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ON ANALYZING INTERREGIONAL TRANSFERS OF WEALTH CAUSED BY ENERGY PRICE SHOCKS

Clarence W. Nelson

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I. Statement of the problem

This paper addresses the problem of analyzing the differential effects among states or regions of the United States—arising from an exogenous shock to crude energy prices such as occurred in 1973 and again in 1979-80. The general features of the problem are familiar. Crude energy (specifically oil), traded internationally in world markets and imported into the United States at the time as a 30- to 40-percent share of total U.S. crude energy inputs, was subjected to collusive actions by major world suppliers which drove up the world oil prices substantially. In response, large increases in resource values and in development activity related to energy materials occurred in the United States. But because deposits of U.S. domestic energy resources are concentrated in a relatively few states, so also were the apparent benefits of increased values induced by OPEC's actions.

Energy-exporting states were thus seen to be on the receiving end of windfall gains in income as a consequence of each new upward jump in world oil prices. The potentially enormous size of such windfall wealth transfers catapulted them into an important political issue during the late 1970s, and discussions of energy-wealth disparities appeared widely in the press.[1/] Public debate, needless to say, was sharply polarized according to which side of the interstate energy trade balance it was being viewed from. Often the debate appeared in the context of energy price decontrol. But the interstate conflict over distribution of the "windfalls" took on an added political dimension when legislatures in some energy producing states (notably the western coal producing states of Montana and Wyoming) raised severance tax rates on energy production.

Because of these public concerns, the problem of understanding the scope of interregional transfers of wealth caused by energy price shocks (and of evaluating them quantitatively) became one of practical importance. However, some of the steam was taken out of the interregional energy conflict when world crude oil prices, which had been sagging since their peak in 1981, dropped sharply in January 1983.

In early 1981, while the issues were still making big headlines, I prepared a simple analysis of the impact of rising energy prices, focused on the Ninth Federal Reserve District (and Minnesota). My conclusion, to distill its essence, was "matters really aren't all that bad." But my good news was not well received. My published report was criticized for being much too limited in scope and for having got the numbers wrong in terms of effects it did attempt to estimate.[2/]

Having learned what is to become a prophet without honor in his own country, I withdrew from the energy scene after 1981 and have since then only occasionally contemplated on the navel of regional energy issues. The Dallas Fed's Energy Conference seemed like a useful occasion to pull together some of those meditations, and that's the emphasis I've tried to convey in my title, "On analyzing interregional transfers of wealth caused by energy price shocks." My remarks are aimed more at how to go about asking the question rather than at providing an answer. I will provide an answer of sorts by recalculating some ad hoc estimates of income shares I generated in my earlier study. The rest of what I have to say is more concerned with defining an approach, yet to be implemented, that would take into account the various potentially significant channels through which differential regional effects could occur as a result of an exogenous energy shock.

The first part of this paper examines the notion of income transfer from energy-importing states to energy-exporting states as directly measured by the dollar increase in energy expenditures after a price shock. The second part considers a framework for analyzing the full complement of linkages between an energy-exporting region and an energy-importing region which may bear significantly on the comparative interregional effects of an exogenous energy price shock.

II. Examining income transfers caused by exogenous world energy price increases from the energy-importing states' perspective

A useful starting point is the energy dollar surplus (or deficit) figures computed by Chase Econometrics for each state in its 1978 report, The Energy Rich & The Energy Poor, which are reproduced in Table 1. These figures were arrived at by computing a net BTU surplus or deficit based on each state's consumption and production of three major classes of fuels, and applying an average U.S. price per BTU for each fuel to convert those net BTU surpluses or deficits into an aggregate dollar deficit. The resulting estimates have been widely cited and reproduced, and were often referred to in a kind of international trade terminology as "regional payment balances on energy account," "balance of payments deficits related to energy," or "dollar value of net energy balance." In the wake of a rise in energy prices, those deficit (surplus) balances of course become larger. In popular discussion in the press, the observed increases in dollar energy-deficits of energy-importing states were often cited as measures of income or wealth transfers from those deficit states—measures analogous to the income or wealth transfer from the United States to OPEC.

It was just such a measure of the increased energy import payment for Minnesota between 1972 and 1978 that my earlier paper looked at. My intuition was that interstate energy payments had some important differences from payments between the United States and OPEC. One obvious difference was that residents of energy-deficit states can and do share in energy-related gains through stock holdings and the redistributive effects of federal corporate and personal income taxes. Essentially, the first part of this paper explores conceptually the notions of interstate energy-payment flows and develops some stylized estimates of the quantitative significance of these redistributive effects.

Portraying the flow sequence of physical energy materials

Energy materials, broadly speaking, occur in three forms which are connected through two broad stages of production: (a) energy deposits into crude energy and (b) crude energy into refined energy (Figure 1). Refined energy is sold to households, government, and to businesses. Electrical utilities can be thought of as energy converters that transform energy materials into electrical energy which is then also sold to households, government, and businesses. Transportation can be viewed as distinct intervening stages adding to final price and value.

A physical sequence of production is involved starting with the production of crude energy from energy deposits, refining energy from crude energy materials and in turn transportation and delivery of refined energy materials—the bulk of it hydrocarbon compounds or other carbon forms—to consuming businesses, governments, and households. Each stage takes the output of the preceding stage as its cost of materials and contributes some "value-added" through payments for labor and other production factors.[3/] These energy materials flows have a specific geography (geographic trace), and we can in principle date and locate all units of material in the sequence.

Corresponding to that product flow we can, conceptually at least, trace a branching flow of payments in the reverse direction. We could start with the total energy bill for an importing state, following the path of payments made for inputs to the energy materials flows until the total "deficit on energy account" has been parcelled into shares representing household income and identified as to locus. The parcelling out can be illustrated by considering income and expense statement entries for a hypothetical firm playing some part in the production and delivery of energy to a deficit state (Figure 2). Revenues to the firm arise from the sale of its energy material output, to be divided, in turn, among the following ten expenditure categories.

(1) Energy materials. Payments are made by the firm for its energy materials inputs (whether crude or refined). Such payments are, simultaneously, revenues received by its supplying firms. Since those payments are obviously not (yet) household income, but are revenues of other firms, they would be further subjected to the expenditure- category analysis of Figure 2.

(2) Other inputs. Payment for "other inputs" (including all materials other than energy, plus supplies and contract services) also constitutes revenues of other firms and so are not yet geographically sited household income. Hence they would be traced further via the expenditure categories of Figure 2. It should be apparent that the exercise of tracing the sequence of payments for intermediate products and services from one firm to another could in principle branch off explosively and extend back indefinitely. The resultant branching network would lead to smaller and smaller fractional shares and would tend to be increasingly diffused geographically. In that respect, payment for "other inputs" would be unlike

payment for the physical energy substance which terminates, so to speak, at an oil well or coal mine.

(3) Royalty payments. Royalty payments[4/] would normally show up only on the books of the crude energy-producing firm, not, for example, the transporter or the refiner. Royalties paid to households would of course be counted as household income and, once identified as to geographic residence of the recipient, ends our trace. Some royalty payments might be made to firms, and would in that case be treated as revenues to be rechanneled further through the format of Figure 2. Royalty payments to trusts, pension funds, and the like would be counted in this schema as "household income" for which cash payment was received and an expenditure decision (namely, to save it) has been made by the household.

(4) Interest payments. Interest payments by the energy firm would also normally not be household income directly, although some of it—for example, that interest related to bondholdings of households—could be. Payments to a bank, though, would be treated as payments to a firm, and thus those amounts would be further sorted into salaries, dividends, taxes, and other inputs--as would the revenues of any other firm.

The first four expenditure categories of Figure 2 that we've just described are conventionally defined as "Cost of Materials"—value purchased from outside the firm. The remaining six categories then comprise what is conventionally defined as "Value Added."

(5) Payrolls. Payrolls are obviously direct wage-and-salary income of households and so would be tallied, sorted by state of residence. However, since personal taxes which households pay have an important redistributional function, after-tax disposable income is the relevant concept of measured income-flow for determining geographic destination of

income flows in this analysis. Thus, not only wage and salary income but household royalty, interest and dividend income is tallied on an after-tax basis. There is a question here whether to use only income taxes in deriving "after-tax" amounts countable as household income, or to include all taxes. Since some states choose to have no state income tax, but to rely on sales taxes, property taxes, etc., it seems appropriate in this analysis to deduct all taxes paid by households in our measure of income incidence.

(6) State and local taxes. State and local tax payments are revenues of governments, not (yet) household income. Governments in this framework are viewed simply as firms producing a set of services for which they hire labor and buy other inputs and capital goods. The division of their revenues into categories of payments can be fit through the same factor payment scheme as private firms (Figure 2), with an additional category of outlay, "Transfer Payments." Transfer payments are direct, pre-tax income to households assignable by geographic incidence. Thus a state receiving increments to tax revenue generated through energy-related activity within that state is not necessarily the state to which is credited the household income incidence of that tax revenue flow. Part will be, part won't. In particular, this means that severance taxes on the production of crude energy materials do not automatically end up as household income in the energy-exporting states, because some of the payments made by state governments out of their revenues are for purchase of out-of-state products and services. (The value of government services is not viewed as implicit transfer-payment income of households, but as the outcome of a kind of nonmarket consumption decision by the benefitting households.)

(7) Federal taxes. Federal taxes are analyzed in the same manner as those of states. Federal wage and salary payments are assigned

geographically, just as those of private firms, by place of employee residence.

