then the loss in national income would be about \$5.0 billion. This national income loss would represent a loss of \$2.93 billion due to the adverse movement in U.S. terms of trade, \$1.68 billion due to the demand side inefficiency from the crude-oil subsidy, and only \$0.39 billion due to the crude-oil supply-side inefficiency of price controls. Thus almost 60% of the loss in national income would be due to the force not discussed in the Arrow and Kalt analysis of U.S. price control legislation: the worsening of U.S. terms of trade for crude oil. The OPEC response to U.S. price controls thus destroys the ability of the Arrow and Kalt equity standard to defend *any* price control policy.

Optimum Tariff Policy

A natural question about optimal U.S. oil policy concerns whether the U.S. can beneficially exploit its monopsony power in world crude-oil markets, the same market power which defeats any oil price control policy. Standard trade theory indicates that an optimal tariff intervention would indeed exist, although application of this theory must accommodate a few special considerations operating in the U.S. petroleum situation. Below I analyze the optimum tariff structure from the viewpoint of both the Arrow and Kalt equity weights and the equal equity weighting scheme for domestic interests usually assumed in the international trade literature.

Given that the U.S. faces an oil cartel, the optimal oil tariff should be ad valorem. An ad valorem tariff reduces the level of demand for OPEC crude oil just as a specific, per unit tariff would. The advantage of the ad valorem tariff, though, originates from the added advantage that tariff policy then would also increase the (absolute value of the) elasticity of demand for OPEC crude oil. As illustrated continually in the analysis of OPEC pricing strategy, policies either reducing the level or making more elastic the demand for OPEC crude oil are both rewarded with lower equilibrium world prices for crude oil. So where generally the choice between an ad valorem or specific tariff would be a matter of indifference, there is a decided theoretical advantage from pursuing an ad valorem crude-oil tariff.

The successful tariff policy must also consider the entire dimension of U.S. trade in petroleum. Conceptually, a crude-oil tariff benefits the

United States by reducing the price paid to foreign producers for imported crude oil. However, the resultant increase in refined-product prices would injure U.S. national income because refined products are imported into the United States. So the design of the optimal tariff intervention must coordinate tariffs on both crude oil and refined products.[31] As with the analysis of the optimal price control policy, the key functions fall into two classes: (1) expressions relating the income of U.S. producers, U.S. refiners, and U.S. consumers to U.S. prices of crude oil and refined products, and (2) expressions relating those prices to the U.S. policy variables.

The income functions for U.S. producers, U.S. refiners, and U.S. consumers are the same functions discussed in notes 24–26. Unlike the case of price controls, however, there are no separate terms for forced income transfers or inefficiencies. All income redistributions and distortions are captured in the second-order approximations to the income functions. A new relationship must be added to the analysis, however, relating U.S. government tariff collections (R) to the tariff policy variables.[32] United States national income, then, is simply the sum of U.S. producer income, I_p, U.S. refiner income, I_r, U.S. consumer income, i_c, and tariff collections, R. The Arrow and Kalt equity function would weight I_c and R by unity, I_r by .71, and I_p by .74 when adding together these incomes. Each income function, and tariff revenues of course, are normalized at zero for their values obtained under an unprotected U.S. petroleum industry.

Equation (10) presents the three key relationships showing how U.S. tariff policy variables affect the world price of crude oil, DPM, the U.S. price of crude oil, DPRM, and the U.S. price of refined products, DP:

31. Analysis of U.S. tariff policy indicates that no crude-oil tariff can increase U.S. national income if free trade in refined products is allowed. The reader can verify this proposition by optimizing the U.S. national income function (defined below), subject to the constraint that the refined-product tariff equals zero. The resulting solution indicates that U.S. national income is increased by a mere $80 million by levying the "optimal" crude-oil tariff of 9%. The increased U.S. national income generated by the lower crude-oil prices is almost completely offset by the lower U.S. national income suffered by the higher refined-product prices. Applying the Arrow-Kalt equity weights, the optimal ad valorem oil tariff is virtually zero (.017).

