

Latest Developments in the Canadian Economic Accounts

Natural resource wealth statistics in the National Balance Sheet Accounts



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- . not available for any reference period
- .. not available for a specific reference period
- ... not applicable
- 0 true zero or a value rounded to zero
- 0^s value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
- ^P preliminary
- ^r revised
- X suppressed to meet the confidentiality requirements of the *Statistics Act*
- ^E use with caution
- F too unreliable to be published
- * significantly different from reference category ($p < 0.05$)

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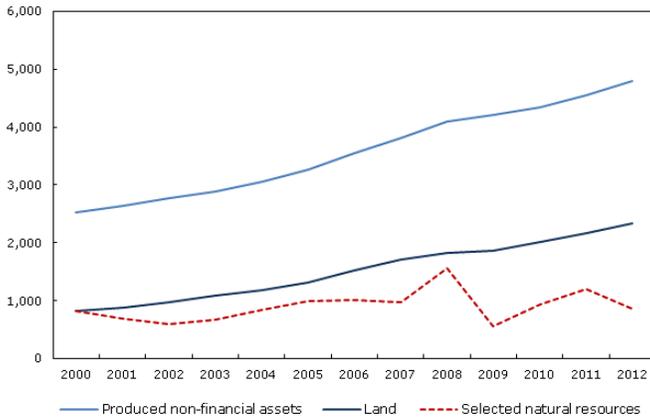
1. Introduction

The objective of this paper is to describe the concepts, methods and data sources associated with the incorporation of natural resource wealth into Statistics Canada's quarterly sector balance sheets of the *National Balance Sheet Accounts* (NBSA). Incorporating natural resource wealth was first implemented in December 2015 and is consistent with the 2008 version of the UN System of National Accounts.

Canada is endowed with substantial reserves of natural resources, from energy and minerals in the ground to accessible stands of timber in forests. Natural resources are considered non-produced non-financial (tangible) assets in the United Nations System of National Accounts (2008 SNA) and should be included in the calculation of national wealth and sectoral net worth.¹

In concert with increased world demand, the value of natural resource wealth has trended upwards over time. Price fluctuations in recent years have also been a significant factor in the valuation of these resources. In 2012, the value of selected² resource reserves stood at \$857 billion (Chart 1). Like other non-financial assets, this component of wealth plays a significant role in relation to production of goods and services in the Canadian economy, the generation of exports, employment and income.³

Chart 1
Dollar value of non-financial assets
billions of dollars



Source: Statistics Canada, Table 378-0005

The current treatment of natural resource wealth estimates in the Canadian System of National Accounts reflects only a partial integration into the National Balance Sheet Accounts. Specifically, natural resource values are produced for the annual estimates of *National Wealth* at the aggregate level. These data were previously presented on the *Consolidated National Balance Sheet*⁴ (CNBS), which covers non-financial assets adjusted for the net international investment position. This statement of national wealth covers produced as well as non-produced assets⁵, with the latter including natural resources by major type.

Natural resource assets are not, however, reflected in the quarterly sector balance sheets of the *National Balance Sheet Accounts* (NBSA) at this time. There are two reasons for this: (i) conceptual challenges and approach to sectoring natural resource assets, and (ii) the need to develop quarterly estimates to match the frequency of the NBSA (National Balance Sheet Accounts).

Fundamentally, physical stocks of natural resources cannot effectively be divided between governments and corporations. For example, for a given coal deposit, one cannot say that x tonnes of the deposit belong to the corporation and the remaining y tonnes belong to the government. Government and corporate accounting standards also disagree on the treatment of these assets since governments account for selected income flows arising from related economic activity, but do not account for natural resource stocks in their financial statements while corporations do account for natural resources in their financial statements for both asset and flows.

To address these conceptual issues, Statistics Canada has developed a methodology for integrating natural resource wealth into the quarterly Canadian *National Balance Sheet Accounts* (NBSA) sector estimates. The inclusion of the missing natural resource asset will significantly increase and improve measures of sectoral net worth.

This paper presents the concepts, methods and data sources Statistics Canada employed to add natural resource assets to the current suite of non-financial assets in the NBSA (National Balance Sheet Accounts). Section 2 of the paper discusses the concepts and rationale related to natural resources in the NBSA (National Balance Sheet Accounts); Section 3 presents the methodology for developing quarterly estimates of natural resources as well as the generation of government and corporate sector shares; Section 4 analyzes the impact of inclusion of natural resources in the sector accounts; and Section 5 discusses the inclusion of estimates in the quarterly sectored NBSA (National Balance Sheet Accounts).

2. Issues and approach to sectoring natural resource wealth

Balance sheet accounts provide the stock dimension to the national accounts. In Canada, these are comprised of non-financial assets as well as financial assets and liabilities. Together they provide estimates of sectoral net worth. The *National Balance Sheet Accounts* (NBSA) are tabulated on a quarterly basis for the corporate sector (financial and non-financial sub-sectors), the government sector (by sub-sector), the household sector, the non-profit institutions serving households sector, and the non-resident sector. They also comprise the aggregate annual *Consolidated National Balance Sheet*, with measures of National Wealth and National Net Worth.

The NBSA (National Balance Sheet Accounts) facilitate current economic analysis as well as the study of structural changes. Users can make informed assessments of the financial stability of each sector of the economy as well as the economy as a whole. They can also obtain a picture of the composition and the contribution of assets to key macroeconomic and financial aggregates and trends.

Current data gap in the accounting for natural resources

The NBSA (National Balance Sheet Accounts) are timely, comprehensive and coherent in their current form, but lack a full accounting for natural resource assets.⁶ Non-financial assets currently recorded in the sectored *National Balance Sheet Accounts* (NBSA) include only land and produced assets.⁷ This data gap in the sector accounts detracts from the interpretability and accuracy of the *National Balance Sheet Accounts* estimates. Additionally, missing quarterly estimates of natural resources adversely affect the relevance of these accounts due to missing capital, particularly in recent years. Conceptually this difference represents a missing asset that is used to generate goods and services; therefore the stock of non-financial assets on the NBSA (National Balance Sheet Accounts) does not fully articulate all the capital inputs that are used in the production process. The proposal to address these issues is presented later in the section, but first, a review of conceptual issues associated with sectoring natural resources is presented.

The exclusion of natural resources is a significant data gap that leads to an underestimation of corporate sector assets as the stock of non-financial assets does not reflect all of the inputs used in the production process. As a result, missing quarterly estimates of natural resources adversely affect the relevance of these accounts—particularly in recent years, as the value of natural capital has fluctuated.

