How should we value and record sub-soil assets and their associated depletion?

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1.0 Introduction

At the fourth meeting of the London group in Ottawa in June 1997, John Joisce, on behalf of the Australian Bureau of Statistics (ABS), offered the services of the ABS to coordinate a sub-group to discuss issues of depletion and natural resource valuation. Following from that meeting, the ABS sent an email on August 8 aiming at encouraging discussion on many of the issues raised, which related to natural resource valuation. This paper is aimed at reactivating that discussion on natural resource valuation, as well as summarizing and analyzing the various proposed treatments for depletion in the national accounts. Given the extent of the outstanding issues relating to measuring depletion and valuing sub-soil assets, the paper limits its scope to these issues. Group participants are encouraged to comment on not only the issues raised in this paper, but their relevance for other non-produced natural assets.

2.0 How should we treat depletion in the national accounts?

2.1 Background to the exclusion of depletion from the conventional national accounts

There appear to be three main reasons why mineral resources have been excluded from national income and wealth. First, mineral resources are not produced by economic (i.e., human) activity and so to include them would have involved changing the production boundary; second, until very recently, economic theory and national accounts were primarily interested in flows, not levels; and third, natural resources were considered to provide endless benefits (i.e., sustainability was not an issue). As a consequence, the national accounts' production and income accounts had excluded both the addition of natural resources to national wealth and their subsequent depletion.

With rising concern about environmental issues in general, and sustainability in particular, natural resource accounting has become an important consideration in the national accounts. This is reflected by the inclusion in The System of National Accounts 1993 (SNA93)(1) of sub-soil assets in the national balance sheets and additions and depletion of such assets in the other changes in volume of assets account. By doing so, SNA93 implies that countries can avoid the uneven impacts on production and income of depletions and additions that may otherwise have sent false policy signals about national income (especially in resource rich countries). In SNA93, non-produced economic natural assets make their economic appearance in the assets accounts as "transfers" from the environment. These assets are considered to lie outside the production boundary but inside the economic asset boundary (2).

In the flow accounts, SNA93 treats depletion as property income received by the owners of non-produced assets (in Australia's case, for the most part, the owners of the sub-soil assets are the state governments but it is possible that some of the sub-soil value is appropriated by (private) extractors/operators). Property incomes are considered to accrue when the owners of non-produced assets put them at the disposal of other institutional units by arranging contracts or leases under which the extractors agree to pay the owners property incomes in the form of rents (rather than treating the sub-soil assets as a purchase and sale).

Further, SNA93 draws a fundamental distinction between property income from natural resources and rentals receivable and payable under operating leases for fixed assets and inventories. Rentals of the latter are treated as sales and purchases of services and not property income. SNA93 outlines the following characteristics which make operating leases on fixed assets and inventories distinct from the renting of land and subsoil assets:

(a) under an operating lease the items traded are all produced assets;

(b) lessors of produced assets are typically engaged in processes of production whereby they provide services to the lessees by purchasing and maintaining inventories of fixed assets which they may lease out;

(c) lessors engage in gross fixed capital formation when acquiring the assets and incur consumption of fixed capital for the assets they lease (SNA93, par. 7.90).(1)

On the other hand, SNA93 regards natural resources as not "produced as outputs of production". They did not enter the economic system by means of a transaction and no capital consumption is incurred in respect of their use. As a result, SNA93 asset accounting principles require that depletion values should be recorded in the "other changes in volume of assets account" rather than in the production accounts. However, some authors are unhappy with this treatment and suggest there is a case to be made for imputing depletion costs in the production accounts. It is these views which will now be discussed.

2.2 Alternative approaches for accounting for depletion

Suggestions that a measure of depletion of non-renewable resources be included within the capital account are underpinned by an analogy drawn between the use of produced and non-produced assets. Acceptance or otherwise of this approach hinges on the validity of this analogy, and the contention of this note is that the following issues need to be satisfactorily addressed before the proposal could be accepted.

The main thrust of the alternative treatments is that extraction of depletable natural resources should be viewed as the use of an existing asset rather than as an addition to income. By defining depletion in such a way implies either the use of an inventory carried over from previous periods (which should not be counted as a part of production in the current period), or the "depreciation" of a capital asset which, though contributing to production, should not be included in Net Domestic Product or Income.

2.2.1 Treating depletion as a fixed asset

Hill and Harrison(3) propose that when sub-soil assets are scarce their depletion must be recorded as a cost in the production account of the owner of the asset. They believe depletion should be recorded as the use of a fixed asset. The details of their proposals as I see them are:

(1) SNA93 recommends including in the balance sheets environmental assets which are the subject of economic transactions. For assets, which are under human control, like cultivated livestock and forests, Hill and Harrison point out that entries in the SNA are treated as produced capital. Additions to the stock of these assets as a result of production are recorded as an increase

in inventories or as fixed capital formation, while decreases in the stock are treated as withdrawals from inventories or as consumption of fixed capital. Changes in the value of the assets due to price variation and changes in their volume due to natural or man-made disasters are recorded in the other changes in assets account.

For natural resources (such as sub-soil assets or native (unmanaged) forests) that are not produced under human control, there is not a complete parallel with environmental assets under human control in the accumulation accounts.

(2) Changes in the net present value (NPV) between beginning and end of year stocks of sub-soil assets due to changes in technology and discoveries would be recorded in the other changes in volume of assets account. Changes in discount rates, which affect the value of subsoil assets, should be recorded as revaluations. Holding gains and losses should be recorded in the revaluation account. All other changes are depletion of natural assets and net depletion should be recorded in the capital account.