(8) Capital goods purchased. The capital expenditure category in Figure 2 in a conventional income-and-expense statement would be filled by capital consumption allowances, usually a kind of weighted average write-off of past capital expenditures. (Capital consumption accounts in the case of crude energy production prior to 1976 or so contained a greater or lesser additional allowance in the form of "percentage depletion" designed to shield income from taxation and presumably awarded to energy producers as a subsidy or incentive.) In principle what we have in mind for this expenditure category is the actual payments for capital goods, facilities, and property (including, e.g., patents and mineral land leases) which play a part in producing the current year's output of energy materials. That introduces an obvious discontinuity into our conceptual exercise of tracing expenditures for imported energy as a "flow" of payments backwards along the various lines of supply. The supplier of the capital equipment that helped contribute to delivery in the current year of the petroleum products for which current year revenues were received was actually paid in cash several years back. The spirit of this inquiry requires that, in order to determine household income incidence, the earlier actual cash payment to the supplier of capital equipment be screened in turn through the expenditure categories of Figure 2, as though the capital goods supplier were another firm supplying "other inputs."

(This procedure, we should reemphasize, is a conceptual sorting out that could in principle be carried out, though it becomes clear that when we begin to involve all the "upstream" contributions of firms to firms and all of the side branching of the variety of contemporaneous intermediate product-and-service contributions of one firm to another (counting also governments as firms), we've defined a procedure that could literally be extended indefinitely. At some point, though, we would presumably exhaust any arbitrarily large fraction of household after-tax income attributed to a current year's energy import expenditures, thus stopping before we were forced to consider the contribution of the cave painters of Lascaux.)

(9) Dividends. The dividends category in Figure 2 covers all cash payments to owners (stockholders, partners, etc.) out of the proceeds of the firm. These payments might be made directly to households, in which case they become pre-tax household income. Dividend payments made to other firms would constitute revenues to be sorted out in turn according to Figure 2 categories.

(10) Net cash accumulated. Finally any cash left over from revenues after the nine preceding expenditure categories, have been deducted is viewed in this schema as net accumulation of cash credited to owners' account.

Our thought picture in this exercise seeks to follow a conceptual aggregate flow of money payments backward along the line of product flow in order to observe the aggregate payment flow branching into finer and finer fractions until we can identify each fraction to be household income by state of household residence. But it is clearly artificial to think of that payment flow moving forward in time. Although the energy product flow that underlies it does move continuously forward in time, the payments received by firms and individuals related to the physical-flow sequence are in general retrogressively stacked in the same way that capital equipment purchases are. That is, the payment for factors (labor, supplies, etc.) is made in anticipation of sale "downstream" and usually occurs before the revenue for the product is received by the producer. That fact of commerce is what most business credit is designed to accommodate and what makes interest expense an important item on firms' statements. Consideration of the correct time sequence will have a more direct bearing on analysis of the impact of an energy price shock. At this point, however, we are simply examining the concept of geographic income incidence of energy payment flows.

How the geographic income incidence of deficit states energy import bill is altered by an energy price shock

We have just described a conceptual process starting with the total refined energy import bill for a given state in a given year that would ultimately apportion all the expenditure into household income by state. That process defines the "primary income incidence" of energy expenditures, which is our sole concern in this first part of the paper. "Secondary" income in this context would be the consequence of household spending of primary income.

Some of the payment flows so traced will be primary income to households in energy-exporting states, but some of the primary income generated by the energy payment flow will go to other states, including the energy-importing state in question. In addition, part of the energy expenditure for some states may be traceable to OPEC or to other oil-exporting countries. Portions of that payment may also return to U.S. households, for example, as dividends paid out by international oil companies on stock held by U.S. residents.

Our plan is to consider what happens to primary income flow incidence after an exogenous energy price shock. The case argued here is that, in response to a price shock, a limited number of the expenditure categories in Figure 2 will quickly expand to absorb the bulk of any given state's increased energy bill, and that these responsive categories act strongly to geographically diffuse household disposable income. Thus the effect of an external energy price shock on income transfer is at most a pale reflection of the pattern portrayed by changes in states' energy dollar surpluses or deficits.

A stylized model of interstate energy payments flow

In the following section we'll portray flows of interstate energy materials in a simplified and stylized way. We'll consider a hypothetical energy-importing state, called "MN," which imports all of its energy from a single, distant state, called "TX," in the form of petroleum liquids. We'll assume that no government price controls or quantity allocations exist to impede market price and quantity decisions. Six generalized stages in the energy-materials production and delivery sequence are represented in Figure 3. We'll portray each stage as though handled by a separate firm, beginning in TX with: (1) an oil production firm whose revenues cover its various production costs, taxes, and profits, including royalty paid to the owners of mineral lands it leases; (2) An oil pipeline firm in our story buys crude oil at the wellhead, the payment for which represents its cost of materials to be covered—along with other costs, taxes, and profits—by its revenues from crude oil it sells to the refinery; (3) a refiner whose cost of input crude oil plus other costs and profit are covered by revenues from sale of its output to (4) the product pipeline firm delivering petroleum products to MN where they are sold to (5) a wholesale jobber in MN whose revenues from delivery of petroleum products to retailers covers what it paid to the pipeline firm plus its own value added (payroll and other costs plus taxes and profits); (6) retailers selling refined energy materials in small lots to households, businesses, and government units in MN use the revenues so generated to cover their own value added and the wholesale cost of the products. Our schema in Figure 3 defines the wellhead source of crude energy to be located in TX and the consumer of refined energy to be located in MN, but allows for the possibility that the refining operation be located in TX, MN, an intervening state, or split among all three regions. "Other states" thus comprise a third region of interest in our stylized model. The particular combination chosen for refinery locations, of course, affects the geographic distribution of value added in the overall process.

While this portrayal of the producer-to-consumer connection is highly stylized and simplified, in principle most energy materials can be reasonably interpreted to flow through stages corresponding to Figure 3. Successive accumulations of value-added results from both processing and transportation stages.

Characterizing the effects of energy price shocks on income in our stylized model

Now let's consider responses in our stylized model to an energy price shock. The story is as follows. Say the world price of crude oil, as measured at U.S. coastal points, is doubled. A substantial portion of U.S. refiners depend on foreign oil. Domestic crude oil producers, though not part of the producer cartel, would immediately be motivated to raise their prices to a point at or near the new world levels and, in response to higher prices, to expand production. Market effects of these actions of domestic producers may drive world prices downward at least by some small amount, but we assume the domestic producer's ability to expand output will be limited both in amount and speed.

Our analysis abstracts from governmental price controls and contractual impediments to price adjustment for simplicity, though that's not important to the conclusions. The result is that the world price increase quickly translates into a corresponding price jump for crude oil at the TX wellhead. In all of the subsequent stages of production, firms mark up their output prices to compensate for the higher input price they now face. Of course, an increasing price for energy materials—crude or refined—can be expected to cause consumers to respond by reducing quantities taken. The full response in demand may take some time to occur, but, as it does, micro-level adjustments will alter profitability of firms all along the supply sequence. Failure of some higher cost firms or operations presumably would act to cause prices to be shaded downward. (Surviving firms presumably are more efficient, hence operating at lower marginal cost.) That path toward balancing supply with demand for energy materials in practice can involve complex and protracted price behavior by both suppliers and consumers.

But since our focus here is on examining the resultant increase in the total energy bill for our hypothetical importing state, we pick up the story at whatever level of increase is observed in response to the world oil price shock at any convenient point in time after the shock. So we'll abstract from the micro-level adjustments and assume they've essentially run their course our illustrative examples.

Table 2A depicts how the revenues received by each stage in the Figure 3 energy delivery chain are divided into the accounting expenditure categories we've discussed earlier. The payments shown are per barrel of crude oil produced at the wellhead or the equivalent in terms of a composite refined petroleum product. I selected the amounts and proportionate shares, based on published balance sheets and statistical data, as roughly representative of actual operations during the mid to late 1970s. They are nonetheless simply "stylized facts," and no precision is claimed or needed for illustrating the principles of the case.

"First-Order" Effects of Increased World Oil Prices.

Next, given the framework of Table 2A, we trace through what we'll call the "first-order" impact of a shock to world oil prices (results shown in Table 2B). We'll assume that event translates directly into a doubling of price per barrel of crude oil—an increase of $10.00—at the TX wellhead.[5/] The crude oil producing firm does not purchase its energy materials input (crude oil in the ground) but produces it under contract, which requires the firm to pay a fraction of the wellhead value of crude oil so produced to the owner of the land or the holder of mineral rights on the property. Thus the value of royalties increases by $1.25 (here we use a standard 1/8 royalty share). The remaining 7/8 of the increase in value belongs to the producing firm, which must pay any production-related taxes out of its share. Some state-and-local tax payments by energy producers will rise more or less proportionately with the value increase. In our example, we assume a flat 8 percent covers the severance tax and other state and local taxes on energy-producing firms in TX. The remainder of the producing firms' increased revenue per barrel is subject to the federal corporate income tax (assumed here to apply at a 52 percent marginal rate). Federal tax take thus increases by $4.13. The remainder of the per-barrel price increase ($3.82) belongs to the stockholders, some of it presumably supporting an increase in dividends and the remainder being an addition to accumulated cash (unless or until it is used for new or replacement capital expenditures).

