Accounting for Mineral Resources: Issues and BEA's Initial Estimates

AMONG NATURAL assets, the characteristics of minerals—oil, gas, coal, and nonfuel minerals—are the most similar to the characteristics of assets included in traditional economic accounting systems. Not surprisingly then, minerals have long been considered as candidates for a treatment that is symmetrical with the treatment given other assets. Such a treatment is at the heart of the integrated economic and environmental satellite accounts (IEESA's), which are the subject of a companion article, beginning on page 33. Failure to account symmetrically for mineral resources as a form of capital has been blamed both for their over- or under-exploitation and for incomplete analysis and policy decisions in areas relating to productivity and budgeting.

The companion article noted three points of asymmetry between the treatment given assets such as structures and equipment in the traditional economic accounts and the treatment given natural assets. First, in traditional economic accounts, there is no entry for additions to the stock of natural resources parallel to the entry for additions to the stock of structures and equipment. Second, there is no explicit entry for the contribution of natural resources to current production, as measured by gross domestic product (GDP), parallel to the entries that capture the value added of structures and equipment. Finally, there is no entry for the using up of the stock of natural resources parallel to the entry for the depreciation of structures and equipment used to arrive at net domestic product (NDP)—which is used by some as a shorthand measure of sustainable product.

This treatment given mineral resources in the traditional economic accounts is anomalous in several respects. First, firms spend large amounts of time and other resources in "proving" mineral reserves, and these reserves, like structures and equipment, yield a flow of services over many years. As firms prove these reserves, they are entered, along with investments in new structures and equipment, in the firms' balance sheets. Additions to these reserves are also recognized by investors and reflected in firms' equity prices. Second, the value added of a resource like coal or oil is included in GDP even though no explicit entry for its contribution is made: Its value added is in a sense "appropriated" by the other factors of production and is included in the rents, royalties, and profits of the owners of invested capital. Finally, although the traditional economic accounts do not include an entry for depletion of natural resources, firms and investors recognize depletion in assessing the value of firms and the sustainability of their current profit levels.

The treatment of natural resources in the mining industry has long been debated in economics literature.[1] While there is a conceptual case for symmetrical treatment of mineral resources and invested capital, the absence of good market prices to value additions, depletion, and stocks has been a stumbling block. Property rights issues, incomplete information, asymmetry in bargaining, and the structure of payments for mineral rights create a situation in which either there are no observable prices or prices are seriously incomplete or unrepresentative. Partly as a result of this situation, traditional economic accounts have treated the value added of mineral resources as free gifts of nature, making entries neither to the flow accounts for additions to, or depletion of, the stock of these resources nor to the wealth accounts.

The omission of explicit entries for mineral resources has import beyond the economic accounts. The absence of an entry, or market price, for depletion may—in combination with common property rights—mean that the accounts do not identify overexploitation. This possibility is particularly important because a large share of the Nation's mineral resources are on public lands. (However, as the current problems in the New England fisheries suggest, the issue clearly has import for a wide range of other resources.) Such omissions have also been cited as the source of problems in productivity analysis. Despite the inclusion of land, labor, and capital in the most elementary production function used in studying

1. Business accounting has also long debated issues in accounting for minerals; further, there was a resurgence in interest after the "energy crisis" in the mid-1970's. Since then, the Financial Accounting Standards Board has issued five new standards to improve accounting for mineral resources.

productivity, measures of natural resources have generally not been available. Finally, the absence of measures of natural resource stocks and stock changes on Federal lands has been cited as contributing to less-than-optimal Federal budgeting decisions.[2]

As previously mentioned, this article is the second of two articles reporting on the IEESA's. It provides initial estimates of the value of additions, depletion, revaluations, and stocks of mineral resources and on the impact such estimates would have on the estimates of the Nation's production, income, and wealth. This article begins with a summary of the major conceptual and methodological issues in accounting for mineral resources. Next, the article describes alternative methods of valuation that can be used to develop IEESA estimates for minerals, and it then presents estimates for oil, gas, coal, metals, and other minerals using these methods. An appendix provides information on data sources and methods. Tables 1–5 appear at the end of the article: Table 1.1–1.6 present estimates of oil—opening stocks, additions, depletion, and the revaluation adjustment—for 1947–91; tables 2.1–2.6 present estimates of gas for 1947–91; tables 3.1–3.4 present estimates of coal for 1958–91; tables 4.1–4.4 present estimates of metals for 1958–91; and tables 5.1–5.4 present estimates of other minerals for 1958–91.

Conceptual and Methodological Issues

In addressing conceptual and methodological issues for mineral resources, as for natural resources and the environment more broadly, BEA has attempted to follow two principles. First, the treatment in the satellite accounts should be consistent with the principles of economic theory. Second, the satellite accounts should embody some concepts and definitions that differ from those of the existing accounts in order achieve their purpose of showing the interaction of the economy and the environment, but in other respects they should be consistent with the existing accounts. Satellite accounts provide the flexibility to make changes that are useful in analyzing natural resources and long-term economic growth, but consistency with the existing accounts will allow the satellite accounts covering mineral resources to link to, and build upon, the existing economic accounts, including the input-output and regional accounts.

2. See, for example, Gavin Wright [35] and Michael J. Boskin, Marc S. Robinson, Terrance O'Reilly, and Praveen Kumar [4].

The conceptual and methodological issues discussed in this section can be divided into two main groups. The first group deals with the accounting treatment for mineral resources. The second group deals with valuation.

Accounting issues

Treatment of additions to reserves.—Symmetrical treatment of proved mineral resources with structures and equipment requires treatment of additions to the stock as capital formation and of deductions as depletion. Capital formation records the initial production of the capital, as well as its addition to the capital stock; depreciation records the reduction in the capital stock associated with its use, as reflected in NDP. Over the life of the asset, depreciation sums to the value of the original investment.

In economic accounting, as in business accounting, what comes off the books must have gone on the books. This business accounting requirement was one of the reasons why estimates of depletion of natural resources have not been included in official estimates of NDP. Beginning in 1942, depletion allowances for minerals and timber were deducted from GDP in the estimates of net national product made by the U.S. Department of Commerce. Discoveries of minerals, however, were not included in capital formation and net product. The depletion allowances were eliminated in 1947 because of this absence of an entry for capital formation.

Despite this accounting requirement for symmetrical treatment of additions and reductions, a number of economists have called for a return to the 1942 treatment—that is, an entry for depletion but not for additions. This position seems to have been based on at least three considerations, each of which is evaluated in the paragraphs that follow.

First, an entry for depletion will respond to at least part of the concern about the treatment of mineral resources in the traditional accounts. If the goal is to produce a measure of NDP that reflects the depletion of mineral resources in GDP, deduction of depletion to arrive at an alternative NDP will provide such a measure. Although it cannot be explicitly identified, as noted previously, the contribution of mineral resources is already included in GDP. Deduction of an estimate of depletion will give a partial measure of sustainability, one that indicates the using up of the existing stock of mineral resources.

What such a partial measure will not do is allow the detailed identification of the contribution

of the mineral resource to income, production, consumption, or wealth, either in the aggregate or by sector. Nor will it provide a complete measure of sustainability. Without an entry for additions, deduction of depletion alone to calculate an alternative NDP may produce misleading signals regarding the sustainability of a nation's production and wealth. For example, with only depletion accounted for, a nation adding to its stock of reserves—through exploration and development and through improved recovery techniques—at a rate that more than offsets depletion would nonetheless have an alternative NDP lower than the traditional NDP. The lower NDP would suggest that the country was running down its resources and that the current level of production was at the expense of future production, despite the fact that reserves were actually increasing.

Second, estimates of the value of additions to the resource stocks are quite volatile, uncertain, and, at times, large. Volatility in resource prices, changes in mining technology, and uncertainty about the ultimate recoverability from existing reserves all affect the value of mineral reserves. It is not clear, however, that the volatility introduced by such estimates would be any larger than that already observed in investment, particularly inventory investment, the most volatile component of traditional accounts.

Third, probably the most important reason for the lack of enthusiasm for including additions to reserves as capital formation in GDP is that additions to reserves are so different from additions to capital stock. This difference, in combination with the volatility of additions to reserves, would limit the usefulness of accounts for conventional macroeconomic analysis. The inclusion of large additions to mineral resources in GDP, such as those associated with the North Slope in Alaska and the North Sea in Europe, are important additions to a nation's wealth and have a significant impact on economic activity, but the effect differs from that associated with investment in a new factory. Both add to wealth, but for the factors of production involved in building the factory, payments have been made, and the resources are available for current consumption. In contrast, much of the increase in wealth associated with adding proved reserves accrues to mining companies and landowners in the form of increases in land values and equity prices. To make these resources available for current consumption would require the "producers" of the mine or well to sell their product.

Many of the concerns about volatility and the different nature of additions to mineral reserves can be diffused by placing these values in a satellite account that allows integrated analysis of mineral resources outside the main accounts. This inclusion of natural resources in a satellite account allows researchers the flexibility to experiment without impairing the usefulness of the traditional accounts. In addition, within the IEESA's, the effect of volatility in mineral prices is largely confined to the revaluation account and has a limited effect on the estimates of current income, production, and consumption.

Fixed capital or inventory treatment.—Even when economic theorists have thought of natural resources as a type of capital, they have disagreed about whether the resources should be treated as fixed capital or as inventories.[3] This disagreement may seem a bit strange because proved mineral reserves seem to fit the classic characteristics of fixed capital: Expenditures of materials and labor are needed to produce a productive asset ("roundabout" production), which yields a stream of product over long periods of time. The rent to owners of fixed assets comprises the reduction in the value of the asset due to its use in the current period (depreciation) and a return equal to what the current value of the asset could earn if invested elsewhere. Inventories, on the other hand, are buffer stocks of inputs and final products that help to smooth production and avoid lost sales. As a rule, inventories are sold within a year or one accounting cycle. Although interest or holding costs are a consideration in determining inventory levels, they are much less important than for fixed capital.

Part of the rationale for treating mineral reserves as inventories may arise from the perception that they differ from fixed capital in that they are a set number of units waiting to be used up in production. However, like the output from a new machine, the number of units extracted from a new field or mine is quite uncertain and varies over time with the path of future demand, changes in technology, prices, costs, and returns on alternative investments. In addition, although a piece of machinery may not appear from the

3. Part of the debate over the treatment of minerals as inventories or as fixed capital may reflect the view that depletion should be counted as a reduction in the highly visible GDP measure, rather than in the less well known NDP. If natural resources are treated like fixed capital, the depletion of the resources in the production process would be treated like depreciation. Because NDP is defined as GDP less depreciation, with this treatment any depletion charge would affect NDP but not GDP (as noted earlier, conventional GDP implicitly includes depletion). On the other hand, the change in business inventories is a component of both GDP and NDP. Consequently, some have argued that if depletion were viewed as a net decline in inventories, it would result in a subtraction from *both* GDP and NDP.

exterior to be used up in production, its parts or service life are most certainly "used up" in production; this "using up" is reflected in the decline in its value, or the depreciation on the equipment.

To emphasize the replaceability of proved reserves, some analysts have chosen to describe these reserves as inventories. This motive notwithstanding, treatment of mineral reserves symmetrically with fixed investment in structures and equipment would serve equally well as a reminder of the "reproducibility" of proved reserves in the IEESA's.

Proved reserves or total resources.—The amount of mineral resources that can be recovered, given current economic conditions, is not certain. Reserves are generally classified by the degree of certainty attached to the estimates. For example, proved petroleum reserves are estimated physical quantities that have been demonstrated by geologic and engineering data to be recoverable under current economic conditions and technology. Reserves whose recovery under current economic conditions is less certain are classified as either "probable" or "possible." Estimates are also available on the total amount of reserves that remain to be discovered—that is, of "undiscovered" reserves. There are a variety of perspectives on which of these measures of reserves should be used in accounting for minerals. Should the accounts be concerned only with "proved" reserves, or should they also account for "probable," "possible," or even "undiscovered" reserves?

Authors who have focused on proved reserves have tended to do so because of the large uncertainty associated with the other measures. As noted in the companion article, BEA ultimately intends to include unproved reserves as part of "nonproduced/environmental" assets, but the mineral reserve estimates presented here are restricted to proved reserves.

One means of dealing with the uncertainty in valuing unproved reserves may be the use of "option" values. Unproved reserves are clearly bought and sold, and the values or options that could be used in these transactions might be used to develop average option values to be used in valuing the entire stock of a nation's reserves. An operational methodology for making such estimates has not yet been identified.

Valuation issues

The absence of complete data on mineral resource prices has meant that the value and contribution of mineral resources to income, production, consumption, and wealth have usually had to be based on methodologies that produce proxy estimates of their market price. There are two elements to making such estimates. The first is separating the contribution of the resource in the ground—which is implicitly included in the price of a marketed mineral product—from that of other factors of production. The second is determining the appropriate per-unit value for estimating the value of the stock of the resource and the value of changes in the stock, including additions, depletion, and revaluations.

In addition, it is useful to identify several terms at the outset. First, "rent" refers to the concept of the return to factors of production after deduction of variable costs. More empirically, "gross rent" is simply gross revenues less expenditures on intermediate goods and employee compensation. (Rent in these situations is not to be confused with "rental income of persons" found in the national income and product accounts.) Second, "invested capital" refers to the structures and equipment in which the firm or industry has invested.

Identifying the return to the resource.—The price of a unit of the resource—for example, a barrel of oil—reflects, in addition to the cost of goods and services used in its production, a return to labor, a return to invested capital, and a return to the resource. The first step in identifying the value of a barrel in the ground is to determine the rent, in this case the rent to the resource and the capitalized value of investments in mining. In industries such as petroleum mining, good data are generally available on the variable costs, so arriving at gross rent is, at least conceptually, relatively simple. The next step is to determine the share of gross rent that accrues to the invested capital and the share that accrues to the resource.

In theory, the rent to owners of both the invested capital and the oil in the ground should equal the reduction in the value of each asset due to its use in the current period (depreciation and depletion, respectively) plus a return equal to what the current value of the well (the invested capital and the oil in the ground) could earn if invested elsewhere. The desirable way to measure the rent would be to observe market prices for these transactions; however, often there is no transaction, and the observable transactions that

take place are often not representative of the full value of the oil. As a result, the various methods described in the next section use indirect techniques to estimate the market value of the return to invested capital, and they derive the return to the oil in the ground as a residual.

Valuing the resource stock and depletion.—Valuing the stock of a resource and valuing the decline in the stock's value associated with extraction are complicated because the extraction takes place over a long period of time. Unless the price, or value, of that resource rises enough to offset the income that could have been earned on alternative investments (including an inflation premium), resources extracted in the future will be worth less, in real terms, than those extracted today. In theory, the market value of the stock should be equal to the present discounted value of the future stream of rent from the stock, whereas depletion is the decline in the value of the stock associated with extraction in the current period. Translating the current per-unit rent of a resource into a per-unit value appropriate for valuing the stock and depletion requires information about the future path of extraction, prices, and interest rates. Unfortunately, such information is generally not available. In the absence of market prices, estimation of the current value of the resource requires either resort to economic theory, use of a set of explicit assumptions, or empirical estimation.

