Sino-U.S. Technology Marathon and Implications for the U.S.

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In the last two decades China made its great forward in the fields of high technology represented by it great progress in R&D and high speed of transformation of high technology into industrial implications. New technologies and their implications have created dynamic marketing forces to the domestic and international firms. Challenges and opportunities to the United States are apparently existed in China markets; however the U.S. although realized the importance of China market it has not captured benefit in the implications of corporations with China in R&D areas. It is suggested that the U. S. needs to adjust its strategies along with the great progress in China in R&D and high technology development and implications.

INTRODUCITON: THE SINO-U.S. TECHNOLOGY MARATHON

There is an international competition for public and private R&D investment in new technologies that will produce the next generation of industries and jobs. While many smaller countries in the West invest a larger percentage of their smaller budgets in R&D, the outcome of this race will be dictated by a marathon of two giants, - The U.S. and China. Current academic literature in the West, notably China's Emerging Technological Edge, by Denis Fred Simon and Cong Cao and published by Cambridge University Press, UK in 2009 is skeptical that China can manage the science and technology human capital resources to achieve China's desired economic output. They write: "it should be clear from this study that China's science, technology and managerial base does not constitute a critical source of competitive advantage in economic and technological terms." (p.345).

My experience in China and research has led me to a different conclusion, namely that in many sectors of new technology, China is nearing par, is on par, or fast approaching par with the U.S. I am not referring to basic science, but to applied and translational research for commercialization. Paradoxically, much of my data is the same as that of the skeptics, except that we place different weight on one metric of competition, – rate of growth. The skeptics are not mindless of this variable. The skeptics diminish the importance of rapid Chinese R&D growth rate, by assuming a steady and even marginally increasing rate in the U.S. By the end of 2008, global contract sales of Huawei Technologies, China's largest telecoms gear maker, jumped 46 percent to 23.3 billion USD. Huawei also forecast sales of more than 30 billion USD in 2009.

The difference between us is the skeptics, notably Simon and Cao wrote their books before September 2008, the date of the fall of Lehman Brothers and the onslaught of the Western financial crisis. From that moment forward, a major alteration in relative R&D growth rates occurred. The U.S. de-accelerated R&D private investment in favor of financial rescue. China continued to grow technology R&D investment. Their skepticism may have been valid before the financial crisis (BFC), not after the financial crisis (AFC). They wrote before this happened. I am writing after it has happened. The irony of this prefatory note is that American academic writers and journalists have steadily assumed American financial stability and constitutionally based social stability; while assuming that with continued wealth growth and income disparity the Chinese social order will implode. In fact, in AFC the American and Western financially order imploded, while China has forged ahead financially and has retained its social stability.

THE FACTS

As of 2010 (YTD) the U.S. is expected to spend $401 billion, or 2.85% of its GDP, on R&D and China is spending $141billion (USD), or 1.48% of its GDP on R&D. China's growth rate of R&D spending is currently running at 17%, far in excess of what the Battelle Institute expects to be a U.S. R&D growth rate of 3.7% of GDP over 2009. With double digit annual R&D growth for the past decade, China I expected to match the R&D spending by all of Europe combined in 2018, and match U.S. R&D spending in 2022.

For a critical understanding of the competition in R&D investment, we have to factor three elements to the equation. The first is the relative ratios of public and private R&D expenditure. 70% of Chinese R&D is government funded (including State-owned enterprises), against 27% for the U.S. While U.S. private sector spending for R&D represent 73% of the total R&D spend, it is important to note that 55% of U.S. private R&D is spent off-shore in consort with offshore production; while very little Chinese R&D is off-shore. Because of this U.S. R&D has a reduced impact on U.S. domestic economic growth and job creation in new technology sectors.

The second element is the relative proportions of R&D expenditure between basic science and applied science R&D. The U.S. spends 18% of total R&D on basic science, while China spends less than 5%. U.S. Federal government R&D expenditure has been historically devoted to basic science performed by National laboratories and universities, while Chinese R&D, both public and private, is principally dedicated to applied science and translational research for commercialization. This factor has a huge impact on near term economic impact. China gets more early economic bang for R&D buck, while the U.S. government subsidizes global applied science.

The third factor is the relative ratios of public U.S and Chinese R&D to defense spending. Historically, between 50 and 60 percent of the U.S. Federal R&D investment is made in defense. Most of this investment (93.6 percent in FY 2010) is made in the Research, Development, Test and Evaluation (RTD&E) account in the Department of Defense (DOD) with smaller amounts coming from Atomic Energy Defense Activities at the Department of Energy and other programs within the DOD. The 2010 U.S. budget shifted more R&D funding to non-defense spending.

