Application of environmental accounting on subsoil asset. The Case study for the Czech Republic.

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Abstract:

The paper discusses the accounting methods for subsoil assets applied for the Czech Republic. The special attention is paid to subsoil assets account, treatment of flows and stock, including a discussion on depletion.

The paper implements three various accounting methods: firstly, a approach of material flow analysis, balances and accounts (Eurostat 2001; SEEA-2003) is applied to assess the share of extracted and imported subsoil assets on entire material inputs and consumption of the Czech Republic covering the period 1990-2002. Moreover, a hidden flows or so called unused domestic extraction related with extracted resources will be analysed and discussed on the base of the results Scasny et al. 2003. The development in extraction sector is assessed by using data on contribution to GVA.

Secondly, methods on classification of environmental assets with emphasis on subsoil assets used in SNA-1993, resp. ESA-1995 and the Integrated Environmental and Economic Accounting 2003 (so called SEEA-2003) are discussed. Current practise in accounting of subsoil assets expressed in physical terms in the Czech Republic is described. A special attention is given to reserves of hard and brown coal.

Third part is focused on valuation of assets, and depletion. The methods to quantify a resource rent used in SEEA2003 are described. The rent can express the depletion that should be considered in capital account as the consumption of fixed capital. There are three approaches for resource rent, and thus asset depletion valuation. The appropriation method based on taxes and fees levied on extraction of materials under ownership of the state present the first one. The other two methods depend on estimating resource rent by partitioning the information on economic rent for all the firm assets into that part pertaining to its produced assets and the part relevant to the non-produced assets. The resource rent can be thus derived either from PIM calculation or capital service flow calculation. Data availability and applicability of these approaches are discussed; a case study on resource rent derivation for coal extraction in the Czech Republic is provided.

Keywords: environmental assets; depletion; valuation; SEEA; MFA; Czech Republic

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1. Introduction

There are the three major environmental issues discussed by environmental accountants and handbooks (like for instance SEEA-2003, see UN et al. 2003, chapter 9). They are defensive expenditures, degradation, and depletion. Defensive expenditures put a monetary value on environmental damage which is either prevented or rectified (see more e.g. in UN 2003, pp. 438-441). Degradation concerns with the impacts and damages of pollution in air, water and soil (see more e.g. in UN 2003, pp. 391-411 and 441-457). Depletion is related with the extraction of natural resource and following decreasing its stock. This paper concerns only with the third one, a depletion.

In many countries, people concerned about the impact of the economy on the environment are more worried about the links brought about by excessive generation of residuals than those of depletion. As SEEA-2003 (p. 64) notes "whereas ten years ago it may have been true to say that the industrial countries cared about pollution and developing countries cared about resource use, there is no longer such a clear divide (if there ever was)." Issues like sustainable extraction and harvesting, issues related with a back-stop technology and substitution, resource use and efficiency, material intensity are among others the key parts of many current strategies and concepts (like e.g. the European Commission and OECD). Consequently, the dematerialisation has become the main goal of many political strategies and agendas.

Mineral production accounts for up to 50 per cent of GDP in some of developing countries (see Davis 1995), and thus accounting for asset value and depletion is particularly relevant to many of them. Depletion is not however the potential problem for the developing countries. Analysis of depletion can provide us information about structural change of any economy, if it follows the sustainable path and if there is a potential for sustainable growth and development. Moreover, we should not omitt that both extraction and consumption lead to degradation, among global warming and damages on health status are some of them in particular.

This paper does not concern with all kind of environmental assets or natural resources. The special attention is given to subsoil assets and fossils fuels in particular. The analysis concerns only to the Czech Republic. The paper is divided into four following parts. Firstly, we discuss the share of mining and quarrying on total economic production and analysis the development of raw material extraction from structural perspective. Secondly, the concept of material flow analysis, account and balance is used to analyse the share and development of raw material extraction and imports on total material inputs, consumption and requirements. Thirdly, the issues related with the classification and valuation of depletion, stocks and income/capital accounts adjustments are discussed. The depletion and value of stock mainly for coal in the Czech Republic are studied more properly as well. Fourthly, this part discusses a possible internalisation of depletion considering mainly currently applied levies on extracted materials and discussed tax on coal in the Czech Republic. Last chapter provides a discussion on further research and identify data gaps in relevant area.

2. Mining and quarrying: macro analysis

2.1. Impact of structural changes on extraction

The structural changes within the Czech economy occurred during nineties had a significant impact on mining sector. The coal extraction felt down by 30% during 1990-1995, and further by 20% during 1996-2002. The coal extraction in 2002 amounted only 57% of a mass extracted in 1990.

Very dramatic change in mining sector had occurred during nineties in the Czech Republic. For instance, the extraction of uranium amounted about 1,150 kt felt down to less than 400 kt within 3 years, and it has amounted only about 100 kt since 1996. The extraction of iron ores amounted about 100 kt yearly during 1990-1992, but had absolutely stopped since 1993. The same situation concerns to non-iron ores. While their extraction amounted about 500 kt yearly in the beginning of 90's, it has absolutely stopped since 1995. There was also a significant fall in extraction of industrial materials in 1990. Their extraction felt by 25% in one year, however afterwards it has been stabilised at about 18 Mt yearly. The same situation also fits to building materials. Their extraction felt down by 40% in 1991 and afterward it was maintained at more-less constant level up to now. Building stone is an exemption. Its extraction was relatively constant during 1990-1996 (600 kt per year), moreover the extraction upwarded by 30% in 1997 and has stayed at level of 800 kt yearly up to now (see more figures in appendix).

A decline in raw material extraction had an impact on share of the sector on value added formation. While, mining and quarrying contributed to GDP on about 4% in 1992, it was only 3.2% in next year (CSO 1994). The decline in mass extraction had an impact on gross value added in following years. Gross value added generated by mining and quarrying sector was continuously declining from about 2.5% of total GVA in 1994-1996 to 1.3% in 2002. As the share of mining and quarrying non-energy raw materials on total GVA was relatively constant during nineties (0.2% of total GVA), mining and quarrying of energy producing materials presented the main factor of the change (see table).

Table 1: GVA by mining and quarrying sector in the CR, 1995-2002.

mil. CZK, current prices	1995	1996	1997	1998	1999	2000	2001	2002
C. Mining and quarrying: total - mil. CZK	**28 342**	**36 811**	**30 263**	**28 570**	**26 499**	**27 653**	**30 320**	**29 389**
- in % of total GVA	***2,32%***	***2,65%***	***2,02%***	***1,66%***	***1,50%***	***1,43%***	***1,44%***	***1,31%***
CA. Mining/quarrying of energy producing materials - mil. CZK	25 558	33 470	26 321	24 266	22 259	23 535	25 462	24 885
- in % of total GVA	*2,09%*	*2,41%*	*1,75%*	*1,41%*	*1,26%*	*1,21%*	*1,21%*	*1,11%*
CB. Mining and quarrying non-energy raw materials - mil. CZK	2 784	3 341	3 942	4 304	4 240	4 118	4 858	4 504
- in % of total GVA	*0,23%*	*0,24%*	*0,26%*	*0,25%*	*0,24%*	*0,21%*	*0,23%*	*0,20%*
Total, bil. CZK	**1 224**	**1 391**	**1 501**	**1 718**	**1 762**	**1 940**	**2 103**	**2 247**

Source: Czech Statistical Office

There could be find a more interesting insights, while we decompose the GVA generated by mining and quarrying sector. The highest generator of GVA of the sector presents mining and quarrying of coal and lignite. Quarrying of uranium is in loss. Although the quarrying of iron materials is in loss as well, we should consider that there has no been any extraction since 1993.

