Towards an 'economic ice age'

Gas laws, when applied to money and economics, suggest that inequality is intrinsic but getting weaker

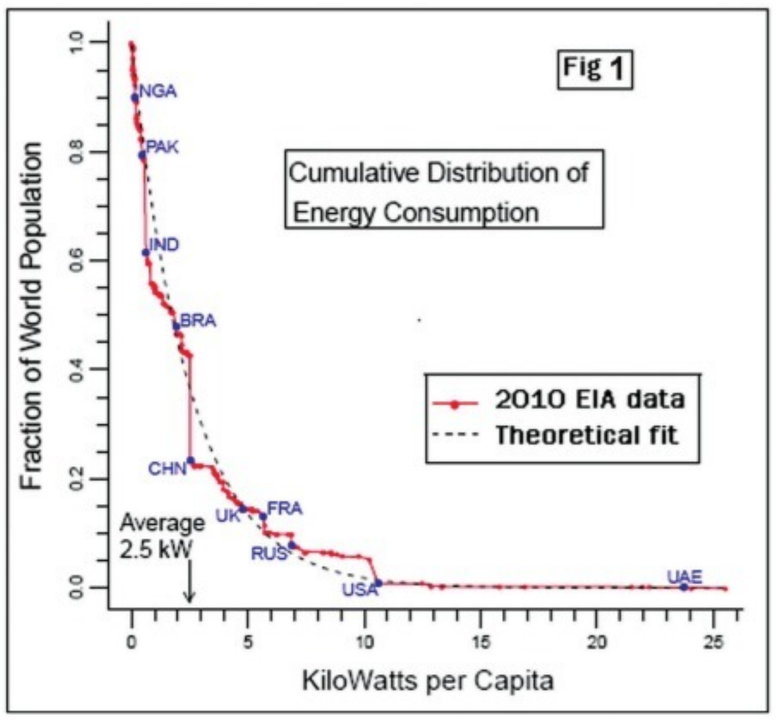
S ANANTHANARAYANAN

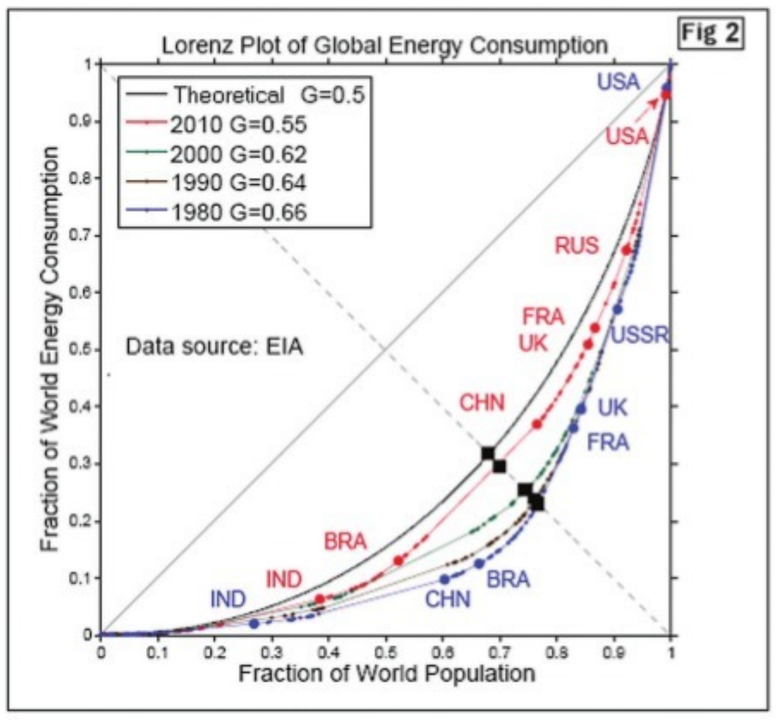
Adam Smith, the 18th century father of modern economics, said that the very motivation of the participants in a market — to seek their own gain — itself impels them to action that leads to better distribution of goods and prices for the consumer.

