SECURITY FORESIGHT

FUTURE ISSUE

IDIOCRACY

THE GLOBAL REDISTRIBUTION OF KNOWLEDGE

The Hague Centre for Strategic Studies

FUTURE ISSUE

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The Global Redistribution Of Knowledge

Tim Sweijs
Caspar Egas
Ramses Alma

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IN BRIEF

In a simple, yet intuitively appealing description, *knowledge* holds the key to the human capacity to manipulate and exploit its environment, and plays an essential role in ensuring a state's socio-political stability, economic prosperity and, above all, security.

This Future Issue sketches a broad picture of the state of *knowledge* in 2009 in order to examine its time-lagged effects on, a.o., socio-political stability and the future distribution of economic and political power. It examines international *knowledge* differences, national distributions of *knowledge* and *knowledge* diffusion for the EU, the US, Japan, South Korea, and at times the OECD states as well as China and India. In doing so, it provides the general trends and context within which future developments will emerge.

The global knowledge landscape is experiencing significant shifts, both with respect to its geographical distribution and to its role and status. These shifts may carry a number of security implications both at the international and the national level for security and business continuity. The four most important implications are:

- The growing number of citizens around the world with tertiary education may affect the socio-political stability of nation-states with authoritarian or hybrid regimes
- The changing *balance of knowledge* may pose a threat to the economic security of states when MNCs decide to relocate (more of) their R&D centers to developing economies and undermine the competitive edge of those states left with little R&D capacity of their own
- The changing *balance of knowledge* may affect the global military balance as numerous nation-states will master the ability to produce disruptive military technologies
- States that are able to create social upward mobility pathways and eliminate gender barriers attain a brain gain and create a competitive advantage vis-à-vis their competitors

PARAMETERS

- International Knowledge Differences
- National Distributions of Knowledge
- Knowledge Diffusion

DRIVERS

- Societal Trends
- Knowledge Investment
- Institutional Regimes
- Technology

SECURITY IMPLICATIONS

- Changing Balance of Knowledge
- Massification of Intelligence
- Changing Status of Knowledge
- Re-Inforcement of Differences Between The Core and The Gap

Winston Churchill's famous dictum that "the empires of the future are the empires of the mind,"[2] seems to hold true, perhaps even more so in the current information-age than in his times. Enormous advances in technology over the last two decades have facilitated the globalisation of knowledge through ICT-developments – i.e., the introduction of the personal computer and the spread of internet – and the advent of cheap air travel. Despite this revolution, substantial knowledge differences exist between - and within states, while recent debates in the popular media often feature pundits asserting a 'dumbing down' of Western society, justifying the question as to what actually constitutes the term *knowledge*.[3]

In a simple, yet intuitively appealing description, *knowledge* holds the key to the human capacity to manipulate and exploit its environment, and plays an essential role in ensuring a state's socio-political stability, economic prosperity and, above all, security.

Indeed, clear correlations exist between a state's size of government and private investment in Research & Development (R&D), the number of graduates with Science & Engineering (S&E) degrees, and the number of patented innovations awarded, and economic performance of that particular state. The extent to which *knowledge* can be found and utilised in a certain region is highly relevant to the success of Multinational Corporations (MNCs) in maintaining their competitive edge.

Since economic power underlies military might, the ability to access knowledge plays an important role in the global distribution of power. Although not at all salient in national security discourses – despite the vast amount of literature on the relationship between technology and military power – innovations oftentimes have a dramatic effect on the military balance. The most pertinent example that comes to mind is the invention of the nuclear bomb, but history shows ample examples of various other technologies – the magnetic compass, gunpowder, airplanes, stealth technology, the internet, GPS, to name only a few in a long row – and their effect on both the military and the economic balance between nation-states.

Within an entirely different perspective, political scientists and sociologists often propose that a certain level of education and general *knowledge* of the general population, may be conducive to the socio-political stability of democracies, suggesting that only the 'educated citizen' is able and willing to participate in the complex workings of a democracy. Extending the logic of this argument, one might speculate on whether an educated populace is able to live under an authoritarian regime.

