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China Closes the Innovation Gap: Surges to World's Second in High Quality Science

By John Walsh
May 18, 2016

The headline reads, “The Rapid Rise of a Research Nation: China’s economic boom is mirrored by its similarly meteoric rise in high quality science.” This was not a headline in *People’s Daily* or *China Daily* but in the most prestigious of Western scientific publications, *Nature*.

The 38 pages, which follow that headline in a special Supplement to the journal *Nature*, tell us that China is now second in the world in high *quality* science publications and growing fast. This certainly contradicts the Western, dare I say racist, stereotype of the hardworking, but unimaginative, Asian drudge, dutifully churning out mounds of low quality work.

But how can we know that claim about China is true? Are we dealing here with release of data by the Chinese government, which, again according to Western stereotype, produces little but fabrications? (This writer has not found that to be the case, but there is merit in using sources that are immune to Western prejudices.)

Before considering the evidence for *Nature’s* claim of high quality Chinese science, we should ask of what significance is it to the layman? Just this, as the U.S. continues its belligerent “pivot to Asia,” which has been designed by Hillary Clinton, Barack Obama and the foreign policy Elite to confront China, we should know what our leaders are getting us into.

Two pillars of a country’s power, hard, soft and military, are its economy and its technology. Since late in 2014 China has been the world’s largest economy according to the IMF, using the Purchasing Power Parity (PPP) metric. It continues to grow at about 7% – or “only” 7% as the Western media are fond of telling us although no Western nation comes near that rate of growth.

Now China appears to be on the cusp of becoming the world's foremost Research and Development (R&D) engine. And that pushes the Chinese economy forward even more rapidly, for technology and science are the driving forces for modern economic development.

We would do well to remember that the last time that the U.S. confronted China directly in armed conflict was the Korean War. When the U.S., using the UN as cover, advanced all the way to the border with China, the Yalu river, China entered the war and the U.S. was driven back south to the 38th parallel. The result was restoration of the *status quo ante bellum*, with Korea divided in the way it remains to this day. At that time China was weak and backward; now it is strong and advanced.

Historical Domination

In a broader historical context, for the last 500 years the West has been in the dirty business of invading and colonizing the rest of the planet. This process continues today in the form of neocolonialism, most recently with U.S. wars, regime change ops and sanctions aimed at resisting nations.

In this entire period 500-year period the West has always enjoyed technological superiority in such encounters, and that has been one of the keys to its success at domination. Some would say that technology was *the* key to subjugation of the planet by the West.

We can envisage the Toledo steel armor and swords of the original conquistadores from 1492 onward to the titanic aircraft carriers of the U.S. lumbering around the South China Sea today. But the advance of science and technology in China means that this will not long remain the case. In fact that day may have passed already for all practical purposes.

So we would be well advised to know what sort of predicament our Elite are creating for us with their "pivot to Asia."

Let us turn to the evidence. How do we know with a high level of confidence that China has succeeded so impressively in its science and technology? The information comes from *Nature* Index (NatureIndex.com), a product of the journal *Nature*. Perhaps relatively few laymen are aware of *Nature*, but virtually every working scientist regards it as one of the most outstanding of scientific publications, a reputation well deserved.

As but one example, the original paper by Watson and Crick on the double helical structure of DNA, along with the paper, by Maurice Wilkins and Rosalind Franklin, providing the data that led to the Watson-Crick structure, appeared in *Nature*.

Nature is published by Elsevier, which has been around for a good long time. Elsevier, headquartered in the Netherlands at the time, published Galileo's "Dialogue Concerning the Two Chief World Systems" smuggled out of Italy to escape Vatican suppression while Galileo was under house arrest. Descartes was also published by Elsevier. The list goes on over the centuries.

Measuring Progress

Now dear reader, you will have to bear with me for four brief paragraphs to describe how NatureIndex makes the determination of *quality* in science. It is all spelled out in great detail at NatureIndex.com. NatureIndex is built on a database of all the original articles published in 68 of the highest quality scientific journals in the world listed here. The selection of those journals is done by a group of prominent active research scientists listed here. All the selected journals are based in the West as are all but a handful of the selecting scientists.