(3) Under SNA93, depletion is recorded in the other change in volume of assets account, i.e., the account reserved for changes in quantities of assets that are NOT attributable to economic activities and their associated transactions. Hill and Harrison argue that recording depletion in this account is not justified, given the way in which the account is defined. Rather depletion is seen as an imputed transaction attributable to the activity of production and it must be recorded in the capital account as well as the production account in the same way as COFC and changes in inventories, both of which they regard as imputed transactions.

(4) The opportunity cost of depleting an asset is measured by the reduction in the future production possibilities incurred by extracting and using up assets in the current period. Depletion leads to a reduction in future production possibilities, so its measurement inevitably involves discounting. Defining the cost of depletion as the decline in the discounted value of future benefits is entirely consistent with the way in which the using up of other physical assets is recorded in the SNA. The current value of the sub-soil asset extracted and the value of depletion are NOT the same because depletion is defined as the decline in present value of the flow of discounted benefits. They argue that this is exactly analogous to the principles involved with consumption of fixed capital.

(5) Harrison(4) suggests that to separate the value of depletion in the period requires removing the effect of changing prices from the changing value of the asset. Therefore, she suggests that the present values of the stock of the sub-soil asset at the beginning and end of the period used in the calculation of depletion should both be based on the average price of the asset within the period.

(6) Harrison considers that depletion is not "rent" in the standard economic meaning of the term, i.e., that the resource is/can be returned to the owner in the same condition it was "rented out". She argues the renting of land is quite different since tenants do not gradually take possession and dispose of bits of the land they are renting. Moreover, at the end of a tenancy, the landlord expects to take the land back in more or less the same condition. By contrast, the extractor is taking possession of an asset and disposing of quantities of the asset belonging to the owner. The

sub-soil resource is, therefore, never returned so it is hard to see it as "rent". Similarly, El Serafy(5) argues asset sales do not generate value added and are therefore not income.

(7) To show the effect of their proposed treatment for depletion, Hill and Harrison separate out the effects of depletion into the accounts of the owner, accounts of the extractor, and aggregated accounts.

The proposal is that ownership of the sub-soil asset passes from the owner to the extractor as the extractor engages in production activity to transform the sub-soil asset into an extracted asset. As a result, in the accounts of the extractor (shown in the paper), the sub-soil asset acquired below ground forms part of the intermediate consumption of the extractor. Thus the gross and net operating surplus of the extractor will fall (by 150 in the example shown in the paper). Further, as the payment from the extractor to the owner is considered a sale, the entry for payment of property income is removed. Consequently, in the distribution of primary income account for the extractor, property income payable is reduced (by 150), leaving the balance of primary income and all subsequent accounts unchanged.

(8) The authors suggest that the owner of the asset is engaged in the activity of leasing, an activity which can be accounted for in the same way as the leasing of buildings or equipment. When a fixed asset is leased by an owner to another unit, a production account is set up for the owner, who is treated as selling services to the lessee. So in the accounts of the owner of the resource, the proposal is that a production account is established, called the "depletion account". In the numerical example shown in the paper where there is a constant rate of depletion, resource sales of 150 are recorded and added to gross value added. But the decline in the value of the stock of sub-soil assets (of 100 in the example) is recorded in the "depletion account", leaving the owner's net value added as 50. With the change in treatment of the value of the extracted sub-soil assets from property income to receipts from sales to an asset, property income receivable by the owner falls (by 150 in the example). Thus the owner's balance of net primary income is lower by 100 (-150 from property income receivable and +50 from net valued added), as are net disposal income and net saving. However, the depletion of 100 which is recorded in the owner's capital account offsets the reduced saving of 100 leaving the owner's net lending or borrowing the same as SNA93.

(9) In the proposal, aggregating the two accounts results in the following:

> reduction of 150 in gross value added of the extractor is offset by an increase of 150 for the owner, so GDP is unchanged.
>
> reduction of 150 in the net value added of the extractor is only partly offset by the increase of 50 (net value added) for the owner: NDP is lower by 100 (value of depletion);
>
> net balance of primary income and disposable income of the extractor are unchanged while those of the owner are lower by 100. Net national income and net disposable income are lower by 100;
>
> net lending or borrowing is unchanged.

The treatment proposed does emphasize correctly that for economic analysis of income measures the focus should be on "net" product and not "gross".

(10) To calculate depletion for natural resources, it is necessary to have an estimate for the life length of the resource. This is usually calculated by dividing the stock at the beginning of the year by the extraction in that year. When the extent of a resource is known exhaustively and there are no possibilities of discoveries Harrison argues this is wholly appropriate.

However, in some cases the calculation of resource life is more difficult. For example, in the case of petroleum, resources are regularly augmented by discoveries or new technologies which convert previously known but uneconomic fields to economic status. Oil companies may only prove sufficient reserves about as quickly as they deplete existing proven reserves (because exploration is expensive).

In these instances, Harrison proposes an alternative for estimating resource life: to take the stock of sub-soil assets at the beginning of the year and divide by the decrease between the start and end of year stocks. The theory is in keeping with the idea of sustainability, i.e., if there is no reduction in the stock levels there is no need to allow for depletion. It is consistent with the treatment of renewable natural assets where the level of depletion is calculated as offtake less natural growth. This means an extension of resource life where discoveries are less than extraction and no depletion in years where discoveries exceed extraction (because of the lumpiness of the series, she suggests a moving average of three to five years). The argument is that while accepting the proposition that it is inappropriate to count the whole value of the discovery as income in the same year, it can be argued that there is a long-term effect from it. The proposal is that the value of the income effect in the year of the discovery is the reduction in the depletion allowance by the effect of extending the life length of the resource.

