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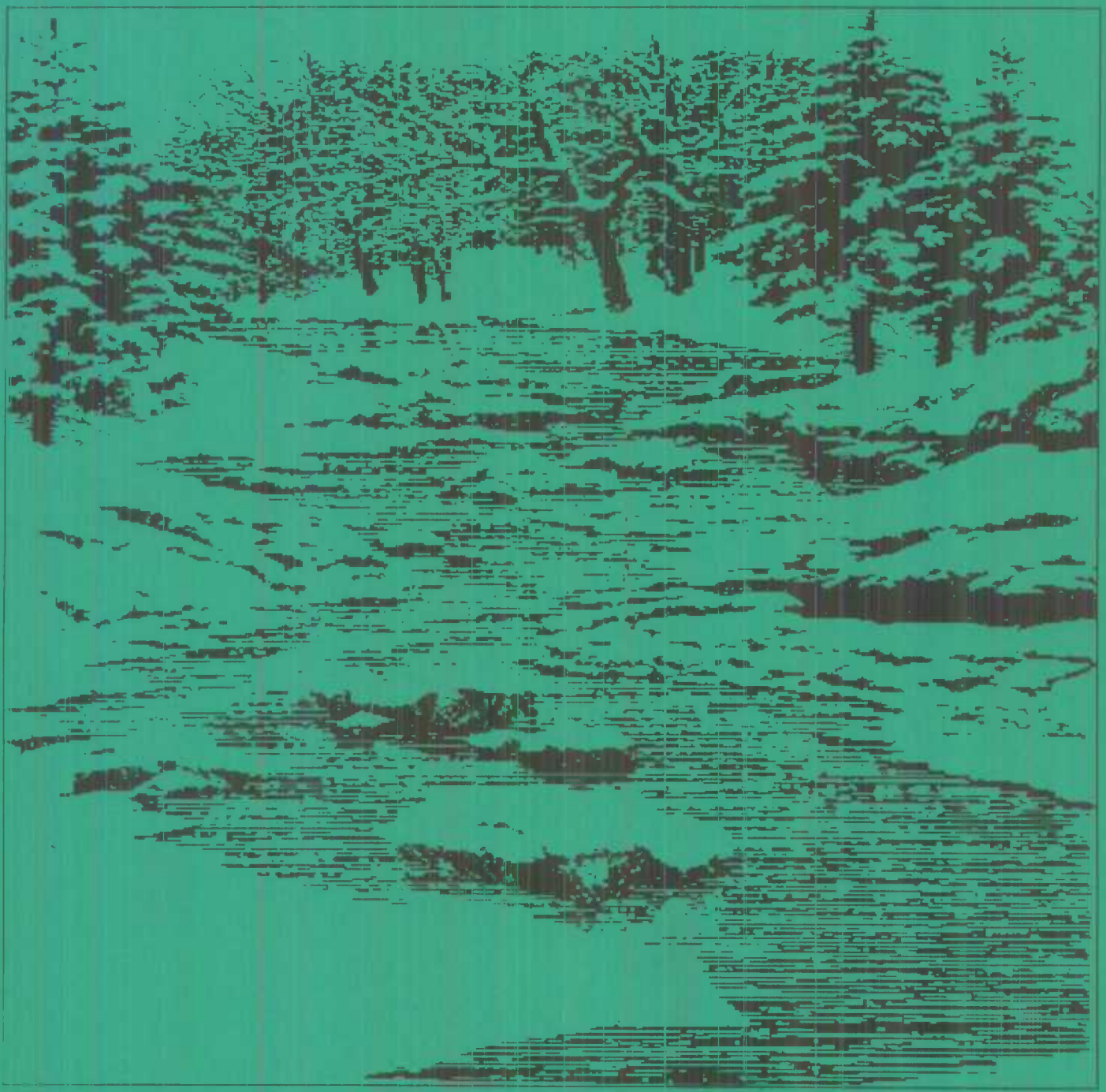

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Valuation of Canada's Mineral Resources: A Discussion of Conceptual Issues