We depicted each subsequent stage in Table 2B facing a higher cost of materials on its input side and raising its product prices on the output side by a straight cost pass-through action. The only payment category increased for any stage after the crude oil production stage is "Energy Materials" and, in particular, wage and salary payments are not increased anywhere in the system. These "first-order" effects are recorded in Table 2B. Notice that at each successive stage the percentage increase in price is lower, in recognition of increasing shares of value added that are not subject to price increase.

"Second-Order" Effects of Increased World Oil Prices

We may then define a set of "second-order" effects as follows. Our Table 2B includes only the energy subsector (production, refining, delivery) of the economy. The remainder of the business sector of the economy, which is the source of "Other inputs" and capital goods for the energy-sector firms in Table 2A, buys refined energy as an input. We'll assume that the business sector reacts to greater energy input costs in the production of its outputs by applying a straight cost pass-through adjustment to its output prices. Thus, the price of output for the composite business sector thus goes up by the percentage increase in retail or wholesale refined energy prices times the fractional share that energy costs make up of total business product value. We assume a 1/20th share times a 44-percent increase, which gives us a 2.2 percent rise. These nonenergy intermediate products compose the "Other Inputs" to the energy sector in Table 2A, so the price increases of those inputs add to the costs of all energy sector stages and our cost pass-through assumption implies a cumulative contribution to in the prices of downstream stages over and above the first-order effects. The net effect of these described second-order effects is summarized in Table 2C.

There are likely additional second-order effects. For example, assuming no change in interest rate, the interest bill will increase somewhat because inventories must be financed at a higher value per physical unit of material, which implies larger debt levels for a given real throughput.

In this treatment, we have adopted the premise that received cost increases are simply passed through by marking up prices a corresponding amount. To the extent that cost increases cannot be fully passed through in prices, then the stockholders' share in crude energy-producing firms, which is a residual, is reduced, although that reduction is partially offset by reductions in corporate income taxes and personal income taxes.

We could continue to identify other orders of effects, each helping to illustrate some individual piece in the complex web of events generated when input price changes feed through the supply side. Pass-through of just the energy cost increases implies reductions in real wages and profit margins. We assume the latter are not restored, so that the increase in relative energy costs "sticks."

The net result of this exercise is shown in Table 3. Given the premises of the exercise, there are four groups claiming the bulk of the increased payment on energy account for energy materials imported from TX into MN: (1) royalty holders, (2) the TX state government, (3) the federal government, and (4) the crude oil producing companies. It can be argued that other income and revenue claimants would also share in the windfall rents in practice. The step-up in energy exploration, development, and production activity that would follow an oil price shock would presumably also act to drive up prices of other inputs directly specialized to the energy industry. For example, new or renewal lease rentals (these are not the same as production royalties) and equipment and supplies used in efforts to expand production would likely show higher price tags as would specialty wage rates. But the cost effects of these higher prices will apply mainly against future production. Costs of future production will also rise because lower quality or less tractable deposits are brought into play. That characteristic of the exploitation of exhaustible resources implies that the windfall rents created by any given oil shock are also an "exhausting resource" whose capture rate will decline toward zero as currently-developed deposits are depleted. Thus the income transfer effects we are examining are also transitory. For our purposes we'll assume the impact of these "forward" or investment costs on current expenditure shares to be small. We'll proceed with the division of shares as in Table 3.

Stockholders-owners share. By deducting royalty, TX severance tax and federal corporate income tax shares from the $10.00 increase per unit of energy materials paid by MN households, businesses, and governments, the remaining $6.18, as shown in the table, accrues to the owners of the producing firms. (We'll ignore for present purposes the windfall profits tax, which has the effect of increasing the federal share.)

Now the question is, what are the consequences to household income incidence by state, of the increases in revenues and tax receipts tallied in Table 3? The results are developed in Table 4A, as follows:

(1) Royalty holders. Some fraction of royalty recipients are not households. Corporations and federal and state governments also own lands or mineral rights on which energy production royalties are paid. Thus while the household incidence of royalty income may be largely to households located in the hypothetical producing state of TX, some unknown share is geographically diffused to become direct households income in other

states. For our stylized model we will arbitrarily assume the royalty income increase to be divided 90 percent TX, 9 percent "Other State," and 1 percent MN.

(2) The TX state government. The TX state severance tax is figured here to expand by $.80 corresponding to the $10.00 wellhead price increase, but the income incidence of that revenue is not entirely TX. Some of TX government expenditures from severance tax revenues, for example, go to purchase goods from other states, thereby some share will end up being countable as primary household income in other states. We do face another choice of assumptions here. The increased severance tax receipts by TX state government could be used to reduce other types of TX taxes or to support expanded government expenditures or a combination of both. To the extent increased expenditures occur, the geographic incidence of resulting household income would depend on the import content of state government purchases. Using a Texas input-output model as a basis for computation, we adopt a split of $.65 as TX income and $.15 as "Other States" income (some of which could even be MN household income). To the extent other types of state taxes are reduced, federal income taxes will rise (because of state tax deductibility) by an amount equal to the marginal federal tax rate times the reduction of state taxes.

(3) The federal government. The federal government's tax share is computed as the increased revenue, less both royalty and state tax increases, times the federal corporation income tax marginal tax rate, which we'll take as 52 percent. We'll assume the normal cost depletion allowance exhibits no per-barrel increase with the price rise (though percentage depletion would). The resulting federal revenue share is thus $4.13. If we assume federal expenditures and transfer payments are dis-

tributed approximately according to state population and remain essentially unchanged in terms of geographic incidence (aside from its direct energy materials purchases), then the $4.13 federal corporate income tax share converts into household pretax income receipts of $.25 to TX households, $.08 to MN households, and $3.80 to households in other states.

(4) In practice, part of the residual $3.82 cash flow would ordinarily be paid to stockholders as dividends. The remainder is accumulated as cash or invested in capital goods or other assets by the firm, which would represent a capital gain for the owner-stockholder. As such as it becomes a claim on a future income stream whose expected present value is presumably at least equal to the present reinvested cash.

For simplicity in our stylized treatment, we'll assume all net cash flow paid out as dividends. Some stockholders are themselves corporations for whom dividends are one source of revenues and thus, in our framework, require tracing through further sets of expenditure categories (as in Figure 2) in order to arrive at household income incidence by state of residence. Good data does not appear to be available on the geographic distribution of energy producer dividend payments to households, but there seems little reason to doubt that the process is substantially geographically diffusing and leveling. To assume that the household income incidence of energy-producing firms' dividends is uniform across states is probably a bit extreme, since it could be argued that some producing firms are privately held by families or closed groups whose residences continue to be in the energy-producing states where most of the firms were founded. Nevertheless, it seems safe to claim that most energy production is controlled by large firms whose stocks are publicly traded and widely dispersed geographically.

Assuming stock ownership in energy-producing firms is distributed by states with double the density in the producing states relative to population as it is elsewhere, then the resulting incidence of household dividend income would be: 11.3 percent TX, 1.8 percent MN and 86.8 percent other states. Assuming the distribution of stock ownership has ten times the density in the producing state TX as it does elsewhere yields the following incidence: 39 percent TX, 1.3 percent MN, and 59.7 percent other states. We adopt the former premise for subsequent calculations.

Adding up the four sets of flows we obtain a regional distribution of incremental income flows (per unit of energy product imported by MN) as follows: TX, \$2.45; MN, \$.16; and Other States, \$7.38. But the federal personal income tax has further redistributive effects, which are calculated in Table 4B. The final result is that of the \$10.00 per-unit increase in MN import bill for energy materials (which we assumed were delivered entirely from TX) \$2.08 goes to TX households, \$.17 returns to MN and \$7.74 flows to households in other states.

Impact on MN households when effects on all states are considered

When an oil price shock occurs, two things are directly increased for MN households: (1) their energy bill and (2) those income flows and offsets which are a result of increased aggregate spending for energy materials anywhere. Thus, the change in MN household disposable income is contributed to by increased expenditures of households in all states, including increased expenditures by each consumer in the energy-exporting states. The income-diffusing processes described above are at work. In this section we want to take the effect of increased total U.S. energy expenditures on MN income into account, along with the fact that some of the increase in U.S. energy payment is drained away as foreign income (mainly to OPEC). That loss to foreign households, of course, must be deducted from the share of payments available to flow to U.S. households.

On the expenditure side we face a choice about what we include in our measure of the increase in household energy expenditures. Our starting focus was on the increase in the total MN dollar energy-deficit measured at the border or at the first turnover after interstate delivery inside the border. For purposes of computation we'll assume the expenditure increase by our hypothetical state, MN, for energy imports rose by $1.3 billion in the wake of the energy price shock. That includes payment increases by businesses, households, and government in MN.[6/] On the income effects side, we will be looking exclusively at household income, so the proposition might be posed that we consider only the increase in household expenditures for energy materials. That approach would measure direct energy spending by households. On the other hand, the total MN energy bill increase could be considered a proxy for direct plus indirect increases in the cost of energy in the MN household budget. In any event, we'll use total increase in the MN energy import bill as a more complete representation of the increase in MN household expenditure caused by our assumed energy price shock.

The essential point is that household income, flowing directly from the rise in energy prices in any given energy-importing state, acts to offset the burden to importing-state households of a higher energy bill. Only the net of the two figures can measure the (nominal) windfall income transfer from a given state's households to households in other states (including energy-exporting states). The relevant information for such a calculation for MN is: (1) the total rise in dollar energy costs for MN (regardless of the geographic location of its crude energy sources) and (2)

MN households' total dollar share in claims on the windfall energy rents, wherever created, as a consequence of the energy price shock.