A bottom-up review of the worldwide *knowledge* discourse reveals a myriad of conceptualisations of the term. The state of *knowledge* in the world is described primarily by contrasting the EU, the US, Japan, South Korea and at times the OECD states, with China and India, distinguishing between three broad categories that have emerged from the literature:

- *International Knowledge Differences*
- *National Distributions of Knowledge*
- *Knowledge Diffusion*

A brief note on the chosen method:

This Future Issue sketches a broad picture of the state of *knowledge* in 2009, drawing upon a wide array of quantitative data. In doing so, it seeks to provide the general trends and context within which future developments will emerge. The concentration and distribution of knowledge have a time-lagged effect on, a.o., socio-political stability and the distribution of economic and political power. The benefits of a greater number of science and engineering students, for example, will only manifest themselves in a larger labour pool of scientists and potentially into more innovations after a few years.[4]

At the same time, future developments may emerge both rapidly and unexpectedly, which would invalidate extrapolation of current trends to the future. The merging of artificial and human intelligence – as anticipated by some to occur before 2030[5] - for instance, will alter the playing field entirely perhaps through the automatisation of the production of scientific articles – i.e., software programmes writing scientific articles.

This Future Issue will therefore only very cautiously deduce a number of general conclusions about the direction of knowledge for the medium term future - i.e., the next 5-10 years – and discuss some of its potential security implications.

INTERNATIONAL KNOWLEDGE DIFFERENCES

An examination of international knowledge differences in the field of education and innovation sheds light on the existing *balance of knowledge.* If traditional indices of national power in the industrial era considered, a.o., steel production, (urban) population, and Gross Domestic Product, a modern index in the Information Age cannot avoid including educational attainment and innovation potential, as a reflection of both economic and potential military power. Educational attainment might also reflect on the socio-political stability of state regimes.

To provide some insight into the general *balance of knowledge*, two general indices will be presented that assess and rank the knowledge positions of states and regions. In moving beyond these general indices, a number of *knowledge* dimensions of education and innovation that may affect socio-political stability and economic and military power will be examined.

For socio-political stability and maturity of state regimes, the educational attainment of various populations will be mapped, the reasoning being that a certain level of education and general *knowledge* of the general population may be conducive to the socio-political stability of democracies, while the spread of tertiary education might undermine authoritarian and hybrid regimes.

Economic power, in turn, depends to a growing degree on a state's potential to innovate which is dependent on, according to economist Richard Florida, the three Ts – Talent, Technology and Tolerance. As innovations often spring from the science and engineering (S&E) sector, enrolment rates in S&E studies will be assessed in addition to scientific publications in the field of S&E. The quality and world ranking of universities will also be considered as an indicator of the geographical distribution of centers of excellence where cutting edge *knowledge* is produced. Finally, the extent to which *knowledge* leads to actual innovations is examined through a consideration of the trends in the numbers of patents received by states.

All the variables examined for economic power have relevancy for military power as well. Military power is partly dependent on a state's capacity to invent, produce and to effectively use superior military technology, to the success of which scientists and engineers are vital. A shift in the balance of knowledge may thus have a dramatic, albeit time-lagged, impact on the military balance of power.

Knowledge Positions

Combining enrolment rates, publications, patented innovations and a number of other variables, the Economist Intelligence Unit and the World Bank rank states on a global innovation and knowledge index.[6] The Economist Intelligence Unit of 2009 scores states' innovation inputs, such as R&D investment as % of GDP, the degree of broadband penetration and an institutional environment stimulating free enterprise and competition.[7] The most noticeable trends in the top-20 – which consists of 13 European states – is the steep climb of South Korea and the steady decline of the US. While the US was positioned third on the index in 2004 following Japan and Switzerland, in the period 2011 it is projected to be in fifth place, surpassed by Finland and Germany. South Korea, although having jumped four places on the index between 2004 and 2006, is outside the top-10 and is projected to stay in eleventh position in 2011. The Netherlands has a stable position in the lower echelons of the top-10.