In a given year at the moment approximately 60,000 original articles appear in these journals. Each author of the 60,000 papers is given a score based on the number of these articles to which he or she has made a contribution. This number is called the Fractional Index (FI). For technical

reasons the FC has to be weighted for certain disciplines giving rise to another number, the Weighted Fractional Index (WFC) for each scientist.

Add up the WFC's for all the scientists in China appearing in the list of contributors in a given year and you have the WFC for the nation of China. The same can be done for any other country. It is as simple as that.

Basically the WFC is a metric for quality because the journals chosen to be part of the Index are those that publish the very best science as best as it can be determined at the moment. Publication of a paper in these journals is a highly competitive business, and every scientist wants to publish his or her best work in them.

The WFC is no bureaucratic or governmental measure. Each article that appears has been reviewed and accepted, usually by at least three scientists acting completely independently, and in fact not even knowing who their fellow reviewers of a given manuscript are. That means we have at least 180,000 independent reviews per year.

And then there are the many more articles rejected by these reviewing scientists. That means the WFC for the countries surveyed is determined by hundreds of thousands of independent reviews each year! They all act independently of one another. Adam Smith would love the model.

This author has been involved for a lifetime in such scientific reviews, as both reviewer and reviewed. The reviews are generally tough, honest and mostly fair. And in general the more prestigious the publication, the more demanding the review.

Again the bottom line is the WFC for each of the countries surveyed. The higher the WFC, the higher the quality of the country's total output. For the 12 months of 2015 the U.S. had the number one WFC by far. But second was China. (The order of the top 20 is: U.S., China, Germany, UK, Japan, France, Canada, Switzerland, South Korea, Italy, Spain, Australia, India, Netherlands, Israel, Sweden, Singapore, Taiwan, Russia, Belgium).

Nature magazine began analyzing China's output in 2012 and it recently (December, 2015) published a hard copy Supplement summarizing the Index in which the WFC for China for the period 2012 to 2014 was assessed. There is much of interest in the 38 pages of this Supplement. It contains evaluations of the science by region, institution (which includes both academia and corporations) and city. The awe of those who prepared the Supplement for the advances in Chinese science is palpable in the text.

Changing Places

For those interested in comparisons, as we should well be if we wish to know accurately our place in the world, the following paragraph from the NatureIndex Supplement is striking: "But what sets China apart is its WFC. While China's contribution (to the global total) grew 37% from 2012 through 2014, the United States saw a 4% drop over the same period."

That paragraph should be read and reread by those who would dismiss the development of China as "merely" quantitative or completely fake.

Moreover, the decline in the WFC of the U.S. comes as no surprise to researchers in the U.S., my colleagues, who have watched many laboratories close and talented investigators forced to quit as federal funding failed to keep pace with expenses. It is sad indeed to watch this tragedy unfold, with all the attendant waste of talent, training and education.

To return to the Nature Index Supplement for China for 2012-2014, here are excerpts from the opening section, which convey much of the magnitude and significance of China's accomplishment:

"China has ambitious plans to source as much as 15% of its energy from renewable resources by 2020, at the same time its economy is expected to slow (to 6.8 -7.0% per year. JW). It also

aspires to be the next space superpower while facing major health and environment challenges, such as an ageing population and water shortages. (China also has set as a goal the total elimination of poverty and the creation of a “moderately prosperous society” by 2020. JW)

“The Chinese government knows that surmounting these challenges while achieving its goals can only be accomplished through science. Indeed, China is pegging its future prosperity on a knowledge-based economy, underpinned by research and innovation. For a country that invented paper, gunpowder and the compass, such lofty ambitions could be realized. This year (2015) pharmacologist Tu Youyou became the first Chinese researcher to be awarded the Nobel Prize in Medicine for helping to discover a new drug for malaria that has saved millions of lives.