32. Government tariff revenues consist, of course, of proceeds collected from the oil (OR) and product (PR) tariffs. Using earlier notation,

$$\mathrm{OR} = T_c(\mathrm{DPM} + P_m^o)M_o^c\left[1 + \frac{\eta^d C^o}{P_m^o M_o^c}(\mathrm{DPKR} - \mathrm{DP}) - \frac{\epsilon^s Q_s^o}{P_m^o M_c^o}\mathrm{DPMR}\right],$$

where M_o^c = prepolicy quantity of crude-oil imports, and T_c = ad valorem crude-oil tariff. Similarly,

$$\mathrm{PR} = T_p M_o^p\left[1 + \frac{\eta Q_o}{P^o M_o^p}\mathrm{DP} - \frac{\epsilon^s Q_r^o}{p^o M_o^p}(\mathrm{DP} - \mathrm{DPMR})\right],$$

where M_o^p = prepolicy level of refined-product imports, and T_p = refined product tariff.

$$\begin{aligned}
\text{DPM} &= (-.243T_c - .006T_p + .063T_c^2 + .002T_cT_p)p_m^o,\\
\text{DPRM} &= (.757T_c - .006T_p - .180T_c^2 - .004T_cT_p + .063T_c^3\\
&\qquad + .002T_c^2T_p)p_m^o, \qquad (10)\\
\text{DP} &= (.040T_p + .379T_c - .090T_c^2 - .002T_cT_p + .032T_c^3\\
&\qquad + .001T_c^2T_p)p_m^o.
\end{aligned}$$

The derivation of these relationships used the following four economic effects of U.S. tariff policy on the equilibrium prices of crude oil and refined products. First, the crude-oil tariff would reduce the world price of crude oil by reducing both the level and the elasticity of the demand for OPEC crude oil.[33] Second, the refined-product tariff would also reduce the demand for OPEC crude oil by reducing the U.S. portion of the world demand for refined products.[34] Third, U.S. crude-oil prices would move differently than world crude-oil prices because of the presence of the U.S. ad valorem crude-oil tariff.[35] Finally, U.S. refined-product prices are influenced by changes in the U.S. price of crude oil and the imposition of the refined-product tariff.[36] Substituting for the price changes given by equation (10) into the income functions for the various U.S. economic interests, U.S. national income (and the Arrow and Kalt justice function) can be ultimately written as "simple" functions of the crude-oil and refined-product tariffs. Optimizing these functions with respect to the policy

33. The dominant-firm model in the Appendix was solved, whereby the change in both the level and the elasticity of demand for OPEC crude oil depended upon the crude-oil tariff, T_c, actually selected. The analytic expressions for these effects are straightforward.

34. At initial world prices for crude oil and refined products, the refined-product tariff, T_p, (assumed to be a per unit, specific tariff) reduces U.S. product demand (in proportionate terms) by $\eta(T_p/P^o)$.

35. In terms of the notation used in the text, DPMR = DPM$(1 + T_c) + P_m^o T_c$.

36. Analytically, the change in refined-product prices equals 50% of the change in U.S. crude-oil prices (using the same assumption about factor price incidence from Arrow and Kalt's analysis) plus the portion of the refined-product tariff passed onto U.S. consumers as higher product prices, λ_T, assuming that U.S. crude-oil prices remained constant: DP = .5DPMR + $\lambda_T T_p$. Assuming competitive behavior in world refined-product markets, simple demand supply analysis yields:

$$\lambda_T = \frac{\epsilon_f}{\epsilon_f + (Q_r^o/M_o^p)\epsilon_r - \eta(Q^o/M_o^p)},$$

where ϵ_f = elasticity of foreign refined-product exports (i.e., elasticity of the foreign excess supply curve): 15.21, computed from using May 1979 quantities in the standard excess supply elasticity formula, ϵ_r = elasticity of the U.S. supply of refined products: .625, η = elasticity of U.S. demand for refined products: $-.5$, and Q_r^o, Q^o, M_o^p are defined above. Setting the ratios at their May 1979 values, $Q_r^o/M_o^p = 4.85$ and $Q^o/M_o^p = 5.85$, and $\lambda_T = .72$.

variables indicates the following optimal U.S. petroleum tariff structure.[37]