Empirical estimation of the factors required for computing the present discounted value of the resource is fraught with difficulties, in part because of the volatility of mineral markets. Simplistic assumptions do at least as well as econometric forecasts in tests of their predictive accuracy, and the assumptions are relatively easy to understand.

Alternative Methods of Valuing Mineral Resources

BEA has prepared estimates using four methods of valuing resource stocks and changes—depletion, additions, and revaluations—in the stocks.[4] These methods rely on estimates of three variables: (1) The normal return to invested capital, based on some average rate of return to all investment in the economy; (2) the return to capital based on the market value of the capital stock in the oil industry; and (3) the per-unit capital cost of additions to the stock of proved reserves. The use of these variables as described in the following paragraphs represents BEA's assessment of the best estimates given existing source data and frameworks. The accompanying box provides an algebraic description of the methods.

Current rent estimates

The simplest assumption that can be used is based on Harold Hotelling's observation that in equilibrium, the price of the marginal unit of a nonrenewable natural resource net of extraction costs (the current per-unit rent to the resource) should increase over time at a rate equal to the nominal rate of interest.[5] At any rate of increase in the per-unit rent above (below) the rate of return on alternative investments, entry (exit) and increases (decreases) in the rate of extraction will combine to reestablish the equilibrium rate of increase in the resource rent. If this observation holds, the value of the stock of the resource is independent of when it is extracted and is equal to the *current* per-unit rent to the resource times the number of units of the resource.[6]

The following two methods assume that over time the rent per unit will increase at the rate of interest; they simply use the current per-unit rent to value the resource and depletion.

The first method, current rent method I, utilizes an estimate of a normal, or average, rate of return to investment to estimate the rent to the associated capital invested in the mining industry and then derives the resource rent as a residual. This method applies this average, economywide rate of return to investment to an estimate of the replacement cost, or market value, of the net stock of associated capital invested in mining and then adds depreciation to estimate a "normal" rent to invested capital. The rate of return used is 6 percent, approximately the 45-year average real rate of return to investment in corporate bonds and equities for the period ending in 1991, which is an estimate of the rate of return available on al-

4. Among the methods that have not been used is one suggested by Salah El Serafy. The approach essentially calculates the amount that must be invested in a "sinking fund" to create an income stream sufficient to replace that produced by the natural resource. The approach, although frequently mentioned in the resource accounting literature, is not included largely because it is inconsistent with the concepts embodied in traditional national accounts and the IEESA's. In traditional accounts, the value of an asset is determined by its market price, or proxy thereof. El Serafy's approach, a welfare-oriented measure, is not intended to estimate the market value of the mineral resource.

5. In other words, the real price of the resource should increase at the real rate of interest, and there is no need for discounting.

6. As discussed later, it may be true that over long periods, the rent per unit for mineral resources—like most tangible assets held for investment purposes—will rise at a rate equal to the nominal discount rate; however, periods of disequilibrium may be quite long. Nevertheless, given the problems in forecasting volatile minerals prices, technology, etc., this simple assumption may yield results as good as or better than other methods.

ternative investments. The steps in estimating the rent to and value of the resource are as follows:

1. Gross rent is calculated as total revenue less current operating expenditures. (Current operating expenditures are those associated with bringing the mineral from the deposit to the wellhead or mine gate.)
2. The resource rent is obtained by subtracting the rent to capital (both depreciation and a normal rate of return for capital) from the gross rent.
3. The per-unit rent to the resource equals the resource rent divided by the physical quantity extracted.
4. The value of the resource equals the per-unit rent times the physical quantity of reserves. Additions and depletion are valued at rent per unit times the physical quantities of added and extracted reserves.
5. Revaluations—the effect of price changes—are computed as a residual: The value of the resource at the end of the current year less its value at the end of the preceding year, plus depletion during the year, less additions during the year.

The advantage of this method is that it is relatively straightforward and requires few assumptions. The main disadvantage is that an explicit assumption must be made regarding the

Algebraic Description of the Alternative Methods of Valuing Mineral Resources

Current rent method I (Based on average return to capital):

$$
\begin{aligned}
GR &= TR - COE \\
RR &= GR - (rNS + DEP) \\
\delta r &= RR/QE \\
VR &= \delta r(QRES) \\
DEPL &= \delta r(QE) \\
VA &= \delta r(QADD) \\
REVAL &= VR(t) - VR(t-1) + DEPL - VA
\end{aligned}
$$

Current rent method II (Based on value of capital stock): *

$$
\begin{aligned}
\delta GR &= GR/QE \\
V &= \delta GR(QRES) \\
VR &= V - NS \\
\delta r &= VR/QRES
\end{aligned}
$$

Net present discounted value: *

$$
\begin{aligned}
\Phi &= \sum_{j=1}^{T} \frac{1/T}{(1+i)^{j-1/2}} \\
\delta r &= \Phi[(V - NS)/(QRES)]
\end{aligned}
$$

Replacement cost: *

$$
\begin{aligned}
bf &= [(QE/QRES)/((QE/QRES)+r)] \\
\delta r &= bf[(TR - COE)/Q] - (\$ADD/Q)
\end{aligned}
$$

Transaction price: *

$$
\begin{aligned}
\delta GR &= (TV/TQ) \\
\delta r &= \delta GR - (NS/QRES)
\end{aligned}
$$

* *DEPL, VA, REVAL* for all methods are computed using the same formulas as presented for current rent method I.

Definitions:

Aggregate value measures:
TR = total revenue
CO = other extraction expenses, including compensation of employees, materials consumed, and overhead cost allocated to current production
GR = gross rent
RR = resource rent
NS = net stock of capital valued at current replacement cost
TV =value of purchased reserves during the year
V =value of the proved reserves (resource and fixed capital values)
VR =value of the resource stock
VA = value of the annual additions
DEP = depreciation
$DEPL$ = value of the annual depletions
$REVAL$ = the effect of price changes on the value of the stock
$\$ADD$ = the annual exploration and development expenditures for drilling oil and gas wells in fields of proven reserves (including overhead costs allocated to development)
Φ = Net discounted present value factor

Quantity measures:
QE = quantity of the resource extracted during the year
$QRES$ = stock of reserves
$QADD$ = Quantity of resources added to reserves during the year (through new discoveries, extensions of existing sites, or revisions in estimated reserves)
TQ = quantity of proved reserves purchased during the year

Per unit measures:
δGR = gross rent per unit (GR/Q)
δr = resource rent per unit

Rates and other items:
r = real rate of interest, or discount rate
N = Life span of a resource (e.g., well or mine), R/Q
j = current year
T = life of asset (NIPA convention)
a = reserve decline rate, Q/R
bf = barrel factor

appropriate rate of return. In addition to the conceptual and empirical problems in identifying an appropriate rate, prespecification of a rate does not allow for relatively low or high rates of return in the mining industry due to conditions specific to the industry.

An alternative method, current rent method II, derives resource rent by removing the market value of capital, both physical and capitalized expenditures, from the value of the resource reserve. The steps to deriving the per-unit rent are as follows:

1. Gross rent per unit is derived by dividing gross rent by the physical quantity of extraction.
2. The total value of the mineral reserve (the resource and the associated invested capital) equals the gross rent per unit times the quantity of reserves.
3. The value of the resource equals the total value of reserves less the current replacement value of the net stock of invested capital.
4. Resource rent per unit equals the value of the resource divided by the quantity of reserves.

The advantage of this method is that it does not require an explicit assumption about the return to invested capital associated with the resource.

Present discounted value estimates

If it is assumed that rent to the resource does not rise enough to compensate the owners of the resource for the nominal interest they could earn on alternative investments, then the stream of future rents must be discounted by the difference between the rate of increase in resource rent and the nominal interest rate. As noted previously, with discounting, identical dollar values during different time periods have different present values, so valuation by present discounted values requires—in addition to an assumed discount rate—a number of assumptions about the stream of future rents.

In BEA's implementation of this method, three simplifying assumptions were made so that each cohort of additions to reserves did not have to be tracked separately throughout its economic life. First, extraction resulting from additions to proved reserves was assumed to be constant in each year of a field's life, and depletions were assumed to result equally from all cohorts still in the stock. Second, new reserves were assumed to be extracted at constant rates over the same timeframe used for depreciating wells and mines in the NIPA's: 16 years until 1972 and 12 years thereafter. Finally, extractions were assumed to occur at midyear and were valued using the per-unit rents described for current rent method II.

Two real rates of discount—3 percent and 10 percent—were chosen to illustrate the effects of a broad range of rates on the values of additions, depletion, and stocks of reserves. Thus, the relatively high and relatively low rates chosen encompass many of the alternatives that have been used in discounting.[7] The 3-percent discount rate has often been used to approximate the rate of time preference. The 10-percent rate has often been used to approximate the long-term real rate of return to business investment.

The steps for estimating the present discounted value estimate of the resource rent per unit are as follows:

1. A discount factor was derived using an estimate of the real rate of discount—the nominal interest rate less the rate of increase in the resource rent—and the NIPA estimates of the lifespans of mineshafts and wells.
2. The rent per unit equals the discount factor times the gross rent per unit derived from the current rent method that is based on the value of capital stock in the mineral industry.[8]

Replacement-cost estimates

The replacement-cost method subtracts from gross rent the cost per unit of adding new reserves, thereby identifying the resource rent as a residual. It uses the per-unit cost of proving new reserves to represent invested capital's share of the gross rent. The value of a unit of resource in the ground is estimated; the cost to replace it by investment is subtracted from that in-ground value, and the residual is the resource rent. This method uses current rates of extraction to estimate future production and uses an

7. Although these real rates—3 percent and 10 percent—are often used to discount future returns, both are probably high for an appreciating tangible asset for a number of reasons: (1) Mineral prices do rise, at least partly, if not fully offsetting the effect of discounting; (2) as many authors have argued, decisions with intergenerational effects should be valued at lower discount rates than other transactions; and (3) a real rate of 10 percent, which is often cited and has been used by the Office of Management and Budget as an estimate of the real rate of return to private capital, is biased upwards. The 10-percent return is based on estimates of the before-tax return to reproducible capital, which is computed as all property-type income divided by the replacement-cost value of reproducible assets. Some authors have attempted to adjust the return to reflect the fact that property-type income is a return to land and other factors as well as to reproducible capital; nevertheless, to the extent that these other factors are excluded from the denominator, the computed return to capital is too high.

8. Because of the simplifying assumptions used, somewhat different discount-extraction factors are applied to stocks and flows; for most years, the differences are very small.

assumed discount rate of 6 percent.[9] Because of the lack of production cost data, transactions data for the sale of reserves, and techniques to estimate those market values for all other minerals, the replacement-cost method is used only for oil and gas. The steps for deriving the per-unit resource rent are as follows:

1. The barrel factor—which is used to calculate the value of a barrel of oil in the ground—is equal to the depletion rate of the reserves divided by the sum of the real discount rate and the depletion rate.[10]
2. The per-unit resource rent is calculated by multiplying the gross rent per unit by the barrel factor and subtracting the per-unit exploration and development cost.

Transactions-price estimates

When oil and gas firms seek to replace the reserves that have been depleted as a result of their production, they face a "make or buy" decision. They can either make new reserves by financing exploration and development efforts, or they can buy reserves that have already been proved by others. This article refers to the purchase price of proved reserves as a "transactions price" because it represents a price that was paid in an actual transaction. The costs of acquiring new reserves by financing exploration and development efforts are termed "finding costs." In equilibrium, and ignoring the different tax treatment of purchasing and drilling for oil, the finding costs should be equal to the transactions price.

If available, transactions prices are ideal for valuing reserves. As it turns out, such transactions are relatively infrequent because companies generally develop their own reserves. As a result, the few transactions that occur are not easily generalized for estimating the total value of reserves.

The estimates of resource values for oil and natural gas presented here are derived from transactions prices constructed from publicly available data on the activities of large energy-producing firms. The derivation of per-unit resource rent is as follows:

1. The per-unit gross rent for the resource and its associated invested capital is obtained by dividing aggregate expenditures for the purchase of the rights to proved reserves by the quantity of purchased reserves.
2. The per-unit resource rent equals the per-unit gross rent less the per-unit net stock of associated capital invested in the oil and gas industry.

Estimates for Mineral Resources

The value of resource reserves and changes in reserves were estimated for the period 1958–91 for major mineral resources using the four valuation methods just discussed.[11] The minerals valued include the fuels (petroleum, natural gas, coal, and uranium), the metals (iron ore, copper, lead, zinc, gold, silver, and molybdenum), and other minerals (phosphate rock, sulfur, boron, diatomite, gypsum, and potash). Petroleum and gas account for the lion's share of mineral production. The other minerals were selected because, of the minerals that have scarcity value, their value of production was relatively high.

The picture that emerges from the various estimates of the value of U.S. mineral stocks is broadly similar, regardless of which methodology is used:

- The value of additions has tended to exceed depletions; since 1958, the value of the stocks of proved mineral reserves in the aggregate has grown in current dollars, while showing little change in constant (1987) dollars (charts 1 and 2 and table A).
- Changes in the stocks of these productive assets over time have largely reflected changes in their resource rents. Increases in resource rents have been accompanied by greater investment in exploration and enhanced recovery technology, and decreases in rents for some resources have been accompanied by reduced exploration activity and the closing of marginal fields and mines.
- Proved mineral reserves constitute a significant share of the economy's stock of productive resources. Addition of the value of the stock of these mineral resources to the value of structures, equipment, and inventories for 1991 would raise the total by $471-$916 billion, or 3–7 percent, depending on the valuation method used.
- The stocks of proved mineral resources are worth much more than the stocks of invested

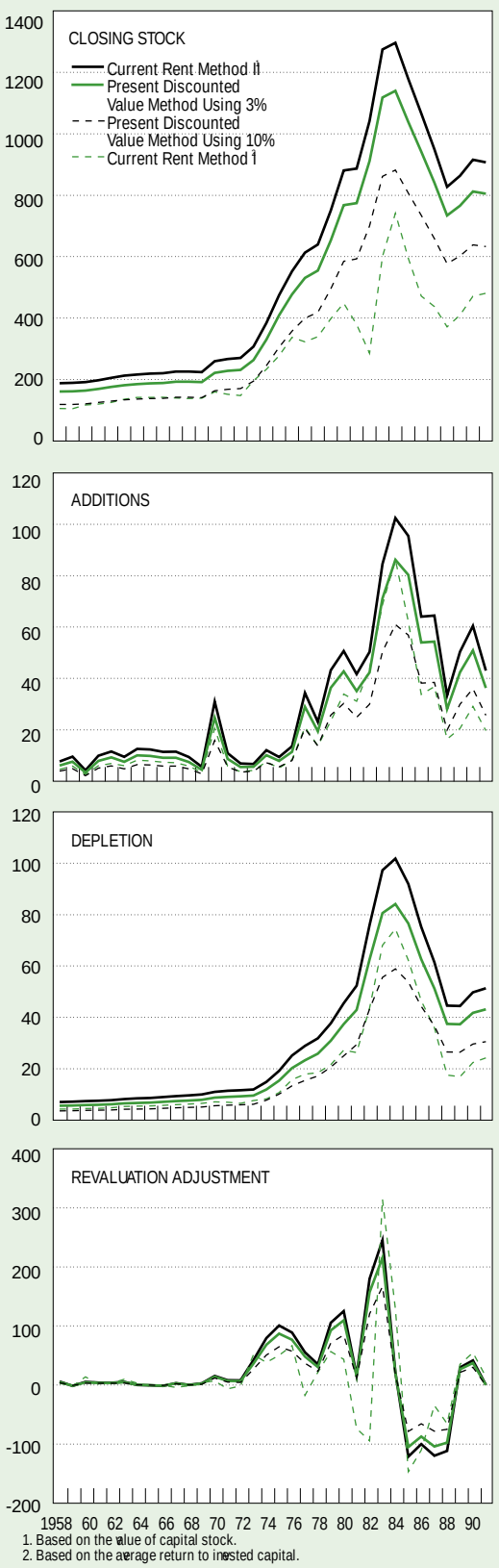
9. The method outlined here is based on the approach used by M.A. Adelman, which has been modified to estimate the resource rent and hence the depletion and the value of oil and gas resources.

