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The Gross Consolidated Product (GCP), an alternative social product consolidating government and household consumption with intermediate consumption.

Potential application to setting greenhouse gas (GHG) intensity targets

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Abstract

The GDP concept is built upon the distinction between intermediate and final consumption. This distinction is arbitrary and not in line with economic reality. This article defines an aggregate social product called Gross Consolidated Product (GCP), which consolidates general government and household consumption with intermediate consumption. GCP applies the capital approach of sustainable development and is the concretization of the Hicksian definition of sustainable income. It is quantitatively considerably smaller than GDP, because it subtracts inter alia the total cost of households for producing labour. At a global level it equals gross capital formation for all types of capital, distinct from its homonymous SNA term, notably by including also the formation of human capital, which it attaches to households. For homogeneity reasons, GCP at national level equals gross capital formation plus the current account balance. At agents' level, GCP can be called gross capital added in analogy to gross value added that corresponds to GDP. The paper shows how GCP could be applied to climate policy for taking into account the level of sustainable development when setting national GHG-targets. Such targets would take the form of CO2-intensities, more precisely, of CO2 / GCP ratios. These reflect the idea that the higher the sustainable income of a country, the higher could be its CO2 quota.

1. Introduction

The Gross Domestic Product (GDP) as defined within the System of National Accounts (SNA93) is probably the most widely-used macroeconomic aggregate[2]. It may have been an indicator for well-being at times production mattered most. Today, well-being is less a matter of production than of sustainable preservation of capital[3] in its various forms (financial, manufactured, human, natural and, possibly, social capital)[4], hence some caution against the misuse of GDP in terms of welfare is appropriate[5]. In the last decades several other measures of well-being have been proposed, some of them complementary to GDP, others as alternatives. Among the complementary measures, there are the indicators based upon the various satellite accounts of the SNA, the most important of them being the draft of the System of Integrated Environmental and Economic Accounting (SEEA 2003)[6], which will be adopted definitively by the UN by 2010, as well as the NAMEA approach[7] and the green GDP experiment by China of 2004[8]. The satellite account for unpaid household labour[9] is also worth mentioning. Among the complements there is furthermore the Human Development Index HDI, which uses indices of life expectancy, education and per capita GDP[10]. The alternatives to GDP comprise e.g. the Measure of Economic Welfare[11], that later became the Index of Sustainable Economic Welfare (ISEW)[12], which in turn was developed into the Genuine Progress Indicator (GPI)[13] or the ecological footprint[14], which is used to calculate the Happy Planet Index (HPI)[15].

The alternatives to GDP mostly focus on environmental aspects (natural resources depletion, pollution, land degradation), much less on social aspects (crime rates, family breakdown). None focuses on the economy. In contrast, GCP focuses primarily on the

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[2] For a good description see e.g. F. Lequilier, D. Blades: Understanding National Accounts, OECD, 2006, available online at http://www.oecd.org/document/58/0,3343,fr_2649_34245_38445370_1_1_1_1,00.html

[3] Pearce, D.W., Markandya, A. and Barbier, E.B. (1989) Blueprint for a Green Economy, Earthscan, London.

[4] Porritt, Jonathon (2005, revised 2007). *Capitalism: As if the World Matters*, Earthscan.

[5] Markos J. Mamalakis, Misuse and use of national accounts as a welfare indicator: Selected analytical and measurement issues, Review of Income and Wealth, Series 42, Number 3, September 1996

[6] UN, EU, IMF, OECD, World Bank: Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003, Final draft circulated for information prior to official editing

[7] M. de Haan and S. J. Keuning: Taking the environment into account: The NAMEA approach. Review of Income and Wealth, Series 42, Number 2, 1996

[8] see e.g. http://www.china.org.cn/english/2004/Jun/96974.htm

[9] J. S. Landefeld, S. H. McCulla: "Accounting for nonmarket household production within a national accounts framework", Review of Income and Wealth, Series 46 Number 3, September 2000, and Duncan Ironmonger, 1996. "Counting outputs, capital inputs and caring labor: Estimating gross household product," Feminist Economics, Taylor and Francis Journals, vol. 2(3), pages 37-64, January.

[10] UNDP (1990) Human Development Report 1990: Concept and Measurement of Human Development. Oxford University press. ISBN 0195064801, and Rao VVB, 1991. Human development report 1990: review and assessment. World Development, Vol 19 No. 10, pp. 1451–1460

[11] Nordhaus, W. and J. Tobin, 1972. Is growth obsolete?. Columbia University Press, New York

[12] Daly,H. & Cobb, J., 1989. For the Common Good. Beacon Press, Boston

[13] Lawn, P.A. "A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes". *Ecological Economics* **44** (2003) 105-118.

[14] Wackernagel, Mathis & Rees, William (1996)"Our Ecological Footprint" (New Society Press)

[15] Nic Marks, Saamah Abdallah, Andrew Simms and Sam Thompson, "The Happy Planet Index: An index of human well-being and environmental impact", July 12, 2006

economy. The main criticism it addresses to GDP is that the latter considers all consumption by general government, non-profit institutions serving households (NPISH) and households (except the service of housing) as final consumption by virtue of an arbitrary convention. As a matter of a further convention, government and NPISH consume the totality of their production. A third convention defines labour, one of the outputs of households that is consumed in corporations, as production factor or primary input into these, denying it thereby the status of an intermediary input. These conventions, which are crucial for GDP, mean that general government, NPISH and households are considered as not being linked to the production process and therefore in a certain sense "not useful" for production. These conventions do not reflect economic and physical reality: Labour may be just as important for production than manufactured capital, and food bought by households may be just as important for labour as energy is for the machine. Still, national accounts only consider the machine and the energy it consumes as linked to production, hence intermediary. GCP, instead, bases itself upon the physical reality: It does not distinguish who consumes, but whether there has been consumption. Its finality is not consumption, but formation of gross capital in all its forms (financial, manufactured, human, natural and, possibly, social capital). For GCP, the distinction between intermediate and final consumption is entirely irrelevant, whereas the one between consumption and capital formation highly matters.