At a more mechanical level, the molecules of a gas, which are in constant and rapid motion, interact with other molecules when placed in a container. These interactions are known to follow well-documented rules, particularly that the total energy of motion when one molecule bounces off another, remains constant. One particle may hence end up with more energy than it started with, but only thanks to something given up by another particle. The second particle is then likely, in the next encounter, to regain the energy lost. The way the speeds of the molecules distribute themselves, finally, is that very few particles have high or low energy but a great many have a level of energy that falls in between. This level of most common particle energy can be shown to be the one where there is the greatest number of different ways for the molecules, with various speeds of motion, to have the same total energy. It could also be called the point of most equitable distribution of energy, given the dynamics of collisions and the conservation of total energy.

Victor M Yakovenko, Qin Liu and Scott Lawrence, of the Joint Quantum Institute, department of physics, at the University of Maryland, have drawn a parallel between the way molecules of a gas tend to share energy and the way incomes, energy use and CO_2 emissions tend to be distributed among the populations of the world. They reported their findings, some months ago, in the journal, *Entropy*. The paper in is based on the US Information Administration International Energy Statistics, which show the historical and projected data, of energy use and emissions.

Although there is improvement in the efficiency of power generation, in terms of lesser emission, both power consumption and emission have been increasing, with rising population. The paper notes that the energy consumption and population of developed countries have stabilised and it is the developing world, like China for energy, and India and others for population, which account for the global increase. This trend, however, is the result of great energy inequality among countries. While the total consumption by developing countries is still less than other countries, the inequality becomes acute if population is taken into account and countries are characterised by consumption per capita.





To see if the gas laws could help in understanding economic activity, the researchers treated the money with an individual as equivalent to the speed of a molecule. In transactions between individuals, like in collisions of molecules, there would be exchange and redistribution of money. The comparison is valid because the total money in a system, like the total energy in a gas, is conserved, or stays constant, for some time. The proposition was that after allowing for the possibility of debt, which does not exist in molecules of a gas, money also distributes itself, with mathematical precision, in the same way as the speed of molecules. In studies of actual distribution of money, to verify the notion, there is a difficulty of different currencies and purchasing power, in cross border comparison. Studies were therefore made of the distribution of income in the US, UK, Australia, EU countries, Romania and others — the results are that the distribution of the number of persons in increasing income ranges, in most cases, over a group of 97 per cent of the population, is exactly like energy in the case of a gas. For the comparison between countries, the differences in currency and purchasing power were not accounted for by taking the energy consumption per capita to represent physical living standards. The studies used data of the World Resources Institute, of 130 countries from 1990 to 2005 and from the US Energy Information Administration, which covers 220 countries over 1980 to 2010. In using energy consumption as a measure, the world-wide energy resources were considered as redistributable and as constant, as also the population of countries, at least for a time.

The proposition again, is that the proportion of persons with higher energy consumption should fall, as the level of energy consumed is raised, in the same way as the distribution of the molecules of a gas. The data is found to strongly support the proposition and the current data shows a progression from highly unequal distribution in 1980 to more uniform, and closer to theory, distribution in 2010 — a feature which the authors of the paper attribute to globalisation of the world economy.

The distribution in 2010 is shown in figure 1, which plots the falling numbers of people who consume increasing levels of energy in the 220 countries studied. The average energy consumption in the main countries of the world is also indicated. A revealing representation of the data is with the help of the so-called Lorenz curve (figure 2), which plots the fraction of energy consumption against fraction of the population at that level of consumption.

The curves for different years, 1980, 1990, 2000 and 2010 have been shown. A case where the numbers of consumers increase uniformly as we consider larger fractions of energy would be complete equality and this is the straight, diagonal line in the graph. The other lines — the curves — indicate actual conditions, from 1990 to 2010, with the deviation from the ideal reducing every decade.

How far the Lorenz curve deviates from the ideal, diagonal, straight line indicates the level of inequity and is measured by a metric called the Gini coefficient — abbreviated as G — of the Lorenz curve. One can see that G=0 is the diagonal itself, where everything is equal, and the opposite is G=1. The figure shows that the G value has been falling from 0.66 to 0.55, approaching the value of G=0.5, which is the equilibrium state of natural distribution, with large numbers of interactions and transactions, as in a volume of gas. The fall from 0.66 to 0.55 indicates reducing inequality and is attributed to the globalisation of the economy in recent decades.

The authors drew a parallel with temperature inequality and the tendency of nature to equalise temperature, which amounts to the dismantling of an element of "order" being the driving force in physical systems. This can also be stated as the tendency to maximise disorder, and another word for the level of disorder is entropy.