Table 2: Decomposition of GVA generated by mining and quarrying sector, 2001.

	Gross Value Added, mil. CZK	**% of GVA, Extraction**	**% of total GVA**
10 Mining and quarrying: coal, lignite, peat	24 692	81,4%	1,174%
11 Mining and quarrying: oil, natural gas	1 376	4,5%	0,065%
12 Mining and quarrying: uranium	-606	-2,0%	-0,029%
13 Mining/quarrying and proceeding: iron materials	-37	-0,1%	-0,002%
14 Mining/quarrying and proceeding: other raw materials	4 895	16,1%	0,233%
Total (C. Mining and quarrying)	**30 320**	**100,0%**	**1,442%**

Source: CSO 2003.

2.2. Material Flows Analysis: De-composition analysis

We analyse the extraction of raw materials by using material flow analyses (hereinafter MFA). We follow the approach of material flows analysis, accounts and balances and derived indicators as it is described in the Eurostat Guide on the economy-wide MFA (Eurostat 2001).

The aim of the MFA approach is to quantify the physical exchange between the national economy and environment on the basis of total material mass flowing across the boundaries of the environment and the national economy (material inputs) and the national economy and the environment (material outputs). Flows inside the economy, for example, products moving between various sectors, are not included; the economy is treated as a "black box".

Due to the dominant share of water and gas flows in total mass flows, the MFA method exclude these flows, and only treat them while there are as a part of the good (like biomass) or as balancing items. Gases from the ambient air (oxygen, nitrogen) that take part in oxidising processes when burning fuel are important examples of such balancing items on the input side, while water vapour from the water and hydrogen content of fuels forms a balancing item on the output side. These inputs and outputs are calculated on stoichiometric principles for emissions to air from combustion and on the basis of the chemical composition of fuel (taking into account its water and hydrogen content).

Material inputs consist primarily of extracted raw materials and produced biomass that has entered the economic system. Material outputs consist primarily of emissions to air and water, landfilled wastes and so-called dissipative uses of materials (e.g. fertilisers, pesticides and solvents).

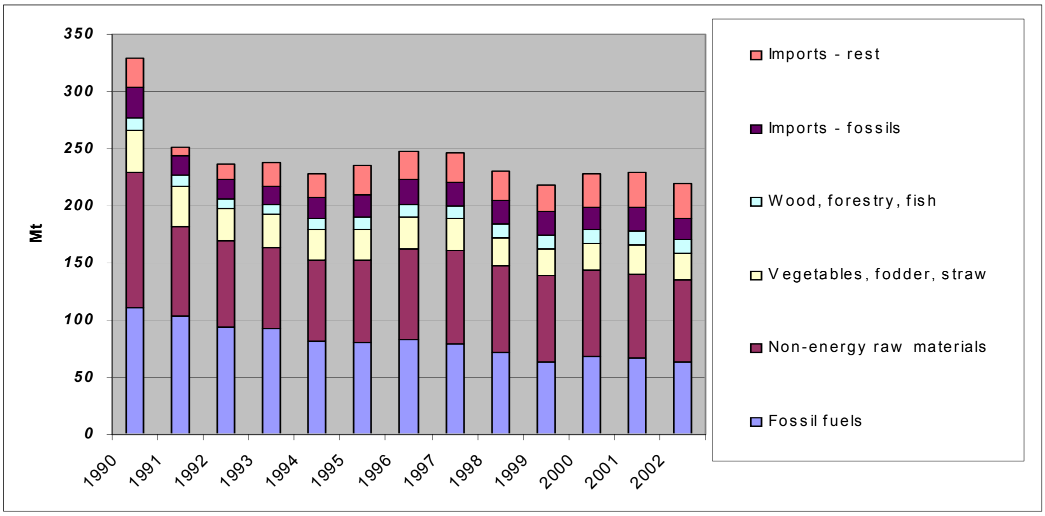
The approach also includes the concept of unused extraction or hidden flows. Unused extractions are material flows that have taken place as the result of resource extraction, but which do not directly enter the economic system. Examples include biomass left in forests after logging, overburden from extraction of raw materials, soil movements resulting from the building of infrastructure and so on.

Foreign trade plays an important role in the analysis because it represents an important material flow across the boundaries of the economic system. Imports of commodities are placed on the inputs side, while exports are placed on the outputs side of the material balance. Unused extraction is associated with foreign trade in the same way as with domestic economic activities (e.g. movement of overburden associated with imported coal) and is identified as indirect flows associated with imports and exports.

Material flow accounts compiled on the basis of the described methodology provide an important data source for the derivation of many aggregated environmental indicators and indicators of sustainable development. See more details on methodology and method application including concrete results for the Czech Republic in Eurostat 2001; Ščasný et Kovanda 2001; and Ščasný et al. 2003.

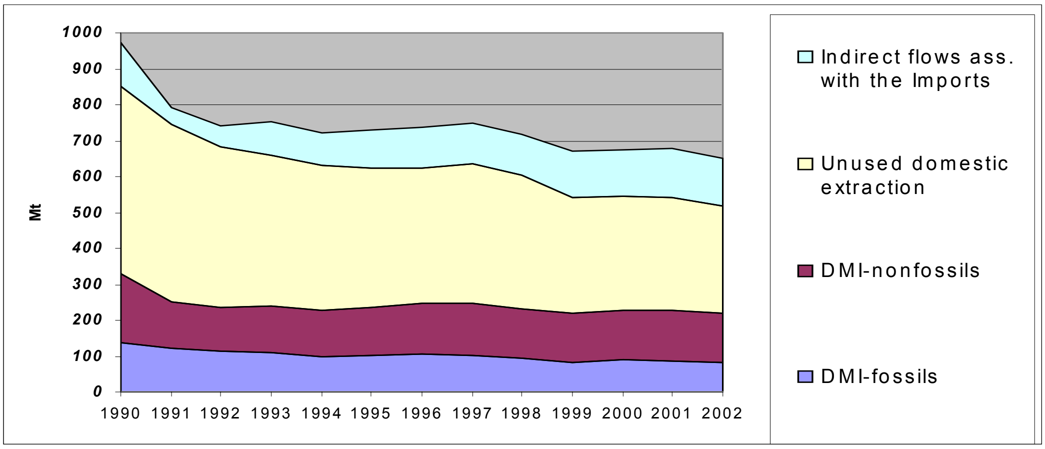
Although, the raw materials extraction dominated in total direct material inputs for the Czech Republic, their extraction continuously downwarded during the relevant period of 1990-2002. Import of fossils amounted comparable mass as the imports of rest of other materials, semi and final products.

Figure 1: Direct Material Inputs, Czech Republic, 1990-2002.