In section two, we first present a symmetric input-output table (SIOT), which lists each agent exactly once in a line and once in a column, and show how the nearest possible approximation of GDP can be represented in that table. The exact representation is not possible in this table and is not the object of this article. Section three presents the new GCP and shows its aggregation and disaggregation properties. Section four shows a possible application of GCP intensities to climate change. The conclusion will discuss and interpret the GCP concept in the wider context of different types of market failures.

2. The Symmetric Input-Output Table (SIOT) for GCP

Economics is a multi-agent interactive exchange process in which each agent is giving and receiving from potentially each other. In order to keep internal coherence, i.e. to count each flow once and only once, it is most convenient to define any accounting quantity from within a symmetric input-output table (SIOT), in which each agent is represented exactly once by a line for its outputs and once by the corresponding column for its inputs. A particular type of such a table is the Leontief inter-industry table. There is however no necessity to postulate the fixity of its technical coefficients; technical coefficients are not even needed at all, only the accounting framework matters. If available data allows, lines and columns of aggregated agents in such a table could theoretically be disaggregated not only to individual agents, but to individual products and services.

Economics is not only about exchanges, but also about production and consumption. Symmetric input-output tables offer the possibility to state the differences between exchanges on the one hand and production-consumption on the other hand. This can be taken most conveniently into account by adding one supplementary line and column to

input-output matrices. This supplementary line and column accounts for capital formation, i.e. inventories and inventory changes as well as for the overall balance, i.e. the gross profits. Such a table with this supplementary line and column will be the framework for the presentation of GDP and GCP in this article.

We consider an economy composed of interdependent agents. For the definition of GCP, it is totally irrelevant how these are being aggregated, but for the purpose of identifying an approximation of GDP as well as for the purpose of climate policy, one might consider that a first aggregate agent, labelled A, could contain all those activities that have a multiple relevance for the three major greenhouse gases CO2, CH4 and N2O[16], i.e. at least two of the following: production, emission, absorption. Aggregate industry A would therefore be composed of the integrated food and energy industries[17]. A second aggregate agent, labelled B, would contain all the other activities, contributing to climate change only through the role of emitters of greenhouse gases, except for those in the third aggregate industry R comprising the financial sector[18], which we identify in order to show explicitly the income and cost of capital, i.e. interests and dividends. We furthermore distinguish an aggregate general government agent[19], which for reasons of compatibility with economic textbooks we note G on the expenditure side and T on the taxes side, an aggregate household agent[20], which we note C on the consumption side and W on the employee compensation side, and an aggregate foreign sector or rest of the world, which we note X on the exports and Z on the imports side. Lastly, we add the supplementary account mentioned earlier for stock changes and capital changes, which we note I on the gross formation of capital side and S on the gross profits side, S being the sum of depreciations and net profits.

To designate each flow specifically, we apply the following convention: The first letter denotes the source of a money flow and the second letter its destination. Thus, AB designates, e.g., a payment or money flow from the aggregate agent A to the aggregate agent B. The corresponding goods or services flow goes in the reverse direction. These flow directions correspond to usual input-output tables. AA is, e.g., the consumption of proper energy by the aggregate energy and food agent. The money flows to and from general government, households, the foreign sector and the supplementary account are preceded by their usual letters of economic textbooks: C for private consumption, W for employees' compensation, G for general government consumption, T for taxes net subsidies, X for exports and Z for imports, I for gross capital formation and S for gross profits.

Each line of table 1 corresponds to the earnings of the aggregate agent in question and each column to its expenditure. The first line represents e.g. the earnings of the aggregate energy and food agent A and the first column its expenditure.

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[16] In the Kyoto Protocol, the three further greenhouse gases SF6, HFCs and PFCs are mentioned. We neglect them here due to their lack of economic significance.

[17] In terms of the forthcoming ISIC Rev. 4 classification, this would include the headings 01 - 06, 10 - 12, 19, 35, 4620, 4630, 4661, 4711, 472, 473, 4781 and 56.

[18] Corresponding in ISIC Rev. 4 to headings 64 and 66. All interests and dividends are supposed to be paid through the banking system.

[19] In terms of the forthcoming ISIC Rev. 4 classification, this includes headings 84 - 88.