2.2.2 Treating depletion as inventories

Vanoli (6) offers a different perspective regarding the measurement of depletion in the flow accounts. While he agrees with some of the principles of Hill and Harrison, his interpretation is a different one and needs to be addressed separately. The following are my interpretations of Vanoli's main arguments:

(1) The sale of a sub-soil resource is the sale of an asset. However, the sale of an asset is not recorded in the national accounts as production, but rather it is recorded in the capital or financial account (Vanoli does not clarify this point which is confusing as many items in the capital account can also form part of the production account). Therefore, he disagrees with the proposal to prepare a production account for the owner (called a depletion account). Rather, he argues natural resources are not the result of a process of production but rather are a gift of nature. Consequently, Vanoli argues that sub-soil assets sold to the extractor are withdrawn from the stocks of raw materials in the ground, so they are similar to inventories (rather than fixed assets).

(2) Vanoli agrees with the Hill and Harrison proposal that a decline in the net present value of the asset should be recorded in the accumulation accounts as depletion. It is how he proposes to reflect this in the accumulation account that is different. His proposed treatment of depletion in the flow accounts is as follows:

The owner is not engaged in a production process but is selling his own assets. In the accounts of the owner, depletion results in withdrawals from stocks of natural assets in the capital account (withdrawals are 150 - receipts from the sale of sub-soil assets in the Hill and Harrison paper's exercise);

the increase in the value of the remaining deposit between the opening and closing balance sheets value (50 in the example) due to the fact that the income streams from future periods have become one period closer in time is recorded as a holding gain and reflected in the other changes in assets account (rather than value added of the owner);

in the accounts of the extractor, intermediate consumption (purchase of an asset) of the extractor increases (by 150 in the example);

consequently, both GDP and NDP fall (by 150)

(3) All depletion is recorded in the capital account even if there are discoveries and no net reduction (or even increases) in the stock of sub-soil assets. Discoveries should only be recorded in the other changes in volume of assets account.

(4) Changes in expectations reflected in a change in the discount rate may influence other elements in the net present value calculations. For example, the timetable of extraction may change, resulting in quantities which are expected to be sold and the resource life of the deposit may be different. Thus, the net present value will be different. According to Vanoli, these changes should be recorded in the other changes in volume of assets account, not in the revaluation account. However, to the extent that the expected receipts are changed, the effect is a holding gain or loss.

El Serafy(5) also outlines four reasons why depletable resources should be treated as inventories rather than fixed capital:

(1) while fixed capital needs to be maintained for the purpose of sustaining future activity, depletable natural capital cannot be maintained if it is exploited;

(2) fixed capital is derived from previous income flows. Natural capital has existed all along, and the cost of locating and developing it, though involving some cost, is not on a comparable scale with the human and other factors' contribution to the formation of fixed capital;

(3) fixed capital is not normally meant to be sold by its owners, and is sold only under exceptional circumstances. Inventories on the other hand are held specifically either to be used up or traded in the normal course of business; and

(4) El Serafy argues that, unlike depreciation of fixed capital, reductions in inventories are directly observable, and whereas depreciation of fixed capital can only be roughly estimated, usually by imputing an arbitrary life span to the asset concerned, the using up of inventories can be readily estimated from book values of stocks, and usually bears some relationship to the level of production.

El Serafy emphasizes income rather than wealth, as he believes wealth measurement in money terms is much less necessary for economic purposes, and society gains little by assigning to unknown quantities of natural assets dubious valuations that either elude the marketplace altogether, or inevitably gyrate as a result of fluctuating market prices.

2.2.3 Another alternative

Hartwick(7) states that differential or Ricardian rent should be treated as income (similar to land rent) and rent due to exhaustibility should be considered economic depreciation.

What are group's views on these proposals?

3.0 Summary and comment on adjusting for depletion

3.1 Fixed assets proposal

I will now provide some thoughts on each of the issues raised relating to the fixed assets proposal. They are presented in the same order below.

(1) Analogy to produced fixed capital.

It is certainly true that produced environmental assets such as livestock and plantation forests are recorded in the production accounts in the same manner as produced fixed capital. However, the reason why there is not a parallel treatment for natural resources, such as sub-soil assets is that such assets are not produced and therefore their additions or withdrawals should not form part of the production account. To change the production account to include such non-produced assets would imply that, like produced physical assets, additions should be included as gross fixed capital formation. No such theory is proposed, as discoveries are not produced. Therefore they should not enter this account.

(2) Recording changes in NPV

I agree with Hill and Harrison that changes between beginning and end of year stocks of sub-soil assets due to changes in technology and discoveries should continue to be recorded in the other changes in volume of assets account. In addition, I agree with their recommendation that holding gains and losses should still be recorded in the revaluation account along the lines of SNA93 guidelines. However, the recommendation that changes in discount rates should be recorded as revaluations is a little more contentious. Vanoli suggests that where the timetable of extraction changes as a result of these discount rate fluctuations, then such changes should be recorded in the other changes in volume of asset account. Vanoli adds though that to the extent expected receipts are changed, due to the discount rate fluctuations, the effect is a holding gain or loss. I believe Vanoli's view is correct, but data constraints will limit such recording in reality. It would be near impossible to extract such data.

Hill and Harrison suggest all other changes (apart from those outlined above) between beginning and end of year stocks of sub-soil assets are depletion, and these should be recorded in the capital account. My thoughts on the relevance of this treatment are addressed below.

(3) Depletion is an imputed activity attributable to production and is analogous to COFC

SNA93 recommends that change in quantities of assets that are not attributable to economic activities and their associated transactions should be recorded in the other change in volume of assets account. To some extent, this suggestion is contradictory as the other change in volume of assets account also records depletion (which is the result of economic activity). However, I believe there is no better alternative. The production account is intended to record assets, which are produced. Establishing a production account for owners of sub-soil assets (which are a non-produced asset) is also not theoretically correct. The issue of which account to record depletion in then comes down to other factors. The most important of these factors is the effect of additions to sub-soil assets on future income. This point will be addressed point later in point 10.