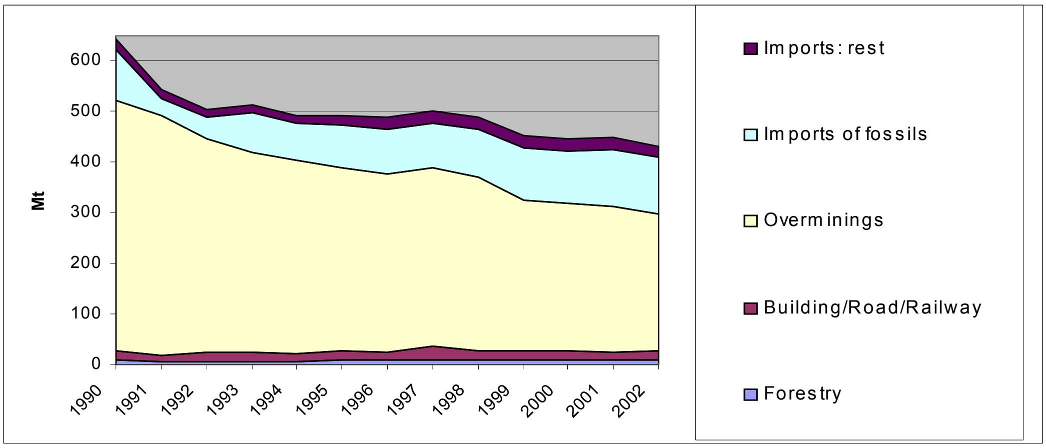
We get total material requirements of the Czech economy, if we sum so called hidden flows to direct material inputs. Unused domestic extraction that is mostly related with extracted raw material and namely coal presented the highest flow of mass in the Czech Republic (see also the figure in the appendix for detailed numbers).

Figure 2: Total Material Requirements of the Czech Economy, 1990-2002.



Hidden flows of forestry present the wood left in the forestry after the roundwood was harvested and taken. The category "Building/Road/Railway" presents the mass that had to be moved during the construction of buildings, road, highways or railway tracks. Flows related with imports present a mass that had to be moved during the extraction, production and transportation (up to the border) of the imported good (see Ščasný et Kovanda 2001 for more details).

Figure 3: Hidden flows – unused domestic extraction and indirect flows associated with the imports for the Czech Republic, 1990-2002.



3. Stock of subsoil assets

Boundary accounting: Environmental assets in SNA1993/ESA1995

In the System of National Account (UN 1993), respectively European System of Accounting (Eurostat 1995) the asset is defined as an entity

(i) over which ownership rights are enforced by institutions, individually or collectively, and
(ii) from which economic benefits may be derived by their owners from holding them or using them over a period of time.

This definition is wide enough to cover many assets of an environmental character, for example cultivated biological resources, some non-cultivated biological resources such as fish stocks and natural forests, and a number of naturally occurring entities such as land and mineral deposits (see chapter 7 of ESA95 in Eurostat 1995). However, it is not exhaustive as far as environmental resources are concerned; land too remote or poor, fish stocks of no interest to mankind for food and mineral deposits whose profitability is uncertain are excluded either because no economic benefit is involved or because no ownership is enforced (SEEA2003 in UN et al. 2003, p. 50).

All tangible non-produced assets under AN.21 are natural assets in SNA, resp. ESA. Natural assets under those a property right are not applied or cannot be enforced are out of the asset boundary definition. There are four categories of tangible non-produced assets (see e.g. Ščasný 2001a; 2001b for more detailed description and discussion):

- AN.2111 Land
- AN.212 Subsoil assets
- AN.213 Non-cultivated biological resources
- AN.214 Water resources

For the SEEA, the asset boundary of the SNA is expanded to cover all environmental entities which are of interest and measurable (UN et al. p.50). The environmental assets covered by the SEEA are grouped into the following broad categories:

- Natural resources,
    - Mineral and energy resources,
    - Soil resources,
    - Water resources,
    - Biological resources,
- Land and associated surface water,
- Ecosystems.

For each of these it is possible and meaningful to talk of a stock of the asset measured in physical terms. This makes the set of assets considered by the SEEA somewhat wider than that considered by the SNA. In neither system, however, is any attempt made to consider air or sea water as an asset for which comprehensive measurement is possible or meaningful.

There is no asset account meaning the environmental one in SNA/ESA accounting system. However, there are accumulation accounts that describe the changes between opening stock and closing stock in balance sheet by using several items. The accumulation accounts consist of four accounts. First two accounts – ***capital and financial accounts*** covers the transactions in non-financial assets or financial assets and liabilities respectively. The third one presents the ***other changes in asset account*** itemises other changes in assets account that causes of change to the value of assets appearing that is not being due to transactions. It covers exceptional events such as natural disasters and valuation changes due to the effects of inflation. The balance sheet reports ***the economic (dis-)appearance***. Economic appearance does not relate to a physical appearance but "rather the case where a pre-existing entity is drawn into the economic sphere by acquiring an economic value" (UN et al. 2003, p. 246). The economic disappearance covers the symmetric case when asset loses its value or leaves the economy.

Asset account is explicitly included within the SEEA structure. The concept of economic (dis-)appearance is changed to ***"environmental" (dis-)appearance*** in the asset accounts. The environmental (dis-)appearance includes not only discoveries and extraction, but also reclassifications due to quality change (for instance while the reserve is changed from probable into proved) and reclassifications due to change of functions (e.g. agriculture land changed into build-up area).

3.2. Stock and flows in subsoil assets in physical terms for the Czech Republic

Minerals (subsoil assets) are divided into reserved and non-reserved (according to the legislation in Act No. 44/1988 Sb. on mineral protection and exploitation amended by several Acts, from all No. 61/2002 Sb. is the latest one). Reserved minerals constitute the mineral wealth of the country and are owned by the Czech Republic. Deposits of non-reserved minerals consists of among others gravel, stone, sand, brick clay. They are constituent part of the land and the Mining Act is not applicable to them. Amendment of the Mining Act dated 1991 cancelled the possibility to state some deposits of non-reserved minerals as reserved and stated them as mineral wealth.

The calculation of reserves is done according to conditions of its use and they express:

- condition of market, price, and enterprise economy,
- mining and technical conditions of use,
- conflict of interests and its use (e.g. environmental protection).

The stock (reserves) of subsoil assets are grouped into the following categories:

- Economic reserves
    - economic proven
    - economic probable
- Subeconomic reserves

Table 3: Reserves of hard coal in Mt, Czech Republic, 1993-2000.

in mil. t	1993	1994	1995	1996	1997	1998	1999	2000
I. Economic reserves	**8 421**	**8 272**	**9 099**	**9 014**	**8 565**	**8 402**	**9 345**	**9 291**
a.economic proven	***2 323***	***2 310***	***2 697***	***2 613***	***2 417***	***2 356***	***2 114***	***2 072***
- proven :unlimited	1 671	1 666	1 954	1 918	1 749	1 698	1 589	1 557
- used	*656*	*655*	*613*	*580*	*491*	*448*	*404*	*382*
- unused	*1 015*	*1 011*	*1 342*	*1 338*	*1 258*	*1 250*	*1 185*	*1 175*
- proven: limited	652	644	743	695	668	658	525	515
- used	*351*	*343*	*344*	*298*	*273*	*262*	*238*	*228*
- unused	*301*	*301*	*398*	*397*	*395*	*396*	*287*	*287*
b.economic probable	***6 098***	***5 963***	***6 403***	***6 401***	***6 148***	***6 046***	***7 231***	***7 219***
- probable: unlimited	5 047	4 930	5 236	5 239	5 010	4 924	5 694	5 682
- used	*453*	*342*	*313*	*311*	*219*	*217*	*172*	*171*
- unused	*4 594*	*4 588*	*4 923*	*4 928*	*4 791*	*4 707*	*5 522*	*5 511*
- probable: limited	1 051	1 033	1 167	1 162	1 138	1 122	1 537	1 537
- used	*146*	*129*	*134*	*129*	*108*	*108*	*97*	*97*
- unused	*905*	*905*	*1 033*	*1 033*	*1 030*	*1 013*	*1 440*	*1 440*
II. Subeconomic	***5 090***	***5 301***	***4 834***	***4 928***	***5 390***	***5 540***	***6 960***	***7 063***
- used	*1 555*	*1 538*	*1 390*	*1 478*	*1 651*	*1 767*	*1 792*	*1 531*
- unused	*3 535*	*3 763*	*3 443*	*3 450*	*3 739*	*3 774*	*5 168*	*5 531*

Economic proved and probable reserves are divided into free and limited. All these categories are further divided into used and unused, thus in total the reserves are subdivided into 10 categories. The flows reflect new discoveries and extraction of minerals, as well as the reclassification due to the economic and market changes, as well technical and regulation constraints. The hard and brown coal reserve is described in following figure. The disappearance of brown coal reserves is shown as well, considering extraction, losses related with the extraction, depreciation at unused and used deposits. We can presume that the classification of stock and flows reflects very closely to the SEEA.