[20] Including Non-profit institutions serving households, NPISH

	A	B	R	V	G	C	V'	X	I	SUM
A	AA	BA	RA	VA	GA	CA	V'A	XA	IA	A
B	AB	BB	RB	VB	GB	CB	V'B	XB	IB	B
R	AR	BR	RR	VR	GR	CR	V'R	XR	IR	R
V	AV	BV	RV	V	G	C	V'V	X	I	SUM
T	AT	BT	RT	T	GT	CT	T'	XT	IT	TG
W	AW	BW	RW	W	GW	CW	W'	XW	IW	WC
V'	AV'	BV'	RV'	VV'	G'	C'	V'	X'	I'	SUM'
Z	AZ	BZ	RZ	Z	GZ	CZ	Z'	XZ	IZ	ZX
S	AS	BS	RS	S	GS	CS	S'	XS	0	S"=I"
SUM	A	B	R	SUM	TG	WC	SUM'	ZX	I"=S"	SUM"

Table 1: Simplified symmetric input-output table of a given country

The lines and columns V and V' stand for intermediate totals. Line V' gives the total of all the lines preceding V', except the subtotal V (else we would have double-counting); the column V' gives the total of all the columns to the left of V' except the subtotal V. SUM and SUM' designate the sums of lines or columns respectively. The terms of the last line S are balancing terms, due to which each line total equals the corresponding column total.

We now identify in the above table the closest possible approximation of the GDP that can be identified within a SIOT that partitions all agents. An exact representation is not possible as the GDP has become too sophisticated for a SIOT with partition of agents. We mentioned above the convention that all consumption of general government and NPISH is consumed by these sectors. If one wants to show the different agents' fiscal contribution to government costs (in the table above: line AT, BT, etc.) and also represent the convention that all output of government is consumed by it, we need to represent the government at least twice. A totally correct way to represent the GDP in all its definitions requires that government and households appear three times[21], because GDP is basically defined in supply and use tables SUT that are not symmetric[22]. The purpose of this article is to focus on the new GCP concept, this is why we only approximate the GDP.

GDP is defined in three distinct ways. One way of defining GDP (noted Y) is according to the expenditure or net final demand approach, whereby GDP is the sum of general government consumption G, private consumption C, net exports of goods and services, i.e. exports minus imports (X – Z) and gross capital formation I.

[21] For the GDP in a SIOT format cf. p. 253 of the UN Handbook of Input-Output Table Compilation and Analysis, Studies in Methods of National Accounting, Series F. No. 74, ST/ESA/STAT/SER.F/74, 1999
[22] cf. p. 74 of the UN Handbook of Input-Output Table Compilation and Analysis, Studies in Methods of National Accounting, Series F. No. 74, ST/ESA/STAT/SER.F/74, 1999

$$Y = G + C + X - Z + I$$[23]

Another way of defining GDP is according to the income approach, whereby GDP is the sum of net production and import taxes T (i.e. production and import taxes minus subsidies), employee compensation W and gross profits S (i.e. the sum of net profits and depreciations of fixed capital).

$$Y = T + W + S$$[24]

The third way of defining GDP is according to the value added or output approach. It equals gross production P minus intermediate consumption V plus net goods taxes D, i.e. goods taxes minus goods subsidies. P – V corresponds to gross value added.

$$Y = P - V + D$$[25]

In table 1, we can approximate GDP from the following equation:

From the SUM = V + G + C + X + I = V + T + W + Z + S
we get: Y = G + C + X – Z + I = T + W + S

The left hand side represents the expenditure approach, the right hand side the income approach of GDP. Note that the light shaded area of table 1 is excluded from GDP, meaning that the term V, standing for intermediate consumption, does not appear in the equation above that defines Y. Only dark shaded terms appear in the definition of Y.

The definition of GDP in the value added approach (Y = P – V + D) involves a quantity that would need a more disaggregated table than table 1, in order to be represented exactly. We would need the term D (net goods taxes, i.e. goods taxes minus goods subsidies or D(21 – 31) of the SNA. This term involves taxes that in the simplified table 1 are identified within T and are therefore already included without having to be mentioned. We propose to approximate GDP at value added approach by neglecting the adjustment D for net goods taxes, i.e. simplify GDP to gross value added: Y = P – V. Gross production P corresponds to SUM – Z of the table 1, intermediate consumption is given by V. GDP in the value added approach can then be stated as Y = (SUM – Z) – V.

Value added of the aggregate industry A can be noted AY and defined as: AY = (A – AZ) – AV. This is mathematically equal to AT + AW + AS, i.e. the contribution of the industry A to GDP in the income approach. Taking the sum of value added of all corporations, AY, BY and RY, gives GDP in the value added approach. GDP calculated this way is approximate. It neglects value added by the final sectors (general government, NPISH and unincorporated enterprises that usually are part of the households sector) as well as their capital formation. It also attributes interests and dividends (i.e. cost of capital) to intermediate consumption within R. These approximations originate in the fact that for the GDP, the distinction between intermediate and final demand is not exactly replicated on the production and income sides; primary inputs (capital, labour) are not produced by final consumers (government, households).

[23] In terms of the SNA, this is: B1*b = S13 + S(14 + 15) + P6 – P7 + P5
[24] In terms of the SNA, this is: B1*b = D(2 – 3) + D1 + (K1 + B*2n)
[25] In terms of the SNA, this is: B1*b = P1 – P2 + D(21 – 31)

3. Definition of GCP

The idea of GCP is to avoid the distinction between intermediate consumption and final consumption and to consolidate all activities of general government and household with activities of corporate enterprises. In other words, private and public consumption C and G are considered as intermediate consumption, government services as well as all primary inputs, such as labour, are considered as intermediate inputs. For GCP it is not important who consumes (intermediate or final sectors), but whether there is consumption or not, i.e. whether something still remains at the end of the period that can be added to capital or not. This is the essence of the capital approach of sustainable development.