Further, missing quarterly estimates of natural resources drive a wedge between the NBSA (National Balance Sheet Accounts) measures of corporate sector net worth as measured by the market, that is corporate equity at market value and corporate sector net asset value as measured on the NBSA (National Balance Sheet Accounts) (total corporate assets excluding corporate equity liabilities). This data gap gives rise to a corporate sector residual net worth that is intuitively difficult for users to interpret (see Table 1).⁸ The left hand side of Table 1 represents the current sectored approach, and the last column reflects the unsectored approach with natural resources. This example illustrates the two main statistical issues associated with the natural resources data gap in the sector accounts: First, the corporate sector has a large residual corporate net worth of \$1,200—the difference between the net asset value⁹ and the market value of corporate equity. The second issue is that the \$3,300 sum of quarterly sectoral net worth does not equal the national net worth of \$4,700. Since the corporate sector is ultimately owned by other sectors, the net asset value and the market value of equities outstanding should be relatively close with residual corporate net worth capturing one or both of (i) measurement error and (ii) market fluctuations above and below corporate net asset values. This is not currently the case.

This situation also means that there is currently no link between the quarterly sectored balance sheets and the *Consolidated National Balance Sheet* in the case of natural resources.

Guidance on sectoring natural resources from 2008 SNA (System of National Accounts)

The 2008 SNA (System of National Accounts) prepared under the authority of the United Nations Statistical Commission provides the main source of

Table 1
Current treatment of natural resources in the sector accounts

National Balance Sheet Accounts sectors/assets	Households	Corporations	Government	Sum of domestic sectors	Consolidated national balance sheet (CNBS)
Total assets	4,500	5,300	..	9,800	4,700
Non-financial assets	..	3,300	..	3,300	National wealth: 4,700
Produced assets	..	3,300	..	3,300	3,300
Non-produced assets					
Tangible natural resources	..	N/A	N/A	..	1,400
Intangible assets related to natural resources	..	N/A	N/A	..	..
Financial assets	4,500	2,000	..	6,500	..
Liabilities and net worth	4,500	5,300	..	9,800	4,700
Debt	..	3,000	..	3,000	..
Equity at market value	..	3,500	..	3,500	..
Sectoral net worth (residual corporate net worth in the corporate sector)	4,500	-1,200	..	3,300	National net worth: 4,700
Memo item: Corporate net worth as a net asset value	..	2,300	..	..	..
.. not available for a specific reference period					
N/A not applicable					
Source: Statistics Canada					

guidance on the treatment of assets in the national accounts. Natural resource wealth is recognised as embedded in two types of assets: non-produced tangible natural assets and intangible assets in the form of licences and leases to extract natural resources.

Treatment for tangible assets

The 2008 SNA (System of National Accounts) puts a premium on economic ownership where "assets appear on the balance sheet of the unit that is the economic owner of the asset" (SNA08 13.3). This is a fundamental principle that is accepted in this paper, where the asset belongs to who is using it to derive economic benefit. At the same time, the 2008 SNA (System of National Accounts) guidance for sectoring natural resource assets somewhat contradicts this principle since it recommends allocating the entire asset to the government without regard of economic ownership; specifically: "in the case of a produced asset financial lease arrangement, the leased asset appears on the balance sheet of the lessee (the economic owner), while the lessor has a financial asset of similar amount and a corresponding claim on the lessee" (2008 SNA (System of National Accounts) 13.3). In the case of a natural resource lease the asset continues to appear in the balance sheet of the lessor even though most of the economic risks and rewards of using the asset in production are assumed by the lessee (2008 SNA (System of National Accounts) 13.3).

This financial lease arrangement in the case of natural resources does not represent the economic reality of the situation in a number of economies and would lead to an undesirable and possibly significant distortion to the net debt of government.

2008 SNA (System of National Accounts) offers the following justification for this treatment "... Because there is no wholly satisfactory way in which to show the value of the [natural resource] asset split between the legal owner and the extractor, the whole of the resource is shown on the balance sheet of the legal owner and the [royalty] payments by the extractor shown as rent" (2008 SNA (System of National Accounts) 13.50).

Thus, according to the 2008 SNA (System of National Accounts), the wealth associated with *in situ* natural resource assets (i.e the tangible non-produced asset) belongs wholly to the government as the legal owner. Two issues come to mind in relation to this: Firstly, there is an explicit admission that this treatment is less than satisfactory; and, secondly, that the rent (royalty payments) associated with the resource would not be in line with the value of the asset on the legal owner's balance sheet except in cases where royalty payments succeed in extracting the full resource rent from extractors.

Treatment for intangible assets

The intangible asset component of natural resources is treated in the 2008 SNA (System of National Accounts) under *contracts, leases and licenses*. "Contracts, leases and licenses may be operating leases, licenses to use natural resources, permits to undertake specific activities and entitlement to future goods and services on an exclusive basis ... these sorts of contracts are regarded as assets only if the existence of the legal agreement confers benefits to the holder in excess of the price paid to the lessor, owner of the natural resource or permit issuer and the holder can realize these benefits legally and practically. It is recommended that such assets (the natural resource lease, permit or licenses) be recorded only when the value of the asset is significant and realized, in which case a suitable market price necessarily exists." (2008 SNA (System of National Accounts) 13.52). Natural resource leases in Canada generally pass the *benefit to the holder* criterion, as well as the *significant value* criterion.

Limitations of the 2008 SNA (System of National Accounts) guideline

Most of the key elements needed for an appropriate accounting for natural resource wealth are present in 2008 SNA (System of National Accounts). However, there are limitations discussed below that can give rise to implementation issues. These limitations may partially explain why the vast majority of countries have not implemented many of the recommendations associated with natural resources:

- it is inconsistent with the economic ownership principle;
- it is inconsistent with Government Financial Statistics;
- it does not reflect the economic reality of natural resource exploitation in some countries¹⁰;
- it is not in line with either corporate or government accounting treatments in some countries;
- it requires adjustments to produce accurate estimates of sectoral net worth (through lease assets-liabilities), which would affect government net debt (these adjustments are not fully addressed in the SNA08 manual); and
- it does not adequately explain the link between natural resources as one type of asset and resource leases as another type of asset, despite acknowledging the existence of both (this ambiguity can lead to measurement and implementation issues).

Government accounting and economic considerations

The situation in Canada is one where governments have a custodial function with respect to natural resources, holding them "in trust for the nation" and balancing the economic goals associated with their use with a host of other concerns, which can include economic growth, sustainability and the protection of the environment. This seems to be what 2008 SNA (System of National Accounts) suggests in 17.313: "... in many countries permits to use natural resources are generally issued by government since it (the government) claims ownership of the resources on behalf of the community at large."¹¹

Governments in Canada do not account for natural resource stocks in their financial statements (public accounts), which is the general off-balance-sheet treatment for assets held in trust. Notably, the inclusion of natural resource stocks on government balance sheets is not included in the IMF Government Financial Statistics manual.

Further, in order to account for natural resources as government assets, one would also want to attribute the benefits accruing from the resources to governments. Governments in Canada do account for selected income flows arising from economic activity associated with the use of natural resources, mainly by charging extraction/harvesting fees. These would include royalties, and to a lesser extent, revenues from the sale of resource rights (existing assets).¹² Nevertheless, the more significant portion of these benefits accrue to corporations in the extraction/harvesting industries.