Figure 4: Decrease of brown coal reserves, Czech Republic, 1993-2000.

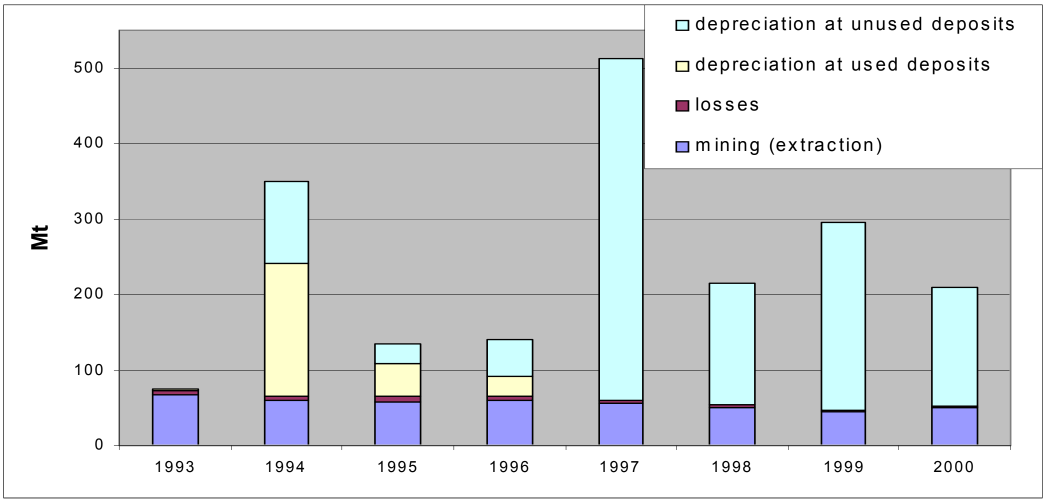


Figure 5: Years of reserves of selected non-renewable resources (years).

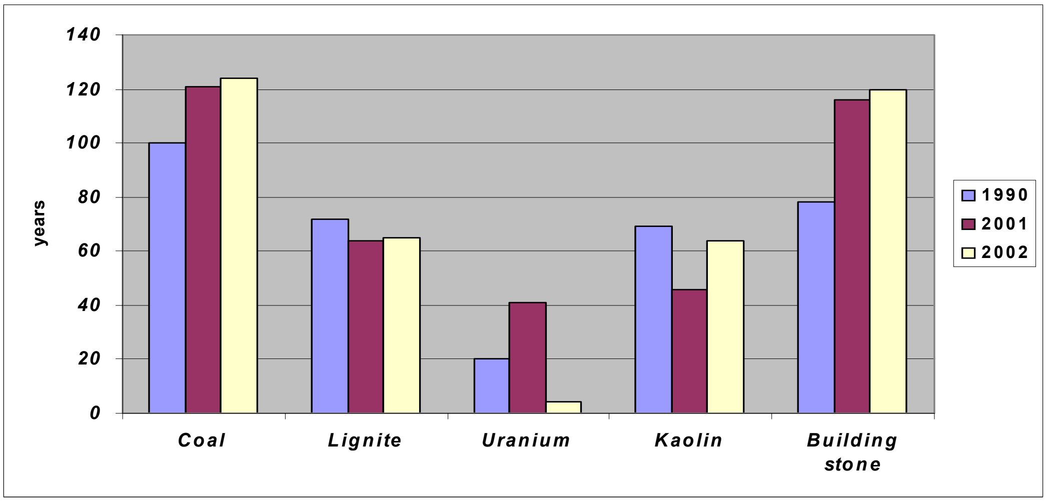
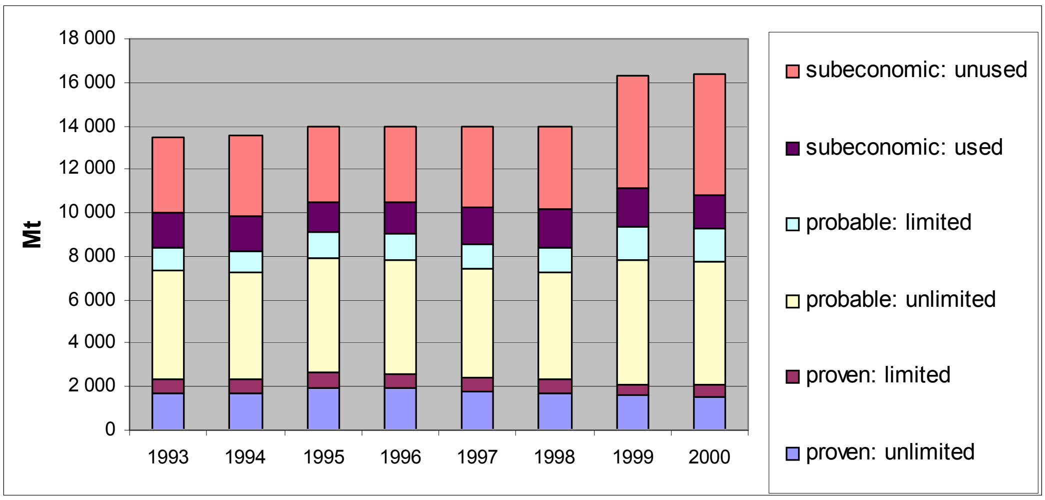
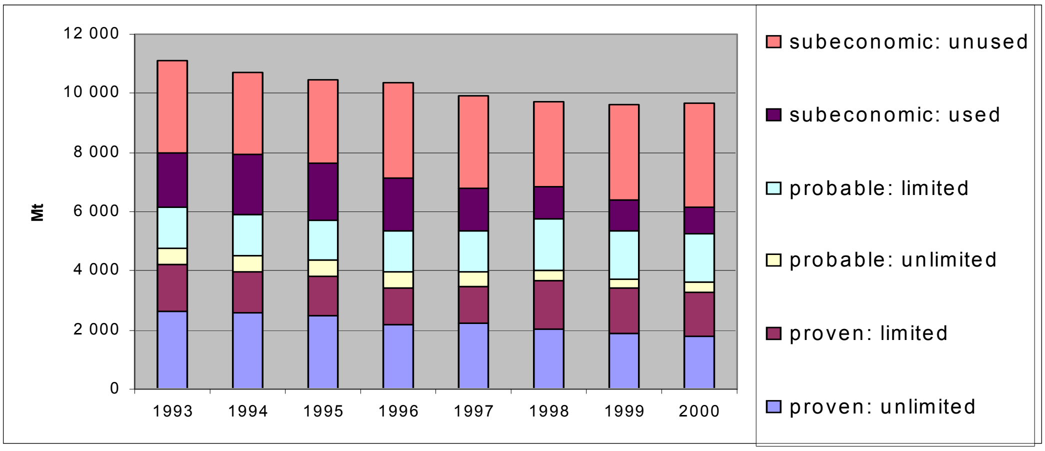


Figure 6: Hard coal reserves, Czech Republic, 1993-2000, in mil. tons.