GCP can formally be defined in three ways, similarly to GDP:

From the total $SUM' = V' + X' + I' = V' + Z' + S'$

we get GCP $Y' = X' - Z' + I' = S'$

The left hand side corresponds to the expenditure approach, a terminology that is however not appropriate for GCP, as it is not primarily the result of different types of expenditure, but of different types of capital formation, as we will see later. It should be renamed formation approach. The right hand side corresponds to the income approach. Also in this case, the terminology is not appropriate as this approach gives different types of capital depreciation and should be renamed depreciation approach. The value added approach can be found in the gross production $P' = SUM' - Z'$, from which we get $Y' = P' - V'$, which is the GCP definition in the value added approach. It is immediately evident that this is mathematically equal to S'. The terminology is also inappropriate in this case. It would be more appropriate to call it the capital added approach. It corresponds to what each agent adds to its capital at the end of the year.

Consolidation means taking only the input and output flows of a unit, neglecting its internal flows. In this sense, GCP consolidates all domestic flows of a country and does not contain the term V', the total domestic consumption, which includes all consumption (intermediate and final) by enterprises, government and households. In table 1, GCP Y' contains only dark shaded terms. If the GDP Y was understood as consolidation of some internal flows, one would say that it is a consolidation of all internal flows of all corporations (financial and non-financial), meaning that the intermediate consumption V is not counted in GDP.

We now show, that, if GCP is homogenously aggregated upward over all countries, it gives a global GCP. The formation approach ($X' - Z' + I'$) contains the terms X' and Z', corresponding to the current imports and exports. The rest of the world in line X and column Z of table 1 can be disaggregated into more than one country. For this demonstration, disaggregating it into two countries, 2 and 3 respectively, will suffice. X'23 means exports of country 2 to country 3 (implying a flow of money in the reverse direction) and analogously for the other off diagonal terms of table 2. The symbol Z is now superfluous. This disaggregation leads to table 2, which expands the last four lines and columns of table 1 to five lines and columns:

	Country 1	**Country 2**	**Country 3**	**I**	**SUM**
Country 1	V'1	X'12	X'13	I'1	SUM'1
Country 2	X'21	V'2	X'23	I'2	SUM'2
Country 3	X'31	X'32	V'3	I'3	SUM'3
S	S'1	S'2	S'3	0	S''=I''
SUM	SUM'1	SUM'2	SUM'3	I''=S''	SUM''

Table 2: Simplified table of international trade flows

For the sake of clarification, the following correspondence between table 2 and table 1 can be given; this correspondence table is the one relative to country 1. Taken in relation to countries 2 and 3, this correspondence must be rotated mutatis mutandis:

Table 1	Table 2
V'	V1'
X'	X'12 + X'13
I'	I'1
Z'	X'21 + X'31
S'	S'1
XZ	V'2 + X'23 + X'32 + V'3
IZ	I'2 + I'3
XS	S'2 + S'3

Table 3: Correspondence between tables 1 and 2 for country 1

From table 2 we get for country 1:

$$SUM'1 = V'1 + X'12 + X'13 + I'1 = V'1 + X'21 + X'31 + S'1$$

and analogous for SUM'2 and SUM'3 of countries 2 and 3. This gives the three GCPs for countries 1 to 3 respectively:

GCP1 $$Y'1 = X'12 + X'13 - (X'21 + X'31) + I'1 = S'1$$

GCP2 $$Y'2 = X'21 + X'23 - (X'12 + X'32) + I'2 = S'2$$

GCP3 $Y'3 = X'31 + X'32 - (X'13 + X'23) + I'3 = S'3$

It can now be seen that the sum of GCP1 + GCP2 + GCP3 simplifies to:

GCP global $Y'' = I'1 + I'2 + I'3 = S'1 + S'2 + S'3 = I'' = S''$

This result can be generalized to the case of n countries. Strictly speaking, it holds only in the case of fixed exchange rates. We find GCP at global level to be equal to global gross capital formation and global gross profits. The strict equality between Y", S" and I", including the equality of I" and S" as postulated by Keynes, is however verified only at the global level or in a closed economy. For each country, there is a difference between gross capital formation and gross profits that equals its current account balance $X' - Z'$[26].

As GCP equals gross capital formation or gross profits, it represents the Hicksian definition of sustainable income, which is the maximum amount an individual can consume during a period and remain as well off at the end of the period as he was at the beginning[27]. This is best illustrated by the example of an individual, who has as only source of income a portfolio of, say, 1 million USD. With an annual income of, say, 10%, the maximum amount that can be consumed is 100'000 USD, which corresponds to the gross capital formation of the year and is the sustainable income in the capital approach of sustainability.

GCP consolidates internal flows at all levels, meaning that it does not count them, but counts only the input and output flows. At global level it equals gross capital formation. At country level, it equals gross capital formation plus the current account balance (X' – Z'). At agents level, it is called gross capital added, noted e.g. AS for agent A and equals the agent's gross capital formation plus his balance of exchanges with all other agents. The formation approach is the most important one as it considers each other agent as potential source of capital formation:

$$AS = IA + (BA - AB) + (RA - AR) + (GA - AT) + (CA - AW) + (XA - AZ)$$

Taking the analogous definition for all other aggregate agents of the country and summing them equals:

$$AS + BS + RS + GS + CS = S'$$

This also shows that the gross capital added has to be defined by using the net (and not the gross) exchange flows of each agent. Only this guarantees that all the agents' gross capital added sums up to GCP at country level.