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Valuation of Canada's Mineral Resources: *A Discussion of Conceptual Issues*

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Valuation of Canada's Mineral Resources:
A Discussion of Conceptual Issues

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Introduction

The inclusion of the value of natural resources in Canada's national wealth estimates and national balance sheet represents the initial steps of integrating economic and environmental accounts, that is, the *greening* of Canada's National Accounts.[2]

However, the valuation of non-produced assets such as sub-soil assets has presented many conceptual issues. Some of the issues are:

- choice of an appropriate discount rate and rate of return to capital;
- assumptions about what is a normal return to produced capital (in particular, what to do about negative resource rents);
- what mineral price to use where there is vertical integration in the industry and transfer pricing;
- how to deal with implicit cost of externalities as the result of resource extraction;
- choice of the method of monetary valuation (net price or present value);
- what reserves to include in the physical and monetary asset accounts (i.e. expand the asset boundary of "tangible non-produced assets" to include both developed and undeveloped mineral reserves); and
- consistency with the accounting concepts of the Revisions to the SNA (1993) (in particular, the treatment of royalties and mineral leases with respect to the value of sub-soil assets in the balance sheet).

While this list is not exhaustive, the purpose of this paper is to raise points for discussion and share experiences related to the actual exercise of monetary valuation of non-renewable resources, namely sub-soil assets.

To date, physical and monetary accounts have been completed for crude oil, natural gas, crude bitumen (tarsands) and coal (bitumen, sub-bitumen and lignite) reserves at the provincial level in Canada. This provincial dimension is important since it is the provinces that own their respective

1. The author would like to acknowledge the helpful comments and discussions with Philip Smith and Gerry Gravel of the National Accounts and Environment Division, Statistics Canada.
2. Smith (1994) provides an overview of the environmental component of the Canadian System of National Accounts.

natural resources. In the near future, metal accounts are to be completed for nine metals as well as potash.

Mineral asset accounts are also underway in several other countries including the United States, Sweden, Norway, Australia, United Kingdom and Mexico (Hahn, 1994 and Statistics Canada, 1994). Work of the United Nations' System of National Accounts and Integrated Environmental and Economic Accounting (SEEA), and by the OECD (Hill and Harrison, 1994) deals with the way in which sub-soil assets should be valued in national balance sheet accounts.

This paper begins with a discussion of the methods of monetary valuation and the problems encountered related to the actual results obtained from the net price and present value approaches. The second part of the paper deals with the integration of the value of mineral assets into the System of National Accounts (SNA) and its impact in context to the revisions to the SNA suggested by the United Nations in 1993.

Methods of monetary valuation

Monetary valuation of natural capital is at the heart of integrated economic and environmental accounting (Bartelmus, 1994). Without such valuation, comparison of different economic and environmental activities is not possible. It is putting a price on what are now treated as "free goods" in the conventional national accounts.

Reserves of depletable natural resource assets such as oil, natural gas and coal reserves generally do not have a market price since they are rarely bought and sold. Therefore, several methods of valuation are used to estimate or impute the market value of the reserves. This imputed value of mineral resources is based on the concept of economic rent which is the difference between gross revenues from the extraction and all factors of extraction, including a normal return to invested capital. The term "invested capital" refers to machinery and equipment, and construction in which the industry has invested in order to find, develop and extract the resource.

In order to estimate the value of the resources, several indirect methods were used. Text Box 1.1 presents the algebraic description of the three methods used to value mineral reserves in Canada: net price method I, net price method II and present value. A more formal description of the methods of monetary valuation is presented by Born (1992). All three methods are based on the calculation of economic rent or return to the natural capital described above. The methods are similar and only differ in the calculation of a normal return to capital and whether or not the imputed income flows are discounted.

The following sections provide a description of the three methods of monetary valuation and the conceptual issues (problems) encountered. The approach favoured by Statistics Canada, as by other countries and in the recent revisions to the System of National Accounts by the United Nations (1993a, b), is the present value approach. However, it is the assumptions of the net price approach that are important to getting the present value calculation "right" since the present value is a discounted net price calculation.

