The gross prosperity product as a second-order econometric indicator

We propose that a second-order econometric indicator that we shall name the gross prosperity product (GPP) is the most meaningful measure to compare economies for year-to-year growth and against each other. To place the argument in the right context, it is useful to go to an early set of ordered indicators. In the history of science, it was Euler, building on the work of Archimedes, who first laid down the beginnings of such an understanding. Figure 1 and Table 1 summarize the steps in going beyond the simple mensuration of area of a plane figure (which is a zeroth-order term) to compute moments about predetermined axes (first-order moment of area) and various second-order moments of area (also known as moment of inertia). The various second-order moments of area are related by an additive theorem familiar to all as the parallel axis theorem. Also introduced are thermodynamic analogies that help us carry the consilience forward through bibliometric indicators to economic indicators (Tables 1 and 2).

Prathap[1,2] showed that primary indicators which are proxies for quantity and quality in bibliometrics led to higher-order indicators, of first or second order depending on the power to which the quality proxy has been raised, which become proxies for performance. The process is summarized in Tables 1 and 2, starting with raw data which collect the citation sequence, i.e. for a series of P papers in a portfolio, the citations c_i for $i = 1$ to P are gathered. P is the primary proxy for quantity of output. The total number of citations given by $C = \sum c_i$ is a composite indicator incorporating both quantity and quality (quasity is the new terminology introduced by Prathap[1,2]). The impact, given by $i = C/P$, is therefore the proxy for quality. The 'thermodynamic' consilience[1,2] then suggests that the quality term be raised to the second power in the definition of what is called the exergy term X. That is $X = i^2P$. Thus, total citations $C = iP$ can be interepreted as a composite indicator of performance of the first-order, where quality is raised to the first power. It is also possible to imagine a parallel energy term E and a non-statistical thermodynamic entropy S as shown in Table 1 and these are related by the additive relationship $E = X + S$. Recent studies[1,2] seem to suggest that the most meaningful single-number measure of bibliometric performance is the second-order indicator X.

We can easily extrapolate these learnings from bibliometrics to econometrics. The primary indicators in econometrics which are proxies for quality and quantity are the per capita income and the size of the population. From these, composite performance indicators can be derived as being of first order (GDP for gross domestic product) or second order (GPP) depending on the power to which the quality proxy has been raised.

Table 2 shows the correspondence between the evolution of the various bibliometrics indicators and the econometric indicators. If a country is taken as a unit and has a population p and a GDP c, then the per capita income is given by $i = c/p$. The population p is the zeroth-order measure of size ($p = i^0p$). Then, the GDP becomes the first-order measure of econometric performance ($c = i^1p$). We now propose an econometric indicator of second order[1,2]. Thus at the unit level, the second-order econometric indicator is $e = x = i^2p$. It appears that at the unit level, one cannot make a distinction between e and x. However, when nations are grouped together, so that $C = \sum c$, $P = \sum p$, $I = C/P$, $E = \sum e$ is distinct from $X = IC$. At this level, except where there is perfect equality across all nations in the comity, $X < E$. Thus X/E becomes a useful measure of inequity.

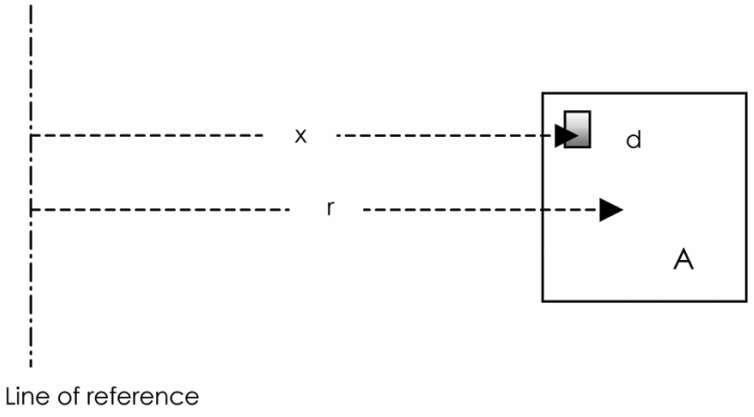

Figure 1. Plane area with reference axis for computation of various moments of area.