For Chinese defense R&D spending, we turn to the OECD which estimates that China's current military budget generally "ranges from roughly US$40 billion to US$90 billion a year. Trends in Chinese spending on R&D are even more difficult to ascertain. However, a reasonable estimate of current Chinese spending on military R&D might be US$2-5 billion." If we take Chinese total 2010 R&D spend at $141 billion, and assume that Chinese defense R%D is contained in its total R&D spend, we have a 2%-4% defense related portion of total R&D spend. This divergence in defense related R&D has a crucial impact on economic output. The greatest portion by far of Chinese R&D is directed toward commercial output. The greatest portion of U.S. R&D goes for basic science and defense related purposes.

A fourth factor of importance in the rate of technology growth is the number of scientists and engineers each country is graduating annually. As of 2006 the U.S. was graduating 70,000 engineers a year (many Chinese and Indians), while Chine was graduating 600,000. A Duke University study subtracted the number of Chinese sub-baccalaureate transactional, or technician, engineers which it estimated at 290,000, leaving and annual number of Chinese dynamic engineers (U.S. standard) at 310,000, or four times the U.S. annual number. The Chinese number has grown since 2006, while the U.S. number has remained stable.

A fifth element is the marathon is scientific research output represented by peer reviewed articles in scientific journals. Here the U.S. enjoys a big lead, but Chinese scientists and researchers have quadrupled the number of published papers in the past decade, second only to the USA, and are on course to overtake the US by 2020.

A sixth element of new technology growth is patent protection. As of 2007 nearly 50 million patent documents, covering 18 countries, are gathered in the Chinese Patent Office. A small percentage of these have international patent protection and domestic IP is relatively weak. By contrast, the U.S. Patent office issued 7 million patents by 2006, with a large percentage that are internationally protected. The U.S. patent is still the fold standard of international IP. The global value of new discoveries and inventions requires U.S. patent protection, since the U.S. is still a major global market for investment and commercialization of new technologies.

Despite China's strides, researchers in China accounted for only about 1% of the roughly 150,000 U.S. patents granted in 2008, whereas U.S.-based inventors accounted for 49% of U.S. patents granted. The relatively weak IP regime in China enables Chinese enterprises to copy international designs and bring them to play in the domestic market more quickly and at lower cost than internationally protected offerings. This perverse effect of weak IP has been a major stimulant to technology advancement in China for the past decades. But with the growth of indigenous discovery and invention, China will have to harden its IP and forsake this advantage.

A seventh element of R&D impact is that Chinese companies in 2008 had the highest number of IPOs in the world, completing 183 deals; while the U.S. completed 54 IPOs in 2008 and Europe completed 62 IPOs. This reflects the greater Chinese R&D emphasis on translational development of research for commercialization, as well as greater liquidity in Asian markets than in Western markets. But it also reflects easier regulatory and underwriting standards.

From the evidences listed above we can see that China is developing indigenous technologies and adopting technologies from all over the world to build a 21st century new technology economy. Barring unforeseen circumstances, China may in the near term equal and even exceed U.S. publicly supported R&D and the U.S. will lag behind China in the economic impact of new technologies. The following graph is illustrates this trend.

THE EAST ASIA MARATHON

Before moving on to the Sino-U.S. technology race, it is important to clarify China's relation to Asian technology. Commentary in the West generally refers to the shifting trends of high tech

R&D from the West to Asia. We have to clarify that reference to Asia in this context principally means China.

China's traditional role in the Asian region, vis a vis the Asian Tigers, was low cost technology assembly, packaging and export of consumer and business products. This is rapidly changing to China's high tech, capital intensive, value added production for a number of reasons: 1) Incoming FDI is increasingly for high tech production; 2) China is advancing its skilled human capital base of scientists and engineers, while retaining low cost intellectual capital; 3) China provides much greater IP security by supporting company measures for "black boxing" technology; 4) The Chinese government had instituted attractive incentives for high tech domestic and foreign innovation; 5) There has been a greater willingness by Hong Kong and Taiwan in both policy and FDI to transfer technology to China; 6) Large numbers of foreign educated and employed scientists and engineers are returning to China; and 7) At current levels of spending, China alone will outspend Japan in R&D by mid-2010.

NEW TECHONOLOGY SECTORS IN CHINA AND U.S.

We will explore the Sino-U.S. marathon in eleven sectors of new technology: 1)Telecommunications; 2) New Energy, including solar, wind power, nuclear power, clean coal, carbon capture & storage; 3) Electric Vehicles and Advanced Batteries; 4) Biomedical, Translational and Clinical Research; 5) Nanotechnology; 6) IC/Electronic Industry; 7) Advanced equipment production (industrial robotics, sensors, signals, etc); 8) High tech research and production parks; and 9) High speed rail.

Telecommunications

ATT&T and its famed Bell Laboratory was for decades a world leader in telecommunications. When AT&T was parcelled into independent regional companies by re-regulation in the 1980s, the Bell Lab was re-structured as an independent equipment maker, named Lucent. In 2006 Lucent merged with French owned Alcatel to better contend for dominance in the global industry. By 2009 Alcatel Lucent revenues of $21 billion USD were topped by a Chinese private Company – Huawei. The story of Chinese leadership in the telecommunication equipment can be seen in the dramatic growth of Huawei revenues of $30 billion in 2009.