The indicators reflecting the lifespan of the stock is very useful for sustainable path assessment. It can be expressed in terms of years during those the stock (reserve) of particular asset can be extracted while the same extraction rate that holds for current accounting year is used. The lifespan for coal, lignite, uranium, kaolin and stone are used as an example in the figure below.

Figure 7: Brown coal reserves, Czech Republic, 1993-2000, in mil. tons.



4. Valuation of depletion

4.1. Placing a value on assets

The SNA recommends that market prices be used wherever practicable to place a value on an asset. Some purpose built man-made assets may not have a market value other than the cost of construction and the market in second-hand assets is frequently too shallow to give realistic market prices. There is a problem to get a value for assets that are out of the scope of asset definition or for asset those market price does not exist. Here a question is raised how to treat value of this kind of assets and its extraction.

Economic theory states that at any point in life of asset, its value should be equal to the value of future income streams to be provided by the asset discounted to the present period. This can be applied to produced assets and also to environment assets.

While the asset is used, its value declines. SNA measures the decline for man-made capital as the consumption of fixed capital. It is referred to as depreciation or amortisation that should be deducted from measures of income while the sustainability is of our concern. Thus, if consumption of fixed capital is higher than the acquisition of new fixed capital, then this situation is not sustainable. As SEEA93 (UN et al. 2003) notes *"the SNA supports this valuation and the calculation of the decline in the value of the natural resource but leaves the value of the decline in the other changes in assets account under a category of economic disappearance"*. Consequently if the natural asset appears, corresponding increase in value is also recorded in the same asset account within the SNA.

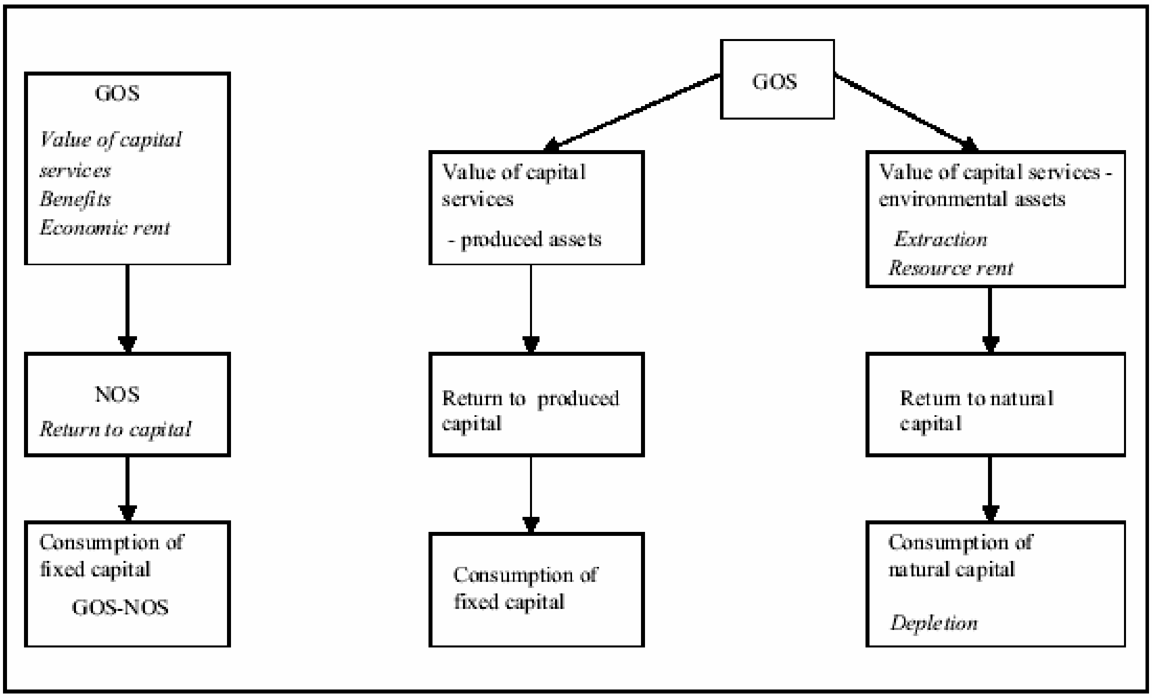
The idea and concept of valuing of stock of the assets can be expressed as following (cited from SEEA2003; in UN et al. 2003, p.56-57):

Assets provide capital services to the production process and these are remunerated in the gross operating surplus generated. Gross operating surplus is that part of value added that remains after deducting the compensation of employees and the other taxes less subsidies on production. This operating surplus can be partitioned to show how much is due to produced assets and how much to natural assets. The part due to natural assets is the ***resource rent****. The other part we will call economic rent though to be accurate it should really be called other economic rent. The value of the stock of the assets, whether produced or non-produced, can be equated with the present discounted value of the rent they will yield over their effective life.*

Economic rent can be partitioned into a part which represents the decline in the value of the asset (the cost of "using up' the asset), and the remainder which represents the return to the owner of the asset... In the SNA, the ***decline in the value of the produced assets*** *is described as the consumption of fixed capital and it is deducted from gross operating surplus to derive net operating surplus. Net operating surplus thus covers the return to the produced asset plus the whole of the resource rent.*

The value of the capital service flows rendered by the natural resources, their share in gross operating surplus, is the value of the ***extraction****, harvest or abstraction of natural resources. It is also referred to as the* ***resource rent****. The term equivalent to consumption of fixed capital is called* ***depletion****. Depletion denotes the total volume of extractions of natural resources times the realised price per unit. It is not considered as the net effect of extractions, once the return to natural resources has been taken into account. Depletion is used, as in the SNA, to mean the change in value of the stock of the resource due to extraction.*

Figure 8: The decline in the value of fixed capital and the income it generates.



Taken from SEEA2003; UN et al. 2003, p. 275.

As it was stated, the resource rent is possible to partition into one part representing the decline in the value of the asset and one part representing the return to the use of the asset in production which is regarded as income. The SNA prior to the 1993 version assumed that natural resources were so abundant that there was no decline in their value and that the whole of the resource rent could rightly be treated as income. There is an opposite view by supporters of a very strong sustainability principle. The whole of the resource rent should be taken as a decline in value of the stock of the resource and none of it regarded as income. The majority opinion is however that one staying in between.

The argument in favour of adjusting the national accounts aggregates for the use of natural resources is that a further deduction should be made from net operating surplus to allow for the decline in the value of the natural resource. Such an adjustment would give a figure for ***depletion adjusted operating surplus****. This would follow through the sequence of accounts and result in other depletion adjusted aggregates, notably domestic product and national income but also saving.*

While, a decline in the value of resource stock due to extraction is subtracted from net domestic product, ***extraction adjusted domestic product*** *is determined. If, a decline in the value of resource stock due to extractions net of discoveries is subtracted from net domestic product,* ***depletion adjusted domestic product*** *is determined.*

Once the resource rent for an asset has been determined, three further pieces of information are necessary to determine the net present value of the asset:

- For how many more years into the future will the asset generate economic rent?
- What will be the pattern of decline (if any) in the economic rent?
- What is the appropriate value of this discount rate?