We now briefly clarify what differentiates GCP from gross profits or gross savings S of the current SNA93 and why it is justified to use the special term GCP and the symbols S' or Y' on the global and national level and the term gross capital added at agents' level. For corporate enterprises (in our case A, B and R) gross capital added is more or less identical to gross profits, but for general government and households, it is not, as some

[26] The current account balance is the balance of all compensations (goods, services, factor incomes), distinct from the capital and financial accounts balance that essentially shows borrowing and lending.
[27] Hicks, 1946, quoted on p. 4 of the Handbook of National Accounting, Integrated Environmental and Economic Accounting, 2003, edited by the UN, European Commission, IMF, OECD, and World Bank

forms of capital are totally excluded in current gross savings S. Capital is understood here as any stock of wealth in five forms (financial, manufactured, human, natural and possibly social) that may contribute to generating an income flow. By putting capital formation into the centre of interest, the rules used to identify it may have to be stated more precisely and homogenously.

Financial capital is primarily generated by exchange as the above formula stating the capital formation of the agent A shows. At the level of an agent, all summands of the formula are related to exchange, except IA. Exchange is the zero sum part of the economic game. The non-zero part comes from IA. Exchange is needed to make the non-zero part profitable. At the global level, there is no exchange, we have Y' = I' = S'. Originally, the formation of financial capital was the easiest to measure, involving only money counting. For this reason, money has become the measurement instrument for all other forms of capital. For financial capital, GCP equals gross profits or gross savings S. With the development of financial derivatives, the evaluation of the formation of financial capital has become very sophisticated.

Manufactured capital is generated by the accumulation of produced durable and consumable goods. Like all the other non-financial forms of capital it is part of the non-zero sum game, i.e. the core determinant of economic growth. At the level of agents, it is measured by periodically inventorying the agent's goods. For agent A, an increase of inventory between the beginning and the end of the period is an earning and is written into IA. This entails an increase of the term A, which is the sum of line and column A. Hence it also increases the balance term AS of agent A. On the contrary, a decrease of inventory or loss of value (depreciation) over the period is an expenditure for agent A and written directly to AS. The net capital formation is calculated after taking the difference between increase and decrease[28]. The question is whether gross capital formation shall contain no subtraction (netting) at all between partial increases and decreases, or whether partial netting is desirable. In this respect, fixed capital (durables) is very different from variable capital (inventories, consumables). Fixed capital includes buildings and infrastructure as well as equipment, such as machinery, trucks, livestock. As it is not physically consumed during the period, but loses quality and therefore depreciates, it makes sense to write its formation by agent A into IA and to write its depreciation separately into AS. The sale of fixed capital by agent A has however to be written into IA with a negative sign (netted), as the acquirer, e.g. agent B, will write it into IB. Only this convention allows homogenous aggregation over all agents. The same has to apply to variable capital. Furthermore, if agent A consumes one stock of variable capital (e.g. milk) and thereby produces another stock of variable capital (e.g. butter), then the diminution of the one must be netted with the increase of the other within IA. Contrary to GDP, there is no reason to ignore in GCP price changes of capital in capital formation, provided they are real[29] (and not nominal) price changes and that volatility is eliminated,

[28] In analogy to the net domestic product NDP, it is possible to define a Net Consolidated Product NCP by deducting from the GCP the annual depreciation of fixed capital.

[29] Theoretically real prices should be measured in a real value unit that is constant and guaranteed to be independent from human behavior. Basket prices do not satisfy this criterion as the weights of their components depends on buyer preferences. This author has recently proposed a constant physically based

by taking mean prices of the past period. For fixed capital, any price increase of agent A should be written into IA and any decrease separately into AS. For variable capital the movements should be netted in IA. In GDP, capital formation of households is limited to dwellings. For GCP, households have to be treated like incorporated enterprises and all their gross capital formation (equipment, cars, inventories) should be counted. As households do not normally keep accounts, the corresponding figures have to be estimated on the basis of other data, e.g. from car registries or from fire insurances.

Human capital is a form of produced capital, yet ignored in GDP. It is often falsely associated with high schools and high tech industries. These are certainly of primary importance for generating human capital, they are however only service providers to the households. High tech industries are reminded of this wisdom each time they experience brain drain. The true owners of human capital are households. For coherence, human capital includes those elements of human health that can be capitalized. The formation of human capital is composed of the gross increase of education and skills in the population on a given hierarchy of education levels for each profession, whereby the increase can be natural (birth and training) or immigrant-based. The skills should be priced at their production cost, i.e. the cost of the corresponding education (vintages)[30], as only in rare cases a transfer price actually exists (e.g. in top-level football). In all cases, the great advantage of attaching human capital formation to households is that it can easily be depreciated following the demographic movements. The corresponding gross annual loss of human capital comprises natural losses (retirement, death before retirement and possibly reemployment at a lower level after unemployment) and emigration-based losses. As human capital is a kind of fixed capital, its formation is part of GCP and written into IW, whereas its natural losses are written into CS and its migratory losses netted in IW with negative sign, as they appear with positive sign in IW of the recipient country.

Natural capital comprises all the mineral resources (lithosphere), water resources (hydrosphere), air (atmosphere) as well as the biosphere (fauna, flora). Sunshine is a flow and therefore not a capital. The owner of natural capital is the government. Natural capital can be included in GCP to the extent it is priced. This is only the case, if a corresponding legislative framework provides for a licensing regime creating walrasian scarcity[31] of a resource and hence a price. In the absence of such a regime, it is not the role of national accounting to bridge the gap by fixing hypothetical prices. To the extent prices exist, the gross capital formation will be written in IT and the depreciation in GS. For the purpose of accounting, it is convenient to consider the lithosphere, hydrosphere and atmosphere as variable capital and the biosphere as fix capital[32]. This means that

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value unit named Walras and estimated its purchasing power for the Swiss Franc in 2003, cf. S. Defilla: A natural value unit - Econophysics as arbiter between finance and economics, Physica A, 382 (2007) 42 - 51.