Text Box 1.1

Alternative methods of valuing mineral reserves

Net Price Method I (based on return to capital):

$$GR = TR - C$$
$$RR = GR - (rK + \delta)$$
$$V = (RR/Q)\,S$$

Net Price Method II (based on the value of capital stock):

$$V = (GR/Q)S - K$$

Present Value Method:

$$PV = \sum_{t=1}^{T} \frac{RR_t Q_t}{(1+r)t}$$

TR = *total revenue from extraction*

C = *extraction costs including fuel and electricity, material and supplies and wages*

GR = *gross rent*

RR = *resource rent*

r = *long-term industrial or provincial bond rate*

K = *net capital stock valued at replacement cost*

δ = *depreciation of the capital stock*

V = *net price value of the reserve stock*

Q = *quantity of the resource extracted*

S = *stock of remaining established reserves*

PV = *present value*

Definition of physical reserves

Those reserves recoverable under current technology and under present and anticipated economic conditions that have been proven by drilling, production, etc. are the only reserves being valued with the methods described above. For Canadian reserves of crude oil, natural gas, crude bitumen and coal, these are called *established* reserves which are approximately equivalent to proven and probable reserves in more conventional internationally used terms. Also, national reserve estimates of metals are reported as the total of proven and probable reserves.

By definition, established reserves are developed reserves that are estimated to be recoverable through existing wells, that is, the wells and equipment needed to extract these reserves are already in place. In our calculations, it is assumed that the net capital stock (K) is this value of existing wells and equipment. Additional produced capital would be needed to increase the quantity of developed reserves.

There are alternative reserve/resource definitions that could be considered when developing the asset account for minerals. This is the case of oil, gas and coal reserves in Canada. An example is the definition of *yet-to-be established* or undeveloped (established) reserves. Yet-to-be estab-

lished reserves are future additions to existing pools and discovery of new pools that will have been developed in an area by the time all exploratory and developed work has ceased. The sum of established reserves and yet-to-be established reserves is termed *ultimate potential.* In the case of oil reserves in Alberta, the addition of yet-to-be established reserves more than doubles the reserve stock currently being valued. [3]

Net price approach

The net price method can be rationalized in terms of the Hotelling model which assumes that in a perfectly competitive market, the price of the marginal unit of a non-renewable resource net of extraction costs should rise over time at a rate equal to the nominal rate of interest. In other words, the price of the resource should increase at the rate of interest and there is no need for discounting. If this assumption is true, the value of the stock of the resource is equal to the net price per unit of the resource times the quantity of reserve stock. However, the net price can also be rationalized as a zero time preference.

Two methods of net price have been used in the monetary valuation of mineral reserves using different assumptions about the treatment of the return to capital used to extract and find the reserves.

Net price method I

The first method, net price method I imputes the value of the rent or the return to the natural capital by netting out the extraction costs and the return to invested produced capital of the mining industry. The "normal" return to invested capital is calculated as the rate of return to produced capital (using an average real rate of corporate bonds) times the net capital stock of the mining industry plus the depreciation of the capital stock. A per unit rent is calculated by dividing the net rent by the quantity extracted. The resource rent per unit is then multiplied by the quantity of the remaining established reserves that has been estimated in the physical accounts in order to derive the stock value of the reserves.

In theory, the net price should be net of all costs including capital costs so that it can accurately represent the value added associated with the natural resource. However, there is some uncertainty regarding the estimation of the return to the invested produced capital in the calculation of the net price particularly when the net operating surplus is already small (United Nations, 1993b). In the case of coal, for example, the net price becomes negative after the deduction of the return to the produced capital. This result suggests that (world) market price of the coal is so low that a normal return on invested capital is not achieved.

The main disadvantage of this net price method is that the assumption made regarding the rate of return to invested capital may be inappropriate. By presetting the rate of return to invested capital, no allowance is made for relatively low or high rates of return observed in the mineral industry (BEA, 1994). In the case of resource rents of coal for British Columbia, negative net price values have existed since 1982. This is in agreement with the negative returns on total capital employed that have been reported by the British Columbia's coal industry from 1989 to 1991 (Coopers and Lybrand, 1992).