Nevertheless, these streams of government property income suggest the existence of some type of corresponding asset in the government sector.¹³ Arguably, this asset should be representative of the public sector's share of the rent arising from the natural resources. Such an asset could be conceived as an intangible asset related to the government's stream of revenue from resource extraction/harvesting.

Corporations' accounting and economic considerations

Corporations, on the other hand, do account for natural resources in their financial statements. What typically appears on the balance sheets of corporations is an intangible asset related to the right to harvest/extract resources acquired from government. The resource right is a legal document, and constitutes claim on the value of the physical resources. This intangible asset is carried at acquisition cost^{14, 15} which may well differ from its market price, with market price values tending to fluctuate in tandem with resource prices.

Resource rights can also be sold to other corporations at market prices—values that may be significantly different from acquisition cost—though these prices are only observable when transactions occur. This emphasizes the need for a methodology to derive current values for resource rights held by corporations as part of the approach to sectoring. These secondary market transactions also underline the reality that corporations have a transferable

claim to the value of the physical resources.

Corporations make substantial revenue from harvesting natural resources that are included in corporate profits. This factor, in addition to the degree of control/responsibility they have for the assets, makes them the *economic owners* of the assets. This underlines the existence of a corporate asset related to natural resources (recognized in SNA08 13.52). These revenues, as well as significant fluctuations in resource prices, are reflected in the changes in the market value of outstanding corporate shares on markets. As such, they should also be reflected in corporate net worth measured as assets less liabilities in the NBSA (National Balance Sheet Accounts) (net asset value). It is therefore important to account for this resource rights asset, at a current or market price value, in the corporate sector balance sheet of the macroeconomic accounts.

Other international guidance

The United Nations System of Environmental-Economic Accounting: Central Framework (SEEA 2012) provides an alternative to the 2008 SNA (System of National Accounts) treatment by exploring options with respect to sectoring natural resource wealth. The SEEA (System of Environmental-Economic) proposes that "the value of mineral and energy resources [be] split between the two owners based on their share of the future stream of resource rent.¹⁶ The share accruing to the government should be based on the expected stream of payments of rent by the extractor to the government."¹⁷

This option is a useful extension of the SNA (System of National Accounts) treatment, as it acknowledges the existence of both government and corporate sector portions of natural resource assets based on returns. This has the advantage that the assets are closely tied to the income flows. This paper supports the SEEA (System of Environmental-Economic) approach in that respect, but does not support a partitioning of the value of the physical assets for both conceptual and interpretability reasons.

Proposed approach for the Canadian SNA (System of National Accounts)

Statistics Canada takes the approach that institutional sectors can have claims on, or associated with, natural resources that are based on the benefits accruing from extraction. Further, it argues that these claims are intangible assets. As such, Statistics Canada's approach is an interpretation of the 2008 SNA (System of National Accounts) and the SEEA (System of Environmental-Economic) 2012.

Defining the assets

The position taken here agrees with an implicit point in the 2008 SNA (System of National Accounts)'s position that there is no effective way to split the stock of physical resources endowed by nature between sectors. Even if there were agreement on a way to partition the value of the physical resource, this would be far removed from the actual accounting by governments and corporations. In many countries, a naturally occurring asset belongs to the nation as a whole, and can be extracted / harvested for economic reasons by corporations at the discretion of governments. As a corollary, the institutional sectors' economic aspect of natural resources could be handled by means other than partitioning the value of the physical stock; and, ideally, such *other* means would be more closely aligned with the financial accounting realities of corporations and governments with respect to natural resources.

Given the above, an alternative treatment is proposed that recognizes sectoral claims on the stock of physical natural resources as *intangible* assets. Specifically sector-level assets are treated as claims on the underlying physical resources; in other words, the claims can be thought of as assets that derive their value from the claims that governments and corporations have in relation to the physical resource assets on behalf of the nation's population who are ultimate owners of these resources.¹⁸ In the case of businesses in the resource industries, this is largely consistent with their accounting for these assets.

Following this approach, two intangible assets at the sectoral level would be created in the *National Balance Sheet Accounts* (NBSA) and added to the government and corporations' sector accounts of the NBSA (National Balance Sheet Accounts). These sectoral assets would be fully reconciled with the value of the aggregate natural resource wealth at the national level; in other words, the sectoral intangible assets related to natural resources would sum to the aggregate value of the tangible natural resource assets measured on the un-sectored national balance sheet.¹⁹ The proposed methodology to generate these sectoral estimates would ensure that this identity holds.

This methodology is presented in three parts in the next section: Estimating the annual value of the tangible natural resource assets (annual natural resource wealth); estimating quarterly natural resource wealth; and generating sectoral estimates related to quarterly natural resource wealth.

Net changes in the value of the physical tangible natural resource assets (e.g. (for example) net depletion plus discoveries) would be shown at the national level in the *Other Changes in Assets Account*, but also apportioned between the two sectoral intangible assets and shown in the same account.

Sectoring the assets

The second major methodological challenge is apportioning the quarterly estimates by economic sector.

The approach proposed in this paper—one that is also supported in the SEEA (System of Environmental-Economic) 2012—is to base the government's share of natural resource wealth on the net present value (NPV) of the expected revenue stream paid by resource extractors to governments (i.e. (that is to say) royalties and special taxes).²⁰ As argued above, this represents the value of an intangible asset reflecting governments' roles in overseeing natural resource extraction. To estimate the value of this asset, data on royalties and special taxes are needed for each natural resource asset for provincial, federal and territorial governments.

The corresponding *corporate* sector asset is calculated as total resource wealth less the above NPV (net present value) of the expected stream of royalties and special taxes. This residual amount is allocated to the corporate sector as *its* share of resource wealth. Assuming that the government's share is estimated accurately, this is equivalent to the value of an intangible corporate asset reflecting the government-conferred right to extract and sell the nation's natural resources.

The value of the corporate sector's share of natural resource assets as derived through this method would in principle be equal to the current dollar value of these claims (resource rights), thus largely ensuring that non-financial assets and sectoral net worth (net asset basis) are correctly measured.

Table 2 is an updated version of Table 1, with the same assumptions and values and presented according to Statistics Canada's proposed approach. It clearly demonstrates the advantages, in terms of more coherent balance sheet data, of the inclusion of estimates of sectoral natural resource based assets.

Table 2 reflects full coverage of sectoral natural resource-based assets in the institutional sectors, and thereby complete measures of net worth on a net asset basis. In the case of residual corporate sector net worth, the numerical value is reduced such that the net asset value of net worth is more coherent with the market value of corporate equity.