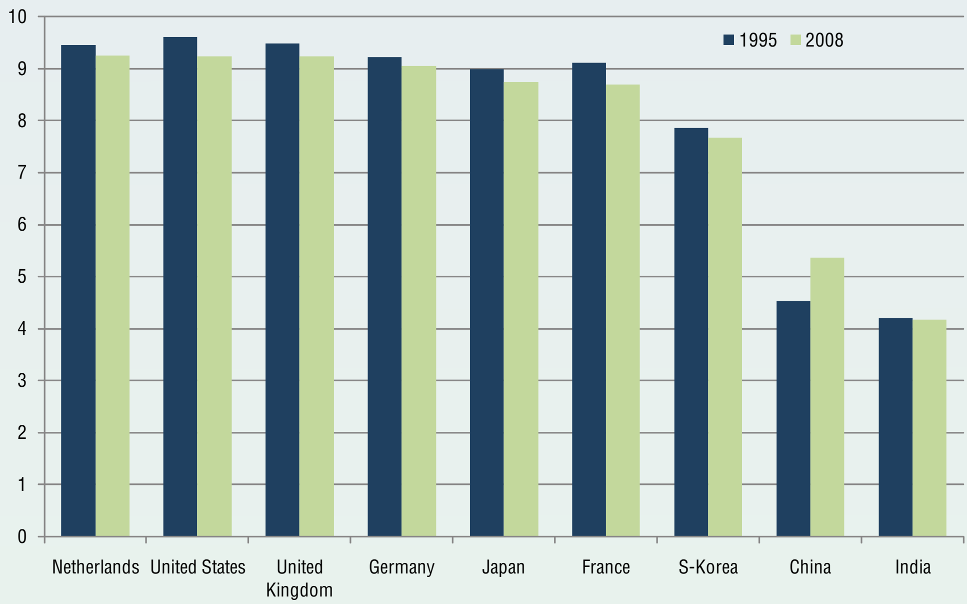
Outside the top-20, China is projected to make a leap jumping 13 places to the 46th place between 2004 and 2011. India makes and is projected to continue to make small progress on the index from 58 to 54. These figures seem to indicate that Western states still have a significant lead when it comes to innovation.

The World Bank's Knowledge Assessment Methodology

The World Bank uses a Knowledge Assessment Methodology (KAM) to benchmark the knowledge position of states or regions on a global Knowledge Index (KI). KI is a composite index of a broad range of indicators, combining educational, innovation and ICT parameters.[8]

The Netherlands, the UK and the US rank in the top-tier of the list, although they score lower than thirteen years ago. China and India are less well positioned and score about half the number of points awarded to the top-tier states. Since 1995, the world index score has dropped with more than half a point, which is surprising, to say the least. The declaratory policies of especially Western governments since the ICT revolution –repeatedly stating the intention of investing in 'knowledge economies' – would have led one to expect that this would be the other way around. Except for China, the drop is equally distributed over all the regions, leaving the respective positions of the regions unchanged.

Figure 1 **Knowledge Index score per state: 1995 - 2008. Source: World Bank**



These figures seem to indicate in the *knowledge* domain only minor alterations from the status quo are taking place. Going beyond these general indices, an examination of a number of underlying variables shows that this assertion is misleading. Rather, the trends portray the picture of a sea of change in the international distribution of *knowledge*, which is only just beginning.

