Latest Data Suggests Global Population Growth is Slowing

Unexpectedly fast deceleration may have profound implications for economics, geopolitics, energy demand, and resource depletion

First Fischer "period of equilibrium" for 600 years in which population growth is decelerating, instead of accelerating; future price stability and huge increases in global per capita income?

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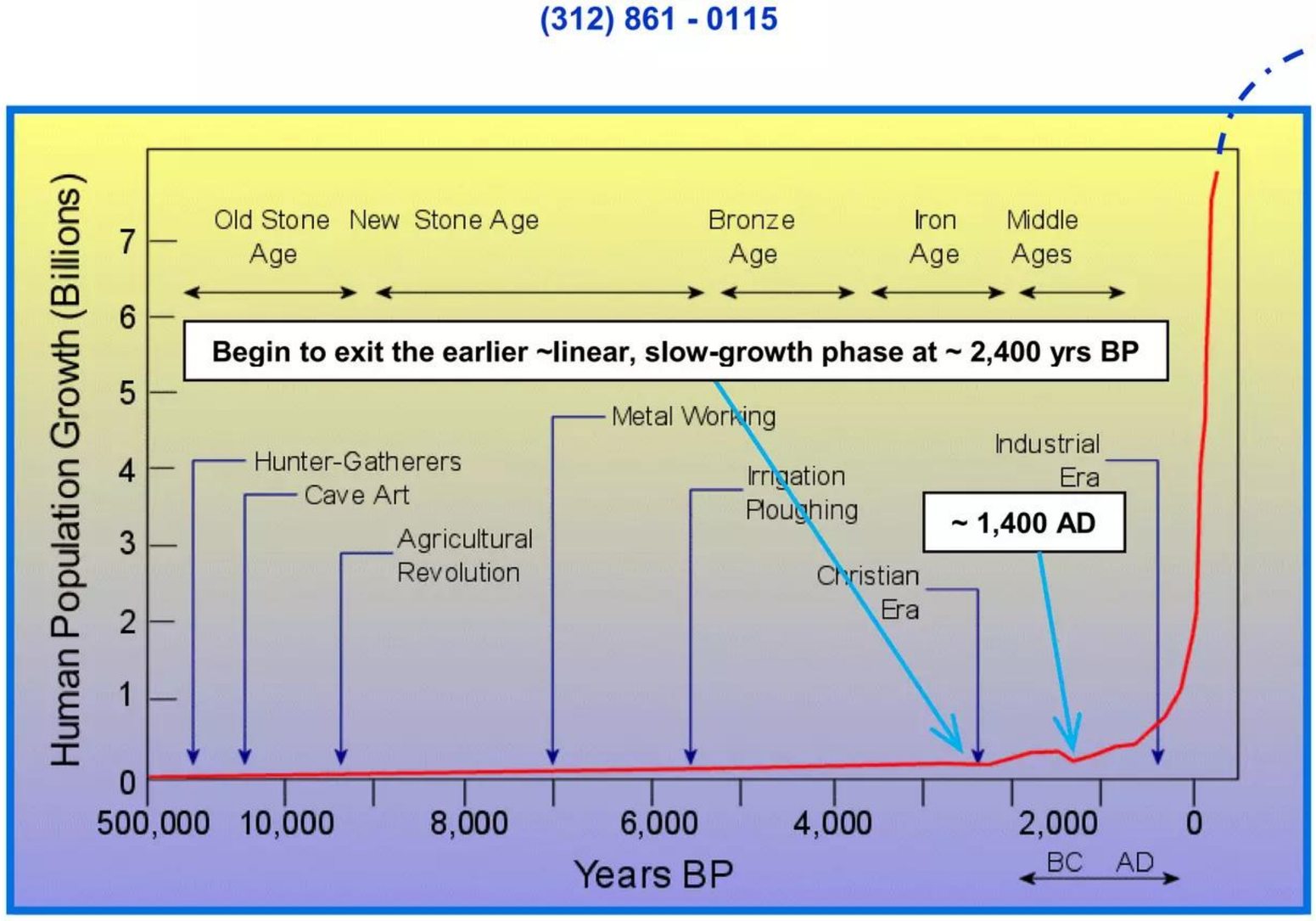


After > 500,000 years of slow, ~linear growth, in ~1,400 AD (just after "*Black Death*" depopulated Europe) human population growth began to accelerate nonlinearly; hyperbolically of late --- going vertical with no end in sight. This scary observation has been grist for Malthusian pundit mills and environmentalists with axes to grind. The issue exploded into the public consciousness 43 years ago with publication of Paul Erlich's famous 1968 book, "*The Population Bomb,*" and has been episodically ballyhooed ever since.