Huawei is the largest networking and telecommunications equipment supplier in China and headquartered in Shenzhen. It was established in 1988 as a private high-tech enterprise specializing in R&D, production and marketing of communications equipments, and providing customized network services for telecom carriers. By the end of 2008, global contract sales of Huawei Technologies, China's largest telecoms gear maker, jumped 46 percent to 23.3 billion USD. Huawei forecasted sales of more than $30 billion in 2009.

Huawei serves 35 of the top 50 telecom operators and puts 10 per cent of revenue into R&D each year. In addition to the R&D centers in China it has R&D centers in Stockholm, Dallas, Silicon Valley, Bangalore, Ireland, Moscow Jakarta and the Netherlands. It is a global Company and has within a short period of time has risen to become the world No. 2 company in the mobile equipment industry behind Ericsson, replacing Nokia Siemens for the #2 spot.

In December, 2009, Huawei beat Ericsson to win deals to build next-generation networks for major mobile carriers in Norway and Sweden. Huawei was the largest applicant for patents in 2009 and in that year overtook Alcatel-Lucent in 2009 to become #1 in global optical networking equipment. Huawei is planning an IPO. Huawei is not positioned to acquire Motorola's network division, which is planned for sale.

The New Energy Race

The U.S. has been struggling for over a decade to lead the worldwide energy race. Every step for forward, propelled by increasing oil prices, has led to a step backwards, as oil prices fell. Congress has failed to pass an energy bill, over disputes on global warming, Cap&Trade, nuclear energy and a sidebar of special interests barriers. Despite rhetoric, President Obama is not making any headway on this front. As a result, the private sector is reluctant to invest is translational research and development. Meanwhile, China races forward.

Deutsche Bank asserts that China is a low risk environment for new energy investment. It has generous and well-targeted clean energy incentives, as well as high levels of private investment and a comprehensive and integrated government plan. By contrast, it describes the U.S. as a "moderate-risk" country with volatile incentives, a lack of enabling infrastructure and an inversion to government-led investment.

According to the New York Times article, China Leading Global Race to Make Clean Energy, "… the West may someday trade its dependence on oil from the Mideast for a reliance on solar panels, wind turbines and other gear manufactured in China." China is making subsidizing greater public investment in applied R&D than U.S. public investment in alternative energies that are not yet cost effective for the market place. Chinese policy mandates for clean technology are stronger than the US. China has a first-mover advantage, and will capture substantial domestic and international investment to clean energy industries than the United States. In the next 5 year plan, China will call for more Chinese domestic consumption. Conversely, the US will import from Chinese clean tech equipment, which will increase the trade deficit. The U.S. will become a clean tech user, not a clean tech producer. This means services jobs, not manufacturing jobs.

China plans to generate 20% of its electricity from renewable sources by 2020, while the US is projected to reach 10% by that date. Chinese local governments are offering firms free land and R&D money. State-owned banks are offering loans to clean tech firms at 2%, much lower than financing in the U.S. The U.S. energy sector invests less than one quarter of one percent of annual revenues in R&D activities. This is one-tenth the US industry average of 2.6%. According to China's Medium to Long Term Plan for the Development of Science and Technology, 2006 to 2020, the criterion for qualifying an enterprise as high tech requires a range of 6% - 3% of sales revenue invested in R&D, the highest degree for smaller firms. Under this standard, the U.S. new energy industry, by average enterprise, would not qualify as high tech by Chinese standards.

As a portion of annual revenues, U.S. energy sector R&D investments are two orders of magnitude lower than leading innovation-intensive sectors such as Biomedical technology R&D at 10-20% of annual revenues; Semiconductor R&D at 16% of annual sales; and Information technology at 10&-15% of annual sales. It may be a forlorn misnomer to even call U.S new energy industry a high tech sector. Let's examine this industry by sectors.

Solar

China currently exports 98% of its PV output, and is the leading solar exporter in the world. It also has the largest solar manufacturing capacity in the world. It has one-third of global solar manufacturing capacity and supplies 30% of the global PV market. The U.S. supplies only 5%.

China's 2008 PV production volume was 1.8 GW, from 820 MW in 2007. US PV production was 375 MW in 2008.\Applied Materials Applied Materials is the world's #1 supplier of PV manufacturing equipment, offering systems for both thin film and crystalline silicon solar products.

Applied Materials, the world's biggest supplier of solar-manufacturing equipment has opened a research center in China and its chief technology officer will relocate to that country next month. Applied Materials was founded in 1967 as a semiconductor company, has manufactured in China for 25 years, but is expanding its presence to be closer to its customers and develop products suited to the country's urban population.

"We're doing R&D in China because they're becoming a big market whose needs are different from those in the U.S.," says Mark Pinto, Applied Materials's CTO. Going forward, he says, "energy will become the biggest business for the company," and China, not the U.S., "will be the biggest solar market in the world." The move by Applied Materials is just the latest sign that China is rapidly moving to the forefront in developing renewable energy technologies.