10. Note that if the resource appreciates at a rate equal to the nominal interest rate, the real discount rate (nominal rate less the increase in prices) is zero, and the barrel factor has a value of one; in this case, the current rent is used to value reserves and depletion.

11. The transactions-price and replacement-cost methods are used for the period 1947–91 and only for oil and gas.

CHART 1

Stocks and Changes in the Stocks of Subsoil Assets, Current Dollars



1. Based on the value of capital stock.
2. Based on the average return to invested capital.

U.S. Department of Commerce, Bureau of Economic Analysis

structures and equipment associated with the resources. In 1991, the value of the stock of subsoil assets was 2 to 4 times as large as the value of the associated stock of invested structures and equipment and inventories.

- Valuing the effect of depletion and additions, as well as including the value of resource stocks, provides a significantly different picture of returns. Compared with rates of return calculated using income and capital stock as measured in the existing accounts, the IEESA-based average rates of return on capital in the mining industry for 1958–91 are lower—4–5 percent rather than 23 percent (table B). Rates of return for all private capital slip from 16 percent using measures in the existing accounts to 14–15 percent using IEESA measures for the mining industries.
- Although the trends that emerge from the alternative methods are similar, the range of estimates is large. The highest estimates of stocks, depletion, and additions were obtained from the current rent estimates based on capital stock values, and the lowest were from the current rent estimates based on average rates of return to capital.

The stock of proved reserves increased from $103-$182 billion in 1958 to $471-$916 billion in 1991. In constant dollars, the stock rose somewhat and then fell, but over the period showed little change: From $544-$1,077 billion in 1958, the real stock slipped only slightly to $530-$1,030 billion in 1991. The patterns vary by type of mineral and reflect the effects of prices and costs of production, the volatility in international minerals prices, increasing environmental regulation, and the effect of strikes and other factors specific to each industry.

For petroleum, despite periodic concerns that the United States was running out of oil, additions have offset depletion throughout the period as oil companies have responded to higher net returns by stepping up exploration and improved recovery techniques to produce stocks of proved reserves sufficient to meet current and intermediate-term needs in light of current prices, costs, and interest rates. The one spike in the constant-dollar oil and gas series was in 1970, the year of the Alaskan oil strike.

For coal, additions have exceeded depletions, resulting in a generally rising constant-dollar value of stocks over time. For other minerals, the stock patterns have varied, with declining stocks in metals reflecting large declines in the returns to metals.

The 1991 stock of mineral reserves would add 3–7 percent to the 1991 value of reproducible tangible wealth of $13,637 billion, of which private nonresidential structures and equipment were $5,440 billion. Over time, the mineral reserves share of an expanded estimate of national wealth has fallen; in 1958, mineral reserves would have added 9–17 percent to reproducible tangible wealth. This decline appears to reflect several factors, including the economy's increased reliance on foreign resources and the increased efficiency in the use of fuels and other minerals.

Although industry makes large investments in exploring and developing mineral resources, the value of the invested capital associated with oilfields and mines is small relative to the value of the mineral reserves themselves. In 1991, the value of subsoil assets was 2–4 times as large as the associated capital invested in mining. Addition of these stocks of productive natural assets provides a more comprehensive picture of both the assets and the returns in the mineral industries.

Treatment of natural resources symmetrically with investments in equipment and structures provides a very different picture of rates of return to mining. Rates of return in the mineral industries calculated using income and capital stock as measured in the existing accounts—specifically, by dividing property-type income by the replacement value of structures, equipment, and inventories—averaged 23.1 percent for 1958–91. The more complete IEESA estimate deducts depletion and adds additions to property-type income, and it adds the value of resource stocks to the value of structures, equipment, and inventories. Depending on the valuation method used, the IEESA rate of return would be 3.5–5.2 percent. The effects of including mining resources are so large that the rate of return to all private capital is reduced from 16.1 percent to 14.1–14.9 percent. These IEESA rates of return provide a significantly different picture of the social rate of return to investments in the mining industries and the sustainability of the industries' output.[12]

As noted, the highest estimates of resource reserves are from the current rent method based on the value of capital stock invested in the industry.[13] The value of subsoil assets using this method was $916 billion in 1991. The lowest value in 1991, $471 billion, was obtained from the current rent method based on a normal return to invested capital. The present discounted value estimates fell somewhere in between—$638-$812 billion.

The replacement-cost and transactions-price estimates were computed only for oil and gas. The transactions-price estimates, despite considerable smoothing, were quite volatile and erratic.

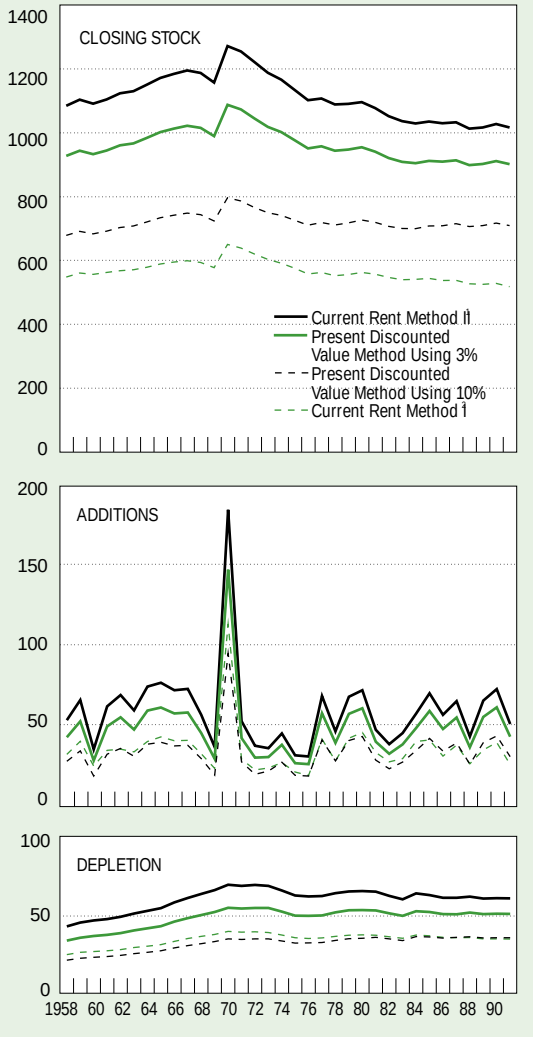
12. Given the effect of tax laws, transfer pricing, and excluded assets, comparison of rates of return across methods is difficult at best. Many of the mining industries have relatively little invested capital (fixed or inventory) associated with the resources, and hence the computed returns to reproducible capital are overstated relative to those that mining companies, which do count the value of property, have on their books.

13. Over the period of this analysis, the current rent per unit for all the resources increased at an annual rate of 4–8 percent. Based on a real time preference rate of 3 percent—or a nominal rate of approximately 6 percent—the current rent methods may not be too far off the mark over long periods of time, given the range of uncertainty in the estimates of rates of return. If one chooses a higher discount rate, then *some* discounting should occur.

CHART 2

Stocks and Changes in the Stocks of Subsoil Assets, Constant Dollars

Billion 1987 $



1. Based on the value of capitol stock.
2. Based on the average return to invested capital.

U.S. Department of Commerce, Bureau of Economic Analysis

Table A.1.—Value of the Resource, Additions, and Depletion of All Subsoil Assets, Current Rent Method I (Rate of Return)

Year	Billions of current dollars					Billions of 1987 dollars			
	Opening stock	Additions	Depletion	Revaluation adjustment	Closing stock (1+2–3+4)	Opening stock	Additions	Depletion	Closing stock (6+7–8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1958	102.6	4.6	4.3	2.8	105.6	544.4	31.4	25.9	550.0
1959	105.6	5.9	4.4	–2.0	105.2	550.0	39.5	27.3	562.2
1960	105.2	2.6	4.5	13.9	117.2	562.2	24.1	27.7	558.5
1961	117.2	6.0	4.6	1.5	120.1	558.5	33.9	28.2	564.2
1962	120.1	6.9	4.8	3.2	125.4	564.2	34.6	29.0	569.8
1963	125.4	6.0	5.3	9.6	135.8	569.8	32.9	30.3	572.5
1964	135.8	8.2	5.5	3.2	141.7	572.5	39.4	31.1	580.7
1965	141.7	7.9	5.5	–2.3	141.8	580.7	42.3	32.1	590.9
1966	141.8	7.4	5.8	–.6	142.7	590.9	39.9	34.1	596.6
1967	142.7	7.2	6.1	–3.9	140.0	596.6	40.2	36.0	600.9
1968	140.0	5.9	6.2	–1.2	138.4	600.9	31.7	37.3	595.3
1969	138.4	3.4	6.5	4.1	139.5	595.3	22.6	38.5	579.5
1970	139.5	20.5	7.1	6.8	159.7	579.5	112.7	40.4	651.8
1971	159.7	5.9	7.0	–6.5	152.1	651.8	28.4	39.9	640.4
1972	152.1	3.7	6.5	–1.4	147.9	640.4	21.7	40.2	621.8
1973	147.9	4.2	7.6	51.1	195.7	621.8	22.9	39.6	605.1
1974	195.7	7.6	8.3	38.2	233.1	605.1	26.2	38.1	593.2
1975	233.1	5.1	10.7	50.3	277.8	593.2	20.4	36.4	577.2
1976	277.8	8.4	15.7	66.6	337.1	577.2	18.2	36.0	559.5
1977	337.1	21.0	17.9	–17.6	322.6	559.5	40.8	36.3	564.0
1978	322.6	13.8	18.4	21.5	339.5	564.0	27.3	37.3	554.0
1979	339.5	23.5	21.6	56.7	398.1	554.0	41.5	37.9	557.6
1980	398.1	33.9	27.2	43.5	448.3	557.6	45.0	38.3	564.3
1981	448.3	31.1	26.3	–73.7	379.4	564.3	32.6	38.0	558.9
1982	379.4	43.9	43.6	–94.5	285.2	558.9	26.7	37.1	548.6
1983	285.2	68.7	68.1	314.7	600.6	548.6	28.8	36.0	541.3
1984	600.6	86.3	74.5	128.9	741.3	541.3	39.4	38.1	542.7
1985	741.3	62.1	62.3	–146.7	594.4	542.7	40.4	37.6	545.5
1986	594.4	33.8	46.4	–110.2	471.6	545.5	30.3	36.7	539.1
1987	471.6	36.8	36.0	–34.8	437.5	539.1	37.1	36.4	539.8
1988	437.5	16.4	17.5	–65.3	371.1	539.8	25.5	36.6	528.7
1989	371.1	20.6	16.9	35.1	409.9	528.7	34.1	35.7	527.1
1990	409.9	29.1	22.4	54.6	471.2	527.1	38.8	35.7	530.3
1991	471.2	19.6	24.2	14.0	480.6	530.3	25.0	35.6	519.7

Table A.2.—Value of the Resource, Additions, and Depletion of All Subsoil Assets, Current Rent Method II (Value of Capital)

Year	Billions of current dollars					Billions of 1987 dollars			
	Opening stock	Additions	Depletion	Revaluation adjustment	Closing stock (1+2–3+4)	Opening stock	Additions	Depletion	Closing stock (6+7–8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1958	181.9	7.7	7.1	5.9	188.3	1,077.4	52.7	43.6	1,086.5
1959	188.3	9.5	7.2	–1.5	189.3	1,086.5	65.3	45.9	1,105.9
1960	189.3	4.3	7.4	5.5	191.6	1,105.9	34.5	47.3	1,093.1
1961	191.6	9.9	7.5	4.0	198.0	1,093.1	61.4	48.1	1,106.4
1962	198.0	11.6	7.8	3.9	205.7	1,106.4	68.4	49.5	1,125.2
1963	205.7	9.5	8.2	5.3	212.3	1,125.2	58.8	51.7	1,132.3
1964	212.3	12.6	8.5	0	216.4	1,132.3	73.6	53.4	1,152.6
1965	216.4	12.3	8.6	–.7	219.4	1,152.6	76.0	55.0	1,173.6
1966	219.4	11.4	9.0	–1.5	220.4	1,173.6	71.4	58.6	1,186.4
1967	220.4	11.5	9.3	3.2	225.8	1,186.4	72.2	61.4	1,197.1
1968	225.8	9.4	9.6	.2	225.8	1,197.1	56.1	63.9	1,189.3
1969	225.8	5.6	10.0	2.8	224.2	1,189.3	35.9	66.4	1,158.8
1970	224.2	31.0	11.0	15.3	259.5	1,158.8	184.1	69.7	1,273.2
1971	259.5	10.9	11.4	8.1	267.1	1,273.2	52.1	69.0	1,256.4
1972	267.1	6.9	11.7	7.9	270.3	1,256.4	36.8	69.6	1,223.6
1973	270.3	6.7	12.0	42.2	307.1	1,223.6	35.3	68.9	1,190.0
1974	307.1	12.1	14.9	79.4	383.7	1,190.0	44.4	66.1	1,168.3
1975	383.7	9.4	19.2	101.1	475.0	1,168.3	30.8	62.9	1,136.1
1976	475.0	13.6	25.2	88.9	552.3	1,136.1	30.1	62.3	1,103.9
1977	552.3	34.4	28.9	55.2	613.1	1,103.9	67.8	62.6	1,109.1
1978	613.1	23.1	31.8	35.0	639.3	1,109.1	45.8	64.4	1,090.5
1979	639.3	43.2	37.7	105.6	750.4	1,090.5	67.3	65.5	1,092.3
1980	750.4	50.7	45.5	125.3	881.0	1,092.3	71.4	65.7	1,097.9
1981	881.0	41.7	52.3	16.7	887.1	1,097.9	46.7	65.4	1,079.3
1982	887.1	50.3	76.0	180.2	1,041.6	1,079.3	37.7	62.8	1,054.2
1983	1,041.6	84.6	97.3	245.2	1,274.2	1,054.2	44.7	60.6	1,038.3
1984	1,274.2	102.5	101.8	21.1	1,296.0	1,038.3	56.8	64.2	1,030.8
1985	1,296.0	95.5	92.0	–121.4	1,178.1	1,030.8	69.5	63.2	1,037.1
1986	1,178.1	64.1	75.3	–100.1	1,066.9	1,037.1	56.0	61.6	1,031.6
1987	1,066.9	64.6	61.5	–119.6	950.3	1,031.6	64.6	61.5	1,034.6
1988	950.3	33.4	44.6	–111.5	827.6	1,034.6	42.5	62.2	1,014.9
1989	827.6	50.4	44.4	29.6	863.2	1,014.9	65.0	61.1	1,018.8
1990	863.2	60.5	49.7	41.5	915.5	1,018.8	72.1	61.3	1,029.6
1991	915.5	43.1	51.3	.4	907.6	1,029.6	50.3	61.2	1,018.7