[30] In analogy to Solow's model with capital vintages, cf. Haines, Joel D. (January 1, 2006) Competitiveness Review A framework for managing the sophistication of the components of technology for global competition. Volume 16; Issue 2; Page 106. Theoretically it would be possible to price skills according to the income they earn. If that option was chosen for human capital, it should also be chosen for all other forms of capital. This would represent a major change with respect to current practice.

[31] L. Walras: Elements of Pure Economics or the Theory of Social Wealth, translated by W. Jaffé, Orion Editions, Philadelphia, PA, 1984, p. 65.

[32] Biological resources allow to produce other biological resources and are therefore fix capital.

gross natural capital formation IT is composed of the build-up of priced biodiversity plus the net increase of priced resources in the lithosphere, hydrosphere and atmosphere. The loss of priced biodiversity is considered as depreciation and written into GS. In order to facilitate the step by step introduction of natural capital into GCP, it is important that changes of real prices are considered as changes of GCP.

Social capital is the most difficult capital form to be measured. It is a kind of produced capital composed of social ties in all its forms, e.g. social networks, family and community ties, clubs, NGOs, etc. Social capital is important for the information of its participants who all are also market agents in their respective fields. The idea is that social capital would increase with an increase of the number and role of such social institutions and it would decrease with their decrease or with e.g. an increase of social conflicts. In terms of accounting, social capital represents fixed capital, attached institutionally to Non-profit institutions serving households (NPISH) and hence formed in IW and depreciated in CS in our simplified table 1. It can only be counted in GCP to the extent it is not counted elsewhere, e.g. neither in human capital nor in manufactured capital of the social networks. Furthermore, it can only be counted, if its unit production cost is known. In that case, the total production cost could be a function of the number of its members, such that depreciation could go with decreasing membership. As for the moment no reliable unit cost figures are available, GCP should not include social capital.

GCP Y" at global level is normally positive and can only be zero in the very special case if all gross capital formation of all agents worldwide is zero. The global NCP can however be positive or negative; it is negative, if global gross capital formation is less than global gross depreciation of fixed capital, which denotes a lack of sustainability. GCP at national level is positive as long as gross capital formation of a country, including human capital formation, exceeds the current account deficit.

GCP needs much less data than GDP. The SNA and the SEEA together contain all data to calculate GCP except data on households concerning gross human capital formation and manufactured capital formation of households.

4. Application of GCP to climate policy

The problem of climate change is caused by a disproportionate anthropogenic emission of greenhouse gases GHG[33] as compared to the natural absorption of these gases in so-called sinks. Under solar radiation, the resulting increased concentration of these gases in the atmosphere causes an increase of average global temperature (greenhouse effect). Following an original proposal by the EU[34], an increase of 2 degrees centigrade is today widely considered as the maximum sustainable increase, beyond which the climate is believed to undergo irreversible damage.

[33] According to the Kyoto Protocol: CO2, CH4, N2O, HFCs, PFCs and SF6. By far the most important one is CO2. It serves as measurement unit for all the others whose effects are calibrated on the ones of CO2. For this reason, one can refer to GHG quotas as CO2 quotas;
http://unfccc.int/resource/docs/convkp/kpeng.html

[34] cf. EU communication of 7th January 2007, COM(2007) 2 final, Limiting Global Climate Change to 2 degrees Celsius. The way ahead for 2020 and beyond.

A purely market-based solution to this problem would consist in scientifically determining a unique global maximal periodic (e.g. annual or daily) emission quota (sustainable emissions target), which would be auctioned by a global climate agency (sale of walrasian scarcity). This global approach is not realistic today, but would be the most efficient method of tackling a global problem of this kind. Emitters all around the world would have to buy all their GHG emissions of the period in this auction. Auction revenues would be used for paying the damage of climate change (e.g. consequences of hurricanes and floods), for developing carbon-poor technologies (renewable energies) and for increasing the GHG sequestration capacity of nature (e.g. carbon capture and storage or increased reforestation).

The Kyoto protocol[35] follows a national approach. Each industrial country took a specific commitment to diminish its GHG emissions between 1990 and the average of the years 2008 - 2012 by a certain percentage. Strictly speaking, this approach is not based upon emissions, but upon changes of emissions and contains also an element of grandfathering (i.e. the right to continue doing as before). Negotiations for the next commitment period are under way. Their main difficulty will be to find a consensus on a set of national reduction quotas, which on the one hand are sufficiently high for attaining the overall objective of avoiding climate change, and on the other hand neither advantage nor disadvantage any country in its economic development. This matters especially for developing and newly industrialized countries that are reluctant to accept targets at all.

As neither emission reduction targets nor absolute emission targets take into account the level of economic development, a possible idea could be to fix GHG-intensity targets, i.e. ratios GHG / GDP or , better, sustainable GHG-intensity targets, GHG / GCP. The global sustainable emissions target would be divided by the global GCP respectively for getting the annual global sustainable intensity target. As long as GHG emissions are not decoupled from economic GCP-growth, any sustainable intensity target would have to be revised annually (i.e. diminished). Each country's intensity could be compared with the global sustainable target. Countries that are above this target (deficit countries in terms of emissions) should reduce emissions or buy emission rights from the countries that are below the global target (surplus countries) that may expand their emissions or sell their emissions rights.