We are seeing a replay in the new energy industry of the earlier off shore movement of U.S. consumer goods manufacture and their import back to the American market. U.S. solar power manufacturers are moving to China for production and research and exporting equipment back for U.S. Once again, we are transfiguring a manufacture industry into a service industry.

China is the largest producer of photovoltaic cells; Suntech is the second largest PV supplier in the world, with American company First Solar ranked #1 of the 1.2 GW of cell production capacity operating or announced by First Solar, less than 20 percent exists in the United States.

Wind Power

China is the largest manufacturer of wind turbines. Only one of the top ten wind turbine manufacturers is American. China's top three companies' manufacturing capacity is each over 4 GW/year. Domestic wind turbine manufacturers supply a majority of the domestic market in China.

Wind energy deployment in US is reliant on a Wind Production Tax Credit (PTC), which has lapsed on three occasions. The U.S. fiscal stimulus bill extends the PTC through the end of 2012. U.S. imports of wind-powered generating sets have increased from $365 million in 2003 to $2.5 billion in 2008, while U.S. wind turbine exports have never exceeded $84 million. It is unlikely that the U.S. will ever dominate this equipment production market.

The U.S. has the world's largest wind market with a current installed wind power base of is ~35 GW. China's total installed wind power is ~25 GW. By 2020, Chinese policy aims for a wind power capacity of over 100 GW, or 3% of the country's overall energy consumption.

Nuclear

China currently has 11 nuclear power plants with a total installed capacity of 9.08 GW. Seventeen new plants are under construction in China and are projected to produce 86 GW of new nuclear capacity by 2020. This will equal today's U.S. nuclear capacity of 96.245 GW. 104 U.S. nuclear power plants produce 20 percent of the electric power grid and use American nuclear technology. The US has not built a nuclear reactor since the 1970's.

President Obama is offering loan guarantee for new plants, but only two are being planned for completion by 2017. The private sector does not view nuclear energy as an efficient investment. It is not unlikely, considering the old age of existing U.S. plant, that the U.S. will out-perform China in nuclear-based electric power.

China is increasingly sourcing its nuclear power plants with domestically produced parts. Heavy forging capacity is critical for nuclear reactor construction. There are few suppliers capable of delivering the ultra-heavy forgings that weigh >400,000 pounds. The US has no such suppliers. Two Chinese companies currently have the largest forging presses in the world, at 15,000 tons of capacity. China Guangdong Nuclear Power Holding Co. (CGNPC) will be the first Chinese company to build a nuclear plant outside the borders, in Belarus. It is positioning itself as a major global player in nuclear electric power construction.

Clean Coal, Carbon Capture and Storage (CCS)

GE, itself a CCS leader, stated that China is currently more advanced in developing CCS technology than the United States and European countries. GE and Shell both signed agreements with China's largest coal company Shenhua Group (Beijing) to develop clean coal technology. A CCS technology developed by China's Thermal Power Research Institute is being licensed for use in the FutureGen project - a 275 MW CCS demonstration plant in the United States and the first commercial scale plant to use the technology.

The same technology is also being used in China's first CCS power plant, GreenGen, which is expected to be operational by 2011. Almost all of the components for that plant are being manufactured domestically.

Electric Vehicles & Advanced Batteries

China's first electric carmaker BYD displayed its e6 and F3DM electric vehicles at Detroit's North America International Auto Show (NAIAS) in December 2009. BYD's ferrous battery e6 has an expected range per charge cycle of 330 km in cruising mode, an estimated acceleration time from 0-100 km/h in less than 14 seconds and with a projected top speed of 140 km/h. These characteristics make the e6 ideal for daily commutes, in-town driving and even long distance travel.

The new version F3DM electric vehicle also features BYD's FE battery together with a BYD 371QA 1.0-liter gasoline engine. It will be equipped with the solar panel sunroof, which can be used to channel power to the Fe battery. The F3DM has a range of about 400 km on one tank of fuel, with a maximum speed of 160 km/h. It can also run for 100 km powered by the FE battery pack alone. These cars will be launched in Los angles in 2010 to the happy anticipation of Warren Buffett, who owns a 10% share of BYD. BYD sold more than 430,000 cars last year, about a 50 percent increase from 2008, and exported its products to the Middle East, Africa and East Europe.

All of China's major state-owned and joint-venture automotive companies have announced plans to launch electric vehicle models. SAIC Motor Corp will release a fully-electric car in 2012. China automaker Chery has introduced the S18 EV, an all-battery electric vehicle that it developed in-house. The S18 electric vehicle has a range of 120 to 150 km (75 to 93 miles) when fully charged, with a top speed of 120 km/h (75 mph).

As Chinese domestic automakers find innovative ways to produce cheap electric cars to fulfill the demand of China's domestic market, they will be able to use this technology to expand internationally. A new generation of Chinese electric cars may help drive down the production cost of electric cars globally. In doing so, electric cars may become the car of choice not only in China, as the fastest growing car market in the world, but also in the United States.