Table A.3.—Value of the Resource, Additions, and Depletion of All Subsoil Assets, Present Discounted Value Method Using 3% Discount Rate

Year	Billions of current dollars					Billions of 1987 dollars			
	Opening stock	Additions	Depletion	Revaluation adjustment	Closing stock (1+2–3+4)	Opening stock	Additions	Depletion	Closing stock [1] (6+7–8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1958	155.6	6.1	5.6	5.0	161.1	921.6	42.0	34.6	929.4
1959	161.1	7.6	5.7	–1.1	161.9	929.4	52.0	36.5	946.0
1960	161.9	3.4	5.9	4.5	163.9	946.0	27.5	37.5	935.1
1961	163.9	7.9	6.0	3.5	169.3	935.1	48.9	38.2	946.4
1962	169.3	9.2	6.2	3.5	176.0	946.4	54.5	39.3	962.6
1963	176.0	7.5	6.5	4.6	181.6	962.6	46.8	41.0	968.6
1964	181.6	10.0	6.7	.2	185.1	968.6	58.7	42.4	986.0
1965	185.1	9.8	6.8	–.4	187.7	986.0	60.6	43.7	1,003.9
1966	187.7	9.1	7.1	–1.2	188.5	1,003.9	56.9	46.5	1,014.8
1967	188.5	9.2	7.4	2.8	193.1	1,014.8	57.5	48.7	1,024.0
1968	193.1	7.5	7.6	.1	193.1	1,024.0	44.7	50.7	1,017.4
1969	193.1	4.5	7.9	2.1	191.8	1,017.4	28.6	52.7	991.3
1970	191.8	24.7	8.7	14.2	222.0	991.3	146.7	55.3	1,089.1
1971	222.0	8.7	9.0	6.9	228.5	1,089.1	41.5	54.8	1,074.7
1972	228.5	5.5	9.3	6.4	231.2	1,074.7	29.3	55.2	1,046.7
1973	231.2	5.6	9.6	36.1	263.4	1,046.7	29.7	55.2	1,020.3
1974	263.4	10.2	11.9	68.2	329.8	1,020.3	37.4	52.9	1,004.0
1975	329.8	7.9	15.4	86.8	409.2	1,004.0	25.9	50.3	978.7
1976	409.2	11.4	20.3	76.6	476.9	978.7	25.3	50.3	953.1
1977	476.9	28.9	23.3	48.0	530.5	953.1	57.1	50.5	959.8
1978	530.5	19.4	25.9	30.5	554.5	959.8	38.6	52.3	945.9
1979	554.5	36.4	30.9	92.4	652.4	945.9	56.6	53.7	949.6
1980	652.4	42.8	37.3	109.8	767.7	949.6	60.1	53.9	956.7
1981	767.7	35.1	42.9	14.9	774.8	956.7	39.3	53.6	942.6
1982	774.8	42.4	62.6	157.3	911.8	942.6	31.7	51.7	922.8
1983	911.8	71.2	80.6	215.5	1,117.9	922.8	37.6	50.2	911.0
1984	1,117.9	86.3	84.1	19.6	1,139.6	911.0	47.8	53.1	906.5
1985	1,139.6	80.4	76.6	–105.0	1,038.4	906.5	58.5	52.6	914.1
1986	1,038.4	54.0	62.7	–87.2	942.4	914.1	47.2	51.3	911.3
1987	942.4	54.3	51.3	–104.2	841.4	911.3	54.3	51.3	916.0
1988	841.4	28.1	37.5	–97.6	734.4	916.0	35.8	52.3	900.6
1989	734.4	42.4	37.3	26.5	766.0	900.6	54.7	51.3	904.1
1990	766.0	50.9	41.8	37.2	812.4	904.1	60.7	51.5	913.6
1991	812.4	36.3	43.1	–.1	805.4	913.6	42.3	51.4	903.9

1. Because of the simplifying assumptions used in the calculation of stocks for this method, closing stocks are not necessarily equal to opening stocks plus additions less depletion. For most years, the differences are very small.

Table A.4.—Value of the Resource, Additions, and Depletion of All Subsoil Assets, Present Discounted Value Method Using 10% Discount Rate

Year	Billions of current dollars					Billions of 1987 dollars			
	Opening stock	Additions	Depletion	Revaluation adjustment	Closing stock (1+2–3+4)	Opening stock	Additions	Depletion	Closing stock [1] (6+7–8)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1958	114.7	3.9	3.6	3.8	118.8	674.6	27.0	22.3	680.4
1959	118.8	4.9	3.7	–.6	119.3	680.4	33.5	23.6	692.7
1960	119.3	2.2	3.8	3.1	120.8	692.7	17.7	24.3	684.7
1961	120.8	5.1	3.9	2.8	124.8	684.7	31.5	24.7	693.3
1962	124.8	6.0	4.0	2.9	129.7	693.3	35.1	25.4	705.4
1963	129.7	4.9	4.2	3.5	133.8	705.4	30.2	26.5	710.0
1964	133.8	6.5	4.3	.5	136.4	710.0	37.8	27.4	722.8
1965	136.4	6.3	4.4	0	138.3	722.8	39.0	28.2	736.0
1966	138.3	5.9	4.6	–.6	139.0	736.0	36.6	30.1	744.0
1967	139.0	5.9	4.8	2.3	142.3	744.0	37.0	31.5	750.6
1968	142.3	4.8	4.9	.1	142.4	750.6	28.8	32.8	745.4
1969	142.4	2.9	5.1	1.3	141.4	745.4	18.4	34.0	726.1
1970	141.4	15.9	5.6	12.0	163.6	726.1	94.4	35.7	798.5
1971	163.6	5.6	5.8	5.0	168.4	798.5	26.7	35.4	788.1
1972	168.4	3.6	6.0	4.4	170.4	788.1	18.9	35.7	767.7
1973	170.4	4.0	6.2	26.8	195.0	767.7	21.0	35.7	751.8
1974	195.0	7.2	7.8	50.8	245.2	751.8	26.5	34.4	743.5
1975	245.2	5.6	10.1	64.8	305.5	743.5	18.3	33.1	728.4
1976	305.5	8.1	13.4	57.3	357.5	728.4	17.9	33.2	712.7
1977	357.5	20.5	15.4	36.8	399.4	712.7	40.4	33.5	720.8
1978	399.4	13.7	17.2	23.2	419.1	720.8	27.3	34.8	713.4
1979	419.1	25.7	20.6	70.9	495.1	713.4	40.1	35.8	719.7
1980	495.1	30.3	25.0	84.6	584.9	719.7	42.5	36.1	728.9
1981	584.9	24.8	29.4	12.3	592.7	728.9	27.8	36.7	721.6
1982	592.7	30.0	43.2	120.8	700.3	721.6	22.5	35.7	709.3
1983	700.3	50.4	55.6	166.9	862.0	709.3	26.6	34.6	702.8
1984	862.0	61.0	58.8	18.0	882.1	702.8	33.8	37.1	701.9
1985	882.1	56.9	53.8	–78.4	806.8	701.9	41.4	36.9	710.4
1986	806.8	38.2	44.3	–65.6	735.1	710.4	33.4	36.2	710.8
1987	735.1	38.4	36.6	–78.2	658.7	710.8	38.4	36.6	717.3
1988	658.7	19.9	26.5	–74.9	577.1	717.3	25.3	37.0	708.2
1989	577.1	30.0	26.4	21.3	602.0	708.2	38.7	36.3	711.3
1990	602.0	36.0	29.6	30.0	638.4	711.3	42.9	36.5	719.0
1991	638.4	25.6	30.6	–.6	632.9	719.0	30.0	36.4	711.5

1. Because of the simplifying assumptions used in the calculation of stocks for this method, closing stocks are not necessarily equal to opening stocks plus additions less depletion. For most years, the differences are very small.

Table B.—Alternative Rates of Return, Averages for 1958–91

[Percent]

	NIPA based	IEESA based			
		Current rent I	Current rent II	PDV 3% rate	PDV 10% rate
Mining industries	23.1	5.2	3.5	4.0	5.0
Total private capital	16.1	14.9	14.1	14.4	14.8

NOTE.—In general, rates of return are some measure of income divided by some measure of capital stock. For the NIPA-based estimates, income is defined as property-type income (profits, rents, net interest plus indirect business taxes), and capital stock is defined as structures, equipment, and inventories. In the alternative IEESA methods, income is also defined as property-type income, but depletion is subtracted from profits, and the value of additions is added; IEESA capital stock is defined as structures, equipment, and inventories plus the value of mineral resources.

PDV Present discounted value

The replacement-cost estimates produced the lowest values among all the estimates for gas. The transactions-price estimates produced the lowest values for oil.

For some of the subsoil asset estimates, especially those employing the current rent method based on a normal return to invested capital, the resource stock values and stock changes are quite low. In certain industries, especially the metals industries, the estimates were negative (indicated with an asterisk in the tables). These negative values indicate that the gross rents in these industries are so low that any procedure that assumes a normal return to capital in that industry must attribute a negative residual rent to the resource if total factor returns are to add up to market output. One can imagine an alternative procedure that assumes a normal return plus a depletion allowance and derives a negative residual for the invested capital associated with the resource.

Appendix: Data Sources and Methods

Current-Dollar Estimates

Petroleum and natural gas

Prices and quantities.—The basic commodity prices used are the average wellhead prices for oil and gas from the American Petroleum Institute (API). The wellhead price for gas includes rents attributable to natural gas liquids (NGL) that, depending on market conditions, may be separated downstream. Oil production quantities are from API and the Department of Energy (DOE) and include both crude production and lease condensate production, both in millions of barrels. Natural gas production is marketed production from API and DOE. Marketed production has not yet undergone the extraction of NGL. Total revenue for oil and gas production is calculated as price times quantity produced.

Reserve estimates are from API and DOE for crude oil and dry gas. The reserve volumes for oil and gas were augmented for reserves of NGL, which are reported separately. Additions were set equal to additions from DOE and API plus any residual change in stocks not accounted for by reported flows. The residual arises out of discontinuities in the estimates caused by the different reserve estimation methods used over the last 40 years.

The basic commodity price data used are yearly average prices. The large fluctuation in commodity prices, however, makes them unstable and thus unsuitable for estimating the average or expected returns that investors presumably have in mind in determining the appropriate price for long-lived assets such as mineral reserves. In order to smooth the estimates, a 3-year lagged average of the yearly average prices is used as the midyear market price.

Costs.—Data on current production expenditures and ad valorem and windfall profits taxes are from API's Survey of Oil and Gas Expenditures (SOGE) and, for 1972–81, the Census Bureau's Annual Survey of Oil and Gas (ASOG). "Finding costs" are obtained as a 3-year moving average of development expenditures per unit of reserve added; the source data are from the SOGE and the ASOG. For years not covered by the SOGE, estimates of costs were interpolated using an indicator series.

Capital stock.—The capital stock, depreciation, and investment estimates are from BEA. BEA defines investment and capital for mining industries differently from standard industry practice. BEA investment includes capital equipment, structures, and all exploration and development expenditures, even those expenditures that are treated as current expenses by operators. NIPA capital and investment estimates are available as an aggregate for oil and gas extraction (SIC 13). The portion of capital for four-digit SIC industry 1321, natural gas liquids, was removed from this series, as this capital is not used in the extraction of oil or gas. Rather, natural gas liquids, a small piece of SIC 13, is a downstream process. The capital stock of the other four-digit components of SIC 13 is considered a part of the capital required for the extraction of oil and gas; for example, oil and gas field exploration services, SIC industry 1382, is used as inputs for oil and gas extraction.

The NIPA investment series for oil and gas extraction from 1959–91 was disaggregated into oil extraction and gas extraction using the ratio of expenditures for successful oil wells drilled to expenditures for successful gas wells drilled. For 1947–58, expenditure ratios for oil wells and gas wells were estimated using the number of successful oil wells and gas wells drilled. These two investment series were then used to generate current- and constant-dollar capital stock and depreciation estimates for oil extraction and for gas extraction.

Other minerals

Inconsistencies in data and a paucity of data for nonbenchmark years present substantial difficulties in making estimates for other minerals. The data that do exist are often classified incongruently, or the definitions for series change over time. For example, Census Bureau data—which are the only comprehensive data available on production, costs, and revenues—are on an SIC basis; BEA data on capital stocks are on an SIC basis but at a more aggregate level than the Census data; and Bureau of Mines and DOE data on reserves, production quantities, and prices are on a commodity basis.

Prices and quantities.—For most minerals, the basic commodity prices used are 3-year lagged averages of the value of production divided by the quantity produced for metals and other minerals from the Bureau of Mines or DOE. For other minerals, a combination of available data on prices, quantities produced, or value of production is used to derive missing data on prices or value of production. Total revenue from current production is equal to the average price times the quantity produced.

Changing definitions for mineral reserve quantities present significant problems for the construction of consistent time series for mineral reserves. Prior to 1978, reserves were defined by the Bureau of Mines as economic reserves, both demonstrated and inferred; between 1979 and 1986, reserve base was the preferred definition, and this comprised demonstrated (but not inferred) economic reserves, marginal economic reserves, and part of subeconomic reserves; since 1987, only demonstrated economic reserves are included in the definition of reserves. Only the last definition is roughly consistent with proved reserves in oil and gas. The published estimates showed such large year-to-year changes—even within subperiods in which reserve definitions were unchanged—that BEA has attempted to develop a consistent, or at least smoothed, time series for these minerals. The BEA series use a weighted average that is based on a constant output-to-reserve ratio and on a judgmentally scaled moving average of published reserves. (Uranium reserves are based on a different method that splices DOE's forward-cost categories to construct a consistent time series.)

Costs.—Consistent data on production expenditures—current variable costs of extraction, including purchased services—were derived from the Census Bureau's minerals industries data and from BEA's benchmark input-output data.

Capital stock.—For census years between 1958 and 1991, data on investment in plant, equipment, and exploration and development were derived from the Census Bureau's *Census of Mineral Industries*. These investment data were then used to construct industry-specific capital stock estimates for mineral industries at a level of detail greater than that at which BEA normally produces estimates.