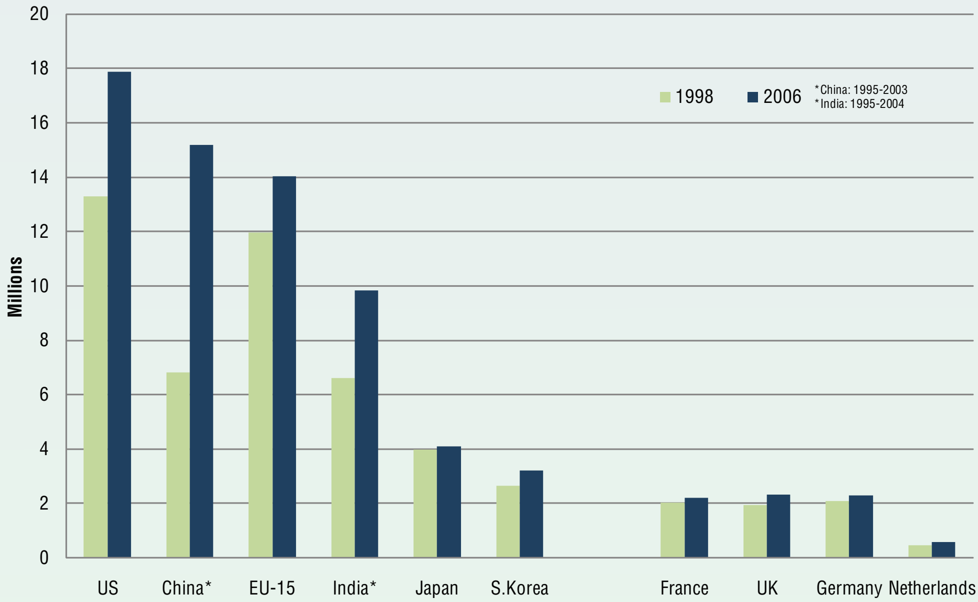
Education Enrolment and Graduation

A certain level of education and general *knowledge* of the general population may be conducive, on the one hand, to the socio-political stability of democracies, whereas on the other, the spread of tertiary education might undermine authoritarian or hybrid regimes. Despite the often-heard assertions of a 'dumbing down of society', these are definitely not founded in reality. On the contrary, a massification of intelligence is taking place.[9]

The overall number of persons with a tertiary degree is increasing, both in the OECD states and in China and India. The absolute number of new students has been rising between 1998 and 2006 for all states under review (see figure 2). The OECD average rate of tertiary education enrolment increased by 19% between 1995 and 2006.[10]

Yet, China more than doubled its enrolment figures, while India increased its student population by over half and it is expected that both states will become world leaders in education enrolment over the next decade with India on top.[11] These figures indicate that the developing economies of the two giants are narrowing the gap with Western states at a rapid pace.

Figure 2 **Tertiary enrolment, absolute numbers: 1998-2006. Sources: OECD, Unesco, Demos**