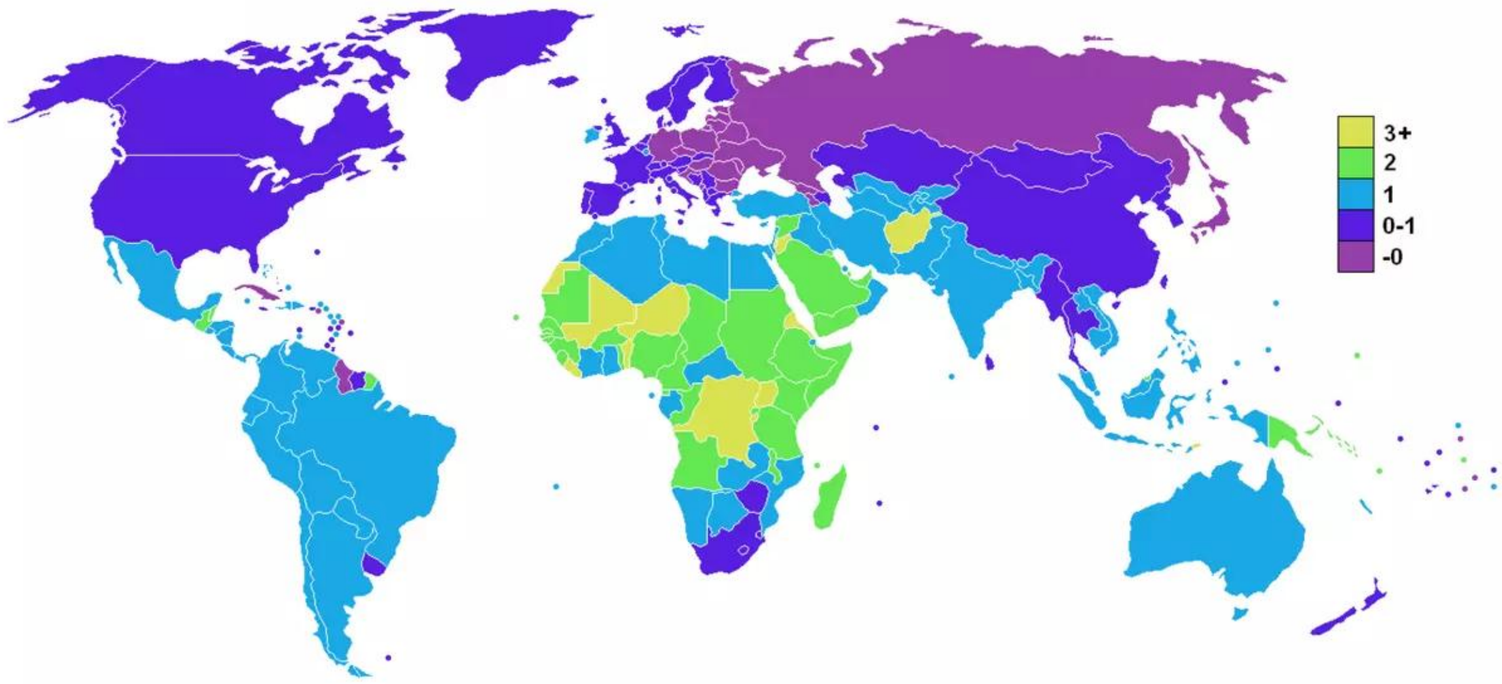
1996: A key event in the long, confused history of academic thinking about human population growth was the publication of a brilliantly constructed theoretical model by a well-known Russian physicist as follows:

"*The phenomenological theory of world population growth*"
Prof. Sergey P. Kapitsa, Moscow Institute for Physics and Technology and Russian Academy of Sciences
Physics-Uspekhi **39** pp. 57 – 71 (1996)

Without delving into detailed assumptions and mathematical features of his sophisticated, well thought-out model, Kapitsa predicted that global human population growth would finally begin to slow-down and eventually level-out in the near future. This bold prediction was greeted with considerable skepticism and scorn by prominent demographers, population theorists, and legion of pundits who had made a 30+-year cottage industry out of forecasting dire, just-over-the-horizon neo-Malthusian population catastrophes.