Turing to the U.S. in this EV arena, the news is grim. There are only two small and unlisted EV makers in the U.S. Tesla and Fisker. Neither Company has gone public for production and marketing capital. Ford is planning to introduce four electric vehicle models in 2012, following earlier Chinese launches. As for GM, its early deliberate destruction of its all electric EV1 is not likely to put GM in the EV race. Chinese and Asian vehicles will dominate the U.S. EV auto market.

Biomedical, Translational and Clinical Research

The U.S. has a clear lead over the China in the field of biotechnology and biomedicine. The U.S. is home to the majority of biotech industry's revenues, profits, and jobs. It has more than 300 publicly listed biotech companies, and leads the world in biotech and biomedicine basic research. But the picture changed in 2008. By the 2nd quarter 2008, following the financial crisis, the number of biotechnology venture backings fell by nearly 50%, and the dollar amount invested fell by more than 40% from the first quarter.

China is moving very rapidly in this field. It has had double-digit growth in its biotechnology industry and has gone from being one of the slowest to one of the fastest nations in the adoption of new biotechnologies. China has more than 2,800 biotech firms and looks to capture clinical and translational research and commercialization. China will focus on regenerative medicine, genomics and stem cell research. The sector has been vigorously supported by public funding in translational research. China has had double-digit growth in its into biotechnology industry and has gone from being one of the slowest to one of the fastest nations in the adoption of new biotechnologies. The government is intent on pushing applied research, driving Chinese firms to develop new therapies in pioneering fields such as gene therapy and stem cells U.S. venture capital in biotechnology, more structured for longer term economic results.

Two new investment factors are entering the picture. On the Chinese side the National Development and Reform Commission (NDRC) announced in October 2009 that it was creating 20 venture-capital funds that would be worth 9 billion RMB (US$1.3 billion). A fair portion of this will go to biotechnology. In addition, American venture capital in 2009 invested $3.7 billion in Chinese start-ups enterprises, an increase from 2007's $3.6 billion, but a decrease from 2008's $5 billion, but only a small portion of this external investment is going into Chinese biotechnology. The interest of potential international investors in Chinese biotechnology is typically muted by concerns about quality control and IP protection. Chinese domestic venture capital has been reluctant to invest in this sector, when they can achieve earlier gains in other technology sector.

The biotech sector is seen in China and internationally as a core area of national scientific and economic development. Backed by government intent to promote innovation and fuelled by the "brain gain" of talented Chinese scientists and entrepreneurs returning from abroad, China's biotech industry only needs a more favorable domestic investment climate and stronger IPR protection to emerge as a global force in the production of new therapies and medicines.

The first commercialized gene therapy product approved anywhere in the world was Gendicine, an injection used in the treatment of head and neck cancers developed by Shenzhen SiBiono GeneTech Co., Ltd. More than 5,000 patients have been treated with Gendicine, about 400 of them from overseas. The drug is currently undergoing further clinical trials in China for several new indications, including liver, abdominal and pancreatic cancer.

Several Chinese companies are working in the field of human and animal stem cells. One of them, Beike Biotechnologies, has organized a network of satellite hospitals, clinicians and research laboratories to commercialize its stem cells therapies, which involve harvesting stem cells from the umbilical cord or amniotic membrane, in vitro expansion, and administration to patients either intravenously or by injecting directly into the spinal cord. Beike has treated more than 1,000 patients, including 60 foreigners, for a variety of conditions including Alzheimer's disease, autism, brain trauma, cerebral palsy, diabetic diabetic foot arteriosclerosis and spinal cord injury.

Despite its daring medical science innovation and stunning breakthroughs, including the world's first commercialized gene therapy product and the sole cholera vaccine tablet, Chinese firms face an uphill battle in attracting high-risk venture capital needed to sustain innovative, research-driven projects. In the view of Peter A. Singer, MD, of the McLaughlin-Rotman Centre for Global Health (University Health Network and University of Toronto, "The Chinese biotechnology industry is like a baby dragon, which will grow quickly and soon become hard to ignore. It's no longer the case that the industrialized world has hegemony over biotechnology innovation."

The U.S. situation in this industry has a peculiar gap between relatively stable public investment in basic biotech research and declining private sector investment onshore translation and commercialization of discoveries. The pharmaceutical companies are moving translational research and clinical trials to China and India, where they are much less expensive and where the FDA is increasingly certifying foreign sourced institutions and facilities. With this trend, venture capital will eventually follow suit. It remains to be seen, whether an economic recovery of liquidity will sustain the U.S. lead or whether the trend of investment is toward Asia, principally China and India.

Nanotechnology

Nanotechnology deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials or devices within that size. Nanotechnology is very diverse, ranging from extensions of conventional device physics to completely new approaches based upon molecular self-assembly, from developing new materials with dimensions on the nanoscale to investigating whether we can directly control matter on the atomic scale.