Further, sectoral net worth (including natural resources) now sums to National Net Worth (including natural resources). However, in order to move from

Table 2
Simplified illustration: Incorporation of natural resources in the sector accounts

National Balance Sheet Accounts sectors/assets	Households	Corporations	Government	Reclassification from sector accounts to national wealth	Consolidated national balance sheet (CNBS)
Total assets	4,500	6,300	400	..	..
Non-financial assets	..	4,300	400	..	National wealth: 4,700
Produced assets	..	3,300	..	..	3,300
Non-produced assets	..	..	400	..	..
Tangible natural resources	..	..	..	+1,400	1,400
Intangible assets related to natural resources	..	1,000 (derived)	400 (calculated)	-1,400	..
Financial assets	4,500	2,000	..	..	..
Liabilities and net worth	4,500	6,300	..	..	..
Debt	..	3,000	..	..	..
Equity at market value	..	3,500	..	..	..
Sectoral net worth (residual corporate net worth in the corporate sector)	4,500	-200	400	..	National net worth: 4,700 (equals sum of domestic sectors' net worth)
Memo item: Corporate net worth as a net asset value	..	3,300	..	..	..
.. not available for a specific reference period					
Source: Statistics Canada					

the quarterly sectoral wealth to annual National Wealth, the sector natural resource claim assets (corporate plus government sectors) must be reclassified from intangible assets to national tangible natural resource stocks.²¹

3. Valuation methodology: Producing quarterly natural resource wealth and sectoral balance sheet estimates

One of the major challenges in developing quarterly estimates of natural resource assets is the fact that much of the source data to which the estimates must ultimately be benchmarked (i.e. (that is to say) monetary and physical measures) are available on an annual basis only, and are not as timely as the *National Balance Sheet Accounts* (NBSA). Thus, methods are needed to interpolate annual historical Natural Resource Asset (NRA) data series on

a quarterly basis, produce timely forward estimates of NRA (Natural Resource Asset)s for inclusion in the NBSA (National Balance Sheet Accounts) and reconcile quarterly forward estimates to annual data benchmarks, in accordance with the NBSA (National Balance Sheet Accounts) revision cycle.

Before discussing the methodology for producing quarterly data specifically, a brief background on the approach to the annual valuation of tangible natural resource assets is given below.

Annual valuation of tangible natural resource assets: A brief background on the net present value approach

Since reserves of natural resources in their natural state (*in situ*) are seldom traded directly in markets, their value must be estimated using indirect approaches. Statistics Canada uses the net present value of future rents approach (NPV). This approach follows the international recommendations for valuing natural resources (2008 SNA (System of National Accounts) 13.24; SEEA (System of Environmental-Economic) 2012, Chapter 5) and has been the basis of Statistics Canada's *Natural Resource Asset Accounts* (NRAA) program since the early 1990s.

The natural resource asset value is calculated in two steps: a) *resource rent* is derived as resource sales revenue less extraction costs²²; and b) the discounted sum (or net present value) of the stream of *resource rents* is estimated.²³ The calculations are based on the following two formulas:

Resource rent (R):

$$R = TR - C - [r_k K + \delta] \quad (Eq.1)$$

Where: TR = total revenue

C = operating cost: notably labour, raw materials and fuel costs

K = produced capital stock net of depreciation

r_k = rate of return to capital

δ = depreciation of produced capital

NPV (net present value) of rents:

$$NPV = \sum_{t=1}^T \left[\frac{R_t}{(1+r_d)^t} \right] = \frac{R_1}{(1+r_d)} + \frac{R_2}{(1+r_d)^2} + \dots + \frac{R_T}{(1+r_d)^T} \quad (Eq.2)$$

r_d = discount rate

$$T = \text{reserve life} = \left(\frac{\text{Period end reserve}}{\text{Production during the period}} \right)$$

Because information on resource extraction paths cannot be forecast with an acceptable degree of certainty, future rents are assumed to be the same as current period rent, i.e. (that is to say), $R=R_1=R_2\dots R_T$.

The NRAA (Natural Resource Asset Accounts) currently include annual NPV (net present value)-based estimates for many natural resource assets²⁴ using physical and monetary data sources. These detailed annual accounts are disseminated at the national and provincial levels, with time series beginning in 1970 or later depending on the resource.

The relationship between the annual program and proposed quarterly NRA (Natural Resource Asset) accounts is discussed in the Appendix 1.

Estimating quarterly rent and NPV (net present value); creating a historical time series and forward estimates for NRA (Natural Resource Asset)s

As noted previously, Statistics Canada currently estimates the value of tangible natural resource assets using a number of annual data sources. For example, revenue and extraction costs are obtained from Natural Resources Canada's *Annual Census of Mines, Quarries and Gravel Pits* (ACM) and Statistics Canada's *Energy Statistics Program*. In order to interpolate these annual data among the four quarters of each calendar year of the historical time series a number of quarterly allocators have been created.

The use of this information to construct a quarterly historical time series and project the NRA (Natural Resource Asset) series forward for current analyses are the mainstays of the approach described in detail below.

While the construction of the historical time series is a one-time exercise, the method used to do so bears explanation, since the same method will be employed as part of a regular revision cycle, whereby the forward quarterly estimates are reconciled (or benchmarked) with the annual data at the time of the revision of the NBSA (National Balance Sheet Accounts). As noted below, many of the annual data series used to calculate estimates of natural resource asset values are lagged *by up to two years* in comparison with the publication of quarterly NBSA (National Balance Sheet Accounts).

Ideally, the data sources used to compile the quarterly data series would be as detailed as the data sources used to compile the annual estimates. In practice, quarterly revenue and cost functions²⁵ are not available and relatively simple formulas must be used to derive quarterly revenue and cost data for estimating the quarterly rent.

Quarterly revenue allocation and estimation

(i) Interpolation for historical revision and annual revision cycles:

Total revenue (TR) of a resource (i.e. (that is to say) gold), is equal to price times quantity sold, i.e. (that is to say), $TR=P*Q$. Using quarterly price and quantity data from a number of sources²⁶ a set of quarterly weights (w) for each resource are calculated using the following formulas:

$$\begin{bmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \end{bmatrix} = \begin{bmatrix} \frac{tr_1}{tr_T} \\ \frac{tr_2}{tr_T} \\ \frac{tr_3}{tr_T} \\ \frac{tr_4}{tr_T} \end{bmatrix} \quad \text{and} \quad \begin{bmatrix} TR_1^E \\ TR_2^E \\ TR_3^E \\ TR_4^E \end{bmatrix} = \begin{bmatrix} \omega_1 * TR^A \\ \omega_2 * TR^A \\ \omega_3 * TR^A \\ \omega_4 * TR^A \end{bmatrix} \quad (Eq.3a)$$

Where:

ω_i = weights used to distribute annual (benchmark) survey revenue data by quarter, i.e. (that is to say), where $\sum_{i=1}^4 \omega_i = 1$
 tr_i = constructed quarterly sales revenue for the i th quarter, based on quarterly price and quantity data, i.e. (that is to say), $tr_i = p_i \cdot q_i$ ²⁷
 tr_T = the sum of constructed quarterly revenue over 4 quarters, i.e. (that is to say) $tr_T = \sum_{i=1}^4 tr_i$
 TR^A = reported sales revenue from *annual* survey sources ²⁸
 TR_i^E = estimated total revenue for i th quarter, where $\sum_{i=1}^4 TR_i^E = TR^A$

Based on these weights, the annual sales revenues are distributed among the quarters of a given calendar year. For example, if ω_s ($\omega_1=0.20$, $\omega_2=0.26$, $\omega_3=0.30$, $\omega_4=0.24$) and $TR^A = \$100$ then the estimated quarterly revenues, TR_i^E , would be \$20, \$26, \$30 and \$24 respectively.