Constant-Dollar Estimates

Constant-dollar estimates for petroleum, natural gas, and other minerals use 1987 as the base year. The base-year estimate for resource rent was used to calculate constant-dollar series for the following methods: Current rent, present discounted value, and, for a shorter period, transactions price. For each method, the 1987 per-unit resource rent for the value of depletion was multiplied by the physical volume of depletion and additions to derive the value of depletion and additions, respectively. The constant-dollar value of the resource stock is the product of the 1987 per-unit resource rent and the end-of-year volume of reserves.

References

1. Adelman, M. A., Harindar De Silva, and Michael F. Koehn. "User Cost in Oil Production." *Resources and Energy* 13 (1991): 217–240.
2. Adelman, M. A., John C. Houghton, Gordon M. Kaufman, and Martin B. Zimmerman. *Energy Resources in an Uncertain Future*. Cambridge, MA: Ballinger, 1983.
3. Ahmad, Yusuf J., Salah El Serafy, and Ernst Lutz, editors. *Environmental Accounting for*

Sustainable Development. Washington, DC: The World Bank, 1989.

4. Boskin, Michael J., Marc S. Robinson, Terrance O'Reilly, and Praveen Kumar. "New Estimates of the Value of Federal Mineral Rights and Land." *American Economic Review* 75, no. 5 (December 1985): 923–936.
5. Gordon, Patrice L., and Raymond Prince. "Greening the National Accounts." Congressional Budget Office, March 1994.
6. El Serafy, Salah. "The Proper Calculation of Income From Depletable Natural Resources." In *Environmental Accounting for Sustainable Development*, edited by Yusuf J. Ahmad, Salah El Serafy, and Ernst Lutz, 10–18. Washington, DC: The World Bank, 1989.
7. El Serafy, Salah, and Ernst Lutz. "Environmental and Resource Accounting: An Overview." In *Environmental Accounting for Sustainable Development*, edited by Yusuf J. Ahmad, Salah El Serafy, and Ernst Lutz, 1–7. Washington, DC: The World Bank, 1989.
8. Ferran, Bernardo. "Corporate and Social Accounting for Petroleum." *Review of Income and Wealth* (March 1981): 104.
9. Grambsch, Anne E., and R. Gregory Michaels, with Henry M. Peskin. "Taking Stock of Nature: Environmental Accounting for Chesapeake Bay." In *Toward Improved Accounting for the Environment*, edited by Ernst Lutz, 184–197. Washington, DC: The World Bank, 1993.
10. Hartwick, John R. "Natural Resources, National Accounting and Economic Depreciation." *Journal of Public Economics* 43, no. 3 (December, 1990): 291–304.
11. Hartwick, John, and Anja Hageman. "Economic Depreciation of Mineral Stocks and the Contribution of El Serafy." In *Toward Improved Accounting for the Environment*, edited by Ernst Lutz, 211–235. Washington, DC: The World Bank, 1993.
12. Hotelling, Harold. "The Economics of Exhaustible Resources." *Journal of Political Economy* 39, no. 2 (1931): 137–175.
13. Jaszi, George. "Review: An Economic Accountant's Ledger," in "The Economic Accounts of the United States: Retrospect and Prospect." SURVEY OF CURRENT BUSINESS 51, no. 7, Part II, 50th anniversary issue (July 1971): 221–225.
14. Jaszi, George. "The Conceptual Basis of the Accounts: A Re-examination." In *A Critique of the United States Income and Product Accounts.* Studies in Income and Wealth, vol. 22, 93–94. New York: University Press, 1958.
15. Landefeld, J. Steven, and James R. Hines. "Valuing Non-Renewable Natural Resources in the Mining Industries." *Review of Income and Wealth* 31, no. 1 (March 1985): 1–20.
16. Lutz, Ernst, editor. *Toward Improved Accounting for the Environment.* Washington, DC: The World Bank, 1993.
17. Lutz, Ernst, and Henry M. Peskin. "A Survey of Resource and Accounting Approaches in Industrialized Countries." In *Toward Improved Accounting for the Environment*, edited by Ernst Lutz, 144–176. Washington, DC: The World Bank, 1993.
18. Nordhaus, William D. "The Allocation of Energy Resources." Brookings Papers on Economic Activity 3 (1973): 529–570.
19. Nordhaus, William D., and James Tobin. "Is Growth Obsolete?" In *The Measurement of Economic and Social Performance*. Studies in Income and Wealth, vol. 38, edited by Milton Moss, 509–532. New York: Columbia University Press, 1973.
20. Organisation for Economic Co-operation and Development, Department of Economics and Statistics. "Extending National Accounting With Regard to Natural and Environmental Resources and to Expenditure on Pollution Abatement: An Overview of the Recent International Discussion." Paper distributed at the meeting of National Accounts Experts, Paris, June 14, 1991.
21. Paddock, James L., Daniel R. Siegel, and James L. Smith. "Option Valuation of Claims on Real Assets: The Case of Offshore Petroleum Leases." *Quarterly Journal of Economics* 98, no. 3 (August 1991): 479–508.
22. Peskin, Henry M. "A Proposed Environmental Accounts Framework." In *Environmental Accounting for Sustainable Development*, edited by Yusuf J. Ahmad, Salah El Serafy, and Ernst Lutz. Washington, DC: The World Bank, 1989.
23. Peskin, Henry M., with Ernst Lutz. "A Survey of Resource and Environmental Accounting Approaches in Industrialized Countries." In *Toward Improved Accounting for the Environment*, edited by Ernst Lutz, 144–176. Washington, DC: The World Bank, 1993.
24. Rasmussen, Jon A. "Finding Costs and the Make-or-Buy Decision for Oil and Gas Producers in 1982–1986." *Petroleum Accounting*

and Financial Management Journal 11, no. 2 (Summer 1992): 60–92.

25. Repetto, Robert, William Magrath, Michael Wells, Christine Beer, and Fabrizo Rossini. *Wasting Assets: National Resources in the National Income Accounts*. Washington, DC: World Resources Institute, June 1989.
26. Soladay, John J. "Measurement of Income and Product in the Oil and Gas Mining Industries." In *The Measurement of Capital*. Studies in Income and Wealth, vol. 45, 347–376. Chicago: The University of Chicago Press, 1980.
27. Solow, Robert. "An Almost Practical Step Toward Sustainability." Print of an invited lecture on the occasion of the 40th anniversary of Resources for the Future. October 8, 1992. Washington, DC: Resources for the Future.
28. Stauffer, Thomas S. "Accounting for 'Wasting Assets': Measurement of Income and Dependency in Oil-Renter States." *Journal of Energy and Development* 11, no. 1 (1986): 69–93.
29. United Nations. *Agenda 21: Programme of Action for Sustainable Development*. Department of Public Information. New York: United Nations, 1992, chapters 8 and 40.
30. United Nations. *Integrated Environmental and Economic Accounting* (interim version). Studies in Methods, Handbook of National Accounting, series F, no. 61. New York: United Nations, 1993.
31. *System of National Accounts 1993*. Brussels: Commission of the European Communities, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, and World Bank, 1993.
32. United States Department of Commerce. Bureau of Economic Analysis. *Fixed Reproducible Tangible Wealth in the United States, 1925–89*. Washington, DC: U.S. Government Printing Office, January 1993.
33. United States Department of Commerce. Bureau of Economic Analysis. "New International Guidelines in Economic Accounting." SURVEY OF CURRENT BUSINESS 73, no. 2 (February 1993): 43–44.
34. World Commission on Environment and Development. *Our Common Future*. Oxford: Oxford University Press, 1987.
35. Wright, Gavin. "The Origins of American Industrial Success, 1879–1940." *American Economic Review* 80, no. 4 (September 1990): 651–668.

Tables 1.1 through 5.4 follow.

Table 1.1.—Value of the Resource, Additions, and Depletion of Oil, Current Rent Method I (Rate of Return)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	2.4	1.8	.....	26.1
1948	26.1	5.7	3.0	6.1	34.9
1949	34.9	4.5	2.5	.5	37.4
1950	37.4	4.1	3.0	.3	38.8
1951	38.8	6.4	3.2	–2.5	39.6
1952	39.6	3.5	2.8	–3.9	36.3
1953	36.3	4.3	3.0	1.2	38.9
1954	38.9	4.0	3.2	3.6	43.2
1955	43.2	4.6	3.9	4.2	48.2
1956	48.2	4.6	3.9	–1.3	47.6
1957	47.6	3.5	3.8	–1.0	46.3
1958	46.3	4.1	3.6	.4	47.2
1959	47.2	5.2	3.5	–5.6	43.3
1960	43.3	3.3	3.3	–1.1	42.1
1961	42.1	3.5	3.3	–.6	41.8
1962	41.8	2.9	3.3	–.5	40.8
1963	40.8	3.1	3.6	1.6	42.0
1964	42.0	3.6	3.6	–.7	41.3
1965	41.3	4.0	3.5	–1.4	40.4
1966	40.4	3.9	3.7	–.6	40.0
1967	40.0	4.1	4.1	2.5	42.5
1968	42.5	3.3	4.2	–.1	41.6
1969	41.6	2.8	4.3	.4	40.5
1970	40.5	16.7	4.6	3.1	55.7
1971	55.7	3.3	4.7	1.0	55.3
1972	55.3	2.1	4.4	–1.8	51.2
1973	51.2	3.6	5.4	28.5	77.9
1974	77.9	3.8	5.8	10.9	86.8
1975	86.8	3.5	7.3	21.7	104.7
1976	104.7	4.2	10.0	19.8	118.7
1977	118.7	13.4	10.7	2.7	124.1
1978	124.1	9.8	11.3	15.4	137.9
1979	137.9	7.1	12.9	60.4	192.5
1980	192.5	19.0	18.9	102.8	295.4
1981	295.4	20.6	22.8	5.2	298.3
1982	298.3	19.8	38.6	102.9	382.4
1983	382.4	54.9	54.7	99.0	481.6
1984	481.6	62.1	51.6	–38.0	454.1
1985	454.1	43.9	43.5	–122.4	332.1
1986	332.1	16.1	30.2	–91.9	226.1
1987	226.1	23.1	20.7	–83.9	144.7
1988	144.7	6.1	7.1	–63.4	80.2
1989	80.2	6.0	7.0	12.8	91.9
1990	91.9	9.2	10.3	32.5	123.3
1991	123.3	5.3	13.0	11.1	126.8

Table 1.2.—Value of the Resource, Additions, and Depletion of Oil, Current Rent Method II (Value of Capital)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	3.0	2.2	.....	31.3
1948	31.3	6.7	3.5	6.4	40.9
1949	40.9	5.5	3.1	2.3	45.6
1950	45.6	4.9	3.6	–.2	46.8
1951	46.8	7.8	3.9	–2.3	48.5
1952	48.5	4.5	3.6	–3.2	46.1
1953	46.1	5.5	3.8	1.8	49.7
1954	49.7	5.2	4.1	4.8	55.5
1955	55.5	5.8	4.8	3.8	60.3
1956	60.3	6.0	5.0	–.2	61.0
1957	61.0	4.7	5.0	.7	61.4
1958	61.4	5.7	5.0	3.3	65.4
1959	65.4	7.4	5.0	–5.3	62.6
1960	62.6	4.8	4.9	–.3	62.2
1961	62.2	5.2	4.9	–1.0	61.5
1962	61.5	4.3	4.9	–.6	60.4
1963	60.4	4.5	5.1	.5	60.2
1964	60.2	5.2	5.1	–.7	59.5
1965	59.5	5.9	5.1	–1.3	58.9
1966	58.9	5.6	5.3	–1.5	57.7
1967	57.7	5.7	5.7	1.1	58.8
1968	58.8	4.6	5.8	–.8	56.8
1969	56.8	3.8	5.9	0	54.8
1970	54.8	23.7	6.5	8.7	80.7
1971	80.7	4.9	6.9	2.0	80.6
1972	80.6	3.3	7.0	1.5	78.4
1973	78.4	4.7	7.0	18.7	94.9
1974	94.9	6.0	9.0	30.1	121.9
1975	121.9	5.5	11.5	33.0	149.0
1976	149.0	6.1	14.4	24.1	164.8
1977	164.8	19.6	15.6	9.3	178.1
1978	178.1	14.7	17.1	19.2	194.9
1979	194.9	10.8	19.7	71.2	257.2
1980	257.2	26.2	26.1	105.2	362.5
1981	362.5	30.2	33.5	37.0	396.2
1982	396.2	26.3	51.4	125.7	496.9
1983	496.9	65.4	65.1	82.1	579.3
1984	579.3	74.2	61.7	–44.1	547.7
1985	547.7	55.4	54.8	–112.6	435.6
1986	435.6	21.9	41.3	–90.4	325.9
1987	325.9	34.2	30.6	–88.3	241.2
1988	241.2	15.9	18.5	–51.1	187.5
1989	187.5	16.4	19.3	30.8	215.4
1990	215.4	20.2	22.6	37.6	250.6
1991	250.6	10.3	25.0	5.8	241.7

Table 1.3.—Value of the Resource, Additions, and Depletion of Oil, Present Discounted Value Method Using 3% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	.....	1.8	.....	26.8
1948	26.8	5.3	2.8	5.7	35.0
1949	35.0	4.4	2.5	2.1	39.0
1950	39.0	3.9	2.8	–.1	40.0
1951	40.0	6.2	3.1	–1.7	41.4
1952	41.4	3.6	2.9	–2.7	39.5
1953	39.5	4.4	3.0	1.7	42.5
1954	42.5	4.1	3.3	4.2	47.5
1955	47.5	4.6	3.8	3.3	51.6
1956	51.6	4.8	4.0	–.1	52.2
1957	52.2	3.7	4.0	.6	52.5
1958	52.5	4.5	4.0	2.9	56.0
1959	56.0	5.9	4.0	–4.4	53.5
1960	53.5	3.8	3.9	–.3	53.2
1961	53.2	4.2	3.9	–.9	52.6
1962	52.6	3.5	3.9	–.5	51.6
1963	51.6	3.5	4.0	.3	51.5
1964	51.5	4.1	4.1	–.6	50.9
1965	50.9	4.7	4.1	–1.1	50.4
1966	50.4	4.4	4.2	–1.3	49.3
1967	49.3	4.5	4.5	.9	50.3
1968	50.3	3.7	4.6	–.8	48.6
1969	48.6	3.1	4.7	–.1	46.9
1970	46.9	18.9	5.2	8.4	69.0
1971	69.0	3.9	5.5	1.5	68.9
1972	68.9	2.6	5.5	1.1	67.1
1973	67.1	4.0	5.6	15.9	81.3
1974	81.3	5.1	7.2	25.6	104.8
1975	104.8	4.7	9.2	28.1	128.3
1976	128.3	5.2	11.6	20.4	142.3
1977	142.3	16.5	12.6	7.9	154.1
1978	154.1	12.4	13.9	16.4	169.0
1979	169.0	9.1	16.1	61.6	223.6
1980	223.6	22.1	21.4	91.6	315.9
1981	315.9	25.4	27.5	32.2	346.0
1982	346.0	22.2	42.3	109.1	435.0
1983	435.0	55.0	54.0	72.2	508.3
1984	508.3	62.5	51.0	–38.1	481.7
1985	481.7	46.6	45.7	–98.6	383.9
1986	383.9	18.5	34.4	–80.2	287.9
1987	287.9	28.8	25.5	–77.7	213.6
1988	213.6	13.4	15.6	–45.0	166.4
1989	166.4	13.8	16.2	27.2	191.1
1990	191.1	17.0	19.0	33.2	222.4
1991	222.4	8.7	21.0	4.4	214.5