There has been much debate on the future implications of nanotechnology. Nanotechnology has the potential to create many new materials and devices with a vast range of applications, such as in medicine, electronics and energy production. Nanotechnology is estimated to be a $2 billion industry by 2012 and id projected to represent 11% of world's manufacturing jobs by 2014.

China's nanotechnology capability is world class. According Dr. Richard Applebaum and Rachel Parker of the University of California at Berkeley's Center for nanotechnology, China is planning to use existing nanotechnology studies as a starting point and then "leapfrog" the West by further developing the current research.

As of 2007 China was second to the United States in government spending on nanotechnology by investing $250 million (Holman *et al* 2006: 25) against a U.S. Government investment of $1.5 billion. The U.S. National Nanotech Initiative projects FY 2010 projects an expenditure of $1.64 billion. We have no comparative for Chinese 2010 investment. But is it generally felt among professionals China's governmental spending on nanotechnology may not be far off when adjusted for purchasing power parity, by taking into account labor and infrastructure. Its investment has already surpassed that of any other country after the US. Applebaum & Parker conclude that Chinese nanotechnology output will likely exceed US output in terms of quality as well as quantity within a decade or less. China has more than 5,000 persons engaged in nanotechnology research and development at leading universities, research institutes and enterprises.

By 2005 China had equaled or possibly surpassed the U.S. in terms of total output for academic/peer-reviewed publications on nanotechnology, with a substantial increase in publication rate from around 2003. By 2009 China produced more scientific papers on nanotech than any other nation.

Nanotech plants have sprung up in cities from Beijing in the north to Shenzhen in the south, working on products including exhaust-absorbing tarmac and carbon nanotube-coated clothes that can monitor health. Companies are working on nano-touchscreens for mobile phones. Teams are working on a material to replace the indium tin oxide (ITO) used in the kind of touch panels found on BlackBerrys and iPhones.

Recently, researchers from Nanjing University and colleagues from New York University unveiled a two-armed nanorobot that can alter genetic code. It enables the creation of new DNA structures, and could be turned into a factory for assembling the building blocks of new materials.

Looking at the 2009 numbers, The U.S. has slipped from being undisputed world champion in 2001 to racing neck & neck with China for a bronze medal in 2009, while Russia and the EU are racing ahead. "The overall trends are irrefutable," says Dr James Wilsdon, director of the Science Policy Centre at the Royal Society, "China is snapping at the heels of the most developed nations, in terms of research and investment, in terms of active scientists in the field, in terms of publications and in terms of patents."

Estimates of the size of the nanotech market are wildly fluctuating. Tim Harper, founder of the nanotech consultancy CMP Cientifica, sees a global nanotechnology market that could top $2tn by 2012. Harper predicts that by 2010, areas of nanotechnology and biology will have merged, setting in motion the production of a wealth of new drugs and clinical equipment (such as the vials of nanomaterials for use in health products, clothes and cosmetics). His research sees nanotech pharmaceutical and healthcare products worth an estimated $3.2tn by 2012, with military-use nanotech products taking 14% of the total market and worth $40bn.

Harper goes onto say that the Chinese are further along in their thinking than even the US on using these technologies for the good of the environment." The US may still lead the nano surge overall, but Harper believes China will be on a par with the EU and US by 2012.

IC/Electronic Industry

USA companies are world's leaders in "fabless" (design only) semiconductor companies, like Qualcomm, AMD, Broadcom, Marvell, etc. These US companies outsource fabrication to foundries in Asia.Taiwan Semiconductor Manufacturing Company (TSMC), which is currently the world's leading pure play foundry. Taiwan's IC industry is increasingly moving production to China for lower cost and as cross-strait investment eases. This movement of production to China has impact on process R&D. Process R&D tends to be associated with place of production. Of the new R&D sites planned for construction in the next three years by the 177 leading semiconductor companies, 77% will be built in China or India, often using US corporate financing.

The production value of China's IC design, manufacturing and backend industries is projected at US$17.6 billion in 2010, growing 15.4% from 2009. Bejing Semiconductor Manufacturing International (SMIC) is China's leading semiconductor producer and leading provider of 16/32-bit embedded RISC processor solutions. In 2009 SMIC joined the ARM® Foundry Program and has licensed the ARM7TDMI® microprocessor core. The ARM Processor Foundry Program is an innovative business model that enables fabless semiconductor companies in emerging markets to gain access to ARM processor technology for use in the design and manufacture of advanced system-on-chip (SoC) solutions. ARM is headquartered in Cambridge, UK and is the world's leading semiconductor intellectual property (IP) supplier and as such is at the heart of the development of digital electronic products.

SMIC will offer fabless semiconductor companies and design houses access to ARM foundry technology in a cost-effective and flexible manner. “ARM’s relationship to significantly strengthens support for customers in China who now have access to SMIC's world-class manufacturing expertise for their ARM core-based designs…. We continue to see a great deal of innovation within the Chinese semiconductor market," said Jun Tan, president, ARM China. “In today's competitive market, many customers are looking for faster time-to-market and greater flexibility for the design and manufacture of their products," said James Sung, vice president of marketing & sales, SMIC.