In Table 5 we illustrate the calculation of MN households' share of the total windfall rent (created by the world oil price shock that doubled TX wellhead prices) after the external drain of dollar payments to OPEC is taken into account. That portion of the increas in energy payments by U.S. consumers is assumed to be unavailable for sharing by U.S. households. Under the assumptions used in this stylized exercise, primary income flows to MN households increase by about $1.0 billion as a consequence of the geographic diffusion of windfall rent claims. That compares with the total expenditure increase of $1.3 billion, leaving a net $300 million as our estimate of nominal "income transfer" away from MN households, or 23 percent of the $1.3 billion increase in total dollar deficits on energy account for the state.

That completes our exercise on evaluating windfall energy-shock-induced transfers of income between states. The results so derived, while based on a very stylized portrayal of an energy-deficit state, are nonetheless offered as an a priori plausible neighborhood for the redistributive effects operative for most states in practice.

III. Examining interregional implications of an energy price shock roughly in the spirit of general equilibrium analysis

What we did in Part II was at best a limited and partial exploration of the regional impact of an energy price shock. The objective of this section is to consider what's involved in taking a more complete and systematic view of the transmission of disparate regional effects. Two broad classes of effects will need to be accounted for: (1) distributional macro-level effects on the patterns of nominal incomes and expenditures flows (which is the sort of thing we were occupied with in a limited way in Part II) and (2) the micro-level effects of a higher relative price of energy on allocative choices and the consequent changes in geographic patterns of real output and trade. The result seems well established theoretically and empirically that an increase in the real price of energy inputs will reduce real output. In simple terms, the micro-level effect tells us that the size of the total pie is reduced, while the macro-level effect tells us that the relative shares in the pie will change, with an increased share going to energy resource owners, energy producers and the taxing authorities. Any complete analysis of energy shock consequences needs to take both effects into account. And both types of effects crop up in arguments about energy-price-related interregional disparities. To motivate our discussion, let's review a kind of composite scenario replete with criticisms of the partial treatment of the problem we offered in Section II.

Starting with some obvious aggregate spending effects, consider the following scenario. Deficit state consumers are forced to spend more of their limited incomes for energy, and so will have less money left over out of given income for spending on other goods. Hence, spending on nonenergy items will be reduced which will, in turn, force cutbacks, particularly for businesses producing for local markets. These secondary losses in payrolls and profits will induce further increments to regional losses following the usual multiplier process. In addition, the state governments in deficit states will, as a result of depressed state income, profits, and employment, suffer losses of revenue and drains on social welfare funds that imply either increased taxes or reduced services. Meanwhile, back at the wellhead (or minemouth or waterfall, as the case may be), energy production and development is booming, state government severance taxes have leaped in direct proportion to the energy price jump. Moreover, prospectively we can be confident such revenues will accumulate at an even faster pace as energy production expands. The business climates in the surplus states are sharply enhanced, thus inducing businesses (currently and prospectively) to move from the energy-deficit states in turn causing further deterioration in employment, income, and tax conditions for the energy-deficit states. Furthermore, the energy boom in the surplus states and the prospects for favorable returns on energy development to exploit the enormous rents created by the higher oil prices draws increasing shares of new investment funds. In particular, investment funds are drawn out of and away from the energy-deficit states, depriving deficit states' industries of capital investment necessary for growth. And while it may be true that much of the windfall energy rents are returned to deficit states through the channels we described in Section II, a substantial portion of that money is income in the form of energy firm dividends (or income derived from converting into cash capital gains on stocks in those firms). That type of income, it could be argued, is mainly received by high-income households that are much more likely to spend their gains out-of-state, in pursuit of the attractive investment opportunities in the booming energy-production areas. Then, too, at the micro level there seems reason to believe deficit region industries will be especially hard hit on profitability and efficiency grounds by rising energy costs. An important segment of the energy-deficit region is composed of northern industrial states distant from major energy sources and facing higher heating requirements than the southwestern energy-exporting states.

Well, what's wrong with that story? Perhaps it's not wrong at all, merely a bit incomplete. There are some other sides to consider. For example, local goods industries in energy-deficit regions may face a loss of some effective demand, but demand for the deficit regions' export products could be raised by booming conditions in energy-producing states. And booming conditions in energy regions could raise local wage service and supply costs to the nonenergy sectors in energy regions. Furthermore, demand by energy-deficit regions for non-energy export goods from energy-surplus regions would presumably drop, which would have a negative effect on some industries in the energy-surplus region. Then, too, for the same reasons that stockholders in deficit regions will share in the gains of booming energy firms, so stockholders in surplus regions will help share the losses (via reduced dividend streams and capital values) of deficit region businesses that are hurt. And on the matter of disparate movements in state and local tax burdens favoring energy-exporting states, such tax payments are deductible from federal corporate and personal income taxes. Any disparate movements in state taxes arising from an energy price shock would thus be at least partially offset by an opposite movement in federal tax liabilities. Even more importantly, on the micro side, the cost of energy will also jump for businesses (and, of course, households and governments) in the energy-producing regions. In fact, as our exercise on transportation value added in Table 2B showed, energy prices in energy-producing states are apt to rise proportionately more than those in distant energy-importing states. As Figure 4 shows, energy costs to manufacturers did in fact rise by greater percentages in the major energy-producing states than in the major energy-deficit regions. While absolute changes in energy costs may have been roughly the same across regions, the differences in percentage increase may be a better index of adverse impact on profitability. There is some evidence that energy state industries have adapted to relatively low-cost energy availability by installing a relatively high energy-input suite of industries which could conceivably exhibit greater vulnerability to adverse impacts of energy prices on production costs. The comparison of two states in Figure 5 illustrates consistent differences in energy intensity within industry categories.

Finally, while an oil price shock does stimulate investment during an energy-development boom in the energy-exporting states, strong incentives are also created to invest in energy conservation in all regions. Thus some industries in deficit regions are stimulated to expand production, for example, those producing temperature and energy control technology, insulation, fuel-saving technology, etc. Return on investment in improved industrial plant energy efficiency proved to be very high when energy costs soared.

The important problem then for those interested in understanding the regional impact of rising energy prices is the complex task of assessing how these linkages described in the preceding scenarios, and other potentially significant interconnections as well, tend on balance to level out or redistribute the gains and losses of an energy price shock interregionally. On that score the present paper merely suggests an approach to organizing the modeling of the problem. It is as yet a planning exercise with no application or results. What follows is an attempt to lay out a conceptual framework for approaching the analysis of regional impacts with sufficient detail to directly represent these effects identified in the public debate as potentially important channels acting either to aggravate or ameliorate interregional disparities triggered by energy price shocks.

The basic approach, as in Part II, is to develop a stylized framework for modeling the problem. It would differentiate two regions consisting of all energy-deficit states as one block and all energy-surplus states as another block. The real world counterparts of these stylized regional blocks would be, say, the two groups of states listed in Table 1 as surplus and deficit. Parameters characterizing regional features of the model where needed would be drawn or estimated with that correspondence in mind. But the stylizing of features would be deliberate in order to isolate and explain the key issues more clearly. We would also abstract from such features of actual experience of the past decade, such as government energy price controls or allocation schemes.

A framework linking the various sectors and the two regions is based on a standard input-output type matrix, $[F_{ij}]$, whose entries are dollar payment flows among sectors. The full version contemplates perhaps 27 sectors intended to specifically accommodate the types of interactions cited in the composite scenarios above. Table 6 shows a condensed version of what I'm proposing—condensed to 11 sectors to make it easier to describe the actors and the connections to be modeled. Subsequently I will indicate how the additional sector detail might serve a useful purpose in evaluating the interregional impact of an energy price shock.

There are 11 sectors listed in the column headings, with the entries in any column indicating dollar amounts paid out by that sector to each of the other sectors as listed in the row headings (and to itself, where appropriate). The same 11 sectors of course are repeated down the row headings at the left. The entries in any row indicate each of the sources of revenue or income to the sector represented by that row.

Let me define the sectors. Sectors generally fall into two blocks, the deficit block (DB) and the surplus block (SB) plus two other sectors, federal government (Fed Gov't) and the foreign suppliers of imported oil (OPEC). Deficit block businesses are split out in two groups: (1) DB Local and (2) DB Export, defined to include, respectively, those businesses that do not sell products outside the deficit block region and those that do. Surplus block businesses are split into three sectors: (3) SB Local and (4) SB Export (which are defined as for the deficit block) and (5) SB Energy, which in this condensed matrix is defined to include all domestic energy production and refining as well as the refining of all OPEC crude energy imported. Thus refined energy products are not produced in the deficit block but only purchased from the surplus block and consumed in the deficit block by DB businesses, governments, and households. Governmental sectors are (6) DB Gov't and (7) SB Gov't, defined to include their respective state and local units, and (8) Fed Gov't. The two regional-block governments get their revenues from taxes on private sectors in their respective blocks and by transfers from Fed Gov't, and then spend such revenues via their employee payrolls, cash transfer payments to households, and purchase of goods produced by private sector business. In addition, the SB Gov't may receive revenue in the form of royalties on crude energy production on property it may own in its region. The federal government functions as though it operates branch governments in the two respective blocks, though applying uniform rules for taxing and allocating its expenditures (purchases and payrolls). In addition, the Fed Gov't makes cash transfer payments to the two block governments under uniform rules. The next sector, (9) OPEC, receives revenue from the sale of crude energy to the SB energy sector and may purchase export goods from the two U.S. regional blocks (though conceivably in lesser amounts than its revenues, in which case it would represents a payment leakage out of the matrix).