(ii) Forward projection

Similar quarterly data sources are also used for *forward projection* of revenues. Forward estimates are essential because annual survey data (benchmarks) are lagged by up to two years in comparison to the quarterly balance sheet schedule.

For the current quarter, the following formula is used for this purpose:

$$TR_t^E = TR_{t-1}^E \left(\frac{p_t}{p_{t-1}} * \frac{q_t}{q_{t-1}} \right) = TR_{t-1}^E \left(\frac{tr_t}{tr_{t-1}} \right) \quad (Eq.3b)$$

Where:

p_t, q_t = quarterly indicators of price and quantity for the current period
 p_{t-1}, q_{t-1} = quarterly indicators of price and quantity for the previous period

In other words, the current period's revenue estimate is the product of three components: the previous period's revenue, TR_{t-1}^E , the inter-period price ratio and the inter-period output ratio. For example, if $TR_{t-1}^E = \$100$, $p_t=\$50$, $p_{t-1}=40$, $q_t=10$ and $q_{t-1}=9$, then $TR_t^E = \$100(50/40)(10/9) = \138.89 .

(iii) Allocation for annual revision

Once annual data for a given year become available, projected quarterly estimates will be benchmarked to them, using the weighting scheme outlined in equation 3a. This ensures coherence and accuracy over the entire time series.

Quarterly extraction costs allocation and estimation

According to equation 1, extraction costs are comprised of operating costs (C) and capital costs ($r_k K + \delta$). These two differ from each other—an operating cost or variable cost is largely dependent upon current output (Q) whereas investment in fixed capital (such as oil rigs or buildings) is a relatively long-term cost commitment of businesses. In the short-term, production continues if the firm can generate sufficient revenue to pay for the variable inputs—notably labour, raw materials and fuel and electricity.

Quarterly labour costs

(i) Interpolation for historical revision and annual revision cycles

Microeconomic theory tells us that, all other things being equal, variable cost is a function of output. Other factors influencing variable costs include technology (e.g. (for example), introduction of a capital intensive technology could reduce labour cost) and input costs (e.g. (for example), hourly wage rate, electricity rate, etc.). ²⁹ Typically, technological change takes time, and any savings in labour costs it affords are reflected in the annual wage bill for a given industry. Thus the variations in labour costs from quarter to quarter are driven largely by the variation in quarterly output and wage rates ³⁰; i.e. (that is to say):

$$\Delta C = \varphi(\Delta Q, \Delta W) \quad (Eq.4)$$

Assuming that the variation in labour cost is proportional to variations in output and wage rate, quarterly labour cost allocators can be derived as follows:

$$\begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} = \begin{bmatrix} \frac{Q_1}{Q_T} \\ \frac{Q_2}{Q_T} \\ \frac{Q_3}{Q_T} \\ \frac{Q_4}{Q_T} \end{bmatrix}; \quad \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} = \begin{bmatrix} \frac{W_1}{W_T} \\ \frac{W_2}{W_T} \\ \frac{W_3}{W_T} \\ \frac{W_4}{W_T} \end{bmatrix}; \quad \begin{bmatrix} \gamma_1 \\ \gamma_2 \\ \gamma_3 \\ \gamma_4 \end{bmatrix} = \begin{bmatrix} \theta\alpha_1 + (1-\theta)\beta_1 \\ \theta\alpha_2 + (1-\theta)\beta_2 \\ \theta\alpha_3 + (1-\theta)\beta_3 \\ \theta\alpha_4 + (1-\theta)\beta_4 \end{bmatrix}; \quad \begin{bmatrix} C_1^E \\ C_2^E \\ C_3^E \\ C_4^E \end{bmatrix} = \begin{bmatrix} \gamma_1 * C^A \\ \gamma_2 * C^A \\ \gamma_3 * C^A \\ \gamma_4 * C^A \end{bmatrix} \quad (Eq. 5a)$$

$$\sum_{i=1}^4 \alpha_i = 1 \quad \sum_{i=1}^4 \beta_i = 1 \quad \sum_{i=1}^4 \gamma_i = 1$$

Where:

$\alpha_1, \alpha_2, \alpha_3,$ and α_4 are quarterly output ratios,
 β_i are wage rate ratios, ³¹
 θ =weight (assumed 0.5)
 γ = weighted average of α and β
 $Q_1, Q_2, Q_3,$ and Q_4 = production in each quarter

Q_T = sum of quarterly production values, i.e., (that is to say) $Q_T = \sum_{i=1}^4 Q_i$
 W_1 = hourly wage rates from quarterly sources
 W_T = sum of hourly wage rates from quarterly sources, i.e., (that is to say) $W_T = \sum_{i=1}^4 W_i$
 C_1^E = estimated labour cost in quarter 1;
 C^A = labour cost from annual (benchmark) survey sources

(ii) Forward projection

In a similar fashion to quarterly revenue, quarterly costs are projected forward using the following formula:

$$C_t^E = C_{t-1}^E \left(\frac{W_t}{W_{t-1}} * \frac{Q_t}{Q_{t-1}} \right) \quad (Eq. 5b)$$

In other words, the current period's cost is the product of three components: the previous period's cost, the inter-period wage rate ratio, and the inter-period output ratio. For example, if $C_{t-1} = \$100$, $W_t = \$25$, $W_{t-1} = 24$, $Q_t = 10$, $Q_{t-1} = 9$, then $C_t^E = 100 \left(\frac{25}{24} * \frac{10}{9} \right) = \115.74

Quarterly other operating costs

A similar approach is also used for interpolation and forward projections of other cost components of rent such as electricity and raw materials costs; e.g., (for example), where hourly electricity rate is used in place of wage rate (W). Data for material inputs are estimated using price indexes and gross domestic product.

Quarterly capital costs

According to equation 1, there are two components of capital cost that need to be accounted for in the calculation of resource rent: depreciation (δ) and the return to fixed capital ($r_k K$). For the former, the perpetual inventory method is used to generate estimates of (geometric) depreciation. While these capital stock and depreciation data are not estimated on a quarterly basis at Statistics Canada, a quarterly investment data series is used to allocate them by quarter. These data are from the Stock and consumption of fixed capital program.

With respect to calculating a *return to fixed capital*, an often contentious issue is the selection of an appropriate rate of return (r_k) to apply to fixed capital stock (K). For these estimates, an internationally accepted rate based on the 5-year bond rate from the Bank of Canada is used.