(4) Measuring the cost of depletion as the decline in the NPV

Measuring depletion as the decline in the NPV (ceteris paribus) is logical, and analogous to the way in which depreciation of physical assets are recorded in the SNA. This analogy does not imply that we have to record depletion in the same way we do depreciation of physical assets however, as again, one is produced and one is non-produced.

(5) Depletion should be based on the average price of the asset within the period

I believe using average prices over the year to measure the value of the change in beginning and end of year stocks is a sensible suggestion for estimating depletion, wherever depletion is ultimately recorded.

(6) Depletion is not "rent" in the standard economic meaning of the term

It is true that to the extent sub-soil assets are "used up" and hence not returned to their owner after the production lease, extraction is not "rent" in the traditional economic meaning of the term. However, a number of factors distinguish the extraction of sub-soil assets from asset sales, implying that SNA93's interpretation of the transaction as property income still stands.

First, for a production account to be established for the owner, assets need to have been created. However, the owner of sub-soil assets is not engaged in production (or creating assets), but rather in a contract where the lessee agrees to pay the lessor a stream of payments (which SNA93 treats as "rent") in return for the lessor placing the sub-soil assets at the disposal of the lessee. This is similar to the national accounting treatment of the land in a mining lease, which is also treated as "rent". Like sub-soil assets, the land from which the resource is extracted is also not returned to its owner in its original state, e.g., large open-cut mines. SNA93 records such changes in the quality of land as economic disappearance of non-produced assets and records these changes in the other changes in volume of assets account. I think this treatment is correct and should be continued.

Second, in the case of produced assets, additions are recorded as gross fixed capital formation, because of the future income the asset is expected to bring. Additions to sub-soil asset resources cannot be included in gross fixed capital formation as their appearance is not the result of production. Thus, to record depletion as reductions in net disposal income, but not record discoveries as additions to net disposal income, is asymmetrical (and incongruous). However, I

am not proposing that these discoveries be included in the production boundary - they are adequately and properly treated as "appearances" in the other changes in volume of assets account.

(7, 8 and 9) Recording depletion in the accounts of the owner, extractor and aggregate accounts

The attractive aspect of the analogy to fixed assets is that no adjustment of GDP is proposed. GDP was never intended as a measure of welfare, and trying to do so in part means that we are left with neither a true measure of sustainable income, nor a true measure of production. Rather, GDP is intended as a measure of economic activity (production). However, while Hill and Harrison are not proposing changing GDP they are proposing an adjustment to NDI. There are a number of problems with this approach: gross disposable income and net disposable income are also not intended to measure "sustainable" income. To adjust disposable income for depletion in an attempt to derive sustainable income is both limiting and incorrect. To measure sustainable income correctly, a vast range of factors would have to be accounted for, some of which may include degradation of land, air and water, and social costs of violence, other crimes and over-population. Valuation of such issues is extremely difficult and contentious and is best left to satellite accounts.

Further, a measure of "sustainability" should include additions to capital stock, as well as withdrawals. If discoveries are not included as additions to net disposable income, then neither should reductions in capital stock be recorded as subtractions from net disposable income. Again, I am not suggesting that discoveries be included in the capital stock. They should continue to be part of non-produced assets on the balance sheets. In summary, the point is that part measures attempting to derive "sustainable income" will only result in false signals.

(10) Net depletion is calculated as a moving average of three to five years

The analogy of depletion to fixed assets is more legitimate than the inventory approach as the latter makes no allowance for additions to capital stock when deducting depletion. However, the major problem with this approach (and the inventory approach) is that large sub-soil discoveries will not be fully accounted for in net depletion (even if depletion is averaged over 3 years) regardless of any analogies. Harrison's paper suggests we use a three to five year average of depletion and additions. This would be suitable where exploration within the mine lease merely extends the life of the mine. But in the case of significant sub-soil discoveries such as Olympic Dam in Australia in 1984 (where among other finds, the expected resource life of Australia's economically exploitable copper resources tripled from 20 to 60 years), North Sea oil exploration in the 1980's, or Prudoe Bay in Alaska in the 1970's, by showing zero net depletion for three to five years and then continuing to record depletion (ceteris paribus) as having a negative effect on disposal income would be understating, over many years, the increase in disposable income resulting from the discovery. Merely recording a zero depletion allowance (up to five years) as the income effect of the discovery is understating future income streams.

Harrison suggests that where is a resource is known exhaustively and there are no possibilities of discoveries that the resource life can be calculated by dividing the stock at the beginning of the year by the extraction in that year. But in effect, because a resource's size is based as much on economic variables as physical, few resources can be considered to be known exhaustively.

Discoveries are not an uncommon occurrence. A complication is that previously "used up" deposits can be reworked for saleable product resulting in a rise of resources valued (West Australian slag iron ore is one such example). It should be remembered that sub-soil assets are measured in both physical and economic terms so that resources available for exploitation respond to price signals as well as physical constraints. Thus, they are not a fixed (or merely reducible) resource.

An indication of the effect on resource life of discoveries can be found in Australian National Accounts: National Balance Sheet 30 June 1996 (8). The sub-soil asset table below shows that for 14 of the 28 major sub-soil commodities, the five-year lagged moving average of resource life increased significantly (over 50%) from 30 June 1985, to 30 June 1996. While some of this increase was due to revaluation, most of the increases were due to finds and/or re-assessments.

Table 1. Change in Australia's EDR, selected resources, 1985-96.