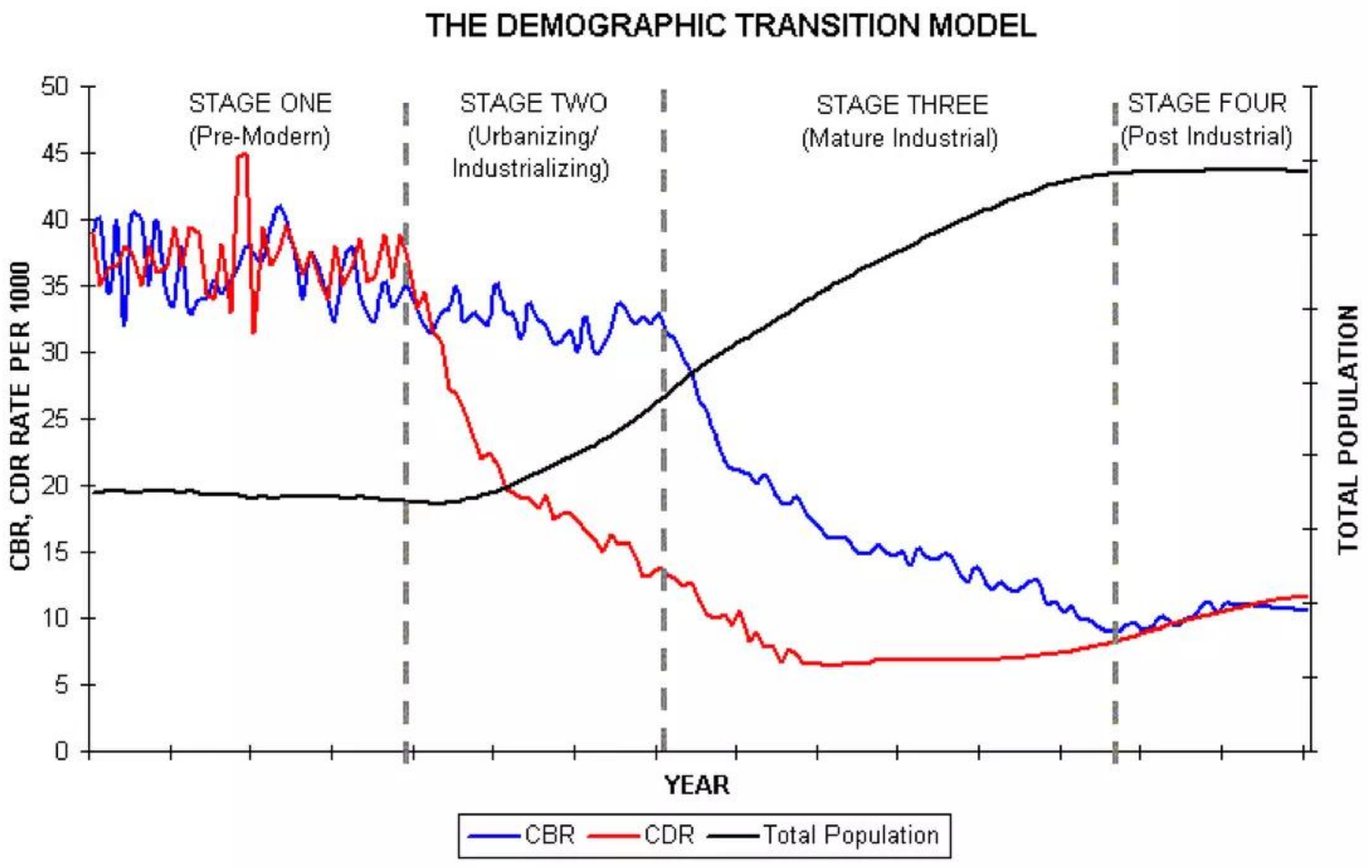
1999 – 2006 time-frame: In the turbulent wake of Kapitsa's controversial and much-ignored paper, during 1999 - 2006 increasing numbers of academic studies started getting published that suggested that human population growth might in fact already be slowing or on the verge of slowing down within 30 – 60 years. Below is a chart of *measured* population growth rates by country as they appeared in 2005, about six years ago:

Source URL = http://upload.wikimedia.org/wikipedia/commons/9/98/Population_growth_rate_world_2005-2010_UN.PNG



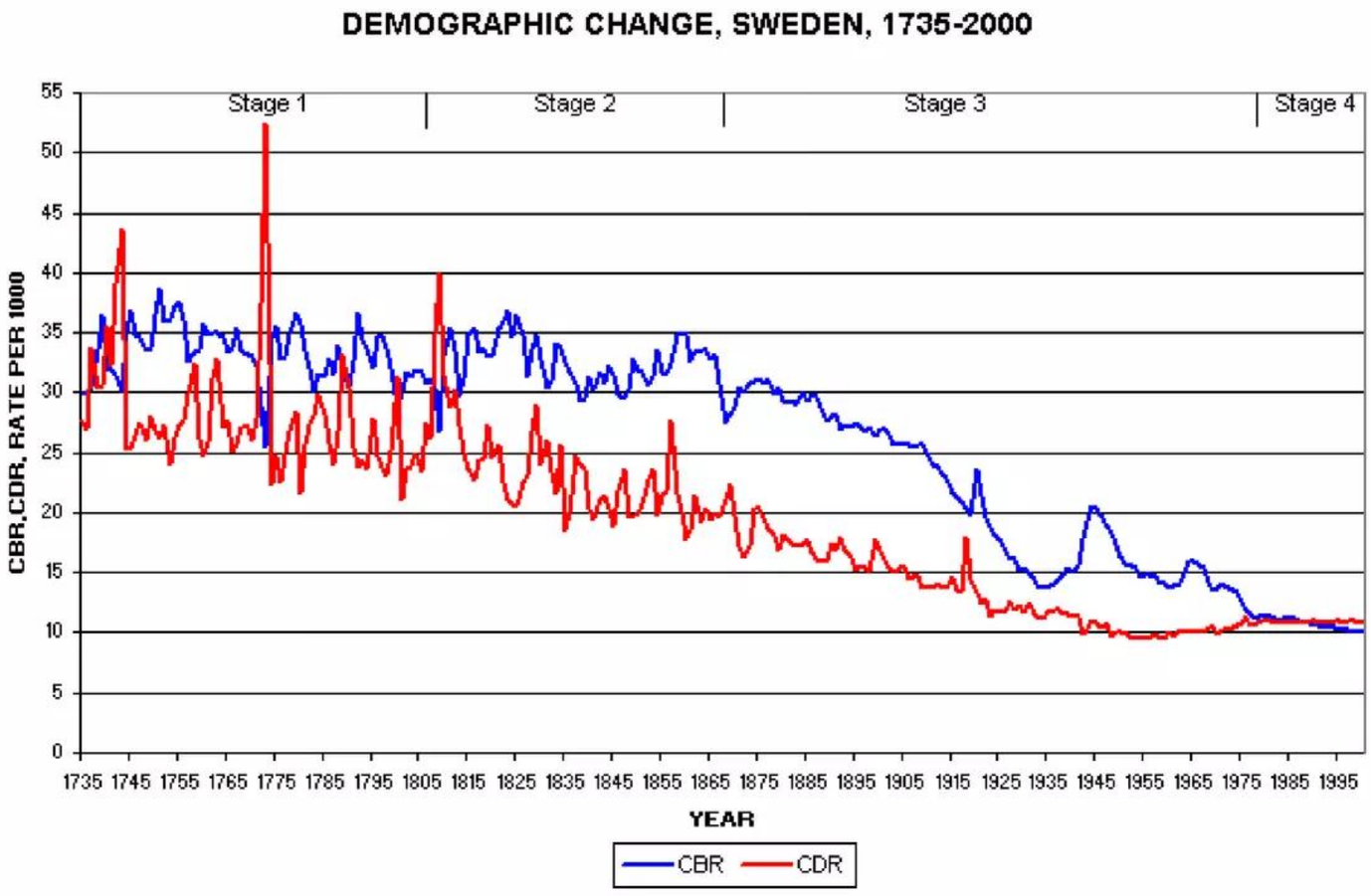
Demographic human population growth models: Following the intellectual lead of Kapitsa in the wake of his brilliant 1996 theory paper, so-called "***demographic***" models of human population growth recently became acceptable concepts. The basic idea, as illustrated in the diagram below, is that birth vs. death rates go through four characteristic 'stages' as human societies, i.e., individual countries, progress through a series of conceptually identifiable steps in their evolution toward more complex social, organizational, economic, and technological structures:

Source URL = http://www.uwmc.uwc.edu/geography/Demotrans/stagesII.gif



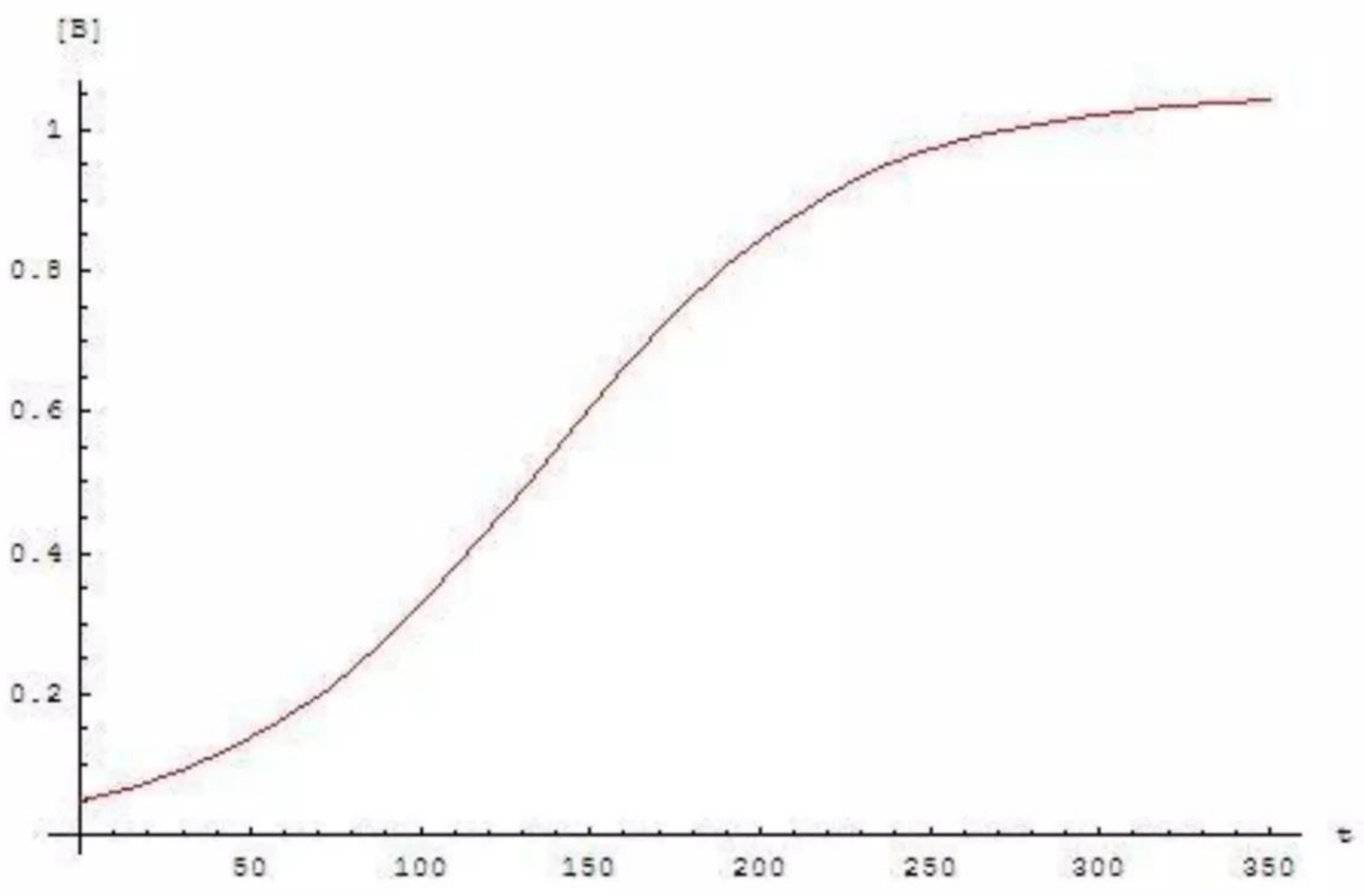
In fact, when detailed historical time-series data are actually available for any given country, it does appear to provide strong confirmation of types of future forecasts made by many so-called "***demographic transition***" population growth models; e.g., see Sweden below and compare it to the chart shown above:

Source URL = http://upload.wikimedia.org/wikipedia/commons/5/52/Demographic_change_in_Sweden_1735-2000.gif

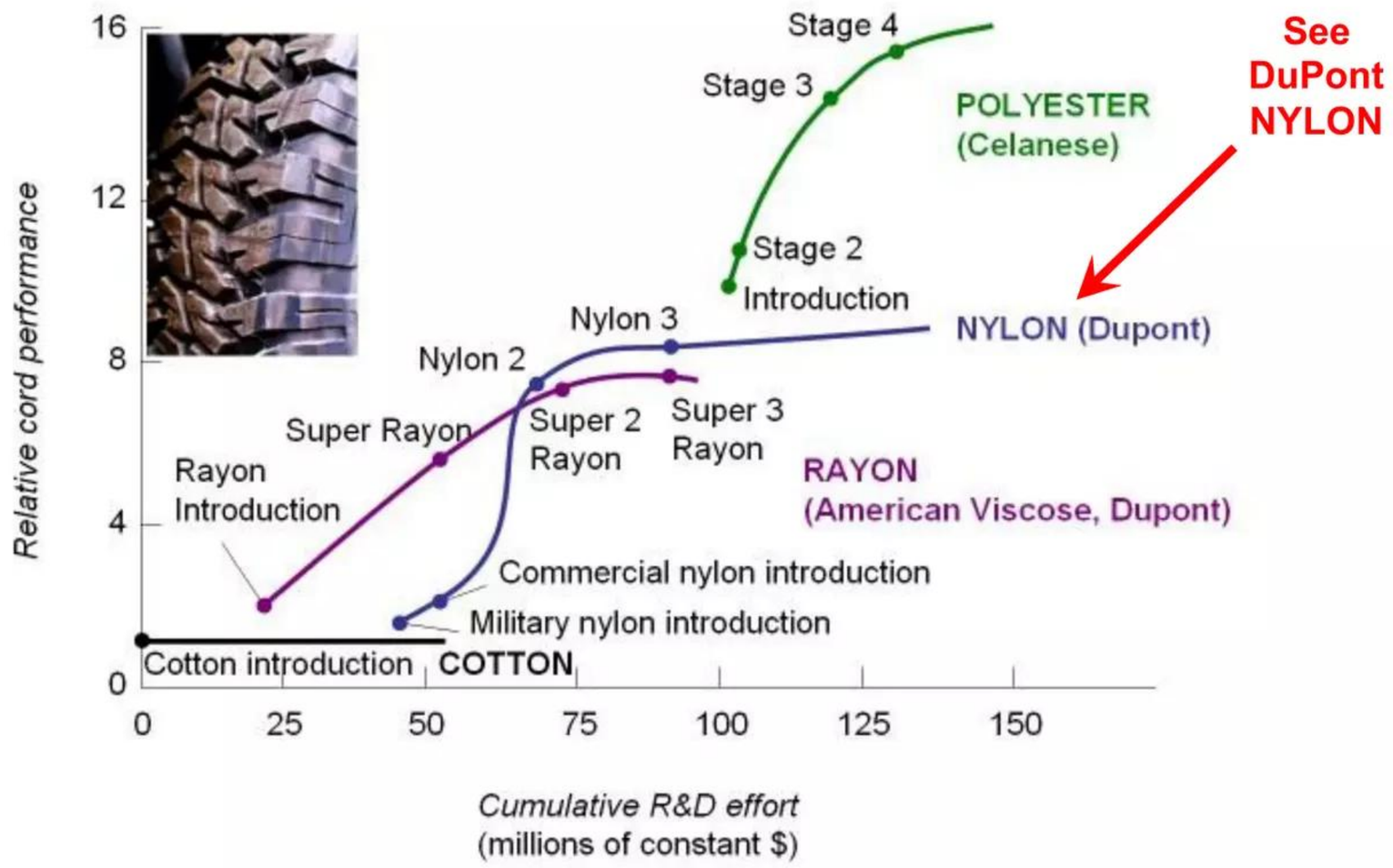


In simple terms, a "*demographic transition*" model of population growth dynamics posits that it behaves like an "***S-curve***" or "***sigmoid curve.***" This type of nonlinear mathematical construct accurately describes the behavior of many different types of complex phenomena over time. Behaviorally, it increases slowly and more-or-less linearly for a period of time, then accelerates nonlinearly during the middle phase, and eventually slows down entirely on its own (i.e., it is intrinsically an internally self-limiting system), finally entering a ~steady-state, roughly linear 'flat plateau' phase at the end of the evolutionary progression.

The following is an idealized example of such an S-curve for an autocatalytic chemical reaction:



The following is an example of an S-curve behavioral phenomenon in a technological context (Nylon):



Old, widely-held beliefs die hard in spite of clear quantitative evidence to the contrary:

Even today, the idea of ***rapidly slowing population growth already being upon us*** is very much a minority opinion. Large, entrenched, very vocal worldwide constituencies of the ca. 1968 'population bomb' *apocalypse chic* thinking are still prevalent in academia and the media for complex reasons.