We can here assume that:

- period during that the asset will generate rent corresponds with ***lifespan of the reserve*** (described above),
- the ***pattern of economic rent*** will be the same as that current one (*ceteris paribus* condition),
- a ***discount rate of 4%*** should be used while the stock is valuated (Eurostat 2002b, p.3). This is close to the average real rate of return on government bonds. The Eurostat Guide applies also discount rate of 0%, 2%, 4%, 6%, and 8%.
  A return to fixed capital is calculated by applying a normal real rate of return to the net stock of fixed capital in the extraction industry, valued at the beginning of the period. Thus an ***8% real rate of return on fixed capital*** should be taken as the default value for EU/EEA countries (Eurostat 2002b, p.2). There are also applied alternative rates at the amount of 6% and 10%.

4.2. Valuation of resource rent

There are three possible ways of estimating resource rent. The first is based on actual transactions and may be called the appropriation method. The other two methods depend on estimating resource rent by partitioning the information on economic rent for all the assets for a firm into that part pertaining to its produced assets and the part relevant to the non-produced assets. These two last methods start with the assumption that there is information available on the gross operating surplus of a firm or industry and also figures for the net capital stock of the same unit.

a) The appropriation method

In many countries, governments are the primary owners of the nation’s natural resources. The approach is based on that governments could in theory collect the entire rent derived from extraction of the resources they own. Resource rent can be collected by governments through fees, taxes and royalties levied on companies that carry out extraction. However, in practice, fees, taxes and royalties tend to understate resource rent as they may be set by governments with other priorities in mind, for instance implicit price subsidies to extractors, and encouraging employment in the industry (SEEA2003, UN et al. 2003, p. 276). Although this method need not be the most appropriate due to arbitrary manner, one can compare the values with those estimated by other approaches while economic policy assessment is required.

Case study: Application of the appropriation method on subsoil assets for the Czech Republic

There are two levies introduced in relevant area in the Czech Republic. Levy on the claims (mining/quarrying area) and a levy on extracted reserved minerals are levied on extractor. The revenue recipient of the first one is municipality budget; the revenue from the second one is further divided into state budget and budget of the municipality under which territory the quarry is placed. The levy on mining/quarry area was introduced mainly due to compensate the negative effects caused by extraction to people leaving it area surroundings. Thus, this levy is not likely directly related with the extracted asset, rather with the process of the extraction. The levy on extracted materials is based on the market price of products (revenues from final production in thousand CZK; REV). The levy is calculated as follows:

$$levy = ((Ce/Cf) * REV * t) /100$$

where t is the rate of the levy,
Ce is the cost of extractions and
Cf is the costs of final production.

The rate of the levy ranges from 0.5% to 10.0% depending on particular asset. For instance, the rate of 1.5% is applied for coal extracted on the surface and of 0.5% for coal extracted underground.

The revenue of levy on extracted materials has constantly amounted about 450 mil. CZK yearly in average.

Table 4: Revenues from levy on extraction of raw materials.

	1995	**1996**	**1997**	**1998**	**1999**
Ores	0	0	0	0	0
Energy producing materials	381	388	404	385	374
Other reserved raw materials	56	60	60	58	64
Total, reserved materials	**437**	**448**	**464**	**443**	**438**
Levy for energy producing materials, CZK per t	***4,74***	***4,70***	***5,10***	***5,36***	***5,94***
Levy for other materials, excl. ores, CZK per t	***3,21***	***3,34***	***3,30***	***3,15***	***3,15***

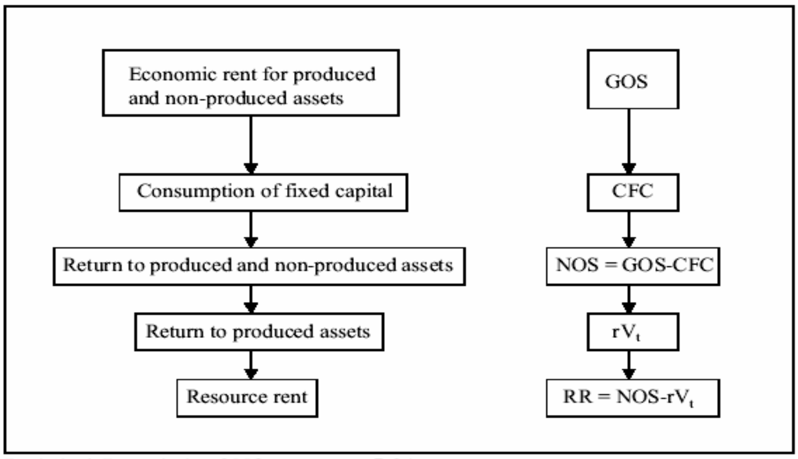
Note: N – data was not monitored in that period.
Source: Czech Mining Institute; ČBÚ 2002.

The resource rent derived by applying the appropriation method reaches about 400 mil. CZK yearly for energy producing materials (5-6 CZK per t) and 60 mil. CZK for other raw materials (3 CZK per t). Total resource rent (only for reserved materials) amounts about 450 mil. CZK (what equals to 14 mil. euro) yearly. Depletion adjusted domestic product thus should be decreased by 450 mil. CZK, what means by 0.02%-0.03% of GDP less. This small amount of adjustments reasons from relatively small rate of royalty applied in the Czech Republic on extraction of subsoil assets.

b) Resource rent derived from PIM calculations

This method starts by determining the value of an asset which is n years old by making assumptions about the rate of decline in its value over the n years since it was purchased. This decline in this value since the previous year is set equal to the consumption of fixed capital. Net operating surplus is calculated by deducting the consumption of fixed capital from gross operating surplus (from the production account) and the return to capital is calculated using the value of capital stock determined by the PIM. The resource rent earned by the unit is derived at the end of this sequence of calculations as it is shown in the figure.

Figure 9: Resource rent derived from PIM calculations.



Taken from SEEA2003; UN et al. 2003, p. 277.

The idea is as follows (SEEA2003, UN et al. 2003, p. 277): taking the economic rent for all assets, the gross operating surplus (GOS) and deducting the consumption of fixed capital (CFC) gives the return to produced and non-produced assets or net operating surplus (NOS). The return to produced capital is taken to be the discount rate (r) multiplied by the value of the produced capital stock at the start of the year (Vt). Deducting this from the net operating surplus gives the return to non-produced assets, or resource rent (RR).

This approach suggests also Eurostat Guide (2002b). The resource rent is generated as follows:

Output (basic "well head" prices)
+ Specific taxes less subsidies on products
– Intermediate consumption
– Compensation of employees
– Other non-specific taxes less subsidies on production
– Consumption of fixed capital
– Return to fixed capital
= Resource rent

Note: Return to fixed capital is calculated by applying a normal real rate of return to the net stock of fixed capital in the extraction industry, valued at the beginning of the period. For EU/EEA countries, an 8% real rate of return on fixed capital should be taken as the default value. Specific taxes and subsidies are those that apply only to the oil and gas extraction industry, while non-specific taxes and subsidies apply to other industries as well. Specific taxes are considered part of the resource rent (appropriated by government). *Source: Eurostat 2002b, p. 2.*

Case study 2: Resource rent derived from PIM calculation

The approach described above is followed by using data by Czech Statistical Office of the Czech Republic. Data for year 1997 reported in Statistical Yearbook (CSO 2002) was used.