Sub-soil Asset (in physical terms)	EDR 1985	EDR 1996	% change
Antimony	14 Kt	90Kt	643
Cadmium	67 Kt	141Kt	210
Cobalt	33Kt	414Kt	1255
Gold	959t	4454t	464
Magnesite	7Mt	180Mt	2571
Ilmenite	41Mt	136Mt	332
Rutile	8Mt	15Mt	188
Zircon	12Mt	21Mt	175
Nickel	2Mt	6Mt	300
Natural gas	691b m3	1292b m3	187
Condensate	82Gl	156Gl	190
LPG naturally occurring	85Gl	154Gl	181
Rare earths	229Kt	1000Kt	437
Zinc	21t	40t	190

The concept of using up an asset when the physical size of the asset to be valued is uncertain and dependant on the level of outlays means that the benchmark from which depletion would be

measured is constantly subject to change, making any rate of depletion difficult to interpret. Moreover, in years prior to discoveries discrete jumps in economic demonstrated resources (which equate to proven plus probable resources) would send incorrect signals of a pending scarcity.

By recording the value of subsoil assets in the balance sheets, along with the additions and depletion of such assets in the other changes in volume of assets account, we avoid uneven impacts on production and income (especially in resource rich countries).

Net disposable income (NDI), GDP and NDP should not be understated by not accounting properly for expected future income from resource finds. We can identify depletion in the other change in volume of assets account without having adverse effects on the accumulation accounts. It would be better if a sub-grouping for depletion were shown separately in this account. From there, and by looking at the corresponding additions to stock in that account, countries can determine quite clearly whether sub-soil resources appear to be in danger of running out. This may be reinforced by including physical measures as complements to monetary measures of sub-soil assets. In Australia's case, this certainly isn't a problem at present, but in countries with fewer resources this may well be a situation they need to follow closely.

It should be noted that running out of resources is only a problem for countries with a high dependence on sub-soil assets (for exports, mining, etc) and where those resources may not be very extensive. Resource lives are limited not just by physical dimensions; they are also affected by the technology that uses the resource and the product that results from that use - so changes in demand and/or technology downstream have as much, if not more, influence on a resource's economic life (which is what we are concerned with). Examples of resources that have been or are likely to be so superseded are: tin, lead, asbestos, coal.

Finally, if production less discoveries is to be accounted for in net depletion , Harrison argues that depletion should be shown as zero in years where discoveries exceed production. This is not the same treatment as produced assets, for example if repairs/improvements to a piece of machinery add to its production life, then this improvement is included in gross fixed capital formation and it extends the asset life of the asset in the capital stock accounts.

Does the group consider that the impact of large additions to sub-soil resources means that depletion should continue to be recorded in the other changes in volume of assets account?

Should depletion be shown separately in the other changes in volume of assets account?

Should the existing treatment be consistent across all countries, or only for those countries which are resource rich? And how should resource rich countries be defined?

3.2 Inventories proposal

Again, a number of problems are identified with the analogy of depletion with inventories. Some of the problems such as the affect of additions to sub-soil assets on GDP are covered above, but the following comments pertain directly to Vanoli's inventories proposal.

(1) Analogy of depletion to inventories

Depletion is similar to withdrawals from inventories in the sense that both record the disappearance of an asset. However, that is where the similarities end. While additions to produced inventories, like fixed assets, are included in gross capital formation, additions to natural resources are not, i.e., they did not enter the economic system by means of economic activity. Consequently, their use cannot be accounted for in the SNA as a re-allocation of previous capital formation to intermediate or capital consumption without a major change to the concept of production.

(2) Proposal for recording depletion in the capital account

As mentioned earlier, the advantage of the fixed assets proposal was that GDP would not be effected by depletion. However, Vanoli's proposal would affect GDP. Adjusting GDP (a measure of the value of goods and services produced) for depletion of non-produced assets would cloud its meaning. Further, it would seem odd to be recording depletion of the resource as a negative contribution to GDP, when the wages and salaries, capital equipment, and transport and storage involved in its extraction and refinement all add to GDP.

(3) Discoveries are not accounted for in calculating depletion in the capital account

In the discussions on the analogy of depletion with fixed assets, it was mentioned that to record net depletion as zero only for a few years after a large discovery was made, significantly understated future income receipts. However, Vanoli's proposal, which does not account for discoveries at all, has more serious consequences. Not only is net disposable income understated, but so too are a number of other aggregates, including GDP. In the advent of a large discovery of sub-soil assets, value added from wages, salaries and supplements and gross operating surplus of the extractors will add to GDP on the one hand, but with Vanoli's proposal, withdrawals from stocks will have a negative effect on the other (though the negative effect will be less than the positive effect due to discounting). Depletion is measured as the decline in the net present value of the resource from opening and closing balances. The expected future income stream is calculated by taking resource stocks at the beginning of the year and dividing by production. Hence in the year of the discovery, depletion will be overstated because the expected future income stream of the discovery will not be accounted for. As mentioned, discoveries are commonplace in resource rich countries, so this misreporting will be commonplace.

(4) Changes in the discount rate effecting resource life to be included in the other changes in volume of assets account

The issue of the effect of discount rates on expected resource life has already been addressed in the comments on depletion being like a fixed assets. Vanoli's suggestion that changes in the discount rate which affect resource life should be included in the other changes in volume of assets account is my preferred treatment, but data constraints are likely to prevent this.

El Serafy is also in favour of treating depletion like withdrawals from inventories, and he raises a few separate (although related) issues. His arguments relate to the treatment of depletion as fixed assets versus inventories but also at issue is whether depletion should be recorded in the capital and production account at all.

(1) Depletable natural capital cannot be maintained if it is exploited

Suggesting depletable natural capital is in danger of being exploited is a pessimistic view given the extent of discoveries in recent decades, particularly in resource rich countries. A good example of the extent of discoveries is presented in the earlier table (relating to Australia's sub-soil asset resources). Mineral exploration is continually discovering resources and new technology is making previously uneconomic resources commercially exploitable. However, where resources are identified as limited, physical as well as monetary estimates of the resource stock need to be examined. The balance sheets are the most appropriate place for this since irregular movements in discoveries and depletion will not affect GDP or disposable income there. Physical estimates can also be shown in accompanying tables.