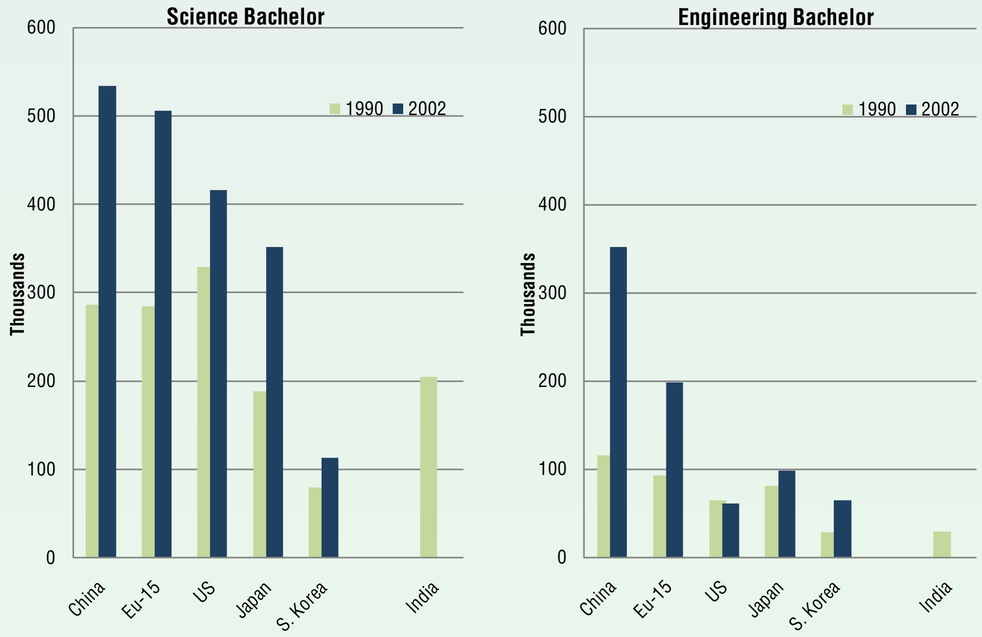


There may be a downside to this development, however, especially for China, as the growing number of citizens with tertiary education may affect the socio-political stability of nation-states with authoritarian or hybrid regimes. Processes of democratisation are oftentimes spurred by and dependent on an educated middle class. To put it more simply, a higher educated citizenry will demand more political rights and freedom, which might result in political reform and liberalisation. Yet, liberal movements may also prompt strong responses on the part of authoritarian or hybrid regimes to restore their hold on power. Moreover, democratising states – those states that are in the process of transition from an authoritarian to a democratic regime – are more prone to war than either authoritarian states or fully-fledged democracies.[12] The yearly ranking published by Freedom in the World 2008 shows a picture of 'global freedom in retreat', while the demand for freedom, transparent governance and democracy, is on the rise. Elements of this process may be observed in rudimentary forms everywhere: from calls for political liberalisation and political reform in Saudi Arabia and Kuwait, to the closing off of networking sites such as Facebook by the Iranian government, to the 87,000 demonstrations in China in 2005 (most recent figures available), a tenfold increase compared to 1994. Attempts by the Chinese government to lower the rising socio-economic inequality in order to quell the domestic unrest may prove to be futile in this regard as it would address only one part of the problem.

Science and Engineering Enrolment Rates

The presence of a highly qualified S&E labour force is one of the pillars of a state's innovation potential and the strength of its economy. This, however, goes beyond economic power. Military innovations are often the result of intensive collaboration between the 'best and the brightest' who will have a greater chance of emerging from a larger pool of candidates. The size of this pool – i.e., the S&E labour force of the future – is determined by the S&E tertiary enrolment rates in the present.

Figure 3 **S&E Bachelor degrees. Source: NSB**[16]



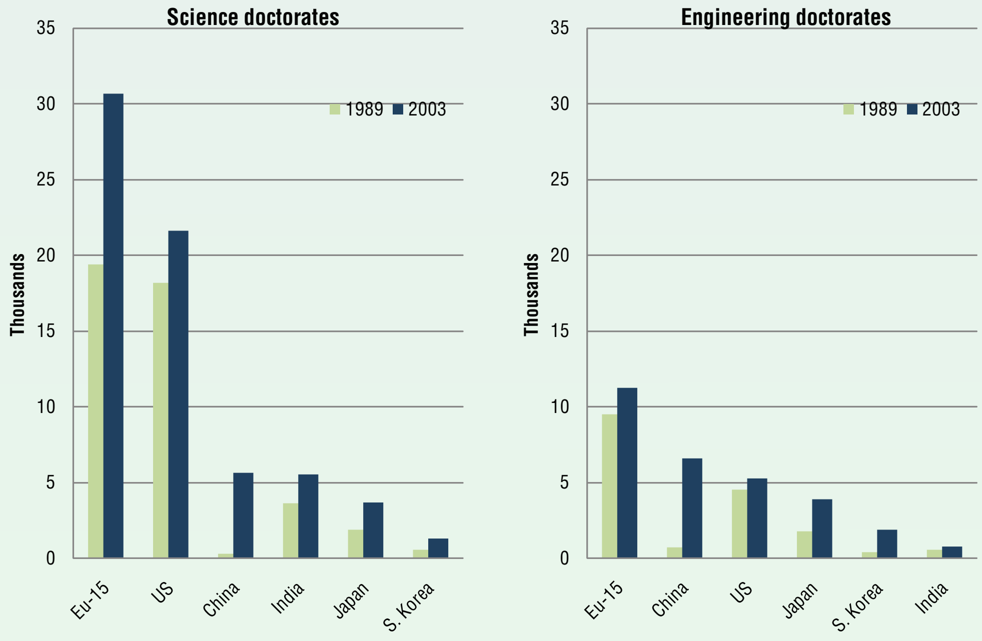
The trends in S&E enrolment rates are worrying in this perspective to Western states. Despite the EU adoption of the Lisbon Strategy in 2000 (and its subsequent updates) – stating the intention to invest massively in, a.o., science and engineering (S&E) education – and successive policy initiatives in the US to increase S&E enrolment rates, both relative and absolute numbers of S&E (including natural sciences, mathematics, ICT and engineering) students are higher in Asian states.