Truly uncontrolled hyperbolic growth modes versus intrinsically self-limiting nonlinear systems:

Nonlinear population growth models fall into two very different conceptual types:

***Uncontrolled and unlimited hyperbolic human population growth*:** once a high-acceleration nonlinear behavioral regime is entered, rates of population growth begin accelerating faster and faster without any intrinsic limit until a random 'singularity' is encountered; that is, until some external cataclysmic event(s) terminates growth. Such apocalyptic events include, for example: mass starvation from inadequate food resources caused by freakish weather patterns; rampant fatal epidemics and resulting mass deaths from overcrowding and disease, e.g., Black Death, AIDS in Africa; population-destroying wars, lately fought over dwindling natural resources, e.g., oil and gas; potential mass-extinction events resulting from global warming triggered by manmade CO_2 emissions; etc. In this view, population growth is ultimately curbed by externally imposed Malthusian 'black swan' horrors that may appear seemingly 'out of nowhere'.

Self-limiting nonlinear human population growth with well-defined developmental phases*:** when key high-level parameters of such systems are plotted correctly, their graphs invariably display a characteristic and distinctive "S-curve***" or "***sigmoid curve***" shape. Note that the array of different internal causal factors that produce a truly self-limiting dynamical system may be many in number, interact with each other in complex back-and-forth feedback loops, and difficult to decipher or quantify. Importantly, just *knowing* that a system's behavior is definitely sigmoid and presuming that reasonably accurate historical time-series data is available; *one can still successfully predict long-term future behavior of the system once the mathematical equations describing a particular sigmoid graph have been determined, even if the details of causative factors limiting its growth are poorly understood*. Thus, with decent high-level data, shifts in population growth can be predicted with reasonable accuracy, as Kapitsa did in 1996.

Final summary and key conclusions:

- ✓ Latest census data shows that world population growth appears to be decelerating significantly faster than most had been expecting; such a slowdown is consistent with predictions of various demographic transition models, beginning with key theoretical work of Kapitsa (1996), which posits that population growth is a self-limiting phenomenon described by sigmoid or "*S-curves*"

- ✓ One prediction of demographic transition models, that significant increases in per capita GDP and related improvements in standard of living are strongly correlated with slowdowns in population growth, has been validated in every country for which historical time-series data are available

- ✓ Evaluating 1,000 years of quantitative socioeconomic data, Fischer (1996) published a novel developmental model claiming that during the past millennium there have been four long-duration, transnational "*Great Waves*." Each is comprised of both a noninflationary "period of equilibrium" averaging 70 – 90 years in duration followed by a longer, more variable-duration inflationary period called a "price revolution." Further postulated that root cause of inflation during all four price revolutions to date was excessive rates of population growth; no explanation was given for key driving force(s) that causes subsequent periods of equilibrium

- ✓ Larsen completes Fischer's conceptual model by postulating that periods of equilibrium are mainly triggered and maintained by bursts of innovation and deployment of newly commercialized technologies, broadly writ; further hypothesizes (more-or-less in agreement with Fischer) that a new period of equilibrium began circa 1979-1980 that may potentially last until ca. 2065; that hypothesis is supported by quantitative data showing worldwide explosion in new patent issuance

- ✓ ***Conclusion****: excessive population growth is unlikely to pose a problem during the era of today's new period of equilibrium; i.e., if history is any guide, based on historical norms a la Fischer the current period of equilibrium is likely to endure until at least ca. 2065, all other things being equal*

- ✓ Empirical data is presented (Huber & Mills - 2005; Brown et al. - 2011) showing that growth in per capita GDP (which is what reduces population growth rates) is strongly correlated with corresponding increases in total energy demand which, in modern energy-intensive societies, determines the overall standard of living; measured against finite fossil fuel supplies and other non-renewables, ratcheting demand exacerbates energy supply issues as GDP growth continues

- ✓ ***Conclusion:*** *single greatest threat to the probable longevity of the present period of equilibrium is huge energy price inflation because available global energy supplies are unable to keep-up with rising demand; new energy technologies must be developed and deployed to avert this*

- ✓ ***Conclusion:*** *today, there is only one type of new energy technology that is potentially capable of substantially solving the accelerating energy supply problem that may loom over the economic landscape for the next 50 years: it is Low Energy Nuclear Reactions (LENRs) which do not produce dangerous quantities of hard neutron/gamma radiation or long-lived radioactive isotopes*

- ✓ If LENRs can be successfully commercialized as a safe, low cost, carbon-free nuclear energy source, it could enable ecologically sustainable global economic growth and democratize universal access to affordable 'green' energy. In doing so, LENR technology could help magnify and intensify the most positive economic, political, and human welfare aspects of the present Fischer period of equilibrium and accelerate various new transformations enabled by the Internet

- ✓ By globally deploying a variety of commercial versions of LENR-based power generation systems over the next 20 - 25 years, roughly 1.6 billion 'energy-poor' people on this planet who are living without any form of electricity today could finally be brought into the 21st century as new well-paid consumers and eager contributors to a diverse, electronically interconnected global society

- ✓ ***Conclusion:*** *if LENRs can solve long-term energy supply issues at affordable costs, the present period of equilibrium might eventually become something akin to a global 'Golden Age of Man'*

Addendum

September 1, 2011

Dear Readers:

Given the brevity of this 5-page excerpt, several comments and additional information may be helpful.