El Serafy's approach also denies resource rich countries the opportunity to sell their resources (and enjoying higher income than otherwise) when the opportunity arises. Current technology, using today's resources, may become superseded. Why then should countries harbour resources that may have little or no value in the future? In addition, such a view is a negation of economic theory as it seems to overlook the power of the market place and the importance and incentive of price signals. This view was typical in the 1970's and early 1980's, following the two oil shocks - that oil would be US$100/barrel by the end of the century. In fact, in real terms, oil is almost as cheap as it was before the first oil shock. The reason: among others was that oil companies responded to price signals.

(2) The appearance of fixed capital involves considerable costs, while natural capital does not

Whilst the appearance of fixed capital does involve more expenditure than natural capital's discoveries, I fail to see what this has to do with natural capital being analogous to inventories. Inventories, like fixed assets, are also created free of charge.

(3) Fixed capital is not normally sold by its owners, while inventories are sold or used up

To the extent that sub-soil assets are sold regularly on demand (like inventories), while fixed capital is not, the analogy is relevant. But more importantly, unlike increases in inventories being included in the capital account, the proposal does not account for additions to natural assets in the same way.

(4) Unlike depreciation of fixed capital, reductions in inventories (and natural assets) are directly observable

I don't agree with the assumption that reductions in inventories are directly observable. I think there are a number of difficulties involved in separating out changes in inventories' values due to real price change, from changes in the level of inventories themselves. Further, I don't see the relevance of the difficulty or otherwise of measuring changes in the value of an asset as being a pre-requisite for its being analogous to another asset.

(5) Valuing natural resources is dubious

El Serafy's claim that valuation of sub-soil assets is dubious is strange. Why then does he propose to measure the change in the net present values derived from such a valuation approach

to measure depletion - which involves having to place a value on the expected future income from the stock?

3.3 Additions to natural resources in the capital account

Another possible alternative is to include additions to natural resources in the capital account (as well as depletion). The SNA production boundary would have to be expanded from economic assets to economically exploitable environmental assets for this to occur. In this way, both additions and depletion would be accounted for, but in both proposals, it would mean having an effect on GDP and run counter to the notion of human economic activity/production being the focus of GDP. The question is: should a slump in economic activity be masked by a mineral discovery? Further, at what classification (probability of existence) would discoveries be recorded? Would we include only those which are currently economically exploitable or all demonstrated resources, or even resources which become inferred?

4.0 What is the extent of the resource stock which should be valued?

Regardless of the "appropriate" answer to the treatment of depletion, the determination of the size of the resource to be valued needs to be resolved. Even if depletion continues to be recorded outside the accumulation accounts, international comparability on the extent of the resource which should be valued in the balance sheets still needs to be established.

What then is the appropriate resource stock to be valued? Subsoil assets are defined in SNA93 to consist of "proven resources of mineral deposits located on or below the earth's surface that are economically exploitable given current technology and relative prices" (SNA93, par.. 13.59).

The ABS considers that this definition is too restrictive in the Australian context as "proven" resources may be too narrow for macroeconomic decision making. This is also the case in countries such as Canada, the United Kingdom and for most subsoil assets in the United States, and maybe for other countries, such as Russia, Mexico and many developing countries, where resources play an important part of economic production. The concept used in Australia by the Bureau of Resource Sciences (BRS) is Economic Demonstrated Resources (EDR)(9) which covers both proven and probable resources. EDR is the basis used by the ABS. It refers to those resources whose geological assurance is demonstrated and for which extraction is expected to be profitable over the life of the mine. In Canada, the equivalent term is "established reserves" and is the basis for most of the assessment of the extent of resources in that country.

It is important to note that EDR in Australia and "established reserves" in Canada almost certainly represent a small component of the total resource stock for many minerals. Mining companies generally only prove sufficient reserves for several years' production and carry out expensive investigations to maintain that level of reserves into the future when necessary. Accordingly, published estimates of the resources' physical quantities may offer a very limited view of the resources' recoverability.

Some commentators have suggested a broader measure of resources such as economically identified resources, as a more appropriate measurement of the available resource stock. In the United States for example, the Bureau of Economic Analysis indicated in its April 1994 Survey

of Current Business (10)that they intend to include the value of unproved reserves as part of non-produced environmental assets. But how should these be valued - what probabilities do they place on their existence? A higher discount rate may also be required and if so what should it be based on? The United Kingdom Office for National Statistics(11) also value possible and undiscovered resources. They make the point that they use the value of proven resources as a lower limit and the value of total resources as an upper limit since they consider proven resources useful for short-term analysis, but not for long-term assessments of sustainability. They argue that mining companies maintain levels of proven resources at a constant rate. This is because the "proving up" of extensive resources and resource lives is very expensive and ties up capital for too long into the future. This indicates that depletion of proven resources is being offset by proving up possible resources. Hence, valuing a broader resource stock is necessary to get a better picture on the total resources which will be extracted.

However, until resources are "brought to account", (i.e., their geological assurance is high enough to render them demonstrated), there is uncertainty about the probability that the economic resource will in fact become "demonstrated". In addition, factors such as the exploration costs which would be associated with bringing these resources to account would also need to be accounted for in the valuation. To take account of these issues in a valuation exercise would be difficult in what is already a contentious exercise. Data constraints would also be a major drawback of this approach.

This raises the question: Should the SNA93 balance sheet asset boundary be widened to include proven plus probable resources, or should an even wider resource stock be valued? And if the latter, how should the future stream of production/income be calculated and discounted?