Table 1.4.—Value of the Resource, Additions, and Depletion of Oil, Present Discounted Value Method Using 10% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	.....	1.1	.....	19.8
1948	19.8	3.4	1.8	4.4	25.8
1949	25.8	2.8	1.6	1.7	28.8
1950	28.8	2.5	1.8	.1	29.5
1951	29.5	4.0	2.0	–1.0	30.6
1952	30.6	2.3	1.8	–1.9	29.1
1953	29.1	2.8	2.0	1.4	31.3
1954	31.3	2.6	2.1	3.1	35.0
1955	35.0	3.0	2.5	2.5	38.0
1956	38.0	3.1	2.6	0	38.5
1957	38.5	2.4	2.6	.4	38.7
1958	38.7	2.9	2.6	2.2	41.3
1959	41.3	3.8	2.6	–3.0	39.5
1960	39.5	2.5	2.5	–.2	39.2
1961	39.2	2.7	2.5	–.6	38.8
1962	38.8	2.2	2.5	–.4	38.1
1963	38.1	2.3	2.6	.2	37.9
1964	37.9	2.7	2.6	–.5	37.5
1965	37.5	3.0	2.6	–.8	37.1
1966	37.1	2.9	2.7	–.9	36.4
1967	36.4	2.9	2.9	.7	37.1
1968	37.1	2.4	3.0	–.6	35.8
1969	35.8	2.0	3.0	–.2	34.5
1970	34.5	12.2	3.3	7.5	50.9
1971	50.9	2.5	3.6	1.0	50.8
1972	50.8	1.7	3.6	.5	49.4
1973	49.4	2.8	3.6	11.6	60.2
1974	60.2	3.6	4.7	18.8	77.9
1975	77.9	3.3	6.0	20.7	95.8
1976	95.8	3.6	7.7	14.9	106.7
1977	106.7	11.7	8.4	6.0	116.0
1978	116.0	8.8	9.2	12.2	127.7
1979	127.7	6.4	10.8	46.2	169.7
1980	169.7	15.6	14.3	69.7	240.7
1981	240.7	18.0	18.8	24.9	264.7
1982	264.7	15.7	29.2	82.9	334.1
1983	334.1	38.9	37.2	56.1	391.9
1984	391.9	44.2	35.7	–27.6	372.8
1985	372.8	33.0	32.1	–75.4	298.3
1986	298.3	13.1	24.3	–62.6	224.6
1987	224.6	20.4	18.2	–59.5	167.2
1988	167.2	9.5	11.0	–34.9	130.8
1989	130.8	9.7	11.5	21.2	150.2
1990	150.2	12.1	13.5	26.0	174.8
1991	174.8	6.1	14.9	2.5	168.5

Table 1.5.—Value of the Resource, Additions, and Depletion of Oil, Replacement Cost Method

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	1.3	1.0	.....	14.2
1948	14.2	3.1	1.6	3.5	19.2
1949	19.2	2.1	1.2	–2.4	17.7
1950	17.7	1.9	1.4	.1	18.3
1951	18.3	2.7	1.4	–2.5	17.2
1952	17.2	1.6	1.3	–.8	16.7
1953	16.7	1.8	1.2	–.8	16.4
1954	16.4	1.8	1.4	3.1	19.8
1955	19.8	2.2	1.9	3.4	23.6
1956	23.6	2.2	1.9	–.4	23.6
1957	23.6	1.8	2.0	.9	24.4
1958	24.4	2.3	2.0	1.6	26.3
1959	26.3	3.2	2.1	–.5	26.7
1960	26.7	2.1	2.1	.2	26.9
1961	26.9	2.1	1.9	–2.7	24.3
1962	24.3	1.7	1.9	–.2	23.9
1963	23.9	1.8	2.1	.6	24.2
1964	24.2	2.3	2.3	2.4	26.6
1965	26.6	2.8	2.4	1.3	28.2
1966	28.2	2.8	2.7	1.0	29.4
1967	29.4	2.8	2.8	–.1	29.2
1968	29.2	2.1	2.7	–1.7	26.9
1969	26.9	2.2	3.4	6.5	32.3
1970	32.3	11.9	3.3	–1.5	39.4
1971	39.4	2.2	3.2	–1.3	37.2
1972	37.2	1.4	2.9	–1.7	34.0
1973	34.0	1.9	2.8	9.2	42.3
1974	42.3	2.0	3.1	7.7	49.0
1975	49.0	1.2	2.6	–4.3	43.4
1976	43.4	2.0	4.8	18.1	58.7
1977	58.7	7.9	6.3	14.1	74.4
1978	74.4	6.7	7.8	21.7	95.1
1979	95.1	4.8	8.7	37.2	128.4
1980	128.4	10.9	10.9	51.1	179.5
1981	179.5	11.9	13.2	4.5	182.6
1982	182.6	12.2	23.8	66.8	237.9
1983	237.9	33.5	33.4	53.8	291.8
1984	291.8	40.0	33.2	–5.4	293.2
1985	293.2	28.9	28.6	–73.9	219.5
1986	219.5	11.7	22.1	–42.4	166.8
1987	166.8	18.2	16.2	–49.0	119.8
1988	119.8	10.0	11.6	.5	118.7
1989	118.7	9.5	11.2	8.4	125.4
1990	125.4	8.7	9.7	–14.2	110.2
1991	110.2	3.3	8.0	–27.6	77.8

Table 1.6.—Value of the Resource, Additions, and Depletion of Oil, Transaction Price Method

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1977	.....	10.8	8.6	.....	93.7
1978	93.7	7.5	8.7	20.9	113.4
1979	113.4	7.2	13.2	42.7	150.2
1980	150.2	16.6	16.5	3.7	154.0
1981	154.0	12.4	13.8	–.5	152.1
1982	152.1	9.4	18.4	–21.5	121.7
1983	121.7	8.8	8.8	–40.3	81.4
1984	81.4	10.4	8.6	–11.1	72.0
1985	72.0	7.0	7.0	–6.1	66.0
1986	66.0	4.1	7.7	–4.2	58.2
1987	58.2	5.8	5.1	–23.1	35.7
1988	35.7	1.4	1.6	–22.3	13.2
1989	13.2	1.2	1.5	4.3	17.2
1990	17.2	1.6	1.8	20.0	37.1
1991	37.1	2.2	5.3	11.1	45.1

Table 2.1.—Value of the Resource, Additions, and Depletion of Gas, Current Rent Method I (Rate of Return)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	(*)	(*)	.....	(*)
1948	(*)	(*)	(*)	(*)	(*)
1949	(*)	(*)	(*)	(*)	(*)
1950	(*)	(*)	(*)	(*)	(*)
1951	(*)	(*)	(*)	(*)	(*)
1952	(*)	(*)	(*)	(*)	(*)
1953	(*)	(*)	(*)	(*)	(*)
1954	(*)	(*)	(*)	(*)	1.1
1955	1.1	.3	.1	1.8	3.1
1956	3.1	.3	.1	–.5	2.7
1957	2.7	.2	.1	–.3	2.6
1958	2.6	.3	.1	1.5	4.1
1959	4.1	.3	.2	.5	4.8
1960	4.8	.3	.3	2.9	7.7
1961	7.7	.6	.4	1.8	9.7
1962	9.7	.8	.5	1.3	11.2
1963	11.2	.9	.7	2.4	13.9
1964	13.9	1.0	.8	.2	14.3
1965	14.3	1.0	.8	–.7	13.9
1966	13.9	.9	.8	–.7	13.3
1967	13.3	1.0	.8	.8	14.3
1968	14.3	.6	.9	.2	14.2
1969	14.2	.4	1.0	.6	14.2
1970	14.2	1.9	1.1	.8	15.8
1971	15.8	.5	1.1	–.2	15.0
1972	15.0	.3	.8	–2.9	11.6
1973	11.6	.2	.8	3.0	14.0
1974	14.0	.2	.6	2.3	15.8
1975	15.8	.4	.8	5.6	21.1
1976	21.1	.7	2.1	18.4	38.2
1977	38.2	2.3	3.6	14.9	51.7
1978	51.7	2.3	4.1	9.2	59.1
1979	59.1	3.9	5.4	20.3	77.9
1980	77.9	6.3	5.2	7.8	86.7
1981	86.7	.8	.7	–45.6	41.3
1982	41.3	3.0	3.0	20.2	61.5
1983	61.5	10.1	11.0	100.9	161.6
1984	161.6	15.6	18.5	51.1	209.8
1985	209.8	10.6	14.1	–65.4	140.9
1986	140.9	10.0	11.3	–34.6	105.1
1987	105.1	6.9	9.3	–24.0	78.6
1988	78.6	–.4	3.6	–44.3	30.3
1989	30.3	2.1	2.2	–5.5	24.7
1990	24.7	4.1	3.7	10.1	35.3
1991	35.3	2.8	3.2	–3.8	31.1

* Indicates that the calculated value of the entry was negative, resulting from a negative resource rent. Because a negative resource rent is simply the mechanical result of treating resource rent as a residual after the deduction of other factor payments, the values have been replaced by asterisks. Where the resource rent was negative in the base year (1987) for individual mineral types, the average for the 3 year period, 1987-89, was substituted for the 1987 rent for the purpose of calculating constant-dollar estimates shown in tables B.1 through B.4. Where the 1987-89 average was negative, a base year price of zero was used for the constant-dollar estimates.

Table 2.2.—Value of the Resource, Additions, and Depletion of Gas, Current Rent Method II (Value of Capital)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	0.3	0.1	.....	6.1
1948	6.1	.5	.2	.7	7.2
1949	7.2	.4	.2	.1	7.5
1950	7.5	.5	.2	–.1	7.7
1951	7.7	.6	.3	.1	8.1
1952	8.1	.5	.3	.3	8.6
1953	8.6	.9	.4	1.5	10.6
1954	10.6	.5	.5	2.2	12.8
1955	12.8	1.4	.6	2.0	15.7
1956	15.7	1.7	.7	.5	17.1
1957	17.1	1.4	.7	.5	18.2
1958	18.2	1.4	.8	1.8	20.7
1959	20.7	1.6	.9	.1	21.4
1960	21.4	1.2	1.1	2.4	23.9
1961	23.9	1.6	1.2	1.8	26.0
1962	26.0	1.9	1.3	1.5	28.1
1963	28.1	1.9	1.5	1.1	29.7
1964	29.7	2.1	1.6	–.1	30.1
1965	30.1	2.2	1.6	–.5	30.1
1966	30.1	2.0	1.7	–.8	29.6
1967	29.6	2.2	1.8	.7	30.7
1968	30.7	1.3	1.9	–.2	29.9
1969	29.9	.8	2.0	–.4	28.2
1970	28.2	3.8	2.2	1.1	30.9
1971	30.9	1.0	2.3	–.3	29.4
1972	29.4	.9	2.2	–.3	27.8
1973	27.8	.6	2.2	3.0	29.2
1974	29.2	.9	2.4	7.5	35.2
1975	35.2	1.7	3.2	15.1	48.9
1976	48.9	1.8	4.8	22.0	67.8
1977	67.8	4.3	6.9	19.9	85.1
1978	85.1	4.6	8.3	18.5	99.9
1979	99.9	7.7	10.6	29.1	126.1
1980	126.1	13.7	11.3	17.2	145.6
1981	145.6	12.1	10.6	–8.4	138.8
1982	138.8	16.7	16.9	78.8	217.3
1983	217.3	22.3	24.2	111.5	326.9
1984	326.9	25.7	30.5	22.0	344.1
1985	344.1	20.6	27.4	–42.0	295.3
1986	295.3	21.5	24.1	–33.3	259.3
1987	259.3	14.9	20.3	–51.8	202.2
1988	202.2	–1.8	14.7	–51.4	134.2
1989	134.2	12.4	13.1	–4.1	129.5
1990	129.5	16.1	14.3	5.7	136.9
1991	136.9	12.2	14.0	–2.3	132.8

Table 2.3.—Value of the Resource, Additions, and Depletion of Gas, Present Discounted Value Method Using 3% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1947	.....	.....	0.1	.....	5.2
1948	5.2	.4	.2	.6	6.1
1949	6.1	.3	.2	.1	6.4
1950	6.4	.4	.2	–.1	6.6
1951	6.6	.5	.2	.1	6.9
1952	6.9	.4	.2	.2	7.3
1953	7.3	.7	.3	1.3	9.1
1954	9.1	.4	.4	1.9	11.0
1955	11.0	1.1	.5	1.8	13.4
1956	13.4	1.3	.5	.4	14.6
1957	14.6	1.1	.6	.4	15.6
1958	15.6	1.1	.7	1.6	17.7
1959	17.7	1.3	.7	.1	18.3
1960	18.3	.9	.8	2.1	20.4
1961	20.4	1.3	1.0	1.5	22.3
1962	22.3	1.6	1.1	1.3	24.1
1963	24.1	1.5	1.2	1.0	25.4
1964	25.4	1.7	1.3	–.1	25.7
1965	25.7	1.7	1.3	–.4	25.8
1966	25.8	1.6	1.3	–.7	25.3
1967	25.3	1.7	1.4	.6	26.2
1968	26.2	1.1	1.5	–.2	25.6
1969	25.6	.6	1.6	–.4	24.2
1970	24.2	3.0	1.7	1.0	26.5
1971	26.5	.8	1.8	–.4	25.1
1972	25.1	.7	1.8	–.3	23.8
1973	23.8	.5	1.8	2.5	25.0
1974	25.0	.8	1.9	6.4	30.3
1975	30.3	1.4	2.6	12.9	42.1
1976	42.1	1.5	3.9	18.8	58.5
1977	58.5	3.6	5.5	17.0	73.7
1978	73.7	3.9	6.8	15.9	86.6
1979	86.6	6.5	8.7	25.2	109.6
1980	109.6	11.7	9.4	15.0	126.9
1981	126.9	10.2	8.7	–7.2	121.2
1982	121.2	14.1	13.9	68.9	190.2
1983	190.2	18.7	20.0	97.9	286.9
1984	286.9	21.6	25.2	19.3	302.6
1985	302.6	17.3	22.8	–36.8	260.3
1986	260.3	18.1	20.1	–29.2	229.1
1987	229.1	12.6	16.9	–45.8	179.0
1988	179.0	–1.5	12.4	–46.0	119.1
1989	119.1	10.4	11.0	–3.7	114.9
1990	114.9	13.5	12.0	5.1	121.5
1991	121.5	10.3	11.8	–2.2	117.8