The U.S. has long lost on shore IC production. It lost design to Taiwan a decade ago. Now it is losing design and R&D to foreign invested companies in China and to big Chinese producers like SMIC. While American IC companies may thrive in global sales, it will not generate jobs in the U.S. and will see a declining job contribution to the global design and R&D sectors of the industry.

Advanced Equipment Production

According to Rick Schneider, President and CEO of FANUC (FANUC Robotics America, Inc., “within 15 years, a labor gap will develop when 70 million baby boomers retire and only 40 million new workers enter the workforce. To fill this gap, it is important to invest in product-enhancing tools such as automation and robotics, enabling manufacturers to increase efficiency, reduce cost, maintain control over their operations and produce the highest quality products. Innovation and automation that produce bottom-line results will make the difference between life and death for manufacturers in the near future,"

Schneider says. "Automation is absolutely critical for North American manufacturers to be competitive in the world market because it helps reduce costs, increase quality and improve control of manufacturing operations." As an example, Schneider cited a case in which welding equipment manufacturer Lincoln Electric (Cleveland) prevented a customer from shipping welding operations to China by creating an automated system that cut weld times by over 25 percent. Added benefits to the new automated process included significantly higher quality and improved process control.”

But the fact remains that China the 3rd largest industrial robot manufacturer behind US and Japan, both by domestic companies like Shenyang SIASUN Robot & Automation Co., Ltd; and foreign invested global robotics producers like ABB Engineering (Shanghai) Ltd. The paradox for Schneider is that robotics can fill the gap of U.S. workforce needs as the population ages, it is not clear that the robotic equipment and devices will be manufactured in the long run in the U.S., where manufacturing and R&D costs are high. Indeed the U.S. will be a consumer of robotics, but will it withstand the pace of China to out manufacture robotics? The technology marathon is not a race for consumption, but for the development, commercialization, production and sale of advanced technologies.

High Tech and Research Parks

An American university research park is an area with a collection of buildings dedicated to scientific research on a business footing and is associated with a university or consortium of universities. They may be managed by universities or independently incorporated and managed, with some form of university affiliation. Typically businesses and organizations in the parks focus on product advancement and innovation, as opposed to industrial parks that focus on manufacturing and business parks that focus on business services.

For the past decade U.S. industrial R&D has migrated increasingly from corporate facilities and staff to American universities, where universities and government grants picks up a good piece of the cost. American universities and American university research parks (URPs) are a major source of U.S public and private sector R&D. The U.S. has 170 university research parks in North America. The median URP employs 750 people, has a <$1 million operating budget, 6 buildings, limited or no profitability, 114 acres, and 30,000 square feet of incubator space. 75% of the parks have either no retained earnings or less that 10% of retained earnings.

This profile does not do justice to the larger URPs like Research Triangle. MIT, Purdue Research Park, and others. Research Triangle Park is one of the oldest and largest science parks in North America. It is a 7,000 acre development that is home to more than 170 companies employing over 42,000 full-time knowledge workers and an estimated 10,000 contract employees. It is located at the core of the Raleigh-Durham-Cary combined statistical area. RTP is a globally prominent high-technology research and development center that serves as an economic driver for the region. Purdue Research Park in West Lafayette, IN is today home to over 140 companies on the main campus alone.

China has a different model for R&D development. Chinese universities have on-campus R&D programs. University R&D, Government research institutes, and private enterprise R&D are located in centrally approved High Tech Parks. There are 54 national high-tech parks in China, employing 6.5 million people in their production companies, research institutes, and incubators. Zhongguancun, referred to as “China’s Silicon Valley,” is a 7-park zone in Beijing, home to over 20,000 high tech enterprises. In 2009, Zhongguancun grew 20% and generated $170 billion in revenues and $20 billion in exports.

Twenty of Z-Park's Chinese high-tech companies are listed on the NASDAQ, including Sina, Sohu and Baidu. According to Craig Spohn of Louisiana Tech Cyber Innovation Center, “China just announced their intention to build 30 research parks by 2010, and 60 percent of their economy will be based on the technology industry and the developments produced from those research parks…We will have to compete with that."

High Speed Rail

The Harmony Express from Wuhan to Guangzhou is the world’s fastest train, accelerating within one minute to 193km/h and doing a steady 350km/h by the time it hit its first bend. Wholly Chinese-built using technology from Siemens and Kawasaki, the Harmony Express is faster than Japan's Shinkansen bullet trains and France's TGVs. It covers the 1000 kilometers between Wuhan and Guangzhou in three hours. The trip previously took almost11 hours. By 2020, China will have 13,000 km of high speed rail (HSR). Travel time from Beijing to Shanghai will be four hours.