As stated herein, latest census data indicates that global population growth may finally be decelerating --- perhaps significantly faster than expected by many experts; this new data may be very important.

If the deceleration in population growth occurring today is sustained over time, then during the course of the next 50 years it could potentially have profound implications for economics, geopolitics, energy demand, and the depletion of an array of nonrenewable natural resources.

That said, apart from immediately obvious corollaries, does the presently observed global trend toward decreasing rates of country-specific population growth have even greater implications when viewed through the 'lens' of a conceptual framework that encompasses the long sweep of human history?

Yes, it does. Such a framework and developmental theory that may provide important new insights into feedback interactions between human population growth and various identified socioeconomic factors was published in 1996 by Brandeis University Professor of History, David Hackett Fischer --- amazingly, during the very same year as Prof. Kapitsa's landmark paper on demographic transition theory.

To elucidate key causative factors and construct his complex, multifaceted conceptual model, Fischer studied an impressive array of quantitative historical time-series data extending over a period of ~1,000 years from the Middle Ages to the present.

Reference to Fischer's "Great Wave" ***transnational*** socioeconomic model:

"***The Great Wave: Price Revolutions and the Rhythm of History***"
David Hackett Fischer
Oxford University Press (1996) ISBN: 019505377X 536 pp.
Paperback edition: June 2000

In his book, Fischer meticulously characterizes and describes the details of what he calls four global "*Great Waves*" that have occurred during the past ~1,000 years from the High Middle Ages up until today.

In Fischer's two-stage conceptual model of a "*Great Wave,*" the first stage is a relatively noninflationary, so-called "*period of equilibrium*" which typically lasts for 60 to 100 years ('average' duration is ~85 years). A Great Wave's second, longer stage is called a "*price revolution*" whose total duration is much more variable than the first stage. In contrast to periods of equilibrium, price revolutions are characterized by progressively higher rates of inflation and interest on debt obligations. They typically reach their final climax in an inflationary economic cataclysm that is immediately followed by a massive deflationary 'crash' which sets the stage for the beginning of the world's next period of equilibrium (which also marks the starting point and beginning 'seed' for the next global Great Wave).

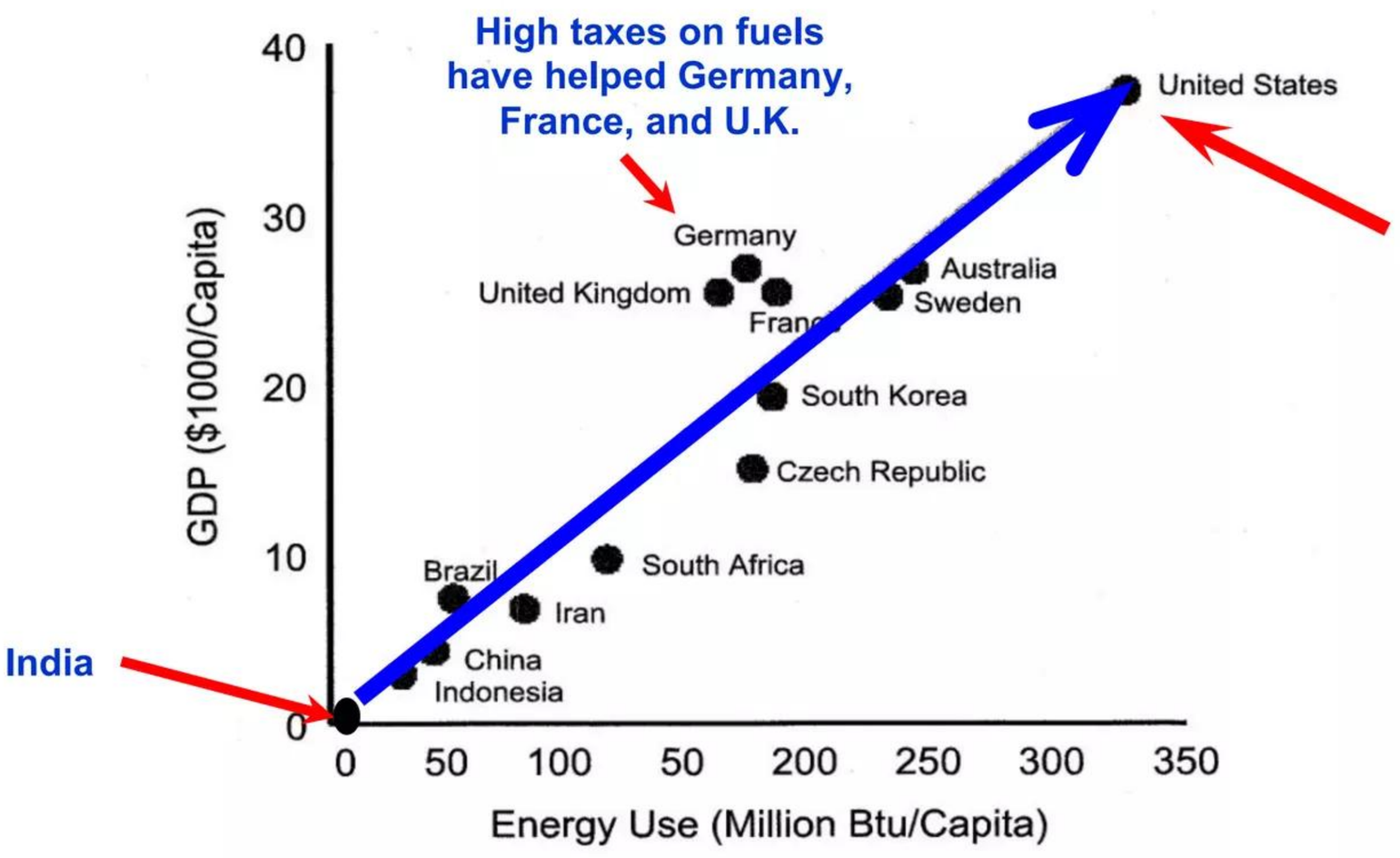
Over the past ~1,000 years, periods of equilibrium have occurred at one point during four well-known historical epochs commonly known as the High Middle Ages (c. 1000 - 1200), Renaissance (c. 1400 - 1600), Enlightenment (c. 1700 – 1800), and finally the Victorian Era (c. 1830 – 1900); i.e., at certain times during the eleventh, fifteenth, eighteenth, and nineteenth centuries.