Table 2.4.—Value of the Resource, Additions, and Depletion of Gas, Present Discounted Value Method Using 10% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2−3+4) (5)
1947	.....	.....	0.1	.....	3.9
1948	3.9	.3	.1	.5	4.5
1949	4.5	.2	.1	.1	4.7
1950	4.7	.2	.1	0	4.8
1951	4.8	.3	.1	.1	5.1
1952	5.1	.3	.2	.2	5.4
1953	5.4	.5	.2	1.0	6.7
1954	6.7	.3	.2	1.4	8.1
1955	8.1	.7	.3	1.4	9.9
1956	9.9	.9	.4	.4	10.8
1957	10.8	.7	.4	.4	11.5
1958	11.5	.7	.4	1.2	13.0
1959	13.0	.8	.5	.1	13.5
1960	13.5	.6	.5	1.5	15.1
1961	15.1	.8	.6	1.2	16.4
1962	16.4	1.0	.7	1.0	17.7
1963	17.7	1.0	.8	.8	18.7
1964	18.7	1.1	.8	0	19.0
1965	19.0	1.1	.8	−.3	19.0
1966	19.0	1.0	.9	−.5	18.7
1967	18.7	1.1	.9	.5	19.3
1968	19.3	.7	1.0	−.2	18.8
1969	18.8	.4	1.0	−.4	17.8
1970	17.8	1.9	1.1	.9	19.5
1971	19.5	.5	1.2	−.4	18.5
1972	18.5	.5	1.1	−.3	17.5
1973	17.5	.3	1.1	1.8	18.5
1974	18.5	.5	1.3	4.7	22.5
1975	22.5	1.0	1.7	9.6	31.4
1976	31.4	1.0	2.6	14.0	43.9
1977	43.9	2.6	3.7	12.7	55.5
1978	55.5	2.7	4.5	11.8	65.5
1979	65.5	4.6	5.8	18.9	83.2
1980	83.2	8.2	6.3	11.6	96.7
1981	96.7	7.2	6.0	−5.2	92.7
1982	92.7	9.9	9.6	53.1	146.1
1983	146.1	13.3	13.8	75.6	221.2
1984	221.2	15.3	17.6	15.4	234.2
1985	234.2	12.3	16.0	−28.2	202.2
1986	202.2	12.8	14.2	−22.2	178.7
1987	178.7	8.9	12.1	−35.4	140.1
1988	140.1	−1.0	8.8	−36.7	93.6
1989	93.6	7.4	7.8	−2.9	90.3
1990	90.3	9.6	8.5	4.1	95.5
1991	95.5	7.3	8.3	−1.8	92.6

Table 2.5.—Value of the Resource, Additions, and Depletion of Gas, Replacement Cost Method

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2−3+4) (5)
1947	.....	(*)	(*)	.....	(*)
1948	(*)	(*)	(*)	(*)	(*)
1949	(*)	(*)	(*)	(*)	(*)
1950	(*)	(*)	(*)	(*)	(*)
1951	(*)	(*)	(*)	(*)	(*)
1952	(*)	(*)	(*)	(*)	(*)
1953	(*)	(*)	(*)	(*)	(*)
1954	(*)	(*)	(*)	(*)	(*)
1955	(*)	(*)	(*)	(*)	(*)
1956	(*)	.2	.1	(*)	1.8
1957	1.8	.1	0	−.5	1.3
1958	1.3	.1	.1	.2	1.6
1959	1.6	0	0	−.9	.7
1960	.7	.1	0	.8	1.5
1961	1.5	.1	.1	.5	2.0
1962	2.0	.3	.2	2.6	4.7
1963	4.7	.4	.3	1.4	6.1
1964	6.1	.5	.4	.9	7.2
1965	7.2	.5	.3	−1.0	6.4
1966	6.4	.4	.4	.2	6.6
1967	6.6	.3	.3	−1.8	4.9
1968	4.9	(*)	(*)	(*)	(*)
1969	(*)	(*)	(*)	(*)	1.0
1970	1.0	(*)	(*)	(*)	(*)
1971	(*)	(*)	(*)	(*)	(*)
1972	(*)	(*)	(*)	(*)	(*)
1973	(*)	(*)	(*)	(*)	(*)
1974	(*)	(*)	(*)	(*)	(*)
1975	(*)	(*)	(*)	(*)	(*)
1976	(*)	(*)	(*)	(*)	(*)
1977	(*)	(*)	(*)	(*)	(*)
1978	(*)	(*)	(*)	(*)	(*)
1979	(*)	(*)	(*)	(*)	27.6
1980	27.6	3.4	2.8	25.7	53.9
1981	53.9	2.3	2.0	−5.8	48.3
1982	48.3	5.5	5.5	33.0	81.2
1983	81.2	7.5	8.2	31.9	112.5
1984	112.5	9.0	10.7	9.7	120.5
1985	120.5	7.1	9.4	−22.8	95.3
1986	95.3	8.0	9.0	−6.9	87.5
1987	87.5	6.8	9.2	.6	85.6
1988	85.6	5.9	6.6	−23.1	61.8
1989	61.8	5.9	6.2	.5	62.0
1990	62.0	7.7	6.8	2.3	65.1
1991	65.1	5.8	6.6	−2.2	62.1

* Indicates that the calculated value of the entry was negative, resulting from a negative resource rent. Because a negative resource rent is simply the mechanical result of treating resource rent as a residual after the deduction of other factor payments, the values have been replaced by asterisks. Where the resource rent was negative in the base year (1987) for individual mineral types, the average for the 3 year period, 1987-89, was substituted for the 1987 rent for the purpose of calculating constant-dollar estimates shown in tables B.1 through B.4. Where the 1987-89 average was negative, a base year price of zero was used for the constant-dollar estimates.

Table 2.6.—Value of the Resource, Additions, and Depletion of Gas, Transaction Price Method

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2−3+4) (5)
1977	.....	7.7	12.2	.....	129.5
1978	129.5	6.3	11.4	20.3	144.8
1979	144.8	12.2	16.8	46.7	186.8
1980	186.8	24.8	20.5	7.0	198.1
1981	198.1	20.4	17.9	10.0	210.6
1982	210.6	21.4	21.7	−25.7	184.6
1983	184.6	10.1	11.0	−42.7	141.0
1984	141.0	10.1	12.0	−12.3	126.8
1985	126.8	7.4	9.9	−5.6	118.7
1986	118.7	9.6	10.7	−1.7	115.9
1987	115.9	6.5	8.8	−32.3	81.2
1988	81.2	−.6	4.9	−33.0	42.7
1989	42.7	4.2	4.4	1.5	44.0
1990	44.0	5.5	4.9	22.5	67.2
1991	67.2	8.1	9.3	16.3	82.3

Table 3.1.—Value of the Resource, Additions, and Depletion of Coal, Current Rent Method I (Rate of Return)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	9.8	0.2	0.2	–0.1	9.7
1959	9.7	.2	.3	1.8	11.5
1960	11.5	.1	.3	1.2	12.5
1961	12.5	.4	.3	.4	13.0
1962	13.0	.5	.4	1.3	14.4
1963	14.4	.7	.4	1.7	16.3
1964	16.3	.7	.4	–.5	16.2
1965	16.2	.7	.4	–.4	16.0
1966	16.0	.6	.4	–.8	15.3
1967	15.3	.5	.4	–1.3	14.1
1968	14.1	.5	.4	–1.3	13.0
1969	13.0	.4	.3	0	13.1
1970	13.1	.5	.4	2.5	15.6
1971	15.6	.5	.4	–.3	15.3
1972	15.3	.5	.5	1.4	16.8
1973	16.8	.6	.5	8.0	24.9
1974	24.9	1.5	1.0	16.5	41.9
1975	41.9	2.3	1.7	18.9	61.5
1976	61.5	3.0	2.4	13.0	75.1
1977	75.1	4.2	2.5	.7	77.5
1978	77.5	.6	2.1	–9.9	66.2
1979	66.2	11.8	2.6	7.9	83.3
1980	83.3	6.9	3.0	4.9	92.2
1981	92.2	2.4	3.0	.4	91.9
1982	91.9	5.9	3.3	5.9	100.4
1983	100.4	.1	3.4	6.1	103.2
1984	103.2	6.1	4.8	22.4	127.0
1985	127.0	7.7	4.9	4.6	134.4
1986	134.4	7.5	5.1	4.0	140.7
1987	140.7	4.4	5.4	3.2	143.0
1988	143.0	5.8	5.3	–5.2	138.3
1989	138.3	4.5	5.3	–2.5	134.9
1990	134.9	7.0	5.6	1.2	137.5
1991	137.5	4.6	5.3	–2.4	134.4

Table 3.2.—Value of the Resource, Additions, and Depletion of Coal, Current Rent Method II (Value of Capital)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	22.7	0.5	0.5	–0.2	22.4
1959	22.4	.5	.6	.9	23.2
1960	23.2	.3	.6	.7	23.6
1961	23.6	.7	.6	.5	24.2
1962	24.2	.9	.6	.5	25.0
1963	25.0	1.0	.7	.6	26.0
1964	26.0	1.2	.7	–1.1	25.4
1965	25.4	1.1	.7	–.9	24.9
1966	24.9	1.0	.7	–.9	24.2
1967	24.2	.9	.7	–.9	23.6
1968	23.6	.9	.7	–.1	23.8
1969	23.8	.7	.7	1.1	24.9
1970	24.9	.9	.8	2.7	27.7
1971	27.7	1.0	.8	3.2	31.1
1972	31.1	1.1	1.0	2.9	34.1
1973	34.1	1.3	1.1	10.9	45.2
1974	45.2	2.6	1.7	20.3	66.4
1975	66.4	3.6	2.6	24.4	91.8
1976	91.8	4.6	3.6	18.6	111.3
1977	111.3	6.8	4.1	10.4	124.5
1978	124.5	1.2	4.0	5.5	127.2
1979	127.2	22.3	5.0	10.1	154.6
1980	154.6	13.3	5.7	11.3	173.5
1981	173.5	4.8	6.0	9.7	181.9
1982	181.9	11.5	6.4	6.1	193.0
1983	193.0	.2	6.3	7.3	194.2
1984	194.2	9.6	7.4	3.0	199.4
1985	199.4	11.5	7.4	.7	204.3
1986	204.3	11.0	7.4	–.2	207.7
1987	207.7	6.3	7.6	–2.1	204.2
1988	204.2	8.2	7.5	–7.7	197.2
1989	197.2	6.4	7.5	–4.7	191.3
1990	191.3	9.7	7.8	–2.4	190.8
1991	190.8	6.5	7.5	–1.3	188.6

Table 3.3.—Value of the Resource, Additions, and Depletion of Coal, Present Discounted Value Method Using 3% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	19.4	0.4	0.4	–0.1	19.2
1959	19.2	.4	.4	.8	19.9
1960	19.9	.2	.5	.6	20.2
1961	20.2	.6	.5	.4	20.7
1962	20.7	.7	.5	.4	21.4
1963	21.4	.8	.5	.6	22.2
1964	22.2	.9	.6	–.9	21.7
1965	21.7	.9	.6	–.8	21.3
1966	21.3	.8	.6	–.7	20.7
1967	20.7	.7	.5	–.7	20.2
1968	20.2	.8	.5	–.1	20.4
1969	20.4	.6	.6	.9	21.3
1970	21.3	.7	.6	2.3	23.7
1971	23.7	.8	.7	2.7	26.6
1972	26.6	.9	.8	2.5	29.2
1973	29.2	1.1	.9	9.4	38.7
1974	38.7	2.2	1.4	17.5	57.1
1975	57.1	3.0	2.1	21.0	79.1
1976	79.1	3.8	2.9	16.1	96.1
1977	96.1	5.7	3.3	9.2	107.7
1978	107.7	1.0	3.3	4.8	110.3
1979	110.3	18.8	4.1	9.4	134.4
1980	134.4	11.2	4.7	10.2	151.2
1981	151.2	4.0	5.0	8.6	158.9
1982	158.9	9.7	5.3	5.7	169.0
1983	169.0	.2	5.2	6.5	170.4
1984	170.4	8.0	6.1	3.0	175.3
1985	175.3	9.7	6.1	1.1	180.0
1986	180.0	9.2	6.2	.3	183.4
1987	183.4	5.3	6.4	–1.5	180.8
1988	180.8	6.9	6.3	–6.4	174.9
1989	174.9	5.4	6.3	–4.2	169.7
1990	169.7	8.2	6.5	–2.0	169.3
1991	169.3	5.5	6.3	–1.2	167.3

Table 3.4.—Value of the Resource, Additions, and Depletion of Coal, Present Discounted Value Method Using 10% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	14.3	0.2	0.3	–0.1	14.1
1959	14.1	.2	.3	.5	14.6
1960	14.6	.1	.3	.4	14.9
1961	14.9	.4	.3	.3	15.3
1962	15.3	.5	.3	.3	15.8
1963	15.8	.5	.4	.4	16.4
1964	16.4	.6	.4	–.6	16.0
1965	16.0	.6	.4	–.5	15.7
1966	15.7	.5	.4	–.5	15.3
1967	15.3	.5	.4	–.5	14.9
1968	14.9	.5	.3	0	15.0
1969	15.0	.4	.4	.7	15.7
1970	15.7	.5	.4	1.7	17.5
1971	17.5	.5	.4	2.0	19.6
1972	19.6	.6	.5	1.8	21.5
1973	21.5	.8	.6	7.0	28.7
1974	28.7	1.6	.9	13.1	42.4
1975	42.4	2.2	1.4	15.8	59.0
1976	59.0	2.7	1.9	12.2	72.1
1977	72.1	4.0	2.2	7.2	81.1
1978	81.1	.7	2.2	3.7	83.4
1979	83.4	13.3	2.7	8.1	102.0
1980	102.0	7.9	3.1	8.4	115.2
1981	115.2	2.8	3.4	6.9	121.6
1982	121.6	6.8	3.7	5.0	129.8
1983	129.8	.1	3.6	5.1	131.4
1984	131.4	5.7	4.3	2.9	135.7
1985	135.7	6.9	4.3	1.6	139.9
1986	139.9	6.5	4.4	1.0	143.1
1987	143.1	3.7	4.5	–.7	141.6
1988	141.6	4.9	4.5	–4.5	137.5
1989	137.5	3.8	4.5	–3.4	133.4
1990	133.4	5.8	4.6	–1.5	133.1
1991	133.1	3.9	4.4	–1.0	131.5

Table 4.1.—Value of the Resource, Additions, and Depletion of All Metals, Current Rent Method I (Rate of Return)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	28.9	–0.1	0.2	1.0	29.6
1959	29.6	0	.2	.5	29.8
1960	29.8	–1.3	.4	10.1	38.2
1961	38.2	1.3	.4	–.7	38.4
1962	38.4	2.4	.4	.5	40.9
1963	40.9	1.0	.4	3.3	44.8
1964	44.8	2.3	.5	4.1	50.7
1965	50.7	1.6	.5	.4	52.1
1966	52.1	1.5	.6	1.2	54.3
1967	54.3	1.2	.4	–5.8	49.3
1968	49.3	1.2	.5	1.5	51.6
1969	51.6	–.1	.7	5.3	56.1
1970	56.1	1.3	.8	2.2	58.8
1971	58.8	1.5	.6	–5.3	54.3
1972	54.3	.6	.7	2.7	56.9
1973	56.9	–.3	.7	10.4	66.3
1974	66.3	1.8	.7	4.7	72.1
1975	72.1	–1.4	.6	.2	70.2
1976	70.2	0	.8	10.7	80.2
1977	80.2	.5	.5	–37.6	42.6
1978	42.6	.3	.4	7.2	49.7
1979	49.7	0	.1	–34.4	15.2
1980	15.2	(*)	(*)	(*)	(*)
1981	(*)	(*)	(*)	(*)	(*)
1982	(*)	(*)	(*)	(*)	(*)
1983	(*)	(*)	(*)	(*)	(*)
1984	(*)	(*)	(*)	(*)	(*)
1985	(*)	(*)	(*)	(*)	(*)
1986	(*)	(*)	(*)	(*)	(*)
1987	(*)	2.2	.2	(*)	38.5
1988	38.5	4.8	1.0	47.9	90.1
1989	90.1	7.7	1.8	29.7	125.6
1990	125.6	8.6	2.3	10.1	141.9
1991	141.9	6.6	2.2	8.2	154.5

* Indicates that the calculated value of the entry was negative, resulting from a negative resource rent. Because a negative resource rent is simply the mechanical result of treating resource rent as a residual after the deduction of other factor payments, the values have been replaced by asterisks. Where the resource rent was negative in the base year (1987) for individual mineral types, the average for the 3 year period, 1987-89, was substituted for the 1987 rent for the purpose of calculating constant-dollar estimates shown in tables B.1 through B.4. Where the 1987-89 average was negative, a base year price of zero was used for the constant-dollar estimates.