HSR in China will enable industry to move from north to south and east to west, and create a mobile high skilled professional work force. Intellectual capital moving throughout the country comfortably and efficiently will have great economic impact. New cities and industrial zones are being built along these lines, and urban terminal districts are being redeveloped for high tech commerce. One-third of the current China fiscal stimulus is devoted to the construction of this HSR system.

The U.S. currently has no HSR system. Plans for regional HSR are just being developed by individual State governments. Funding is uncertain and the U.S. has no HSR production capability. Nor is any planned.

CONCLUSIONS AND IMPLICATIONS FOR THE U. S.

Since the middle of 1980s China has repeatedly declared its resolve to reach technological parity with the west world. More recently, China has more than doubled its proportion of gross domestic product the government spent on research and development, while at the same time U. S. government declined the budget on research and development. Chinese high-tech industry has experienced a wave of remarkable expansion in terms of size, R&D expenditure, and product development. An increasing number of researchers regard marketing capability as a critical factor that leads to high-tech product success in the marketplace. Although among China's R&D priorities are superscale integrated circuits, computer software, and information security systems, they have forgotten the other sectors of new technology. We can highlight the above discussions into the following table (Table 1):

TABLE 1
CHINA R&D DEVELOPMENT OUTCOMES AND TRENDS

- China's technological capability is moving faster than the 20th century Asian tigers.
- China's government investment is consistent (based on 5 year plans), whereas U.S. public budgets are volatile, subject to elections and the shifting forces of special interests.
- China-based enterprises have government support for translational research, whereas U.S.R&D focuses on basic science to universities and government laboratories. There is no significant government support for translational research. 50% of U.S. Federal government R&D is defense related, with limited GDP impact.
- Chinese R&D stays onshore, while U.S. companies are moving substantial R&D offshore to Asia, principally to China in many sectors; and to India in some sectors.
- US business has moved from translational R&D and commercialization to acquisition.
- China is winning the race on new energy and nanotechnology. .
- China will be produce and export electric cars to the US market within a short period of time.
- The race for biotechnology basic science dominance is the USA's to lose. China will lead the world in nanotech.
- Chinese high tech parks are far beyond the scope and scale of even the largest US research parks.
- China is a breeding ground for high tech startups
- China will lead the world in HSR transit.

If the U.S. objective is to create new drivers of economy and new high skill and high wage jobs, than the U.S. R&D budget is misallocated in many respects. In the first instance U.S. basic science R&D is subsidizing the Chinese R&D agenda of translational research and commercialization. It saves the cost of discovering and invention. In the second instance, the budgetary focus of a deeply indebted society on social improvement is misaimed. For example, federal support for improved health care assistance does not create new capital intensive industries and market-based jobs.

The U.S. needs an industrial policy that supports translational R&D for commercialization in new technologies that produce new job drivers for the economy. It needs a technology investment bank to finance start-ups in which at private VC is loath to risk. There has to a culture change in American scientific faculties from allegiance to basic science to a new dedication to applied science and engineering. The U.S. can no longer afford to subsidized knowledge for its own sake. This was only possible when American industry invested in onshore applied R&D. That period has gone.

The Federal Government cannot rely on universities to translate and commercialize discoveries and inventions. It needs more national laboratories for technology advancement and commercialization, as well as regulated relationships and fiscal policies for private business affiliates that will incentivize them to produce onshore. Otherwise, R&D and high tech investment will continue to migrate abroad to lower cost countries like China that have great science and engineering talent pools and vast new markets to access. U.S. venture capital will migrate along with human capital assets. There are more IPOs in China than in the U.S.

The US must open its door wide to all foreign scientific and engineering talent that wants to come in it, in order to maintain a university and National laboratory pool which is already over 50% foreign. This takes big money. For a debtor nation, so the Government has to allow the sale to all interested buyers of advanced technologies that are now restricted for sale. The U.S. must rectify its trade deficit and gain revenues for reinvestment in technology. Without sales and re-investment, technology leadership, where it still persists, will vanish.

These are harsh steps, but the facts command attention. The technology marathon is already half over and the U.S. is behind. The only energy for a final leg of the race is a culture change to force feed our children in science and engineering; a social change to commercialize our scientists; a political change to let talent in the door and induce them to remain; and a national security change to sell advanced technology for the financial nutrition to get to the finish line.

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Editor’s note: Mr. Milton Kotler has over forty years of professional experience in marketing strategy and management. He is President of Kotler Marketing Group (KMG, Inc.), headquartered in Washington DC, with offices in Beijing, Shanghai and Shenzhen, China. Mr. Kotler has led projects for Motorola, Ford Motor, Northwestern Mutual Trust Bank, AT&T, IBM, JP Morgan Private Banking and SAS Airlines. Company clients include Exxon Mobil, American Express, Microsoft, Novartis, British Telecom, Pfizer, and other Fortune 1,000 companies. Mr. Kotler has been active in China since 1999 as an economic advisor to the Mayors of Xian, Dalian, Harbin, and Zhengzhou, and delivered public seminars in over 50 Chinese cities.