Table 1. Evolution of moment of area indicators of various orders for a plane area and the additive rule for the second-order indicators, also known as moment of inertia. The correspondence with various bibliometric indicators is also shown

	Zeroth-order indicator	First-order indicator		Second-order indicator			
	Quantity	Quasity	Quality	Energy	Exergy	Entropy	Energy theorem
Moment of areas	Zeroth moment $M_0 = A = \sum \mathrm{d}a$	First moment $M_1 = \sum x\,\mathrm{d}a$	Centre for gravity $r = M_1/M_0$	Second moment $M_2 = I = \sum x^2\,\mathrm{d}a$	$X = r^2A$	$S = \sum (x - r)^2 \mathrm{d}a$	$M_2 = X + S$
Bibliometrics indicators	Zeroth order $P = \sum 1$	First order $C = \sum c_i$	Impact $i = C/P$	Second order $E = \sum c_i^2$	Exergy $X = i^2P$	Entropy $S = \sum (c_i - i)^2$	Energy theorem $E = X + S$

Table 2. Correspondence between bibliometric and econometric indicators of different orders

		Quantity	Quasity	Quality	Energy	Exergy
		Zeroth order	First order	Per capita GDP	Second order	Second-order GPP
Econometrics indicators	Country level Comity level	p = Population $P = \sum p$	c = GDP $C = \sum c$	$i = c/p$ $I = C/P$	$e = ic = i^2p$ $E = \sum ic$	$x = ic = i^2p$ $X = IC$
Bibliometrics indicators	Portfolio level	Zeroth order $P = \sum 1$	First order $C = \sum c_i$	Impact i = C/P	Second order $E = \sum c_i^2$	Exergy $X = i^2P$

Table 3. The various econometric indicators ranked according to gross prosperity product (GPP) for the eight most prosperous countries, and Luxembourg, India and China

Per capita GDP		Zeroth-order – indicator		First-order indicator – GDP			GPP as a second-order indicator	
Rank	US$/person	Rank	Population	Rank	US$ m	Country	Rank	US$^{2}/person
15	48,147	3	312,892,101	1	15,064,816	The United States	1	7.25E + 17
18	45,774	10	127,919,408	3	5,855,383	Japan	2	2.68E + 17
19	44,558	15	81,435,949	4	3,628,623	Germany	3	1.62E + 17
20	44,401	21	63,247,787	5	2,808,265	France	4	1.25E + 17
5	66,984	51	22,503,911	13	1,507,402	Australia	5	1.01E + 17
22	39,604	22	62,644,632	7	2,480,978	United Kingdom	6	9.83E + 16
10	51,147	36	34,384,812	11	1,758,680	Canada	7	9.00E + 16
24	37,046	24	60,619,392	8	2,245,706	Italy	8	8.32E + 16
…	…	…	…	…	…	…	…	…
91	5,184	1	1,348,084,491	2	6,988,470	China	13	3.62E + 16
…	…	…	…	…	…	…	…	…
1	122,272	165	514,721	72	62,936	Luxembourg	34	7.70E + 15
…	…	…	…	…	…	…	…	…
136	1,527	2	1,207,191,880	10	1,843,382	India	46	2.81E + 15
…	…	…	…	…	…	…	…	…

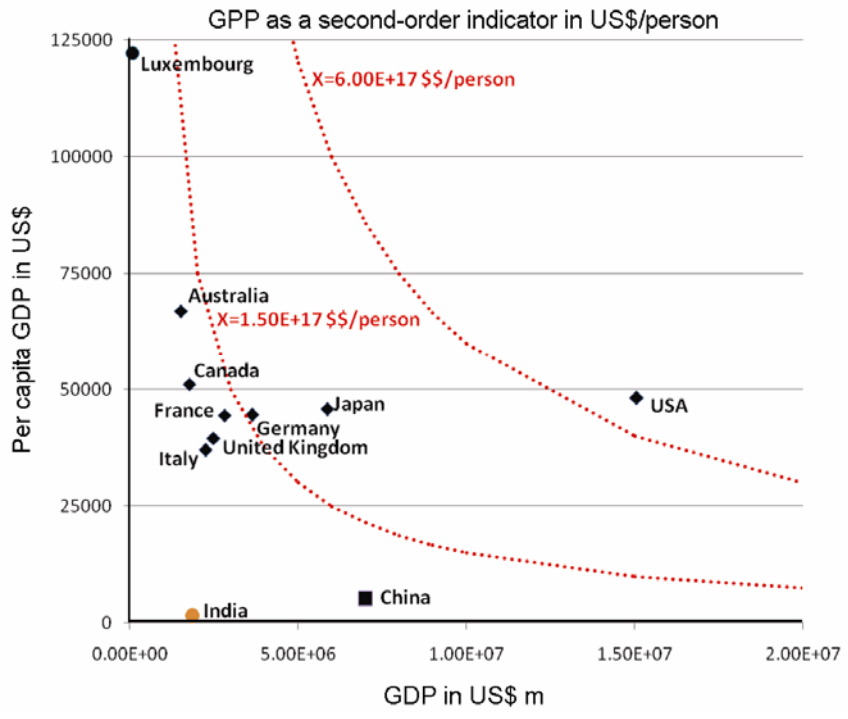

Figure 2. Gross Prosperity Product (GPP) for the list of the eight most prosperous countries and Luxembourg, India and China from Table 3.