The authors note that developed countries now have ageing populations and reducing consumption, including of energy, and stagnating growth. But developing countries, China particularly, have become rising consumers of energy, per capita. And even this growth is slowing down and there is talk of an "economic ice age", the paper noted. While different causes have been suggested, the authors propose that the slowdown appears to be intrinsic and, in terms of thermodynamics, arises from falling inequality and increasing entropy.

On a brighter note, they ask if economic slowdown may bring in reduced carbon emissions and slow down climate change. The progression from 1980 to 2010, however, only shows changes in distribution, not control of emissions. While the parallel with thermodynamics helps with insight into the mechanisms at work, population control and using renewable energy sources may allow growth and economic activity without affecting the environment.

The writer can be contacted at response@simplescience.in

Don't call them ancient

The Dani people — an indigenous tribe of New Guinea — are alive and well, and were part of a thriving agricultural society long before Westerners 'discovered' them in the 1930s

EMMA GILBERTHORPE

In *Down the Mighty River with Steve Backshall*, the adventurer and naturalist took a journey through New Guinea, the world's second largest island. As he travelled along the Baliem River for the new documentary series, through some of the densest jungle on the planet, Backshall visited the Dani people, which the *BBC* described as an "ancient tribe".

I spent two years living with groups not far from the Dani, and was disappointed to hear this sort of language still being used. This distorted perspective perpetuates the myth of the "living fossil" or the "backwards tribe".

After all, what exactly is an "ancient tribe"? Surely, by definition, an ancient tribe is either really, really old, or really, really dead. The Dani are neither. Nor are they "backward". The 25,000 or so Dani people scattered across the Baliem Valley are very much alive and well, prospering in a challenging region despite being faced with land dispossession from mining, military control from Indonesia, and the occasional film crew from "the West".

Indeed, the Dani have featured in several TV and film documentaries over the years. The first of these, *Dead Birds*, made in the early

1960s by anthropologist-filmmaker Robert Gardner, followed two males as they went about their everyday business. Back then, the Dani were a model of "tribal culture" representing what was fast becoming an elusive example of "stone-age man". They used stone tools, practised gift exchange and fought over territory.

Such practices were typical across the island of New Guinea, particularly in the vast central highlands. Over 50,000 years of habitation, this almost impenetrable rainforest proved the ideal environment for developing permanent agriculture, complete with drainage canals.

The Dani themselves were only first "discovered" in 1938 when, completely by chance, a pilot flying overhead spotted their cultivated fields. But they had long been part of a complex social network of exchange and interaction that reached across the island. Even the government patrols and prospectors that once infested New Guinea were restricted to more accessible coastal regions, so the island's rural inhabitants continued farming, trading and intermarrying across huge distances. They live 1,600 metres above sea level in the heart of the Cyclops Mountains.

By the time of "discovery", the indigenous population had, politically, already been divided in two. In 1828, European colonisers separated New Guinea in half, right down the 141st meridian. By 1963 the western half was formally annexed to Indonesia, while the east became formally detached from Australia in 1975 to form the independent state of Papua New Guinea.

The Dani people are therefore governed ultimately from the Indonesian capital Jakarta, some 3,500km away, while an international border separates them from their kin in Papua New Guinea. These culturally and historically linked groups have been fighting ever since to release West Papua from Indonesia.

The region's cultural complexity has made it an ideal location for anthropologists and my own work has taken me to the Kutubu and Ok Tedi regions in Papua New Guinea. In Ok Tedi, which lies just on the other side of the 141st meridian, my friends and hosts were very similar to the Dani people that Backshall met. Like the Dani, they value the *sal kambun* (penis gourd) and *bul bul* (grass skirts) as symbols of identity, and they value the stone axe for its practical ability to outlive and outperform the modern alternatives sent to replace it — steel axes and knives.

The ritual amputation of digits is common across the island. As anthropologist Karl Heider recalls in his ethnographic examination of the Dani, close female relatives of males killed in warfare (not those who die from "natural" causes) "have their fingers chopped off". This is not unique to the Dani — in fact, digit/hand amputation was not unusual among men and women across the highland region before missionary intervention.