Finally, the household sectors in each block, (10) DB Households and (11) SB Households, receive wages for working for their respective regional businesses or governments, transfer payments from their respective regional governments, dividends on equity ownership of businesses, and royalties from crude energy production on energy properties owned by households.

Capital goods production is ignored in Table 6, but replacement capital to repair physical depreciation can be included in the interindustry intermediate product flow.

Now that the sectors have been defined, let's describe the entries shown in Table 6 where an assortment of zeros and letters appear. In more exacting notation, each cell could contain a nonnegative flow amount, F_{ij}, properly subscripted as to row i and column j. All are cash payments. In their stead, for ease of identification, the following generally mnemonic scheme of letters appears (subscripts are dropped, so bear in mind that each appearance of a letter is in principle a different dollar payment amount):

x = interindustry flows (payments for the "intermediate products" of an input-output table)

g = government purchases of goods and services

z = foreign purchases of domestic products and services

c = consumption purchases of households

t = tax collections by governments

r = royalty payments on crude energy production to households and governments

v = income transfers from federal to state governments to households

w = wage and salary payments to households from government and businesses

d = dividends paid to households by businesses

Zeros are arbitrarily assigned to some cells representing "plausible" values, given the author's intended interpretation of the structure of payment flows in the model (for example, by the definition of "local" business sector, DB output is not sold to SB purchasers nor the reverse. In the condensed model of Table 6, all activity is on a cash basis and all funds flow are included, which implies an assumption of no borrowing and no debt paper ownership. Equity ownership is of course implied by the dividend flow, and a parallel accounting matrix corresponding to the cash flow matrix can be imagined to exist to record equity share ownership by households (and conceivably OPEC) in each of the business sectors. In this setup there is no investment, additional equity issue, or cash accumulation so that all after-tax profits are paid out as dividends.

The product or service content corresponding to each payment cell obviously covers a broad class of things. The products behind the $x_{2,4}$ going from DB export to SB export is presumably different from the product behind the $x_{4,2}$ going from SB export to DB export, and reflects some form of established regional specialization and trade (consistent with a "no-coals-to-Newcastle" sort of premise).

Each row represents an equation saying the following: Total revenue received by sector i equals the sum of payments made to sector i by all of the sectors j. Each column, correspondingly, respresents an equation saying the total expenditures by sector j equals the sum of the payments made to each of the sectors i. There is also a set of equations holding for Table 6 that says expenditures of any sector i is equal to the revenues of sector i (with the possible exception of the OPEC sector). These relationships are of course simply a cataloging of the sources-uses flow identities and budget constraints, which must hold by definition regardless of whatever changes or adjustments occur among sectors.

We might think of the flow amounts defined for a period of, say, one quarter with the notion that our plan ultimately is to trace changes that occur over a longer span of time in the sequence of flows in response to an energy price shock after a period in which a more or less stable pattern had been established. So the objective of this exercise is to interpret and understand the implicit dynamics of adjustment.

We are interested in examining what happens in consequence of an energy price shock. We might represent the initial, partial effects of such an occurrence as depicted in Figure 9. Here we see increased payments in line (5) in payment for energy sold by energy producers to the various sectors. In turn, that increased flow [picture it as flowing down column (5)] gets divided among OPEC, SB Gov't, Fed Gov't and SB and DB Households, thus increasing those respective sectors' incomes or revenues. That increase (picture it as flowing to the left along the rows) gets funneled around by those five sectors to be spent (flowing downward into various entries in the respective columns), altering further the revenues and incomes captured by the various sectors as measured along the rows, and so on. These are the macro-distributional flows that in some sense were the focus of Part II.

But while these few steps in our story started out like an exercise in network hydraulics, in order for such flows and flow adjustments to make any economic sense we would need to look behind the dollar payment flows. We need to recognize that the payment flows are in general a product of a price (or price index for the composite of physical items making up the transactions) and a quantity (also in general an index standing for quantity of a composite of specific goods and services). Underlying the payment flows, then, must be a corresponding set of price and quantity decision processes of consumers and producers which need to be described and be broadly consistent. Technical and budget constraints must be observed. For governments, some kind of tax rules and expenditures policy need to be described.

In principle it would be presumably possible to write out a general equilibrium-type model including all of the various sectors as optimizing agents with well-behaved utility functions, production functions, tax-revenue setting rules, etc., facing well-defined constraints, and to produce a model that could be solved either with estimated or assigned plausible parameters. A traditional treatment would seek to examine "equilibrium values" in such a model before and after an exogenous price shock occurs. However, it's apparent from recent history that the adjustment process is not instantaneous. Firms don't capsize immediately, nor are workers immediately laid off. Debt and "eating up" capital can prolong the survival of effectively unprofitable enterprises. As they say about travel, "getting there is half the fun." In our case, the adjustment process, which can run several quarters, serves up at least half the interest value of the problem. For that reason, generating steady-state, equilibrium results doesn't seem to answer the quest for an understanding of the process and characteristics of regional adjustment to energy price shocks.

How one would model an adjustment process that would mirror the real world's "viscosity" in any clean or elegant way I really dont know, and particularly in the context of the multisector, multiregion structure I'm proposing (I would welcome suggestions). I can imagine (with difficulty) a tedious, cut-and-try process of tracing an assumed price shock as we began it above, through all the recyclings that work out the main orders of effects, during which the underlying agent price-quantity decisions were given at least stylized representation (cost pass-through pricing, for example). Such repeated iterations would presumably, produce some "disequilibrium" outcomes, including unemployment, that in turn would provide the basis for some presumed adjustments in pricing and quantity decisions in subsequent periods. The hope would be that some set of consistently formulated transition rules, however ad hoc, would ultimately yield a sequence of outcomes that appears broadly conformable to the measurable features of actual experience. A strictly general equilibrium modeling strategy seems a bit remote for dealing with such disequilibrium adjustment phenomena as the lagged pace of expansion of domestic energy production or the timing and extent of labor migration in response to interregional shifts in job opportunities. That's why working "roughly in the spirit of general equilibrium modeling" may be as much as one could expect in analyzing the regional energy impact issues.

A more complete set of sectors with financing and capital accounts

The expanded set of sectors to be briefly described here (listed in Table 7) adds detail to the sectors listed in Table 6. For one thing, a Rest-of-the-World sector is added to accommodate our non-OPEC trading partners. For another, explicit capital goods production sectors are added (for the DB and SB regions and the Rest-of-the-World separately).

Other detail occurs in the form of further differentiated sectors, particularly related to features of energy production or use. The intent is to afford relevant detail for clarifying the locus of windfall gains and losses and for demonstrating results in a setting of a somewhat more useful articulation of regional industrial structure for purposes of representing both micro- and macro-level responses. Thus the surplus block energy sector is split into crude energy and refined energy production. Refined energy production also occurs in deficit-block states based on crude energy purchased either from the surplus block or OPEC. Further splitting out of an energy transportation sector introduces a "value-added" differential explicitly generating higher delivered-energy prices in the deficit block and higher percentage rates of increase in energy prices in energy-surplus block, appropriate to exploring some of the concerns expressed about interregional competitive impacts. On the issue of effects on relative regional competitiveness of an energy shock, the modeling of regional differences in the intensity of industry usage of energy should be explored.

A related disaggregation within each of the final-goods-producing sectors differentiates between a high energy-intensity subsector and low energy-intensity subsector. This would help portray some of the micro-level adjustment process via consumption substitution shifting among mix of output. Such consumer decisions, in response to increased relative prices of more energy-intensive products and services, can generate transitional unemployment and capital losses quite apart from the macro-level failure of local aggregate demand arising from the diversion of a deficit region's income flows to energy imports.

A final proposed elaboration of sectors is the differentiation between high-income and low-income households in a stylized way in each of the two regions. Ownership of equity and bonds can by definition be confined to high-income households so that all income in the form of dividends, bond interest, and capital gains on equity and bond portfolios accrues to high-income households. These results are of course stylized, outside limits to income class differentiation with respect to sharing in energy-shock induced income reflows. In practice, presumably most families—even those in the lower half of the income range—catch at least some shares of capital gains through pension funds, state trust fund holdings, or other savings plans. Nonetheless, the possibility that wealth transfers due to energy shock may be more sharply an inter-class phenomenon than an interregional phenomenon suggests that it is useful to allow that effect to be evaluated explicitly within the structure of the model.

The framework is intended to cover all funds flows. Besides payments for current purchases, payrolls, and taxes, other payments involved in capital transactions borrowing, selling equity, repayment of principal and interest, etc., are covered and recorded on a cash basis. Investment in plant and equipment by firms or governments is likewise recorded on a current, when-acquired basis.

Firms can sell equities to household, OPEC, or Rest-of-the-World sectors, while governments and firms can sell bonds. In principle it is also possible for sectors to accumulate cash (temporarily) or remedy an excess of expenditures over income by short-term borrowing. Thus three categories of financial assets are defined: equities, bonds (long-term debt paper), and cash (including short-term interest earning paper). Correspondingly, three sets of records conforming to Table 7 are assumed to be maintained showing the holdings by each eligible sector of the equity claims, long-term debt claims, and short-term debt claims issued by each other sector as a basis for determining interest and dividend payments as well as capital gains on financial holdings. In addition, a separate set of asset accounts records real capital holdings by sectors (changing from period to period via new capital goods purchases or sales, and physical depreciation) as part of the information relevant to sector production functions. Ownership of energy deposits is also recorded by sector used in determining flows of lease and royalty payments.