3. As suggested by BEA (1994), "option" values might be used to price these undeveloped reserves, thus reflecting the total value of a nation's reserves, developed and undeveloped.

Negative values indicate that the gross rents are so low that any procedure (be it net price or present value) that assumes a normal return to capital, will yield a negative residual or negative resource rent.

An alternative approach might derive a negative residual or return for invested capital associated with the resource and a positive rent to the resource (BEA, 1994). Negative asset values do present empirical problems with regards to the balance sheet entries. Some have considered attaching the value of zero to negative wealth measures (e.g. Sweden; Tengbland, 1993).

Mineral prices and return to invested capital

As observed in calculating the net price, negative operating surpluses were sometimes obtained when a "normal return to capital" was assumed.

In the case of coal, where it is an input into provincially owned and provincially regulated power plants, returns to capital from upstream operations (i.e. coal extraction) may be captured from returns from electrical power generation. With low coal prices, a "normal return" to capital is not achieved under our current assumptions. The effect of this transfer pricing is assumed to have a major impact on resource revenues, therefore the net price value.

Unless the price or the value of the 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 (BEA, 1994).

Present mineral price structures raise the question whether environmental protection and restoration costs or even more hypothetically, environmental damage are adequately priced by the free market. Market imperfections which do not properly reflect the cost to the environment have resulted in world mineral price levels that are lower than socially optimal (von Below, 1993). As long as the revenues from mineral sales can accommodate exploration, development and extraction costs, but not necessarily environmental rehabilitation costs, mining will be sustained.

Net price method II

An alternative method, net price method II calculates the resource rent by subtracting out the current replacement value of the produced capital from the value of the reserve stock (Text Box 1.1). The *total* value of the reserves (that is, the resource and the associated produced capital) is the gross rent per unit times the quantity of reserves. The value of the reserve itself is derived by subtracting the replacement value of the net capital stock.

The advantage of this method is that it does not require an explicit assumption about the return to the produced capital associated with the mineral resource (BEA, 1994). However, this method assumes all the capital is in place to extract the stock of reserves being valued.

Comparison of the two net price methods

The mathematical difference between net price II and net price I is approximately the return to invested capital times the stock of remaining reserves divided by annual extraction:[4]

$$\textit{Net price II - Net price I} = rk\,(S/Q)$$

In other words, net price method II assumes that the return to invested capital is zero and the difference between revenues and costs, less the net capital stock represents the return to the natural capital. Since estimates from net price II exceed estimates derived from net price I, it is assumed that net price method II is the upper value and that second net price method is the lower value limit to net price calculations.

Present value approach

In the case of natural resource assets for which the returns either are delayed (as with timber) or are spread over a lengthy period of time (as with sub-soil assets), although normal prices are used to value the ultimate output, a rate of discount should be used to compute the present value of the expected future returns (United Nations, 1993b).

In Canada, we have estimated the present value of minerals based on the value of resource rents derived from the net price I. It was assumed that year-end resource rents will remain the same over the life of the reserves. These estimated operating surpluses or resource rents expected over the life of the reserves are converted to present values using a discount rate. A 4-year moving average of resource rents was used in order to smooth price volatility which is characteristic of mineral markets. Even with averaging, negative present values resulted for some years in the time series.

Another approach to estimating the present value is based on gross rents or income flows derived from net price II since negative gross rents based on the first net price method yield negative present values. This is assumed to be the upper bound of any present value, depending of course on the discount rate used.

Choice of a discount rate

The choice of an appropriate discount rate is an issue of considerable debate in terms of choosing a private or social discount rate. There are considerations of intergenerational equity, social opportunity cost of capital and social time preference.