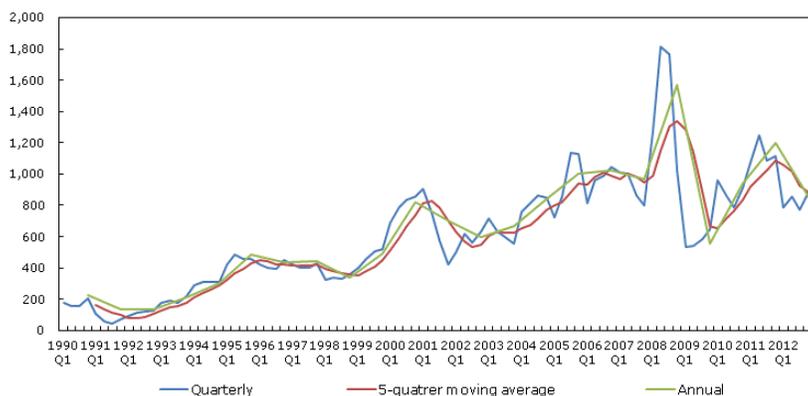
4. Analysis: Sectored natural resource wealth

It is clear that the generation of quarterly estimates improves the coherence of the balance sheet accounts. This, alongside an accounting for a missing asset of significance, also contributes to the relevance of the statistics.

Nevertheless, one issue that has generated some discussion in international circles is whether it is appropriate to reflect quarterly fluctuations in resource prices in the annual stock of natural resources. In this regard, it should be noted that Statistics Canada maintains the annual stock of natural resources, such that users can select the resource series most appropriate for their analytical purposes. In any case, it is clear that there is a very close association between the annual values and the quarterly values (Chart 2). A five-quarter centered moving average is essentially equivalent to the annual values.

Statistics Canada's position is that natural resource price fluctuations impact on production, employment and stock market prices and, hence, wealth positions. In other words, and stated more generally, current prices are important for economic and financial activity. And, in an integrated set of quarterly balance sheets, net asset values for corporations (including natural resources) should reflect the value of share prices (for resource based corporations). The methodology more or less ensures this relationship.

Chart 2
Natural resources, annual, quarterly and moving average of quarterly
 billions of dollars



Source: Statistics Canada, International Accounts and Trade Division, special tabulation, 2015.

Sector detail

Ideally, the NPV (net present value) of quarterly royalties and special taxes would be calculated for each resource individually and then summed over all resources to arrive at the governments' share of total resource wealth on a quarterly basis. However, detailed quarterly data on royalty payments are not available, so it is necessary to use the quarterly ratio of *total government royalties to total resource rent* as a means of allocating quarterly resource wealth between the government and corporate sectors. There are minor computational challenges associated with this method. Specifically, calibration is needed to account for the fact that reserve life as well as royalty rates vary from one resource to the next. The calibration to correct for this difference is made through the use of detailed *annual* royalties data by commodity. The adjustment is marginal.

A consequence of the approach described above is that the quarterly sectoral intangible asset values of governments and corporations will be an

aggregate of claims on all types of natural resources, whereas the annually published values of natural resource wealth will be broken down by natural resource type.

Preliminary findings suggest that the inclusion of sectoral natural resource assets in the quarterly *National Balance Sheet Accounts* (NBSA) would increase the average net worth of governments and corporations (Charts 2 to 4). The most significant change to sectoral assets would occur in the corporate sector, with a large upward revision to non-financial assets.

Corporate sector results

The inclusion of assets related to natural resources on the balance sheet, has a substantial effect on the measures of non-financial assets and corporate sector net worth.

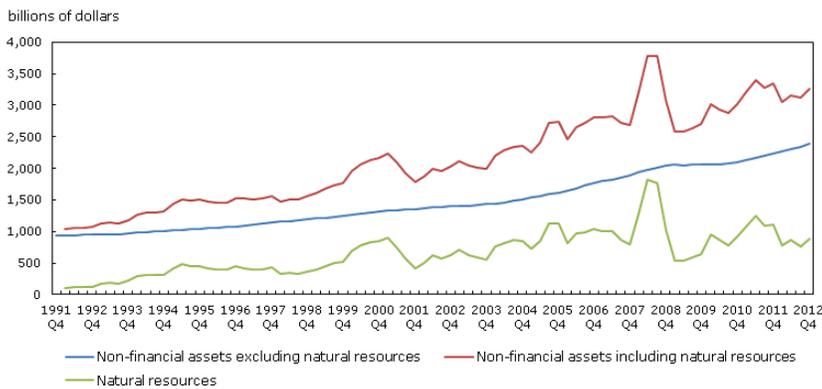
Corporations' non-financial assets

On average, the corporate sector accounts for 88% of the value of natural resources in Canada in the current value of the rights to extract. This share has remained relatively constant over time. As a result, non-financial assets of corporations are revised up substantially with the inclusion of natural resource based assets (Chart 3). Natural resources account for 22% (on average) of corporations' non-financial assets. This significant revision underlines the importance of natural resources to the economy as well as the need to deal with the associated sectoral data gap.

The upward revision on non-financial assets also produces a better relationship between corporate surplus and the stock of productive assets. This, in turn, leads to a more robust measure of the rate of return on non-financial assets in the corporate sector. Prior to the inclusion of natural resource assets, this rate was overstated.

The natural resource based assets allocated to the corporate sector display the fluctuations in the markets for natural resource commodities that are evident in the quarterly estimates of aggregate natural resource wealth. Therefore, the new estimates for corporate sector non-financial assets also reflect this volatility, and make for a notable departure from the previously published data largely based on capital stocks and land.

Chart 3
Non-financial assets of the corporate sector with and without accounting for natural resource assets; corporate sector natural resource based assets



Source: Statistics Canada, International Accounts and Trade Division, special tabulation, 2015.

Links to the market value of corporate equity

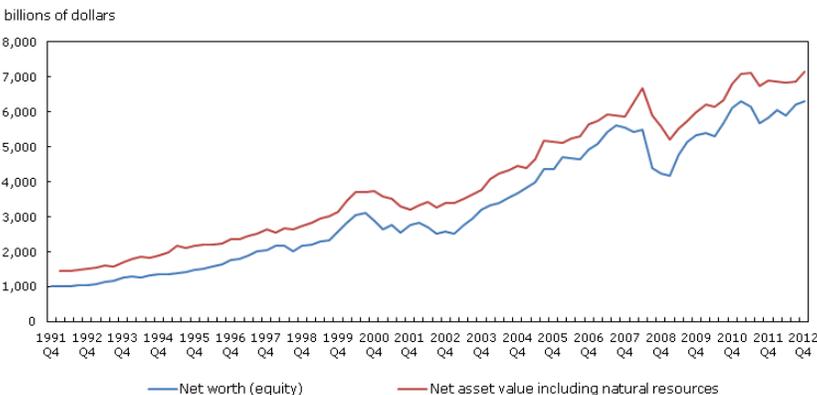
The increased magnitude and volatility of the new net asset value measure of corporate sector net worth (NAV) demonstrates the impact of natural resources adjustments with the market value of corporate equity outstanding (MVCE), which is a second measure of corporate sector net worth (Chart 4).