Current intersector cash flows can for all purposes be pictured as a three-dimensional matrix with its base (horizontal) grid as Table 6 and vertically stacked layers to differentiate, principally, current account real flows from capital flows. The base would record payments for goods and services, tax payments, payrolls, and transfer payments. The second layer would record equity sales and dividend payments, the third would have bonds sales and payment of interest and principal on long-term debt, and the fourth, royalty payments. Summing up the vertical dimension yields a single matrix measuring the total of intersectoral cash flow for all purposes. Any differences between total payments and total receipts appearing for a given sector then represent net flows into or out of cash balances (defined to include short-term interest-bearing accounts and netting of both principal and interest amounts). With these added accounts as defined, some further flow identities must hold, for example, equality of sources and uses for short-term balances, bond funds, and equity.

One intended objective of this effort to develop such an elaborated stylized framework is to recognize that all varieties of asset and goods transactions are interrelated and, as the composite scenario given earlier suggests, are potentially significant parts of the story for explaining the balance of interregional effects following an energy price shock.

It may be noted that my intent was to think out what might be sufficient disaggregation. The proposed elaboration is conceived of as in some sense the maximum amount of detail one might need to draw up to literally represent most of the issues that have been raised in the course of the interregional debate about rising energy prices, hopefully tied together in a coherent and consistent framework. For many purposes and at many stages of discussion, a more streamlined model may be appropriate. "Zeroing out" various sectors and or elements in the matrix may be a useful way to define the streamlining.

There are of course a great many issues in regional energy debates this approach would not usefully address. If the framework suggested here has practical value in the debates about regional energy price impacts, it will be as a disciplined reminder of the need to balance any assessment of particular issues or proposals by taking into account the full range of forces set in motion—in the spirit of general equilibrium.

Table 1

Net Energy Dollar Surplus or Deficit by State, 1976
(Millions of Dollars)

State	Surplus (Deficit) as % of Personal Income	Net Dollar Surplus (Deficit)	State	Surplus (Deficit) as % of Personal Income	Net Dollar Surplus (Deficit)
Wyoming	54.9	1441	Michigan	(4.9)	(3122)
Louisiana	48.6	10059	New Jersey	(5.0)	(2693)
New Mexico	26.9	1640	Ohio	(5.0)	(3475)
Oklahoma	12.6	1967	Florida	(5.2)	(2686)
Texas	12.3	9555	Wisconsin	(5.5)	(1606)
West Virginia	12.1	1199	Alabama	(5.7)	(1074)
Alaska	10.8	421	Vermont	(5.8)	(150)
Montana	9.8	412	Hawaii	(5.9)	(359)
Kentucky	8.6	1595	North Carolina	(6.0)	(1787)
Kansas	1.6	243	Arkansas	(6.1)	(648)
North Dakota	0.7	24	Tennessee	(6.2)	(1413)
Utah	(1.0)	(70)	Idaho	(6.2)	(296)
Colorado	(2.1)	(351)	Nebraska	(6.3)	(608)
California	(2.6)	(3959)	Missouri	(6.4)	(1844)
Virginia	(3.1)	(984)	Minnesota	(6.5)	(1581)
Pennsylvania	(3.8)	(2941)	Massachusetts	(6.5)	(2481)
Washington	(4.2)	(1030)	New Hampshire	(6.5)	(319)
Illinois	(4.2)	(3526)	Iowa	(6.6)	(1216)
Mississippi	(4.2)	(457)	South Carolina	(6.6)	(962)
Oregon	(4.5)	(665)	Georgia	(6.8)	(1870)
Maryland	(4.5)	(1590)	Indiana	(6.8)	(2267)
Rhode Island	(4.6)	(278)	Delaware	(7.3)	(309)
New York	(4.7)	(5981)	South Dakota	(7.6)	(252)
Arizona	(4.8)	(632)	Maine	(8.0)	(459)
Connecticut	(4.8)	(1102)	Nevada	(8.0)	(357)

From <u>The Energy Rich & The Energy Poor</u>, Chase Econometrics, July 1978.

Table 2A

Expenditures for Inputs by Sequence of Energy-Operating Firms, Circa 1978,[a] a Hypothetical Construction

		Retailer	Wholesaler Jobber	Product Pipeliner	Refiner	Crude Pipeliner	Crude Producer
(1)	Energy materials	21.20	20.20	19.50	10.60	10.00	
(2)	Other purchased inputs	.30	.20	.18	1.30	.11	.50
(3)	Royalties						1.25
(4)	Interest	.06	.05	.02	.40	.02	.40
(5)	Payrolls	.86	.34	.14	1.90	.12	.80
(6)	State and local taxes	.20	.05	.04	.70	.03	.90[b]
(7)	Federal taxes	.09	.08	.06	1.50	.06	2.39[c]
(8)	Capital goods	.20	.20	.20	1.70	.20	1.55
(9) (10)	Dividends / Net cash accumulation	.09	.08	.06	1.40	.06	2.21
	TOTAL	23.00	21.20	20.20	19.50	10.60	10.00

a/ Amounts in dollars per composite unit of product derived from one barrel of produced crude oil.

b/ Includes .60 severance tax.

c/ Assume amortization for tax purposes equal to capital goods expenditure shown.

Table 2B

Stylized Changes in Expenditures for Inputs Based on Doubling of Crude Oil Price in Table 2A and Direct Materials Cost Pass-Thru

		Retailer	Wholesaler Jobber	Product Pipeliner	Refiner	Crude Pipeliner	Crude Producer
(1)	Energy materials	+10.00	+10.00	+10.00	+10.00	+10.00	
(2)	Other purchased inputs						
(3)	Royalties						+1.25
(4)	Interest						
(5)	Payrolls						
(6)	State and local taxes						+.80[a/]
(7)	Federal taxes						+4.13[b/]
(8)	Capital goods						
(9)	Dividends }						+3.82
(10)	Net cash accumulation }						
	TOTAL Δ	+10.00	+10.00	+10.00	+10.00	+10.00	+10.00
	NEW PRICE	33.00	31.20	30.20	29.50	20.60	20.00
	% Δ	+43%	+47%	+49%	+51%	+94%	+100%

a/ Assume severance tax at 6% plus .20 other taxes.

b/ Assumes cost depletion with no increased increment per barrel as a result of crude oil price increase.

Table 2C

Stylized Changes in Expenditures for Inputs Indirectly
Passing Through Higher Energy Costs for Input-Producing Firms

		Retailer	Wholesaler Jobber	Product Pipeliner	Refiner	Crude Pipeliner	Crude Producer
(1)	Energy materials	+.234	+.209	+.195	+.012	No change	
(2)	Other purchased inputs[a/]	+.007	+.005	+.004	+.033	+.002	+.01
(3)	Royalties						
(4)	Interest[b/]	+.02	+.02	+.01	+.15	+.01	+.20
(5)	Payrolls						
(6)	State and local taxes						
(7)	Federal taxes[c/]						-
(8)	Capital goods[c/]	+	+	+	+	+	+
(9)	Dividends						
(10)	Net cash accumulation						
	TOTAL	+.261	+.234	+.209	+.195	+.012	No change; set by world price

a/ Raised by assumed 1/20th share of energy in production of these inputs x 44% energy price increase as a weighted average of retail and wholesale percentage price increase shown in Table 2B.

b/ Assumed 1/4 of interest cost for inventories with amount of inventory credit raised proportional to price of product.

c/ Changes in capital goods prices and federal tax liabilities (e.g., production cost increase for crude oil production would lower tax liability) not figured in.

Table 3

Net Division of Increased Revenue Flow Per Barrel

Total Increase Per Barrel of Crude Oil at the Wellhead		$10.00
Less:		
Royalty holder payment at 12.5%	$1.25	
TX State Severance Tax at 6% (+ 2% other)	.80	
Federal Corporation Income Tax at 52%	4.13	
		$6.18
Residual to stockholders of crude oil-producing firms		$3.82

Table 4A

Geographic Household Income Incidence Flowing from MN Energy Expenditure Increase, Per Unit of MN Energy Use

	Total	TX	MN	Other States
Royalty Holders	1.25	1.125	.012	.112
TX State Gov't	.80	.648	—	.152
Federal Government	4.13	.247	.082	3.799[a/]
Crude Oil Firms' Stockholders	3.82 (3.82)	.431 (1.489)	.068 (.049)	3.315[b/] (2.280)[c/]
Total Expenditure Increase Per Unit of Energy Imported	$10.00	2.451 (3.509)	.162 (.143)	7.378 (6.343)

a/ Assumed expenditure distribution according to population, i.e.: 6%, 2%, and 92%, respectively.

b/ Assumed stockholder density in TX equals 2 times that in other states, which are otherwise uniform.

c/ Assumed stockholder density in TX equals 10 times that in other states, which are otherwise uniform.

Table 4B

Redistributional Effects of Federal Personal Income Tax on Household Income Results of Table 4A

	TX	MN	OTHER
Increment to Household Income	$2.451	$.162	$7.378
Federal Personal Inc. Tax (at 20%)	.490	.032	1.475
After-Tax Income	1.961	.130	5.903
Plus Distribution[a/] of Federal Take	.119	.039	1.838
After-Tax Household Income Incidence	2.080	.169	7.741

a/ Based on assumed distribution proportioned to population, i.e., 6%, 2%, and 92%, respectively.