United States national income is maximized by levying a 40% ad valorem crude-oil tariff and a $4.30/barrel refined-product tariff on unregulated U.S. petroleum markets. This tariff policy increases U.S. refined-product prices by $5.20/barrel, $0.90/barrel exclusive of the refined-product tariff. United States crude-oil prices would be increased by $4.13/barrel. World crude-oil prices would be reduced by $1.83/barrel. The resulting gain in U.S. national income would be about $1.8 billion annually. United States consumers would suffer annual losses of $31.5 billion. United States refiners and U.S. producers would enjoy annual pretax gains of $5.8 and $13.3 billion, respectively. United States tariff revenues would equal $14.2 billion annually. This optimum tariff structure illustrates the importance of coordinating tariffs on refined products with tariffs on crude oil. The relatively high 40% crude-oil tariff becomes optimal, because the high refined-product tariff reduces the volume of refined-product imports on which the United States must pay higher prices ($0.90/barrel) to foreign refiners.[38] The Arrow and Kalt equity criterion would reject this tariff policy, because the weighted average of the gains and losses indicates a $3.3 billion loss in equity. An unregulated and unprotected U.S. petroleum industry offers more justice.

Examining the distribution of the gains and losses from the optimal policy, the U.S. government revenue interest captures the "societal" gains from the optimum tariff policy. Yet the large product and implied crude-oil tariffs, $5.20/barrel and $5.96/barrel, respectively, generate large economic incentives for private importing parties to evade payment of the tariff on at least some volumes of their imports. Tariff evasion activities, however, consume societal resources and represent another source of deadweight losses excluded from the above analysis. Furthermore, if only 12% of importing activity is "underreported," then the actual U.S. government revenue interest will not offset the standard net losses to U.S. national income from the inefficiencies

37. The resulting functions yield first-order equilibrium conditions involving two nonlinear equations in the two unknown tariff variables. Rather than solving for an explicit solution, I approximated the solutions by plotting the objective functions over the following ranges of the decision variables: $0 \leq T_c \leq 1.0$, $0 \leq T_p \leq 6$. The functions were well behaved in these regions for the tariff variables, with the global optimum being considerably greater than other local optima.

38. The computed effect of this optimum tariff structure on U.S. imports is worth noting. The policy reduces U.S. dependence on foreign crude oil by slashing the volume of refined-product imports, which would decline by an estimated 89%! U.S. crude-oil imports would actually increase by a modest 4%, because the U.S. refining sector expands as the tariff structure increases the equilibrium spread between U.S. refined-product and U.S. crude-oil prices by $1.07/barrel. Total U.S. petroleum imports (crude oil plus refined products) are computed to decline by 27% with the imposition of the optimum tariff structure.

generated by creating wedges between world and domestic prices of crude oil and refined products. Modest underreporting destroying U.S. gains does not bode well for the "optimum tariff policy." The erosion of the tax base due to evasion has been an empirically important phenomenon in excise taxation and tariff policy alike (see Smith 1976). Thus the U.S. national income gains from the optimum tariff policy may be completely illusionary, once the prospect of evasion is taken into account. These considerations, of course, do not qualify the earlier conclusion that optimal U.S. policy would unleash an unregulated U.S. petroleum industry against OPEC.

V. Economic Analysis and Public Policy

Certainly the history of oil price control regulation has not embraced the "just" policy (whatever the relationship between U.S. regulation and OPEC pricing decisions). Is the political system driven by another equity standard, or irrationality, or by another decision-making process altogether? Such fundamental questions of political economy can not be addressed here. Instead, I close with a different viewpoint on the formulation of U.S. oil pricing policy.

Discarding standards of justice, I apply Peltzman's (1976) and Becker's (1979) positive theories of government-inspired income redistribution. Their hypothesis is that government policy intervenes to buffer the gains and losses which parties experience from unanticipated events. The rise of OPEC would enrich U.S. oil-producing interests and diminish the income of U.S. refiners and U.S. consumers in an unregulated market. Thus regulation that transfers income from U.S. oil producers to U.S. refiners and U.S. consumers would be no surprise. The division of the gains between refiners and consumers, in turn, would depend upon the relative political power of these groups. Corporate interests and standard powerful lobbies were well taken care of. Preferential treatment in product allocation programs was given to farmers and "bulk" (i.e., corporate) buyers of refined products. Product import subsidies were given to the fuels used by the utility and industrial sector. The insistence of the ever-powerful independent refiner lobby generated the Entitlement Program and their later preferential treatment under that program. The controversy over whether consumers benefited from this regulation probably attests to the little political power a diffuse interest group with small per capita stakes would normally exert. The pre-Carter policy certainly is understandable from the Peltzman-Becker viewpoint of political economy.