Importantly, as of ca. 1979-80 it appears to me that we may have also entered the first Fischer period of equilibrium for 600 years in which population growth is decelerating instead of accelerating. That possibility might also have extraordinarily important implications, if correct.

Implications are as follows: according to Fischer's model, a gradual leveling-out of global population during such a period of equilibrium could potentially create a socioeconomically 'benevolent' era characterized by comparative price stability, positive social progress, and huge global increases in per capita income between today and ca. 2065. *In other words, a much better world may be aborning just ahead of us, all other things being equal.*

The apparent slowdown in the rate of global population growth is the really good news. The bad news is that improved standards of living and directly related increases in per capita GDP that produce substantial improvement in the lives of ordinary people (and inevitable reduction in the birth rate when women finally take charge of their bodies and their own lives) *are inextricably linked to increases in the total demand for energy in many different forms*. In fact, the relationship between per capita GDP and energy use per capita is very well-behaved, as illustrated in following Figure:

Figure 8.2 Energy and Prosperity



Source: CIA, *World Factbook*; BP p.l.c.

The more energy a nation uses, the richer it gets. Powered machines boost productivity, which boosts wealth.

Note – India added to Huber & Mills chart: in 2008 India (not shown in the published version of the above Huber-Mills' chart) had an estimated GDP ($1000/capita) of 1.327 and Energy Use (Million Btu/capita) of 12.6, placing it squarely near the origin of the bold arrow in the lowermost corner of the left quadrant. Also please again recall that India and China now account for ~40% of the world's population.

Upward progression of countries along the trajectory of the bold blue arrow creates increases in total world energy demand. The faster GDP per capita rises in all countries, the faster total global energy demand increases. Thus, expansion in the world's demand for energy is inextricably linked to economic growth and improved standards of living for greater numbers of people.

Roughly speaking, a simple extrapolation of the above chart implies that if India and China are to attain the same energy use per capita as Western Europe by the year 2048, their combined demand for energy will have to increase by ~14% per year for the next 40 years. If energy supplies (whatever their form might be) are not increased correspondingly over the same time-frame, such huge demand increases will be unsustainable. *That is, the price of energy will inexorably rise to whatever levels are necessary to throttle-back vast global demand for energy-equivalents.*

In a recent peer-reviewed paper, a group of academics have rigorously confirmed exactly the same causal relationship shown in previous chart adapted from Huber & Mills (2005):

"***Energetic Limits to Economic Growth***"
J. Brown et al.
BioScience **61** pp. 19 - 26 (January 2011)
Source URL = http://www.aibs.org/bioscience-press-releases/resources/Davidson.pdf

A nontechnical document that readers may also find useful in this context is a 16-page excerpt from a Lattice Energy LLC White Paper as follows:

"***Commercializing low energy nuclear reactions (LENRs): cutting energy's Gordian knot - a Grand Challenge for science and energy***"
Lewis Larsen
April 12, 2010
Source URL = http://www.slideshare.net/lewisglarsen/cfakepathlattice-energy-llc-white-paper-excerptapril-12-2010

For readers interested in technical aspects of LENRs, the physics 'core' of the W-L theory of LENRs titled, "***Ultra low momentum neutron catalyzed nuclear reactions on metallic hydride surfaces,***" was published in March 2006 in a well respected, peer reviewed, mainstream scientific journal, *The European Physical Journal C - Particles and Fields.* In October 2010, a 21-page review paper summarizing all of the publicly-released W-L theory work to date titled, "***A primer for electroweak induced low-energy nuclear reactions,"*** was published in a peer-reviewed journal of the Indian Academy of Science, *Pramana - Journal of Physics*
Source URL = http://www.ias.ac.in/pramana/v75/p617/fulltext.pdf

For the balance of the 21st century, reducing the effective price and increasing the availability of readily usable, new sources of energy, while at the same time reducing emissions of CO_2 into the atmosphere, are the keys to sustainable economic growth and continued widespread global improvement in the average standard of living.

Prof. Fischer's book is well worth reading; in fact, it is brilliant scholarship in my opinion. Buy a copy and decide for yourselves.

I hope that you find this report interesting and thought provoking; questions are always welcome.

Thank you for your interest.

Lew Larsen
September 1, 2011

Energy, broadly defined, has become the most important geostrategic and geoeconomic challenge of our time."

Thomas Friedman, *New York Times*, April 28, 2006