The MVCE is the measure that brings the equity assets and equity liabilities in the NBSA (National Balance Sheet Accounts) matrix into line with each other, by setting the matrix control total for this financial instrument. Estimates of the market value of corporate equities outstanding are generated using actual market values for listed companies and a mark-up factor for unlisted companies (using a size cut-off).

In particular we see that the turning points in the new NAV estimates largely correspond to those of the MVCE. This is not the case with the published NAV time series.

On the new basis both measures reflect, among other things, the relative impact of the natural resource sector in Canada. This increased coherence makes for a substantial improvement in data quality.

Chart 4
New net asset value measure of corporate sector net worth and the market value of corporate equity outstanding



Source: Statistics Canada, International Accounts and Trade Division, special tabulation, 2015.

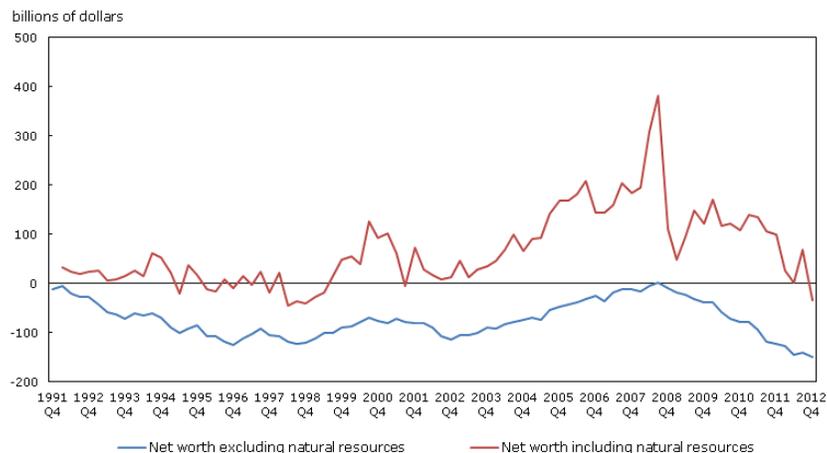
Given that the NAV and the MVCE are in principle equal, statistical improvements—in this case, extending the coverage of assets to include natural resource based assets—should bring them closer together. This, however, is the not case; the upward revision to the NAV, pushes the NAV above the MVCE, and the gap between the two measures actually increases. This, in turn, impacts the absolute value of residual corporate sector net worth.

Government sector results

Provincial governments

The net worth of provincial governments, when natural resource wealth is included, has been positive since 1999Q3 (Chart 5). This reflects the increased value of natural resources in this period. In addition, the volatility of net worth in the provincial government sector increased with the addition of a natural resource asset.

Chart 5
Provincial governments' net worth with and without natural resource assets



Source: Statistics Canada, International Accounts and Trade Division, special tabulation, 2015.

Between 1991Q4 and 2008Q3 provincial government net worth with and without natural resource assets exhibited a generally upward trend, with a few exceptions (Chart 3). Since the global economic downturn, however, published net worth has trended downward as debt advanced, declining at an average rate of 25% or more from 2009Q1 and 2012Q3. Adding the natural resource assets, provincial government net worth was relatively flat over this period.

Federal government

As natural resources are largely the domain of provincial and territorial governments, the value of the federal government sector natural resource asset is relatively small. The overall impact of adding a natural resource asset to federal government net worth, then, is fairly inconsequential.

5. Summary and concluding remarks

This paper takes the view that the 2008 SNA (System of National Accounts) does not clearly link income flows to resource assets or the natural resource stocks and the rights to extract. It also does not adequately address sectoring issues in the balance sheet account, at least one that reflects the economic reality in Canada. This paper proposes a method based on the SEEA (System of Environmental-Economic) 2012 to divide natural resource wealth among sectors. It also suggests an approach to developing quarterly estimates of natural resource wealth.

With natural resource wealth included in the quarterly sector balance sheets of the NBSA (National Balance Sheet Accounts), the net worth of both sectors increases, most significantly, in the case of the corporate sector. Corporate net worth estimates will also align more closely with the market value estimates of equities. This makes for more complete and coherent sector balance sheets providing a more coherent picture between the production of goods and services, flow of income and the wealth of the nation.

Incorporating a natural resource asset into the sector accounts of the balance sheet will put natural resources on equal footing with other income-generating assets that are already included in the balance sheet.

The inclusion of quarterly, sectored, natural wealth resources better integrates the stocks and flows and enhances the relevance and interpretability of the macroeconomic balance sheet account in Canada and more generally the Canadian System of National Accounts.

Appendix 1 Treatment of natural resource asset by type

2008 SNA (System of National Accounts) provides specific recommendations for natural resource asset types in Chapter 17. This paper is interested specifically in timber and subsoil assets, given that these are the largest resource assets valued in Canada.

(i) Timber

This paper agrees with 2008 SNA (System of National Accounts) on the points below. In Canada, companies typically acquire the rights to harvest timber, and stumpage fees constitute income of government. In addition, timber is not treated as a produced asset in the Canadian national accounts.

If a unit is given permission to clear fell an area of natural forest, or to fell at its discretion without any restriction in perpetuity, the payments made to the owner constitute the sale of an asset. (The sale of forested land may be recorded as the sale of the timber and the land separately, depending on the intended use of each. (SNA08 17.329)

The option to have a lease permitting felling at the lessee's discretion but subject to the restoration of the land, in an acceptable forested state, at some time in the future is improbable. It is more common for timber felling to be allowed under strict limits with a fee payable per unit volume of timber felled (stumpage). The limits are usually such that the harvest of timber is sustainable and so the payments are recorded as rent in the case of a natural forest. (SNA08 17.330)

Forests may also be produced assets, in which case the extraction of timber is treated as the sale of a product. (SNA08 17.331)

(ii) Subsoil assets

This paper agrees with 2008 SNA (System of National Accounts) on most of the points below. Natural resource rights are typically acquired by companies from government. Since it is not possible to distinguish different arrangements (e.g. (for example), sale of natural resources versus acquisition of resource rights), the practical approach is to universally assume that minerals are accounted for as rights acquired in the Canadian national accounts.