It could be interesting to investigate how the ranking order of countries is expected to change if GDP or GCP intensities instead of GHG emissions are chosen as target, the highest order of these rankings being always the country that best fulfils its respective target. The GDP or GCP intensities favour all those countries that have a lower GHG / GDP or GHG / GCP ratio than the respective sustainable global intensity target and penalize the other ones. Table 4 lists GDP intensities of selected countries for 2004.

If for instance the sustainable global intensity target was a quarter of the 2004 global intensity, it would have been 0.12 kg / USD 2000 PPP, a number that would diminish in subsequent years as the global GDP grows. In 2004, only few rather poor countries would have satisfied the target. Energy producing as well as transition countries would have failed most.

[35] http://unfccc.int/resource/docs/convkp/kpeng.html

Country	CO2 emissions (Mt)	GDP (PPP bln. USD 2000)	CO2 / GDP (kg / USD 2000 PPP)
World	**26583**	**52289**	**0.51**
OECD	**12911**	**29493**	**0.44**
G8 and BRICS			
Brazil	323.32	1385.12	0.23
Canada	550.86	946.9	0.58
China (rep.pop.)	4732.26	7023.71	0.67
France	386.92	1678.33	0.23
Germany	848.6	2160.03	0.39
India	1102.81	3115.31	0.35
Italy	462.32	1495.76	0.31
Japan	1214.99	3431.64	0.35
Russia	1528.78	1309.12	1.17
South Africa	343.36	468.12	0.73
United Kingdom	537.05	1661.29	0.32
United States	5799.97	10703.9	0.54
High end (>120)			
Bahrain	16.95	13.66	1.24
Brunei Darussalam	5.19	4.16	1.25
Iraq	81.22	27.13	2.99
Kazakhstan	162.15	102.53	1.58
DPR of Korea	70.2	30.78	2.28
Kuwait	64.85	43.82	1.48
Libya	43.51	33.71	1.29
Netherl. Antilles	3.66	2.94	1.24
Qatar	38.57	25.74	1.50
Serbia Montenegro	52.97	21.9	2.42
Trinidad Tobago	22.15	14.57	1.52
Turkmenistan	39.33	28.95	1.36
Uzbekistan	126.21	45.03	2.80
Low end (< 12)			
Cameroon	2.89	32.04	0.09
Dem. Rep. Congo	2.24	36.17	0.06
Ethiopia	5.07	48.6	0.10
Haiti	1.59	13.69	0.12
Mozambique	1.82	22.08	0.08
Myanmar	9.32	267.01	0.03
Nepal	2.97	36.41	0.08

Table 4: CO2 emissions and CO2 / GDP intensities of selected countries in 2004[36]

Remark that the GDP intensity can not be broken down homogenously to all agents, including households, as employee-households produce no value added and have therefore no GDP intensity. A GDP intensity would require a separate emissions quota for employee households. On the contrary, GCP intensities can be homogenously broken down to all sectors, activities and agents.

[36] IEA: Key World Energy Statistics 2006

In the absence of GCP figures it is of course premature to draw any conclusions how the above ranking would change, if GCP intensity would be taken instead of GDP intensity. Nonetheless, some qualitative indications are given below. A corresponding GCP ranking is likely to be very different, as GCP contains neither governmental nor private consumption, but contains instead human capital formation. Compared to the above GDP ranking, GCP ranking would favour those countries having a small consumption level and a strong population growth that is being reflected in human capital formation. As developing and newly industrialized countries have still comparatively low, albeit fast growing, consumption levels and a strong population growth, GCP intensity is likely to favour them twice compared to GDP intensity.

GCP is however also equal to the current account balance plus gross capital formation including human capital formation. It favours countries having a positive current account[37] (China, Japan, Germany, Saudi-Arabia, Russia, Switzerland, Norway, Netherlands, Kuwait) and strong gross capital formation including population growth. It disfavours countries having a heavily negative current account balance (US, Spain, UK, Italy, Australia, Turkey, Greece, France) and weak capital formation with a stable or declining population.

GCP target approach might not work for countries, whose GCP is negative. Among these, one expects not only some very poor countries having little capital formation and a negative current account balance, but probably also some of the richest countries, such as the US, whose impressive negative current account balance would probably not be upset by positive gross capital formation even if gross human capital formation is included.

5. Conclusion: Discussion and interpretation

The GCP concept presented here is not meant to replace the GDP concept, just as the NASDAQ did not render obsolete the Dow Jones. GCP might however change the interpretation of GDP: GDP and value added might loose their status as universal well-being indicators and retain an interpretation of primarily being an indispensable fiscal quantity. It would, on the contrary, be totally counterproductive to tax GCP flows in the same way as value added is being taxed by VAT. GCP contains the core of non-zero sum sustainable economic development and growth and should be totally exempt from taxation and from any other obstacles.

Hereafter we discuss GCP in the context of different types of market failure.

People in search of a true indicator of sustainable income might be disillusioned with GCP as it is heavily market-based. Truly, GCP shares some of the inherent limitations that are known to exist for GDP. These concern a first type of market failure, namely the one related to natural capital, where markets do not exist unless they have been specially introduced by a regulatory framework creating walrasian scarcity and allowing government to sell its natural resources. This is also called internalization of externalities, in this case of positive natural externalities, but externalities might just as well be

[37] IMF World Economic Outlook database, 2006

negative ones like CO2. Neither GDP nor GCP proposes to set hypothetical prices in the case of such market failures. Where governments have failed to create this kind of regulatory framework, the national accountant can not but remind the governments of the need for action. Once such action has been taken, GCP takes it into account.