Econometric data are taken for 184 countries from the IMF figures as displayed in Wikipedia (http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal), accessed on 17 January 2012). There is huge disparity in per capita income (US$ 122,272 for Luxembourg and US$ 197 for Burundi). The equity index was found to be 0.308 (where 1 means perfect equity across nations). Table 3 shows only the results for the top eight countries ranked according to the new GPP indicator, along with China, India and Luxembourg.

It has now become fashionable for consulting groups like Goldman Sachs, and bodies like the IMF and World Bank, to predict the eclipse of USA by pretenders like China and India. According to IMF China will achieve this feat by 2016; Goldman Sachs Asset Management says this will have to wait till 2027. Figure 2 captures the GPP (which fortuitously is a product of GDP and per capita GDP) on a two-dimensional map. We see that India and China are far from being close competitors to USA. It is possible by

taking the time series for GDP and per capita GDP figures to show the trajectories of these economies on the same contour map. This will be taken up as a future exercise.

We conclude that when a second-order indicator like GPP is used, China and India have a long way to go before they can be called the 'most prosperous' nations on earth. It is important that economics and other areas of social science, where indicators are being used increasingly, move up to this higher level of understanding.

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Occurrence of nontronite in amygdales of Deccan basalts at Nagewadi basalt quarry, Satara, Maharashtra

The smectite group includes dioctahedral smectite, such as montmorillonite and nontronite ($Ca_5(Si_7Al_8Fe_2)(Fe_{3.5}Al_4Mg_1)O_{20}(OH)_4$) and trioctahedral smectite – saponite ($(Ca/2, Na)O_3(Mg, Fe^{++})3(Si, Al)4O_{10}(OH)_2{\cdot}4(H_2O)$. Both nontronite and saponite are found to occur as amygdular fillings in basalts (http:/en.wikipedia.org/wiki/Clay minerals).

Green-coloured, well-crystallized, nearly monomineralic nontronite of hydrothermal origin has been recorded from marine white smoker chimneys of the Galapagos Rift and Mariana Trough[1]. Study on the relation between clay mineral and chemical characteristics as well as biological conditions at such sites suggests that Fe-oxidizing sheath-forming bacteria play a decisive role in nontronite genesis. Ueshima and Tazaki[2] recorded the possible role of microbial polysaccharides in the formation of nontronite in the surface layers of deep-sea sediments from Iheya Basin, Okinawa Trough, Japan. Singer *et al.*[3] recorded smectite close to the pure Fe end-member or the nontronite–beidellite series from fine clay separated from a 354 cm deep sediment core in the southeastern Pacific Basin. A sediment core containing a yellowish-green bed was recovered from an area of extensive hydrothermal deposition on the southeastern slope of the Eolo Seamount, Tyrrhenian Sea[4]. The clay bed is composed of pure nontronite, which appears to be the most aluminous nontronite ever found among the seafloor hydrothermal deposits. Study of the occurrence of nontronite in Washington, Idaho and Oregon of the Columbia River region by Victor and Veron[5] suggests that the nontronite has formed by weathering of basaltic glass, palagonite, iddingsite and augite under conditions of poor drainage in the presence of alkalis, magnesium and probably ferrous iron.

There are several quarries in the Deccan Traps at Nagewadi (17°45′24.39″N–73°59′24.31″E) on the Pune–Bangalore Highway. One such quarry located about 7.62 km north of Satara, Maharashtra exposes the basaltic lava flows in a 73.5 m deep cut. Here, a 40.5 m thick, vertically jointed compact basalt is overlain by 10 m thick, grey, amygdaloidal basalt. The amygdales are made up of greenish-grey clay mineral (Figure 1). The amygdales range in size from 0.11 to 0.16 cm and the average size is 0.75 cm. In general, the amygdales are rounded to sub-rounded in form. Rarely, other minerals found as amygdales include quartz and appophyllite. Overlying this flow is an approximately 3 m thick reddish, tuffaceous horizon with an appreciable concentration of secondary minerals. The tuffaceous horizon is overlain by another flow. The lower 10 m zone of this flow is grey, compact and amygdaloidal. The uppermost 10 m of the upper flow is highly weathered forming a typical soil horizon.

The greyish-green clayey mineral was carefully scooped out from the amygdales using a steel pocket knife. Its physical, optical and geochemical characterization has been carried out. The clay mineral exhibits a waxy luster and has a relative hardness of about 1.5–2.0. It yields a greenish-grey streak. Host basalt reveals intergranular and intersertal texture; sometimes glomeroporphyritic aggregates of plagioclase are seen. Plagioclase feldspar, pyroxene, olivine and opaques are primary minerals, whereas palagonite and iddingsite are secondary alteration products. Under the microscope, the clayey mineral appears opaque (Figure 2) and is traversed by randomly oriented undulating cracks.

Figure 1. Field photograph of the Deccan Trap exposure at Satara quarry. Note the vesicles entirely filled with greyish-green nontronite.