Mineral resources differ from land, timber and fish in that although they also constitute a natural resource, there is no way of using them sustainably. All extraction necessarily reduces the amount of the resource available for the future. This consideration necessitates a slightly different set of recommendations for how transactions relating to their use should be recorded. (SNA08 17.340)

When a unit owning a mineral resource cedes all rights over it to another unit, this constitutes the sale of the resource. Like land, mineral resources can only be owned by resident units; if necessary a notional resident unit must be established to preserve this convention. (SNA08 17.341)

When a unit extracts a mineral resource under an agreement where the payments made each year are dependent on the amount extracted, the payments (sometimes described as royalties) are recorded as rent. (SNA08 17.342)

The treatment of natural resource assets is summarised as:

The owner (in many but not all circumstances government) does not have a productive activity associated with the extraction and yet the wealth represented by the resource declines as extraction takes place. In effect, the wealth is being liquidated with the rent payments covering both a return to the asset and compensation for the decline in wealth. Although the decline in wealth is caused by the extractor, even if the resource were shown on the balance sheet of the extractor, the rundown in wealth would not be reflected in the extractor's production account because it is a non-produced asset and thus not subject to consumption of fixed capital. (The SEEA (System of Environmental-Economic) 2003 describes a form of satellite account where such a deduction from national income can be made for minerals as well as for other natural resources used unsustainably.) For these reasons, simple recording of payments each year from the extractor to the owner as rent and changes in the size and value of the resource as other changes in the asset accounts of the legal owner is recommended. (SNA08 17.343)

This implies that the government is the owner and receives part of the rent (in the form of royalties) as current income. It is difficult to view the rent payments to government as a compensation for the depletion of the resources, since (as the section notes) depletion is not an SNA (System of National Accounts) entry except in the Other Changes in the Volume of Assets Account.

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Nazrul Kazi

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United Nations, 2012, *System of Environmental-Economic Accounting: Central Framework (white cover draft)*, New York.

Notes

- 1 This is as recommended in SNA (System of National Accounts) 2008: "The 2008 System of National Accounts, ♦ United Nations, New York. This is discussed in detail in the next section.
- 2 The selected natural resources include: coal, crude oil, crude bitumen, natural gas, gold, iron, copper, nickel, molybdenum, uranium, potash, diamonds, and timber. Data necessary to value other resources such as fresh water and fish have not been developed.
- 3 For details, see Cross, P (2008), *The Role of Natural Resources in Canada's Economy*, ♦ Canadian Economic Observer, Statistics Canada, Catalogue no. (number) 11-010-XIB.
- 4 Consolidated refers to the elimination of all domestic holdings of domestic liabilities, leaving the net international investment position as the only remaining financial instrument (net foreign asset or net foreign debt)
- 5 Non-produced assets include the value of agricultural and other developed land and natural resources.
- 6 Most countries, except Australia have yet to include natural resources in their national balance sheet accounts. The Australian balance sheet accounts are very similar to Canada's at the moment, recording un-sectored annual natural resource wealth at the aggregate level only alongside other non-financial assets. The natural resource wealth estimate is primarily used for estimating per capita net worth. For details, see, www.abs.gov.au.
- 7 The produced assets include residential structures, non-residential structures, machinery and equipment (including research and development), consumer durable goods and inventories. For details, see, *The Daily, National balance sheet accounts* www.statcan.gc.ca/daily-quotidien/101213/dq101213a-eng.htm, accessed Feb 2011.
- 8 Assumptions are as follows: There is a closed economy with no non-resident liabilities. This implies that there is no net international investment position, such that National Wealth (sum of all non-financial assets in the economy) is equal to National Net Worth. No assets-liabilities are assigned to government. The only non-produced assets relate to natural resources. Households own all of the equity of corporations. Corporations hold two-thirds of their own debt as assets, while households hold the balance.
- 9 The net asset value is the difference between total assets and total liabilities (debt). It is equivalent, in principle, to the market value of corporate equity; however, in practice the two measures rarely equal.
- 10 The 2008 SNA (System of National Accounts) makes the valid point that there are different arrangements across economies to acquire the rights to extract various types natural resources, from acquiring the physical assets to short and long-term leasing agreement. In Canada, the most common practice for the assets that are currently valued in national wealth—subsoil assets and standing timber—is the acquisition from government of long-term rights to extract natural resources; and these rights are transferable in a secondary market.
- 11 This treatment is conceptually similar to that already adopted in the CSNA (Canadian System of National Accounts) for the electromagnetic spectrum.
- 12 Sales of resource rights were re-classified from "sales of existing assets ♦ at the time of the 1997 historical revision to the Canadian System of National Accounts to "property income ♦. In light of the 2008 SNA (System of National Accounts) and the reasoning in this paper as well as the current treatment for the spectrum, "sales of existing assets ♦ seem to be the correct treatment. The rights come into being as volume changes at the time of initial sale.
- 13 Though the SNA (System of National Accounts) 2008 drops the tangible-intangible terminologies, for a lack of better terms this paper uses them.
- 14 New accounting standards will likely lead to resource rights reflected at values closer to market prices.
- 15 The asset is also adjusted for depletion, which is treated as a volume change in SNA (System of National Accounts).
- 16 This approach was proposed by Statistics Canada in the review of the SEEA (System of Environmental-Economic) 2012 draft.
- 17 United Nations, 2012, *System of Environmental-Economic Accounting: Central Framework (white cover draft)*, New York.
- 18 This treatment is conceptually similar to that already adopted in the CSNA (Canadian System of National Accounts) for the electromagnetic spectrum.
- 19 Which are included as part of *annul* national wealth at the aggregate level on the consolidated national balance sheet.
- 20 The amount of royalties depends on a number of factors, such as resource price, quantity of production and governments' policies.
- 21 These flows are recorded in the Other change in the volume of asset accounts.
- 22 It is assumed there is no resource rent and asset has no current value if value is negative.
- 23 For details, see Statistics, 1997, Concepts, sources and methods of the Canadian system of Environmental and Resource Accounts, Statistics Canada Catalogue no. (number) 16-505-GIE, Ottawa.
- 24 Energy resources (natural gas, crude oil, crude bitumen and coal), mineral resources (gold, nickel, copper, zinc, lead, iron, molybdenum, uranium, potash and diamonds) and timber. Other natural resource stocks, including water and fish, are not currently valued due to data limitations.
- 25 Firm level data on quarterly output, price, input costs are not available.

- 26 Quarterly production and price data are compiled from several sources including Natural Resources Canada, Alberta Energy Board, Producer Prices Division and CANSIM tables.
- 27 Quarterly production and price data are compiled from several sources including Natural Resources Canada, Alberta Resource Conservation Board, and Statistics Canada, including Producer Prices Division, International Trade Division, CANSIM, and Metal Prices.com.
- 28 Sources of annual total revenue include: Natural Resources Canada's Annual Census of Mines, Quarries and Gravel Pits for minerals; Statistics Canada's Manufacturing and Energy Division's Energy Program and Annual Survey of Manufactures and Logging.
- 29 Apart from these, there are irregular issues, such as weather and labour unrest, which could impact labour cost.
- 30 For details, see, Greene, W. (2000), Econometric Analysis, 4th edition (pp. (pages) 327-329), Prentice Hall.
- 31 More precision of θ would require additional quarterly data (i.e., (that is to say), quarterly cost functions), which are currently unavailable.
-