GCP goes further than GDP in the case of a second type of market failure related to produced non-market goods. An example of such a good is the classical public good, for which there is no market. To the category of produced non-market goods in the widest sense belong however all produced goods whose production costs are above market price, which therefore need some kind of third party financing. GDP has begun to value non-market output like e.g. government output at its production cost. GCP extends this method to human capital by evaluating it at its production cost and considering it as a form of capital. Evaluating at production cost bears the genuine risk of overvaluation, as the story of agricultural good can tell, except that with non-market goods, the amount of overvaluation is not known. This evaluation has however a certain economic reality behind it, namely its cost, which is being borne by the producer.

Neither GDP nor GCP corrects for overvaluation in case of a third type of market failure, more precisely the partial market failures or market distortions caused by lack of competition or the abuse of dominant positions or market power (natural monopoly).

GCP is more robust than GDP in case of a fourth type of market failure related to non-market exchanges within a unit. Unpaid household production is an example of such a non-market exchange, but more generally, any non-market service rendered by a given unit of a corporation to any other unit of that corporation also belongs to this category. Any non-market exchange within a corporation can be understood as de facto partial consolidation within that corporation. The greater robustness of GCP in this respect comes from its homogenous aggregation properties: by definition, GCP does not change in case of consolidation between any agents, i.e. it does not change, if agents are counted separately or as a common unit. On the contrary, GDP only allows consolidating within the same group, i.e. within final or within intermediate consumers, without being affected quantitatively. In case of consolidation of e.g. enterprises with households, GDP changes, which has been paraphrased by Hicks in his famous saying that the GDP diminishes if you marry your cook.

Both, GCP and to a large extent GDP take into account the fifth type of market failure, the failure of all markets to yield real prices. Markets can only yield nominal prices. All real prices must be calculated by the national accountant, except the one of the numeraire that is fix by definition. Both, GCP and GDP therefore correct nominal market prices for inflation and changes of exchange rates for their purchasing power difference. GDP does not however consider pure gains of holding capital as production and, therefore, does not count them. On this point GCP is more walrasian in its approach: a real price increase of capital is a genuine wealth increase, provided it is not mere volatility. Volatility is a partial market failure in the sense that markets do not fix a price more exactly than what is given within the price band determined by the standard deviation of the price. Volatility can easily be overcome by taking average prices of the past period.

Neither GDP nor GCP can take into account a sixth type of the market distortion caused by information asymmetry.

7. Bibliography

Atkinson, Giles: Sustainability, the capital approach and the built environment, Building Research & Information, 36:3, 241 — 247 (2008).

Daly, H. & Cobb, J: For the Common Good. Beacon Press, Boston, 1989.

Defilla S: A natural value unit - Econophysics as arbiter between finance and economics, Physica A, 382 (2007) 42 - 51.

M. de Haan and S. J. Keuning: Taking the environment into account: the NAMEA approach. Review of Income and Wealth, Series 42, Number 2, 1996.

Haines, Joel D: Competitiveness Review A framework for managing the sophistication of the components of technology for global competition. Volume 16; Issue 2 (January 1, 2006).

Hicks, J. R: Value and Capital, 2nd Edition, Oxford: Oxford University Press (1946).

Duncan Ironmonger: Counting outputs, capital inputs and caring labor: Estimating gross household product, Feminist Economics, Taylor and Francis Journals, vol. 2(3), pages 37-64, January, 1996.

J. S. Landefeld, S. H. McCulla: Accounting for nonmarket household production within a national accounts framework, Review of Income and Wealth, Series 46 Number 3, September 2000.

Lawn, P.A.: A theoretical foundation to support the Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), and other related indexes. Ecological Economics **44** (2003) 105-118.

F. Lequilier, D. Blades: Understanding National Accounts, OECD, 2006, online: http://www.oecd.org/document/58/0,3343,fr_2649_34245_38445370_1_1_1_1,00.html

Nic Marks, Saamah Abdallah, Andrew Simms and Sam Thompson: The Happy Planet Index: An index of human well-being and environmental impact, New Economics Foundation, UK, July 12, 2006

Nordhaus, W. and J. Tobin: Is growth obsolete? Columbia University Press, New York, 1972.

Pearce, D.W., Markandya, A. and Barbier, E.B: Blueprint for a Green Economy, Earthscan, London, (1989).

Porritt, Jonathon: Capitalism. As if the World Matters, Earthscan (2005, revised 2007).

Rao VVB: Human development report 1990: review and assessment. World Development, Vol. 19 No. 10, pp. 1451–1460, 1991.

UN Handbook of Input-Output Table Compilation and Analysis, Studies in Methods of National Accounting, Series F. No. 74, ST/ESA/STAT/SER.F/74, 1999.

UNDP (1990) Human Development Report 1990: Concept and Measurement of Human Development. Oxford University Press. ISBN 0195064801

United Nations, European Commission, International Monetary Fund, Organization for Economic Co-operation and Development, World Bank: Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003. Final draft circulated for information prior to official editing.

Wackernagel, Mathis & Rees, William: Our Ecological Footprint (New Society Press) (1996).

L. Walras: Elements of Pure Economics or the Theory of Social Wealth, translated by W. Jaffé, Orion Editions, Philadelphia, PA, 1984.