5.0 What is the most appropriate valuation technique for sub-soil assets?

SNA93 recommends that, where possible, asset valuation should be on the basis of current, observable market prices as this is the basis on which decisions by producers, consumers, investors and other economic agents are made. However, for the most part, there are insufficient data on transactions in natural resources to provide a suitable way to do this. This problem is recognized by SNA93 which suggests NPV of the future stream of income as an appropriate conceptual substitute. SNA93 recommends that the value of resources be determined by the present value of the expected net returns resulting from the commercial exploitation of those assets although such valuations are subject to uncertainty and revision. It is difficult to value subsoil assets as they have not yet entered the production process.

In Australia, valuation of subsoil assets on the basis of market transactions was not possible as there are insufficient data because of the rarity of transactions. In consequence, the approach taken by the ABS was the NPV of the future stream of net "rent"/receipts, based on the current cost, price and production regimes and the resources' physical sizes, as identified in their EDR. Other methods of monetary valuation of subsoil assets examined by the ABS were the net price method and the user (or replacement) cost method. However, neither was considered to be appropriate. As estimates derived using the net price approach do not discount the values of the sub-soil asset regardless of the number of years required to extract the resource (given current resources and production rates), the net price approach will overvalue the existing sub-soil value. Further, estimating the value of sub-soil assets on the basis of (replacement) costs will not

necessarily produce valid results as the discounted replacement cost (projected costs) may differ greatly from the actual costs.

Generally, the international discussions relating to depletion and the thoughts from the London Group meetings appear to be that the net present value method is the most conceptually appropriate method where market transactions data are not available.

Is there agreement that the net present value method is the most conceptually appropriate for valuing subsoil assets in the absence of market transactions data?

6.0 Principles of valuation

If we make the assumption that the net present value method is the most consistently used method for valuing subsoil assets (which London Group literature suggests), then a number of factors involved in its calculation need to be resolved/agreed upon.

6.1 How do we estimate the rate of return on capital?

The assumptions of the net price approach are the key to deriving the NPV since the latter is a discounted net price calculation. Two methods of the net price approach have been used in the monetary valuation of resources. The methods use different assumptions about the calculation of returns to capital.

This first method imputes the value of rent or the return to the natural capital by subtracting the extraction costs, including a "normal" return to produced capital invested in the mining industry from the gross income (gross "rent") to derive a net "rent". This has been referred to as the net price I method. The "normal" return to invested capital is calculated as the rate of return to produced capital (using an appropriate market rate) 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 in period t.

The main disadvantage of this 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. In principle it is not possible for "rent" to be negative. However, where returns to capital are overstated in any given year it is possible to derive negative "rents" (though these are recorded as a zero valued in many countries). What seems to be occurring is that in years where there are relative price falls in a particular resource, the impact of these falls are absorbed by the extractor by taking lower returns on their capital, but continuing to operate as they believe the returns will be positive in the long run. In such circumstances, it does not seem appropriate to allow the drop in revenue to be represented as a reduction in "rent". If normal returns to capital are being calculated correctly, this implies that the value of the capital stock is being overstated in that the value should equate to the NPV of future income streams - and if returns to capital in the extractive industry have fallen, the value of the capital stock should, therefore, be adjusted down. In addition, there is the issue of transfer pricing. Companies may extract a resource "uneconomically" in order to supply it at a "subsidized" price to a more profitable downstream operation. Separating returns to capital and the resource here is very difficult.

The alternative method (net price II) calculates the resource rent by subtracting the current replacement value of the produced capital (net capital stock for the mining industry) from the total value of the resources (that is, the resource and the associated produced capital). This is derived as the gross rent per unit times the quantity of resources at year end. The value of the resource itself is derived by subtracting the replacement value of the net capital stock from the total value.

The net price II approach has the same data problems as the net price I approach except that it is not necessary to derive a normal return to capital. However, implicit in this approach is that all the produced capital necessary to extract the resources is already in place.

Born and Joisce(12) found that the first method represents the lower boundary value and the second the upper boundary. Although the first method makes the dubious assumption that rates of return are homogenous for all commodities, it may be a better approach than subtracting the current capital stock estimates from resources as not all the capital stock is in place at present to extract the EDR. Given the expected life of some sub-soil assets in Australia (some are over 100 years), this is an unrealistic assumption. Further, the problem of negative resource rents using net price I may be overcome somewhat by averaging of production, cost and/or price data.

Alternatively, Harrison suggests we should not be attempting to separate returns to capital from returns to the resource at all. She disagrees with both the net price I and net price II approaches. Rather she suggests putting values on these assets using comparable data from different but similar enterprises. Essentially, this is the principal suggestion of SNA93, i.e., using market price data. But the reason these data are not used is that it is simply not available, thus alternatives are necessary.

An alternative may be to discount the expected future receipts from royalty payments, but in Australia's case at least, royalties are very low (or even nonexistent) in some states so that there is no reasonable basis for using royalties for the derivation of 'rent" and the value of the resource.

What are the Group's views on the two net price approaches? Are there any better alternatives?

6.2 What is the appropriate discount rate?

The choice of discount rate is fundamental in the use of the net present value approach. At present, countries use a range of discount rates based on factors such as government standards (e.g., Securities Exchange Commission in the United States) the cost of capital and government bond rates. Central to the choice of discount rate is the opportunity cost of those funds. What method then is the best for deriving this opportunity cost?

SNA93 suggests that the rate of discount should be derived based on transactions in the particular type of asset concerned rather than a general rate of interest, such as the yield from government bonds. This suggests the use of a private discount rate, rather than a social discount rate. In the 1996 balance sheets, the ABS chose to use a private discount rate representing the average cost of borrowing to the mining industry. The assumption is that mining companies generally borrow to invest. Consequently, as most mining companies in Australia are large enterprises, the borrowing

rate chosen was the large business borrowing rate. A five year moving average of this rate has been used as the nominal discount rate.