This should be quite enough to convince the reader of the extent, rapidity and quality of science in China. But is there corroborative data for the Nature Index study? Yes, from our own U.S. National Science Foundation (NSF). The NSF released an assessment of China’s R&D in January 2016 entitled: “U.S. science and technology leadership increasingly challenged by advances in Asia: China is now the second largest performer of research and development.”

This assessment is drawn from Science and Engineering Indicators, 2016, which is in turn produced by the National Science Board (NSB) a leadership body of the NSF whose 25 members are presidential appointees. The assessment is worth reading in full, but the bottom line is the following:

“According to *Indicators 2016*, China is now the second-largest performer of R&D, accounting for 20 percent of global R&D as compared to the United States, which accounts for 27 percent.”

That means of course that China now produces almost 3/4 as much R&D as the U.S., if we are to believe the NSF’s figures, and China’s output is growing fast. Here are some other quotes from the NSF assessment:

“Between 2003 and 2013, China ramped up its R&D investments at an average of 19.5 percent annually, greatly exceeding that of the U.S. China made its increases despite the Great Recession. (This last indicates to this writer a deep commitment to R&D.)

“China has also made significant strides in S&E (Science and Engineering) education, which is critical to supporting R&D as well as knowledge and technology-intensive industries. China is the world’s number-one producer of undergraduates with degrees in science and engineering. These fields account for 49 percent of all bachelor’s degrees awarded in China, compared to 33 percent of all bachelor’s degrees the U.S. awards.

“In 2012, students in China earned about 23 percent of the world’s 6 million first University degrees in S&E. Students in the European Union earned about 12 percent and those in the U.S. accounted for about 9 percent of these degrees. (Note that China is now producing more undergraduate degrees in S&E than the US and the EU combined, i.e., more than the entire “West.” jw)

“The number of S&E graduate degrees awarded in China is also increasing. However, the U.S. continues to award the largest number of S&E doctorates and remains the destination of choice for internationally mobile students. (But with the enormous numbers of undergraduate S&E degrees awarded in China, it would seem to be only a matter of time before graduate degrees follow. jw)

U.S. Retrenchment

Now let us see what the NSF has to say about the growth rate of R&D in the U.S., something it knows probably better than anyone else. Again we quote:

“Federal investment in both academic and business sector R&D has declined in recent years, reflecting the effects of the end of the investments of ARRA (American Recovery and

Reinvestment Act), the advent of the Budget Control Act, and increased pressure on the discretionary portion of the federal budget.

“Since the Great Recession, substantial, real R&D growth annually — ahead of the pace of U.S. GDP — has not returned. Inflation-adjusted growth in total U.S. R&D averaged only 0.8 percent annually over the 2008-13 period, behind the 1.2 percent annual average for U.S. GDP.

“‘Decreased federal investment is negatively impacting our nation’s research universities,’ said Kelvin Droegemeier, NSB vice chair and vice president for research at the University of Oklahoma. “Our universities conduct 51 percent of the nation’s basic research and train the next generation of STEM-capable workers. Federal support is essential to developing the new knowledge and human capital that allows the U.S. to innovate and be at the forefront of S&T.’”

I would pull from this quotation one phrase that is of special significance for the decline in federal funding for R&D, to wit *“increased pressure on the discretionary portion of the federal budget.”* Discretionary spending excludes earned benefits, principally Social Security and Medicare, which are in the non-discretionary category.

Do I have to tell readers that the biggest portion of the federal discretionary budget is the Pentagon? According to OMB the military consumed 55% of the federal discretionary budget in 2015 whereas science got 3%!! “International Affairs” also received 3%. The U.S. is building - and using – vast amounts of instruments of destruction while China is building up its scientific and technical enterprise.

I have outlined the facts and evidence for China’s great leap forward in science and technology. In the light of China’s impressive record in both economic development and in R&D, should the U.S. not terminate its bellicose pivot to the Western Pacific and seek a peaceful win-win relationship with China?