When considering intergenerational equity in determining the rate of depletion of a non-renewable resource, a zero discount rate of time preference may be considered an appropriate discount rate rather than the use of today's rate of time preference or the rate of interest used in capital markets. However if one views Alberta's Heritage Savings Trust Fund[5] as one of creating produced (reproducible) assets funded by the depletion of energy resources, one could view the fund as a source

4. It is assumed that the term $\delta(S/Q)$ is the same as the value of the net capital stock, K. However, the actual calculation of the net capital stock uses service lives of the machinery and equipment, and construction which differ slightly from the reserve life of S/Q.
5. the Alberta Heritage Savings Trust Fund was created by legislative action in 1976. The legislation stated that 30 per cent of Alberta's non-renewable resource revenues be put in the fund.

of tangible assets for future generations. The average yield on the assets in the fund might represent a good approximation of Alberta's social (or intergenerational) discount rate rather than a zero discount rate. The average real rate of return of the fund was 4.8 percent over the 1978 to 1989 period.

In our earlier valuation of oil and natural gas reserves, discount rates of 10 percent and long-term corporate bond rates in real terms were used to calculate various present values. This reflects a private rate of return instead of a social indicator. A constant real 10 percent discount rate is assumed to represent the rate of return on private investment before taxes and after inflation, and is the discount rate used by oil companies to value their reserves in corporate annual reports. Canada's National Energy Board uses a 15 percent real rate to approximate the "hurdle rate" used by investors while other Canadian studies have used long-term industrial bond rates when determining the present value of replacement costs of oil and gas reserves in Alberta.

The 1993 SNA suggests that the discount rate should be derived from information based on transactions in the type of assets under consideration - forest lands, mines, quarries, etc. - rather than using just a general rate of interest, such as one derived from the yield on government bonds.

The US Bureau of Economic Analysis' (BEA) approach was to use two real rates of discount - 3 percent and 10 percent - where the 3 percent rate is used to approximate the rate of time preference and the 10 percent rate reflects the long-term real return to business investment on reproducible capital. These rates reflect social and private discount rates and are similar to the ones used in the Canadian calculations.

The choice an appropriate discount rate is difficult but must reflect certain aspects of the resource being valued. There are several things to consider: a private versus a social discount rate, time preference, intergenerational equity and ownership of the resource. However, as concluded by BEA, even real rates of 3 percent and 10 percent are probably too high for sub-soil assets.

From Statistics Canada point of view, we have not chosen the "appropriate" discount rate and will continue to publish a range of present values - from 0 percent (based on the net price approach) to an average long-term corporate bond rate.

Impact of the 1993 revisions of the SNA on sub-soil assets

The 1993 System of National Accounts (SNA) encourages countries to develop satellite accounts in a more flexible manner than the conventional SNA accounts. One major change is the change in the asset boundary to include the value of subsoil assets as tangible assets in the Balance Sheet Account. Also, the SNA suggests including the value of mineral leases and other land costs as part of the resource rent. This requires changing our current treatment of mineral leases as intangible assets to including these values as part of the value of sub-soil assets. Below is a more detailed description of the revisions suggested by the 1993 SNA and how they apply to the valuation of sub-soil assets.

Rents on sub-soil assets

In the 1993 SNA, the term "rents" is used only for rents collected from land and sub-soil assets and are part of property income. Property income is defined in the 1993 SNA as the income received by the owner of a tangible non-produced asset in return for putting the tangible non-produced asset at the disposal of another institutional unit. It is this property income that represents

the return to natural capital being extracted. Although natural resource rents are calculated residually by the net price and present value methods, it is important to identify what is implicitly included as part of these resource rents.

Government owners of the assets grant leases to other institutional units permitting them to extract such deposits over a specified period of time in return for the payment of rents. These rents take the form of periodic payments of fixed amounts, irrespective of the rate of extraction or may be a function of the quantity or volume of the asset extracted. Also, mining companies engaged in exploration make payments to owners of the mineral rights to make test drilling or investigate by other surveys in order to locate sub-soil assets. Such payments are also to be treated as rents even though no extraction has taken place (United Nations, 1993b; Paragraph 7.133).