Table 4.2.—Value of the Resource, Additions, and Depletion of All Metals, Current Rent Method II (Value of Capital)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	60.8	–0.1	0.5	0.8	61.0
1959	61.0	–.1	.5	2.3	62.7
1960	62.7	–2.1	.7	1.9	61.9
1961	61.9	2.1	.7	1.9	65.2
1962	65.2	4.1	.7	1.8	70.4
1963	70.4	1.6	.7	2.7	74.0
1964	74.0	3.5	.8	2.0	78.7
1965	78.7	2.5	.8	1.9	82.2
1966	82.2	2.4	.9	1.4	85.0
1967	85.0	2.3	.8	1.8	88.4
1968	88.4	2.3	.9	2.3	92.1
1969	92.1	.2	1.1	3.6	94.8
1970	94.8	2.4	1.2	4.3	100.3
1971	100.3	3.8	1.1	4.2	107.2
1972	107.2	1.3	1.2	4.2	111.5
1973	111.5	–.1	1.3	7.8	118.0
1974	118.0	2.2	1.4	16.5	135.3
1975	135.3	–1.9	1.5	21.6	153.6
1976	153.6	.7	1.7	18.8	171.3
1977	171.3	2.9	1.6	13.1	185.7
1978	185.7	1.4	1.7	–9.3	176.1
1979	176.1	1.6	1.6	–9.1	167.0
1980	167.0	–2.2	1.4	–15.4	148.0
1981	148.0	–4.8	1.2	–28.2	113.8
1982	113.8	–3.3	.4	–33.9	76.1
1983	76.1	–2.3	.7	42.2	115.2
1984	115.2	–6.2	1.1	39.3	147.2
1985	147.2	7.3	1.4	31.4	184.5
1986	184.5	9.2	1.6	23.2	215.3
1987	215.3	9.2	2.2	22.5	244.8
1988	244.8	10.9	2.9	–.8	251.9
1989	251.9	14.6	3.6	7.2	270.1
1990	270.1	14.1	4.1	0	280.1
1991	280.1	13.6	3.9	–1.8	288.0

Table 4.3.—Value of the Resource, Additions, and Depletion of All Metals, Present Discounted Value Method Using 3% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	52.0	–0.1	0.4	0.7	52.2
1959	52.2	–.1	.4	1.9	53.6
1960	53.6	–1.7	.5	1.5	52.9
1961	52.9	1.7	.5	1.7	55.8
1962	55.8	3.3	.5	1.7	60.2
1963	60.2	1.3	.6	2.3	63.3
1964	63.3	2.8	.6	1.9	67.3
1965	67.3	2.0	.7	1.7	70.3
1966	70.3	1.9	.7	1.3	72.7
1967	72.7	1.9	.6	1.6	75.6
1968	75.6	1.8	.7	2.1	78.8
1969	78.8	.2	.9	3.0	81.1
1970	81.1	1.9	1.0	3.7	85.8
1971	85.8	3.1	.9	3.8	91.7
1972	91.7	1.1	1.0	3.6	95.4
1973	95.4	–.1	1.1	6.9	101.2
1974	101.2	1.8	1.1	14.4	116.2
1975	116.2	–1.6	1.2	18.8	132.3
1976	132.3	.6	1.4	16.4	147.9
1977	147.9	2.4	1.3	11.7	160.7
1978	160.7	1.1	1.4	–7.8	152.7
1979	152.7	1.4	1.3	–7.6	145.2
1980	145.2	–1.8	1.1	–13.2	129.0
1981	129.0	–4.1	1.0	–24.6	99.4
1982	99.4	–2.8	.4	–29.6	66.7
1983	66.7	–2.0	.6	37.0	101.1
1984	101.1	–5.2	.9	34.5	129.5
1985	129.5	6.1	1.2	28.2	162.6
1986	162.6	7.8	1.3	21.1	190.2
1987	190.2	7.7	1.8	20.6	216.7
1988	216.7	9.2	2.4	.1	223.6
1989	223.6	12.3	3.1	6.9	239.7
1990	239.7	11.8	3.4	.5	248.6
1991	248.6	11.5	3.3	–1.2	255.6

Table 4.4.—Value of the Resource, Additions, and Depletion of All Metals, Present Discounted Value Method Using 10% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	38.3	–0.1	0.3	0.4	38.4
1959	38.4	–.1	.3	1.4	39.5
1960	39.5	–1.1	.3	.9	39.0
1961	39.0	1.1	.3	1.4	41.1
1962	41.1	2.1	.3	1.5	44.4
1963	44.4	.8	.4	1.8	46.6
1964	46.6	1.8	.4	1.6	49.6
1965	49.6	1.3	.4	1.4	51.8
1966	51.8	1.2	.5	1.0	53.6
1967	53.6	1.2	.4	1.3	55.7
1968	55.7	1.2	.4	1.6	58.1
1969	58.1	.1	.6	2.2	59.8
1970	59.8	1.2	.6	2.8	63.2
1971	63.2	2.0	.6	3.0	67.6
1972	67.6	.7	.6	2.7	70.3
1973	70.3	0	.7	5.3	74.9
1974	74.9	1.3	.7	11.0	86.4
1975	86.4	–1.1	.8	14.2	98.7
1976	98.7	.4	.9	12.6	110.9
1977	110.9	1.7	.8	9.2	121.0
1978	121.0	.8	.9	–5.5	115.4
1979	115.4	1.0	.9	–5.3	110.2
1980	110.2	–1.3	.8	–9.8	98.3
1981	98.3	–2.9	.7	–18.7	76.0
1982	76.0	–2.0	.2	–22.6	51.2
1983	51.2	–1.4	.4	28.6	78.0
1984	78.0	–3.7	.6	26.6	100.2
1985	100.2	4.3	.8	22.6	126.4
1986	126.4	5.5	.9	17.4	148.3
1987	148.3	5.5	1.3	17.2	169.7
1988	169.7	6.5	1.7	1.3	175.7
1989	175.7	8.7	2.2	6.1	188.4
1990	188.4	8.4	2.4	1.0	195.3
1991	195.3	8.1	2.3	–.3	200.8

Table 5.1.—Value of the Resource, Additions, and Depletion of Other Minerals, Current Rent Method I (Rate of Return)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	15.0	0.2	0.1	0	15.0
1959	15.0	.2	.2	.8	15.8
1960	15.8	.1	.2	.8	16.6
1961	16.6	.3	.2	.7	17.3
1962	17.3	.3	.2	.6	18.1
1963	18.1	.3	.2	.6	18.8
1964	18.8	.5	.2	.1	19.1
1965	19.1	.5	.3	–.1	19.3
1966	19.3	.5	.3	.3	19.8
1967	19.8	.4	.3	–.1	19.7
1968	19.7	.2	.3	–1.6	18.0
1969	18.0	0	.2	–2.1	15.7
1970	15.7	.1	.2	–1.8	13.8
1971	13.8	.2	.2	–1.7	12.1
1972	12.1	.2	.1	–.8	11.4
1973	11.4	.1	.2	1.3	12.6
1974	12.6	.2	.2	3.8	16.5
1975	16.5	.3	.3	4.0	20.4
1976	20.4	.4	.5	4.6	24.9
1977	24.9	.7	.6	1.7	26.8
1978	26.8	.9	.5	–.5	26.6
1979	26.6	.6	.6	2.5	29.2
1980	29.2	–.1	.6	3.0	31.4
1981	31.4	0	.6	.9	31.7
1982	31.7	–.2	.4	–5.2	25.9
1983	25.9	–.1	.5	2.7	28.0
1984	28.0	–.1	.6	4.1	31.4
1985	31.4	.8	.6	–1.4	30.3
1986	30.3	.6	.4	–2.1	28.4
1987	28.4	.1	.4	4.6	32.8
1988	32.8	.2	.5	–.3	32.2
1989	32.2	.4	.5	.7	32.8
1990	32.8	.2	.5	.7	33.2
1991	33.2	.3	.5	.9	33.9

Table 5.2.—Value of the Resource, Additions, and Depletion of Other Minerals, Current Rent Method II (Value of Capital)

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	18.8	0.2	0.2	0	18.8
1959	18.8	.2	.2	.5	19.3
1960	19.3	.2	.2	.7	20.0
1961	20.0	.3	.2	.9	21.0
1962	21.0	.4	.2	.7	21.8
1963	21.8	.4	.2	.5	22.5
1964	22.5	.6	.3	–.1	22.8
1965	22.8	.6	.3	.2	23.3
1966	23.3	.5	.4	.4	23.9
1967	23.9	.4	.4	.4	24.3
1968	24.3	.2	.4	–1.0	23.2
1969	23.2	0	.3	–1.5	21.4
1970	21.4	.2	.3	–1.4	19.9
1971	19.9	.2	.2	–1.0	18.9
1972	18.9	.3	.2	–.5	18.4
1973	18.4	.1	.3	1.7	19.9
1974	19.9	.3	.3	5.0	24.9
1975	24.9	.4	.5	6.9	31.8
1976	31.8	.5	.6	5.4	37.1
1977	37.1	.9	.8	2.5	39.7
1978	39.7	1.2	.7	1.2	41.3
1979	41.3	.8	.8	4.4	45.6
1980	45.6	–.4	.9	7.1	51.3
1981	51.3	–.5	1.0	6.6	56.4
1982	56.4	–.9	.8	3.5	58.2
1983	58.2	–.9	.9	2.1	58.5
1984	58.5	–.8	1.0	.9	57.5
1985	57.5	.7	1.0	1.1	58.4
1986	58.4	.5	.9	.7	58.7
1987	58.7	0	.9	.1	57.9
1988	57.9	.2	.9	–.4	56.7
1989	56.7	.7	.9	.4	56.9
1990	56.9	.4	.9	.5	57.0
1991	57.0	.4	.9	.1	56.6

Table 5.3.—Value of the Resource, Additions, and Depletion of Other Minerals, Present Discounted Value Method Using 3% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	16.1	0.2	0.1	0	16.1
1959	16.1	.2	.2	.4	16.5
1960	16.5	.1	.2	.6	17.1
1961	17.1	.2	.2	.7	18.0
1962	18.0	.3	.2	.6	18.7
1963	18.7	.3	.2	.4	19.2
1964	19.2	.5	.2	0	19.5
1965	19.5	.5	.2	.2	19.9
1966	19.9	.4	.3	.3	20.4
1967	20.4	.3	.3	.4	20.8
1968	20.8	.2	.3	–.9	19.9
1969	19.9	0	.3	–1.3	18.3
1970	18.3	.1	.2	–1.2	17.0
1971	17.0	.2	.2	–.8	16.2
1972	16.2	.2	.2	–.5	15.7
1973	15.7	.1	.2	1.5	17.1
1974	17.1	.3	.3	4.3	21.4
1975	21.4	.3	.4	6.0	27.4
1976	27.4	.4	.5	4.7	32.0
1977	32.0	.7	.6	2.2	34.3
1978	34.3	1.0	.6	1.1	35.8
1979	35.8	.6	.7	3.8	39.7
1980	39.7	–.3	.8	6.2	44.7
1981	44.7	–.4	.8	5.8	49.3
1982	49.3	–.7	.7	3.1	51.0
1983	51.0	–.8	.8	1.9	51.3
1984	51.3	–.7	.9	.9	50.6
1985	50.6	.6	.8	1.1	51.5
1986	51.5	.4	.7	.7	51.9
1987	51.9	0	.7	.2	51.3
1988	51.3	.1	.8	–.3	50.4
1989	50.4	.6	.8	.4	50.5
1990	50.5	.3	.8	.5	50.6
1991	50.6	.4	.8	0	50.2

Table 5.4.—Value of the Resource, Additions, and Depletion of Other Minerals, Present Discounted Value Method Using 10% Discount Rate

[Billions of current dollars]

Year	Opening stock (1)	Additions (2)	Depletion (3)	Revaluation adjustment (4)	Closing stock (1+2–3+4) (5)
1958	11.9	0.1	0.1	0	11.9
1959	11.9	.1	.1	.3	12.2
1960	12.2	.1	.1	.5	12.6
1961	12.6	.2	.1	.6	13.2
1962	13.2	.2	.1	.5	13.8
1963	13.8	.2	.1	.3	14.2
1964	14.2	.3	.1	0	14.4
1965	14.4	.3	.2	.2	14.7
1966	14.7	.3	.2	.3	15.1
1967	15.1	.2	.2	.3	15.3
1968	15.3	.1	.2	–.6	14.6
1969	14.6	0	.2	–1.0	13.5
1970	13.5	.1	.1	–.9	12.5
1971	12.5	.1	.1	–.6	11.9
1972	11.9	.1	.1	–.3	11.6
1973	11.6	.1	.1	1.1	12.6
1974	12.6	.2	.2	3.2	15.9
1975	15.9	.2	.2	4.5	20.4
1976	20.4	.3	.3	3.6	24.0
1977	24.0	.5	.4	1.7	25.8
1978	25.8	.7	.4	1.0	27.1
1979	27.1	.5	.5	3.0	30.1
1980	30.1	–.2	.5	4.8	34.1
1981	34.1	–.3	.6	4.5	37.7
1982	37.7	–.5	.5	2.4	39.1
1983	39.1	–.6	.5	1.5	39.6
1984	39.6	–.5	.6	.7	39.2
1985	39.2	.4	.6	1.0	40.0
1986	40.0	.3	.5	.7	40.4
1987	40.4	0	.5	.2	40.1
1988	40.1	.1	.5	–.1	39.6
1989	39.6	.4	.5	.3	39.7
1990	39.7	.2	.5	.3	39.7
1991	39.7	.3	.5	0	39.4