Table 5: Calculation of resource rent by applying PIM approach, the Czech Republic 1997.

bln. CZK, 1997 current prices	**CA**	**CB**	**C**
GVA	**26.314**	**4.111**	**30.425**
Compensation of employees	16.143	1.945	18.088
Taxes on production	0.350	0.063	0.413
Subsidies on production	4.339	0.155	4.494
Other costs	0.155	0.000	0.155
GOS	**14.005**	**2.258**	**16.263**
CFC	7.034	0.948	7.982
NOS	**6.971**	**1.310**	**8.281**
Value of fixed assets	58.937	8.478	67.415
Return of produced capital *(8%)*	**4,715**	**0,678**	**5,393**
Resource rent	**2,256**	**0,632**	**2,888**
Return of produced capital (1%)	*0.589*	*0.085*	*0.674*
Resource rent (1%)	*6.382*	*1.225*	*7.607*
Return of produced capital (10%)	*5.894*	*0.848*	*6.742*
Resource rent (10%)	*1.077*	*0.462*	*1.540*

Data source: CSO; calculation by author.

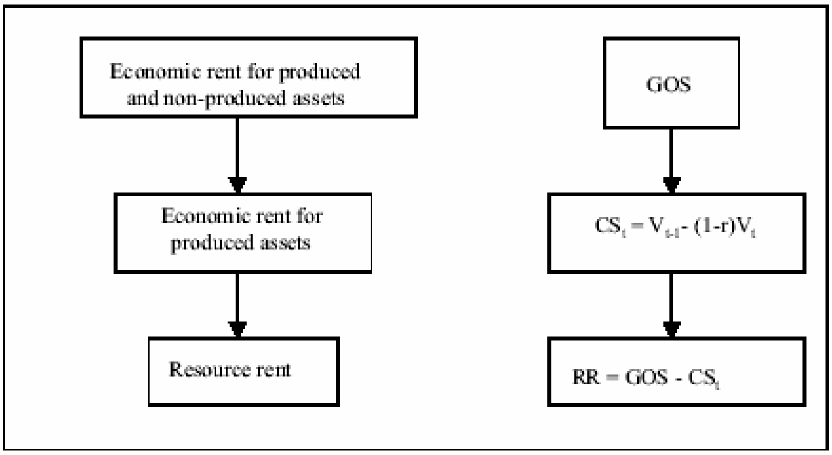
c) Resource rent derived from capital service flow calculations

The third method uses the theory of capital service flows to determine how much of the gross operating surplus represents the capital services rendered by the stock of produced capital. What is left when this is deducted from gross operating surplus is then resource rent attributable to the non-produced assets in use.

This methodology starts by considering and modelling the decline in the service provided by the asset over its life rather than the decline in price. (A light bulb for example may shed the same light throughout its life even though its value declines as it ages because the length of time for which it is expected to function declines.) Such measures of capital service flows are used in productivity studies as well as in the calculation of net income flows. The value of the capital service flows (CS) estimated from the stock of capital is deducted from the total economic rent (GOS) as recorded in the production account. The result gives the resource rent (RR) directly (see SEEA2003, UN et al. 2003, p. 278).

The capital service flows can be derived as follows (cited from SEEA2003): „If the value of the assets at the start of the year is V and the discount rate is r, then the income element can be expressed as rV. For this reason, this income is regarded by economists as representing the ***return to the capital*** used by the firm. For the firm as a whole, this item is the ***net operating surplus***. The decline in the value of the asset is referred to as the ***consumption of fixed capital*** and is the difference between the value of the capital service flows rendered (and thus used up) and the income element which arises in the same period."

Figure 10: Resource rent derived from capital service flow calculations.



Taken from SEEA2003; UN et al. 2003, p. 278.

Case study 3: Resource rent derived from capital service flow calculations

The approach described in SEEA2003 is followed and resource rent for subsoil assets derived from capital service flow calculation.

Table 6: Resource rent derived from capital service flow calculations for the CR, 1997.

Bln. CZK, 1997 current prices	**CA**	**CB**	**C**
GVA	**26.314**	**4.111**	**30.425**
Compensation of employees	16.143	1.945	18.088
Taxes on production	0.350	0.063	0.413
Subsidies on production	4.339	0.155	4.494
Other costs	0.155	0.000	0.155
GOS	**14.005**	**2.258**	**16.263**
Value of fixed assets (Jan97)	58.937	8.478	67.415
Value of fixed assets (Dec97)	58.137	8.112	66.249
Capital service flows (8%)	**5,451**	**1,015**	**6,466**
Resource rent	**8,554**	**1,243**	**9,797**

Data source: CSO; own calculation by author.

d) Comparison of resource rent calculation for subsoil assets in the Czech Rep., 1997

The various methods fro resource rent calculation were applied following the SEEA2003 approach (see table).

Table 7: Comparison of resource rent calculation for the Czech Republic, 1997.

Bln. CZK, 1997 current prices	**CA**	**CB**	**C**
a) the appropriation method	**0.404**	**0.06**	**0.464**
% of GDP (1997)	**0.024%**	**0.004%**	**0.028%**
b) PIM method			
- d.r. 4%	4.614	0.971	5.584
- d.r. 1%	6.382	1.225	7.607
- d.r. 8% (default value)	**2.256**	**0.632**	**2.888**
- d.r. 10%	1.077	0.462	1.54
% of GDP (1997) for default value	**0.13%**	**0.04%**	**0.17%**
c) capital services flows			
- d.r. 4%	10.88	1.568	12.447
- d.r. 1%	12.624	1.811	14.435
- d.r. 8% (default value)	**8.554**	**1.243**	**9.797**
- d.r. 10%	7.391	1.081	8.472
% of GDP (1997)	**0.51%**	**0.07%**	**0.58%**

The resource rent derived by PIM and capital service flow method ranges at the interval 2-8 bln. CZK or 0.1-0.5 of yearly GDP for energy producing raw materials, and 0.6-1.2 bln. CZK or 0.04-0.07 % of GDP for rest of the raw materials extracted. Total resource rent presents about 3-10 bln. CZK or 0.2-0.6 % of GDP of the Czech Republic. Resource rent derived by the appropriation method present a magnitude of one order lower.

e) Resource rent for the coal mining firm

The value of stock can be generated by assuming lifespan of the particular reserves (for instance about 120 years for coal, see above) and stabile patterns of economic rent generation. The value of stock is further equal to present value of resource rents generated by the stock extracted during the lifespan of the reserve.

The value of stock can be imputed by using "net price" method imputation approach (Miller et Upton, 1985). The imputed value of the in-ground asset $V(t)$ at time t is equal to difference between spot price of the mineral $P(t)$ and marginal extraction costs $C_q(t)$ dependent on output level q times the remaining economic reserves $R(t)$. As Miller et Upton proposed when average cost $a(t)$ is used in place of marginal cost for reasons of tractability, the modified formula

$$V(t) = [P(t) – a(t)] * R(t)$$

values mineral reserves with a reasonable level of accuracy (see more in Davis et Moore 2003, p. 106). This equation is called as the Hotteling valuation principle (HVP). However, it was found, while HTP was due to the empirical tests, that HTP overvalues mineral assets, and at worst that [P(t) – a(t)] is uncorrelated with mineral asset value (see more in Davis et Moore 2003, p. 107). Last mentioned authors also proposed that the formula

$$V(t) = \phi + \delta[P(t) - a(t)]\,R(t)$$

has considerable empirical merit compared with the HVP and other reserve valuation approaches. They found a reasonable representation of the Unrestricted Valuation Principle is in North America:

$$V(t) = 0.7[P(t) - a(t)]\,R(t)$$

Extraction costs can be further defined as the sum of the following items from the resource rent calculation (Eurostat 2002b):

- Intermediate consumption
- Compensation of employees
- Other non-specific taxes less subsidies on production
- Consumption of fixed capital
- Return to fixed capital

If we apply this approach for data reported in balance sheet and Profit and loss account of two gig coal extraction firm in the Czech Republic, we can find that the resource rent (production minus extraction costs) are continuously negative. This is among others due to high amount of fixed capital that contribute to the costs significantly even very small return rate is applied. This case however has to be analysed much more properly in next research.