In the development of monetary accounts for oil and natural gas reserves in Canada, it was assumed that payments of royalties, mineral leases and land costs to governments and other owners represented part of the economic rent or return to the natural capital. This is clearly the case for royalties. However, for mineral leases and land costs, it is less clear. Although bonus bids and other land payments are considered by firms as part of their costs in obtaining oil and natural gas reserves, they are not part of the physical costs of exploration, development and extraction. They are payments generally to government and represent an *ex-ante* form of rent collection while royalties represent an *ex-post* rent.

Treatment of mineral leases in the CSNA

In the Canadian Financial Flow Accounts, purchases and sales of mineral, petroleum [and timber] rights are included under Net Purchases of Existing and Intangible Assets. However, while transactions in land and natural resources are especially important, they are inadequately valued and reported.

In the Canadian National Balance Sheet, mineral leases are treated as intangible assets. However, they are not currently reported as such in the balance sheet. If we are to include the value of sub-soil assets in the national balance sheet accounts, our current treatment of mineral leases and other lease costs will have to change in order to be consistent with the above definition of "return to natural capital" described above.

Mineral exploration

The 1993 SNA recommends treating expenditures on mineral exploration as capital formation. Whether successful or not, these expenditures are needed to maintain the resource stock and therefore should be treated as gross fixed capital formation. This recommendation is in line with the existing Canadian practice already. Only those expenditures that are considered "off-site" in the mining industry, and geological and geophysical expenditures in the petroleum industry are treated as intermediate consumption. However, 80 percent of exploration and development expenditures in the mineral industry are currently capitalized in the CSNA. This change of treating all such expenditures as capital formation and as part of the produced capital stock, is anticipated to have only a minor affect on the value of sub-soil assets as it is currently calculated.

The reconciliation statement in the balance sheets

The 1993 SNA states that changes in assets, liabilities and net worth between opening and closing balance sheets should be recorded in the other changes in the volume of assets account and the revaluation account. There are two kinds of changes. The first kind of change is due to discov-

eries or depletion of sub-soil assets which change the *volume* of the assets. The second kind of change consists of changes in assets and liabilities, and net worth due to changes in the level and structure of prices, which are reflected in holding gains and losses. The changes of the first kind are shown in the other changes in the volume of assets account and those of the second kind, in the revaluation account.

Many of the items discussed in the 1993 SNA form, in principle, the Reconciliation Statement (not yet fully developed) in the CSNA Balance Sheet. The development and compilation of this account is of high priority in the CSNA (Lal, 1995). Reconciliation accounts for sub-soil assets have been already developed reflecting the value of opening and closing stock, depletion, reserve additions and revaluation due to price changes.

Concluding remarks

The worldwide demand explosion in the 1970s, together with the manipulation of oil supplies by OPEC countries in 1973 and 1974, produced a new environment in resource markets. With the "threat" of resource scarcities, resource policies in Canada focused on capturing what were considered to be excessive profits or economic rents accruing to resource industries. Governments now felt that previous tax and royalty treatments of resource industries did not adequately compensate the public for exploitation of non-renewable resources.

Under the Canadian Constitution, the provinces are the owners of natural resources within their boundaries. In theory, the government, as landlord should collect the difference between the selling price of a commodity and the cost of its production, including a "normal" return to investment. This difference, economic rent, is collected as fees, taxes and royalties.

However, the major problem with collecting economic rent is that this rent is usually difficult to compute. For national accountants who are valuing a nation's mineral assets, this imputation is equally challenging.

Our assumptions about normal returns to invested capital, discount rates, and the method of valuation need to be discussed. Estimates of oil, natural gas and coal reserves stocks in Canada using the first net price approach (based on subtracting a normal return to invested capital), resulted in some negative values. A present value approach based on this method of calculating economic rent of the resource has been suggested by the 1993 version of the SNA. This would also yield negative values. As a statistical agency, we will have to decide on an appropriate valuation method before incorporating our results into the Canadian National Balance Sheet. Until then, Statistics Canada will continue publishing a range of values of Canada's mineral resources.

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