In one of his most memorable scenes, Backshall was invited to sleep alongside the smoke-dried remains of a legendary village elder. Such mummification is actually quite rare across the highlands, even among the Dani, who according to Heider cremate the dead in a detailed and lengthy series of funerary rites. The practice is typically associated with the Anga language group in Papua New Guinea and likely spread eastwards to the Dani.

In recent years, the Dani have been affected by mining, tourism and ongoing attempts to "Indonesianise" their highland culture. But perhaps the biggest threat of all comes from the military presence representing Indonesian interests in a resource-rich land with what they see as a "backwards" culture. Like the colonialists who described the vast area of internal New Guinea as "uninhabited", government bodies and multinationals still view rural landscapes as *Terra nullius*, "no one's land".

The illusion of "no one's land" and "the ancient tribe" is not helpful to the amazing people who live there. My friends in Ok Tedi and Kutubu are artists, school teachers, academics, gardeners, widows, businessmen and businesswomen. And yet, everything they do remains tightly entwined by a rich, resilient and dynamic culture.

The writer is a senior lecturer in anthropology at the University of East Anglia, UK

the independent

PLUS POINTS

Growing reef crisis

Coral reefs are failing to keep pace with rising sea levels, increasing the depth of the sea and removing a natural form of storm defence, according to a new study.

Researchers were stunned by the amount of reef lost due to erosion at sites in the Pacific off Hawaii, Florida's Atlantic coast and in the Caribbean, saying it had resulted in water depths not predicted to occur until 2100. They said it was evidence that an "Anthropocene reef crisis" had begun.

Corals are facing an array of problems from bleaching caused by the rising temperatures and ocean acidification to dredging and pollution from the land. The iconic Great Barrier Reef has been so badly affected that one leading environmental writer was moved to write its obituary.

In the new study, researchers examined two sites in the Florida Keys, two in the US Virgin Islands and also the waters around the Hawaiian island of Maui.The sea floor was found to be lower at all five sites by anything from nine to 80 centimetres. All five reefs had lost large amounts of coral, sand and other sea floor materials to erosion.

Kimberly Yates, of the US Geological Survey, said, "Our measurements show that seafloor erosion has already caused water depths to increase to levels not predicted to occur until near the year 2100.

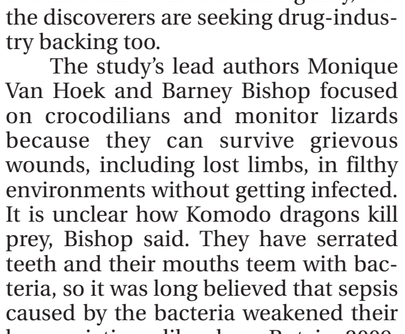
"At current rates, by 2100 sea floor erosion could increase water depths by two to eight times more than what has been predicted from sea level rise alone."

Writing in the journal, *Biogeosciences*, the researchers warned that the deeper water would increase coastal erosion, storm surges and tsunami hazards.

"The magnitude of reef volume lost due to erosion provides evidence for the onset of an Anthropocene reef crisis similar to ancient reef crises caused by climate change and marked in the geologic record by regional and global declines in reef volume," they added.

Ian johnston/the independent

Enter the dragon



Biochemists may have discovered a type of antibiotic that sounds like something out of a fairy tale — it is based on dragon blood.

Scientists from George Mason University in the US recently isolated a substance in the blood of a Komodo dragon that appeared to have powerful germ-killing abilities. Inspired by the discovery, they created a similar chemical in the lab and dubbed it DRGN-1. Tests on mice that were given skin wounds infected with two types of bacteria showed that DRGN-1 had three valuable properties — it punched holes in the outer membranes of both Gram-negative and Gram-positive bacteria, it dissolved the bio-films that glue bacteria together, and it sped up skin healing.

The research was published in the journal *Biofilms and Microbiomes*. The work was funded by the US military's Defence Threat Reduction Agency, but the discoverers are seeking drug-industry backing too.

The study's lead authors Monique Van Hoek and Barney Bishop focused on crocodilians and monitor lizards because they can survive grievous wounds, including lost limbs, in filthy environments without getting infected. It is unclear how Komodo dragons kill prey, Bishop said. They have serrated teeth and their mouths teem with bacteria, so it was long believed that sepsis caused by the bacteria weakened their larger victims, like deer. But in 2009, Australian researchers discovered that the dragons also inject shock-inducing venom.

The straits times/ann