The Carter policy, though, represents a slight enigma. Decontrolling U.S. oil prices destroys the superstructure of this political buffering of the income of the beneficiaries of price controls. Certainly the U.S. refining sector is left in the lurch during another episode of increasing world crude-oil prices. Yet minor evolution in policy can fully restore the political equilibrium. Notwithstanding talk of deregulation, the government will maintain its authority to allocate products during "shortages." This maintenance of controls will keep intact the existing preference given to corporate and agricultural users of products. Next, the administration will soon discover the virtue of refined product tariffs that will provide economic protection to the refining sector. Presumably, this trade policy will levy higher tariffs on products used by the unorganized consumers (such as gasoline) than the products used by industry. Finally, the windfall profits tax itself can be rationalized as an attempt more effectively to transfer income from the U.S. petroleum industry to the public at large. Yet, as with the wisdom of implementing the optimal neoclassical price control policy, the sensibleness of this Carter energy policy (from a positive political economy viewpoint) depends critically on the generally unanalyzed issue concerning U.S. oil regulation. Has increasing the level and reducing the elasticity of the demand for OPEC oil affected OPEC pricing strategy? I urge policy analysts to redirect their attention to this critical question.

Appendix
Computing U.S. Regulation's Effect on OPEC Pricing Strategy

A. Equation (A1) gives the preregulation equilibrium condition for OPEC:

$$\mathrm{MC} = P_o + Q_o B_o, \tag{A1}$$

where MC = (assumed constant) marginal cost, P_o = preregulation oil price, Q_o = preregulation OPEC output, and B_o = inverse of price slope of (linear) demand for OPEC oil before U.S. regulation.

B. Equation (A2) gives the postregulation equilibrium conditions for OPEC:

$$\mathrm{MC} = P_l + Q_l B_l, \tag{A2}$$

where subscript l denotes postregulation values. Substituting $P_l = P_o + dP$, $Q_l = Q_o + dQ$, $dQ = d\gamma + dP/B_l$, $B_l = B_o + dB$, and substituting for MC (from equation [1a]) yields:

$$dP = \frac{-Q_o dB - d\gamma(B_o + dB)}{2},$$

where $d\gamma$ = shift in demand for OPEC oil due to U.S. regulation.

C. I now derive the expression for dB in terms of known parameters: The difference in post- and preregulation price slopes (S_l, S_o) is:

$$dS = -FQ'_b + Q'_s,$$

where F = the percentage decline in the price responsiveness of U.S. refiners' demand for crude oil (0.70), and Q'_b, Q'_s = respectively, the price slopes of U.S.

refiner demand and U.S. oil supply. Now define $S_l = (l - \lambda)S_o$. Then, $dS = -\lambda S_o = -FQ'_o + Q'_s$. Converting to elasticities,

$$\lambda = \frac{Fq_c\eta_D - \epsilon_s q_Q}{\eta_{\text{OPEC}}} > 0, \tag{A3}$$

where q_c is the ratio of U.S. refiner oil use to OPEC oil production (0.51), q_Q is the ratio of U.S. oil output to OPEC oil production (0.27), and $\eta_D, \epsilon_s, \eta_{\text{OPEC}}$ are elasticities of U.S. refiner demand (−0.5), U.S. oil supply (0.1) and demand for OPEC oil (−1.1 according to standard excess-demand formula). The values for elasticities of demand and supply are those used by Arrow and Kalt. Finally,

$$dB = \frac{1}{S_1} - \frac{1}{S_o} = \frac{1}{(1 - \lambda)S_o} - \frac{1}{S_o} = \frac{\lambda}{S_o} \doteq \lambda B_o.$$

D. Substituting for dB into the equation for increased price yields, after converting to elasticities:

$$\frac{dP}{P_o} = \frac{-[\lambda + (1 + \lambda)d\gamma/Q_o]}{2\eta_{\text{OPEC}}}, \tag{A4}$$

where $d\gamma/Q_o = 0.09$. Evaluating equations (A3) and (A4), I obtain

$$\frac{dp}{P_o} \cong .1335.$$

The observed oil price ($18.96/barrel) equal 1.1335 the price without regulation. That is, P_o = $16.73/barrel so that U.S. regulation would increase the world oil price by $2.23/barrel.

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