Table 5

Balance of Energy Expenditure and Income Increments from Energy Price Shock for MN Households

Total MN expenditure increase $10/bbl x 130 million bbls imported		$1.3 billion
Total share in windfall revenue and income increase:		
Expenditure increase by all states $10/bbl x 9 billion bbls	$90 billion	
Less increment collected by OPEC $10/bbl x 3 billion bbls	$30 billion	
Net windfall increase available for claim by U.S. households	$60 billion	
Share of increment to MN per Table 4B at 1.7% of $60 billion		$1.0 billion
Share to all other at 98.3% of $60 billion	$59.0 billion	
Net increase for MN households (Net increase = 23% of total energy bill increase for MN households)		$0.3 billion

Table 6

Payment Flows Matrix for Stylized 11-Sector 2-Region Model

Payment to ↓ / Payment by →	1 DB Local	2 DB Export	3 SB Local	4 SB Export	5 SB Energy	6 DB Gov't	7 SB Gov't	8 Fed Gov't	9 OPEC	10 DB Households	11 SB Households
1 DB Local	x	x	o	o	o	g	o	g	o	c	o
2 DB Export	x	x	x	x	x	g	g	g	z	c	c
3 SB Local	o	o	x	x	x	o	g	g	o	o	c
4 SB Export	x	x	x	x	x	g	g	g	z	c	c
5 SB Energy	x	x	x	x	x	g	g	g	o	c	c
6 DB Gov't	t	t	o	o	o	o	o	v	o	t	o
7 SB Gov't	o	o	t	t	t,r	o	o	v	o	t	t
8 Fed Gov't	t	t	t	t	t,r	o	o	o	o	t	t
9 OPEC	o	o	o	o	x	o	o	o	o	o	o
10 DB Households	w,d	w,d	d	d	d,r	w,v	o	w	o	o	o
11 SB Households	d	d	w,d	w,d	w,d,r	o	w,v	w	o	o	o

Table 7

Proposed Sector Detail

1. DB Local
   a. High energy intensity
   b. Low energy intensity
2. DB Export
   a. High energy intensity
   b. Low energy intensity
3. DB Refined Energy
4. SB Local
   a. High energy intensity
   b. Low energy intensity
5. SB Export
   a. High energy intensity
   b. Low energy intensity
6. SB Refined Energy
7. SB Crude Energy
8. SB Energy Support Industry
9. DB State Government
10. SB State Government
11. Federal Government—DB
12. Federal Government—SB
13. OPEC
14. Rest-of-the-World
15. DB Households
    a. High income
    b. Low income
16. SB Households
    a. High income
    b. Low income
17. DB Capital Goods
18. SB Capital Goods
19. R.O.W. Capital Goods
20. Net Cash Accumulation

Figure 2 - Generalized Expenditure Categories Relevant in Tracing Household Income Incidence of Energy Revenues

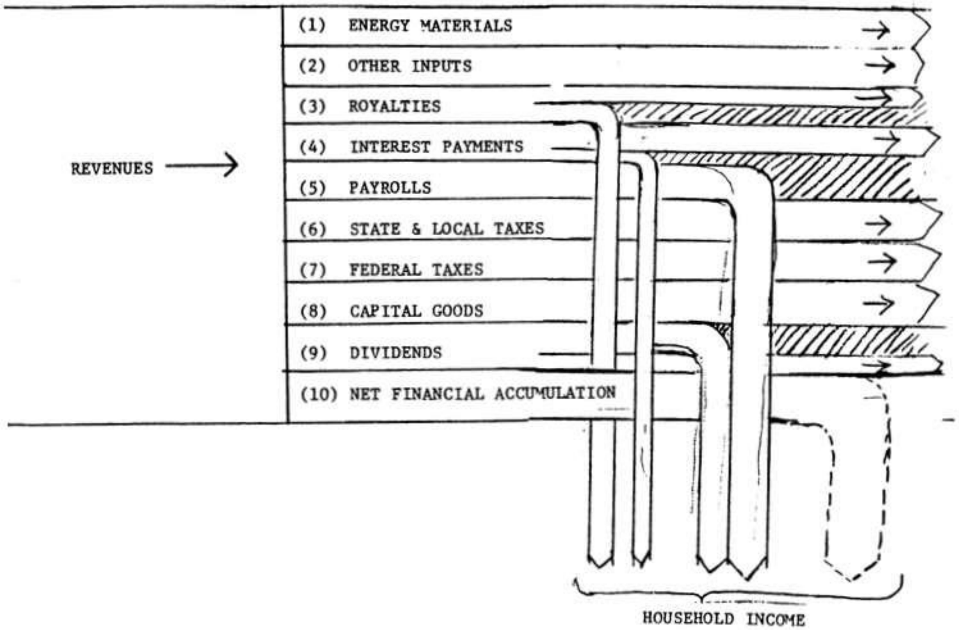


Figure 1 - Generalized Flow of Energy Materials

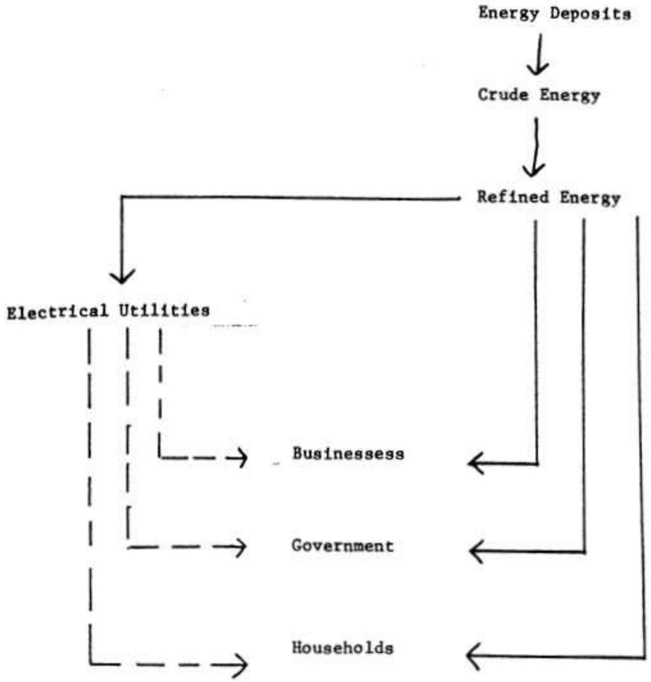


Figure 3 - Stylized Sequence of Operating Firms Functioning in the Delivery of Energy Materials from TX to MN.

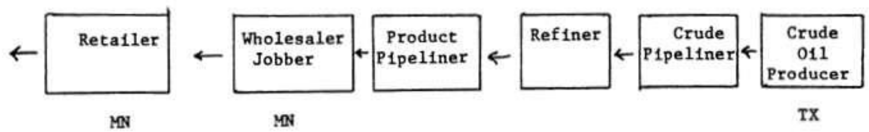
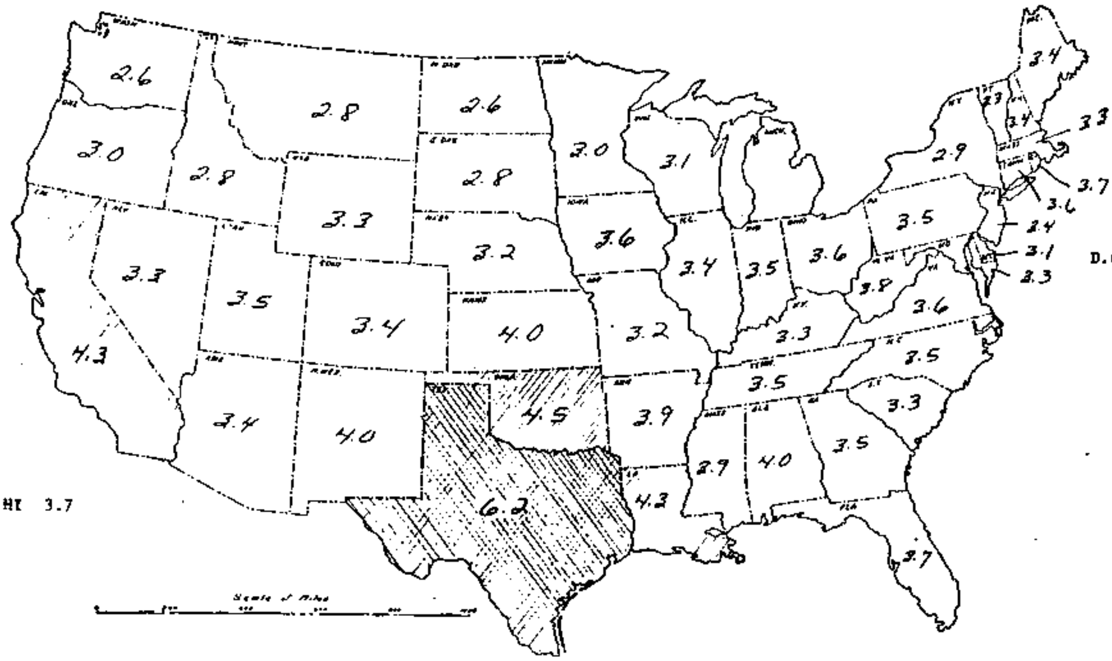


Figure 4 - Ratio of 1978 to 1971 costs of purchased fuels and electricity by the manufacturing sector, by state.