However, is the use of a purely private discount rate applicable? Countries such as the US(10), UK(11) and Canada (13) have chosen social discount rates, suggesting that private rates are too high and issues of inter-generational equity are appropriate. It is argued that the rate of interest determined in the market often exceeds the rate that is optimal for society as a whole. According to Born(13), the average real rate of return on riskless long-term government bonds reflects a social rate of return on investment as opposed to a private rate which would be higher to adjust for the impact of taxes and risk. The social discount rate is said to reflect the owner's (government's) time preference and is the discount rate that governments would use in allocating resources in the future. However, it is generally recognized that not all the returns from sub-soil assets flow directly to the owner of the asset, i.e., that the extractor/operator appropriates some of the "rent". It may be therefore inappropriate to allocate social discount rates to this proportion of "rent", because of the impact of taxes and risk in this industry. Therefore, it may be more applicable to use a social rate of discount for the expected future income flows to government where government is the owner (discount expected future royalty payments), but use a private discount rate to discount the remainder of the rent (where the sub-soil assets are owned privately) or where the "rent" is (partly) appropriated by the extractor.

Do Group participants agree that a combination of social and private discount rates should be used to reflect the expected future rent appropriated by these owners/extractors?

If a social discount rate is used in the calculations, what should it be?

Another issue is the extent of international comparability. Is it appropriate to set an international discount rate for the future income stream provided by sub-soil assets? (after all these assets are traded internationally). If so, what is the appropriate rate? Should there be some pro-rating and/or different rates? The United States corporate bond rate could be used as a reflection of the opportunity cost of capital. This is based on the assumptions that capital is mobile, and that the bond rate represents a minimum which investors could earn on their capital. Should only that proportion of rent which is not received by government in the form of royalties be discounted in this way?

6.3 How should the discount rate be deflated?

After the discount rate has been chosen, it must be converted from nominal to real terms to remove the effects of inflation. Income flows are expressed in real terms as the future stream of income is based on a "steady-state" assumption (i.e., current price and regimes apply across the whole period for which the income stream is to be discounted); hence, the discount rate should also be expressed in real terms. A real discount rate can be derived by using a general indicator of price change or an industry specific indicator of the change in the price level of industry inputs, on the basis that the returns to the owners will be reinvested in the industry. This may or may not be a valid assumption.

A general indicator of price change is the consumer price index. The advantage of it is that it is simple and internationally recognized. The disadvantage is that it includes items that are not

directly relevant to the mining. Moreover, the components and weighting of the CPI are different for each country so international comparability is compromised.

An industry specific indicator may be derived from an index of weighted industry inputs. Use of an industry specific deflator is appealing because input costs reflect the price level of industry inputs required for future extraction. These can be calculated using supply and use tables.

An alternative approach may be the implicit price deflator for general government expenditure (as in many countries the government owns the resource in the ground). The reasoning behind this is that the returns to government may be consumed as part of government consumption. A refinement may be that the deflator could represent a weighted average based on the percentage of "rent" received from government in the form of royalties compared to the expected income from extractors. The government proportion of total sub-soil NPV would use the general government implicit price deflator and the private percentage of sub-soil NPV would use a weighted average of industry inputs. The two indices could then be combined according to the ownership weight to give a single deflator to convert nominal into real discount rates.

What should be used as the deflator and should there be differentials applied depending on recipient?

6.4 Is it appropriate to average prices/costs and production rates? If so, what timeframe is appropriate?

Balance sheets are defined as statements of assets and liabilities drawn up at a particular point of time (implying that the prices should be as at balance sheet date). However, prices, costs and production rates tend to have considerable variability from year to year. Without averaging, large price falls or one-off increases in the costs of extraction would mean a sub-soil commodity may be uneconomic to produce in the year being appraised, but mining companies would continue to extract the resource as they expect that it will be profitable over the resource life. Therefore, to show zero values for the resource in one particular year due to irregular factors does not seem analytically useful. After all, not all the resource can be extracted in any one period, so one period's prices may not be the best indication of the future value of the resource. The choice of 'five year' moving averages is based on the understanding that mining companies make investment decisions for the medium to long term, but data availability may prevent the use of longer time series of moving averages.

Do participants agree that moving averages of prices, costs, production and resource life are appropriate? What time frame is appropriate?

7.0 Concluding comments

This paper aims at addressing the fundamental issue of measuring depletion in the flow accounts. A number of analogies have been made previously regarding depletion as being similar to either consumption of fixed capital for fixed assets, or use of inventories. There are a number of problems with these analogies: however the biggest problem is how to account for additions. By accounting for depletion, but not additions (and thus lowering net disposable income), we are understating disposable income, which may send incorrect signals to government and other

analysts regarding mining industry policy. Further, where depletion is proposed to be recorded as a run-down in inventories, what other asset has a negative effect on GDP from being produced without first adding to GDP?

Apart from this issue, the paper also addressed a number of the outstanding issues related to valuation of sub-soil assets. Determining the most appropriate approach in deriving the NPV of the asset is first and foremost. Alternative net price approaches are discussed, and agreement needs to be reached on what is the most appropriate technique. Following from this, appropriate indicators for nominal and real discount rates need to be agreed upon, as does the size of the resource which should be valued and whether averaging of prices, production, and resource life is appropriate. The paper presents some suggestions for each of the issues discussed and Group participants are encouraged to discuss these and any other views they may have. so as to try to move to resolution of some of the issues. International standards on such approaches would be a major step towards the acceptance of balance sheets as an integral part of a nation's economic condition.