5. Conclusions

Data availability does not present the main obstacle for the valuation of extraction and stock of particular subsoil assets, meaning a coal reserves and extraction in the Czech Republic in particular. This research presents the first attempt to analyse the reserve and extraction in the Czech Republic by applying a relatively new accounting method.

A special attention should be given not only to proper application the accounting method, but also to the issue related to the rate of return of fixed assets, the discount rate and the amount of produce assets that can significantly change the final value of resource rent under our examination.

Future research should also deal the issue of distribution of the total resource rent between raw materials, brown and hard coal, coal and other energy producing materials and non-energy materials in particular.

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Appendix:

Figure: Raw material extraction – domestic used extraction according MFA for the Czech Republic, 1990-2002.

kt	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CA Energy materials	**111 091**	**103 446**	**94 422**	**92 229**	**81 919**	**80 352**	**82 526**	**79 266**	**71 765**	**62 916**	**68 377**	**66 630**	**63 776**
10 Coal, lignite	**110 919**	**103 257**	**94 210**	**92 016**	**81 634**	**80 038**	**82 225**	**78 989**	**71 456**	**62 597**	**68 091**	**66 351**	**63 432**
černé uhlí	30 714	25 769	24 691	23 862	20 910	21 309	21 784	20 847	19 521	17 227	17 028	14 808	14 097
hnědé uhlí	78 391	75 988	68 100	66 891	59 811	57 954	59 539	57 395	51 283	44 858	50 610	51 036	48 834
lignit	1 814	1 500	1 419	1 263	913	775	902	747	652	512	453	507	501
11 Crude oil, natural gas	**172**	**189**	**212**	**213**	**285**	**314**	**301**	**277**	**309**	**319**	**286**	**279**	**344**
ropa	47	64	80	107	131	149	155	159	172	176	168	178	253
zemní plyn (1000 m3 = 1 t)	125	125	132	106	154	165	146	118	137	143	118	101	91
12 Uranium	1 148	887	726	388	156	141	115	103	76	84	99	96	91
CB Non-energy raw materials	**117 221**	**77 911**	**74 140**	**70 445**	**70 964**	**72 201**	**79 073**	**81 967**	**75 297**	**75 480**	**75 150**	**73 929**	**71 598**
13 Mettalic ores	**613**	**581**	**328**	**111**	**15**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
iron ore	93	102	64	0	0	0	0	0	0	0	0	0	0
non-iron ore	520	479	264	111	15	0	0	0	0	0	0	0	0
14 Other raw materials	**116 608**	**77 330**	**73 812**	**70 334**	**70 949**	**72 201**	**79 073**	**81 967**	**75 297**	**75 480**	**75 150**	**73 929**	**71 598**
industrial raw materials	25 324	18 975	18 531	17 328	17 390	17 460	17 947	18 207	18 388	20 287	20 917	19 789	16 936
building/construction materials	91 284	58 355	55 281	53 006	53 559	54 741	61 126	63 760	56 909	55 193	54 233	54 140	54 662
C TOTAL	**228 312**	**181 357**	**168 562**	**162 674**	**152 883**	**152 553**	**161 599**	**161 233**	**147 062**	**138 396**	**143 527**	**140 559**	**135 374**

1990=100	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
CA Energy materials	**100**	**93**	**85**	**83**	**74**	**72**	**74**	**71**	**65**	**57**	**62**	**60**	**57**
10 Coal, lignite	**100**	**93**	**85**	**83**	**74**	**72**	**74**	**71**	**64**	**56**	**61**	**60**	**57**
černé uhlí	100	84	80	78	68	69	71	68	64	56	55	48	46
hnědé uhlí	100	97	87	85	76	74	76	73	65	57	65	65	62
lignit	100	83	78	70	50	43	50	41	36	28	25	28	28
11 Crude oil, natural gas	**100**	**110**	**123**	**124**	**166**	**183**	**175**	**161**	**180**	**185**	**166**	**162**	**200**
ropa	100	136	170	228	279	317	330	338	366	374	357	379	538
zemní plyn (1000 m3 = 1 t)	100	100	106	85	123	132	117	94	110	114	94	81	73
12 Uranium	100	77	63	34	14	12	10	9	7	7	9	8	8

CB Non-energy raw materials	**100**	**66**	**63**	**60**	**61**	**62**	**67**	**70**	**64**	**64**	**64**	**63**	**61**
13 Mettalic ores	**100**	**95**	**54**	**18**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
iron ore	100	110	69	0	0	0	0	0	0	0	0	0	0
non-iron ore	100	92	51	21	3	0	0	0	0	0	0	0	0
14 Other raw materials	**100**	**66**	**63**	**60**	**61**	**62**	**68**	**70**	**65**	**65**	**64**	**63**	**61**
industrial raw materials	100	75	73	68	69	69	71	72	73	80	83	78	67
building/construction materials	100	64	61	58	59	60	67	70	62	60	59	59	60
C TOTAL	**100**	**79**	**74**	**71**	**67**	**67**	**71**	**71**	**64**	**61**	**63**	**62**	**59**

Figure: Hidden flows for the CZech Republic, 1990-2002.

kt	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Unused domestic extraction	**523 737**	**492 602**	**446 247**	**419 696**	**403 981**	**387 340**	**375 441**	**389 256**	**371 340**	**324 237**	**319 112**	**313 361**	**298 767**
1. Agriculture - wood harvesting	8 275	6 698	6 138	6 447	7 398	7 677	7 828	8 405	8 727	8 859	8 991	8 959	9 048
2. Industry	496 192	474 279	423 233	396 474	383 968	361 360	350 899	352 376	345 297	296 854	292 697	287 636	272 850
- overminings	470 692	451 600	405 367	379 896	367 828	343 294	328 914	337 800	330 495	284 680	283 609	275 420	261 818
- quarring works	1 873	1 434	1 230	1 733	2 268	2 217	2 216	1 920	1 764	1 466	1 421	1 445	1 365
- mining/quarring losses	23 627	21 246	16 636	14 845	13 872	15 849	19 770	12 657	13 037	10 709	7 667	10 771	9 667
3. Building construction	5 436	3 925	5 014	4 581	4 828	5 252	5 522	5 301	4 448	5 046	6 360	5 789	5 789
4. Transport - road and railways	13 835	7 700	11 862	12 194	7 788	13 051	11 192	23 175	12 867	13 477	11 065	10 976	11 080
Indirect flows ass. with the Imports	**118 711**	**50 097**	**56 991**	**95 054**	**87 758**	**105 397**	**112 371**	**111 317**	**116 248**	**127 450**	**126 004**	**137 206**	**133 042**
- ass. to fossils	21 116	17 253	15 261	16 564	16 093	19 731	23 905	23 747	22 100	22 337	22 839	24 055	22 770