AK 1.4



D.C. 3.8

HI 3.7

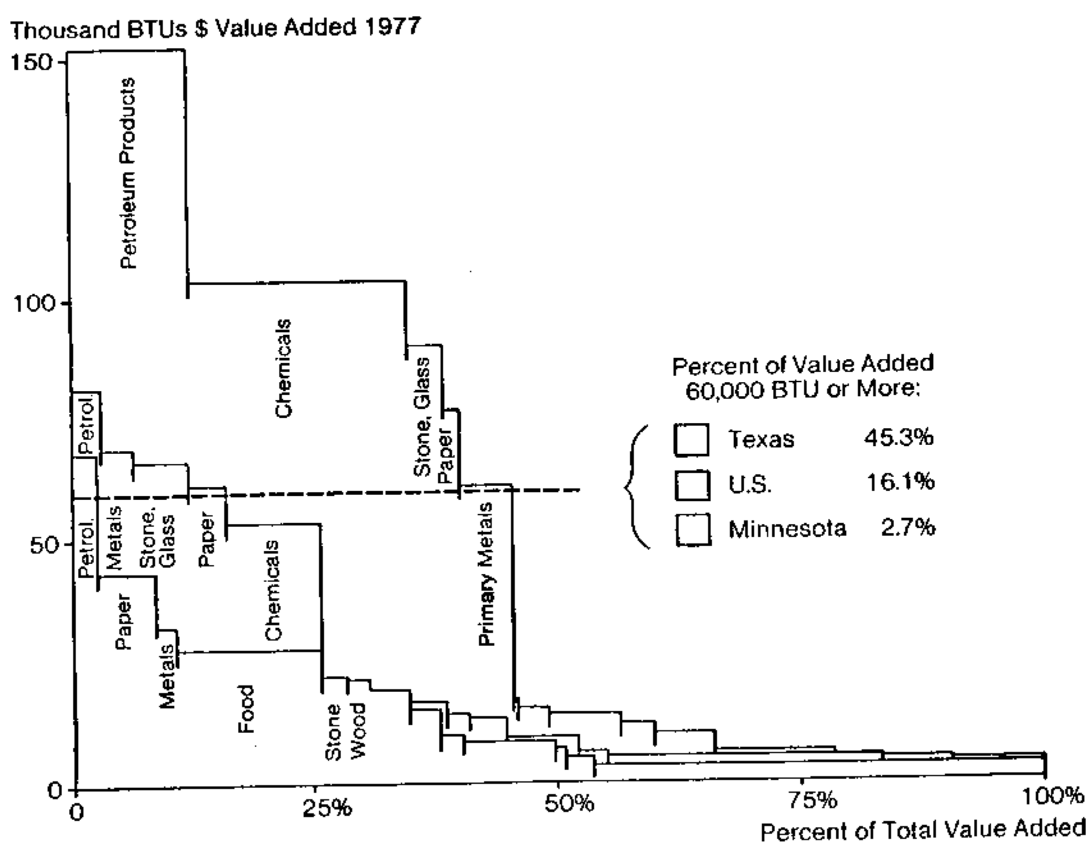
U.S. = 3.6

U.S. ENERGY CPI = 2.02 (10.0% per year)

U.S. TOTAL CPI = 1.61 (6.35% per year)

Data from Annual Census of Manufacturers

Fig 5 - Shares of Manufacturing Value Added, Industries Ranked by Energy Intensity



Footnotes

[1]See, for example; "Rising Energy Prices--What's Good for Some States is Bad for Others," National Journal, March 22, 1980, p. 468; "States divide over energy issues in scramble for supply, revenue," Oil & Gas Journal, June 8, 1981, p. 43; "Wars Between the States," Time, August 24, 1981, p. 19; "Now Energy is What Counts in the War Between States," Business Week, October 26, 1981.

[2]C. W. Nelson, Regional Inpact of Rising Energy Prices, Federal Reserve Bank of Minneapolis Special Studies, June 1981. Minnesota Energy Agency, "Regional Impacts of Rising Energy Prices, Federal Reserve Bank of Minneapolis, A Critique," August 1981. "Two studies differ on effect of energy cost," Minneapolis Tribune, September 1, 1981; "Minnesota economy: losing energy," (editorial), Minneapolis Star, September 3, 1981; "Insulated Fed slights cost of energy dependence," (editorial), Minneapolis Star, November 4, 1981.

[3]The value of crude energy inputs as a share of the value of final goods output in the U.S. economy was small prior to OPEC (a few percent or less) but increased significantly with the two oil price shocks. If we define crude energy value to be the sum of crude oil wellhead value for domestic production (or landed crude oil value for imported oil or product equivalent) mine-mouth value for domestic coal consumed, wellhead value for domestic natural gas and natural gas liquids production (or border value for imported natural gas), dam site value of hydroelectric power generated, and generator value of nuclear power then crude energy inputs to the U.S. economy constituted about 2.2 percent of GNP in 1972, 4.8 percent in 1978 and 7.5 percent in 1983. Even those figures exaggerate the "crude materials input value" for energy input to the U.S. economy because they con-

tain more or less substantial "value-added" amounts incurred in raising oil, gas, and coal from their position as natural occurrences and separating out natually-occurring companion dilutents or contaminants, plus substantial value-added amounts in converting the kinetic energy of falling water into electrical energy. Only the pure rents assignable to the produced crude energy material "in-place" or to the waterfall site per unit of energy produced would constitute the true energy resource input share. It is that kernel of the final delivered energy product costs that fundamentally receives the shock when an energy price shock occurs.

4/ In our context the category, "Royalty payments," is restricted to mineral lease royalties on energy deposit production only. Other types of royalty payments, such as patent royalties, would be included under category (2) "Other inputs."

5/ The assumption that the increase in rents induced by the energy price shocks accrues to the mineral property ownership requires that essentially competitive conditions prevail in subsequent stages of shipment, processing and distribution. Competition would presumably preclude any expansion of the value-added element by firms in subsequent stages from absorbing part of the windfall rents. Whether that is true in practice is an empirical issue; in the case of some western coal production it seems clear that unilateral rate increases by the Burlington Northern railroad as the sole railroad serving major coal-producing mines in Wyoming and Montana represented a noncompetitive action to share in the producing firms' windfall rents. As long as the transporter is at least as effective as the producer in geographically diffusing the income incidence of the windfall rents, the matter of which firms capture the rents is of little consequence for our analysis.

[6]For motivation, that number represents the increase in the energy-import deficit for the state of Minnesota between 1972 and 1978 in real terms (1978 dollars).

References

Alt, Christopher B., Michael G. Baumann, and Martin B. Zimmerman, "The Economics of Western Coal Severance Taxes," Journal of Business, 1983, vol. 56, no. 4.

Axel, Helen, ed., Regional Perspectives on Energy Issues, A Report, The Conference Board, New York, 1982.

Bjornstad, D. J., D. P. Vogt, and D. N. Stuckwish, "The regional impact of changes in import oil prices," Review of Regional Studies, vol. 9, no. 3.

Congressional Budget Office, Understanding Natural Gas Price Decontrol, U.S. Government Printing Office, April 1983.

Governor's Office of Policy and Planning, State of New Jersey, "Western Energy Production: Related Taxes, Subsidies, and the Impact Upon the Northeastern Region," Staff Report, 1979.

Kolstad, Charles D., and Frank A. Wolak, Jr., "Competition in Interregional Taxation: The Case of Western Coal," Journal of Political Economy, 1983, vol. 91, no. 3.

Krohm, Gregory, "The Connection Between Rising Energy Costs and Regional Income Growth," (Draft mimeo), Wisconsin Division of State Energy, January 1983.

Leone, Robert A., "Impact of Higher Natural Gas Prices on the Northeast Economy," Contemporary Policy Issues, Western Economics Association, Number 1, October 1982.

Levy, Yvonne, "American Emirates?," FRB SF Weekly Letter, Federal Reserve Bank of San Francisco, October 9, 1981.

McLure, Charles E., Jr., and Peter Mieszkowski, Fiscal Federalism and the Taxation of Natural Resources, Lexington Books, 1983.

Minnesota Energy Agency, "Regional Impact of Rising Energy Prices, Federal Reserve Bank of Minneapolis Study, A Critique," September 1981.

Nelson, Clarence W., Regional Impact of Rising Energy Prices, Federal Reserve Bank of Minneapolis, Special Studies, June 1981.

Northeast-Midwest Institute, The United American Emirates: State Revenues From Non-Renewable Energy Resources, Washington, D.C., June 1981.

_______________, "The Effects of Rising State Severance Tax Revenues, 1980-1990," Regional Energy Impact Brief no. 10, February 1980.

Pfister, Richard L., "Regional Impacts of Rising Energy Prices, A Skeptical View of the Dire Predictions," Draft (mimeo) for annual meeting midcontinent section, Regional Science Association, June 1982.

Schmidt, Ronald H., "Effects of Natural Gas Deregulation on the Distribution of Income," Economic Review, Federal Reserve Bank of Dallas, May 1983.

Testa, William A., "Natural Gas Policy and the Midwest," FRB Chicago Economic Perspectives, Federal Reserve Bank of Chicago, October 1983.

Zimmerman, Martin, and Christopher Alt, "The Western Coal Tax Cartel," Working Paper Series No. E-80-9, Domestic Studies Program, Hoover Institution, Stanford University, March 1981.