The ratio of engineering students to the entire student population in Japan and Korea are, respectively, three and four times as high as those of the US.[13] These ratios have been decreasing for all states reviewed – including Japan and Korea – except for India's, whose ratio almost doubled.[14]

In the number of bachelor and doctorate degrees awarded a similar trend emerges, with a rising East, a EU keeping pace, and a trailing US (see figure 3). Although comparable data from India are missing, sources estimate India to be in the top-3 of engineering degrees by now.[15]

Figure 4 shows the number of PhDs awarded. Untypically, Asia hasn't penetrated the world top in science doctorate degrees, indicating that the highest levels of scientific knowledge acquisition remain to be found in the US and particularly in the EU, although especially China is rapidly narrowing the gap.

Figure 4 **S&E doctorates. Source: NSB[17]**



The spread of knowledge may affect the global military balance, as states with adequately skilled scientific personnel will master the ability to produce disruptive military technologies. If past examples have been both numerous and disruptive – the invention of the nuclear bomb, intercontinental ballistic missiles, Stealth-technology etc. – advances in nano- and information-technology and the convergence of biology and chemistry will undoubtedly affect the military balance of power of the future.[18] Aspiring nuclear states may no longer need thirty plus years to master the technology to produce a nuclear bomb, and the biological and chemical weapon conventions (BWC and CWC) may become worthless in time.

Given sufficient funding, it may entail that several states will be able to establish national research agencies that will be able to compete in terms of innovativeness with the US' Defense Advanced Research Projects Agency (DARPA). Rather than seeking to balance the military dominancy of the US with existing technologies, they will venture out in newly emerging fields, which is evidenced by the Indian rapid buildup of its capabilities in space – as described in more detail in the Future Issue on *Space based warfare* – and the military modernisation pursued by China.[19,20]

Scientific Publications

The number of scientific publications is another indicator of national knowledge accumulation. The EU-15 and the US each account for a third of the world's scientific publications (see figure 5). While Japan and particularly China make a far smaller contribution, China's share has more than quadrupled between 1985 and 2007. Confining the analysis to the S&E field, a different picture emerges (see figure 6). The number of S&E articles published in Asian states and the EU-15 has grown considerably, while the US production growth has nearly flattened. The EU-15 output surpassed the US in 1996 and is twice the output of Asian states.[22]

Innovation is very much dependent on the presence of human capital. The overview of S&E enrolment rates indicates that skilled personnel will increasingly be found in developing economies while in the West the growth in supply of skilled personnel does not keep pace. Whereas in the past immigrant scientists often filled the available spots, there is growing anecdotal evidence that the flow is reversing and that especially the Indian diaspora is returning to the homeland.[24]

Faced with insufficient supply of skilled labour to man their R&D laboratories in the West, MNCs may decide to relocate their R&D centres to developing economies. Innovation clusters may then start to emerge in developing economies while current centres of excellence in Western nation-states may lose their innovative ability. The first signs of this process are already on the wall. Mumbai has emerged as the Indian Silicon Valley, and Shenzen, previously a Walhalla for manufacturers of toys and other low-value added goods, is slowly on transforming to a R&D centre in, a.o., the fields of biomedicine. If the latter would come to pass, it would significantly hinder economic growth and undermine the competitive edge of the EU and the US.

Figure 5 **Share of scientific Publications, in Percentages: 1985-2007 . Source: SCIE (adapted from Zhou & Leyersdrff, 2008)**[21]

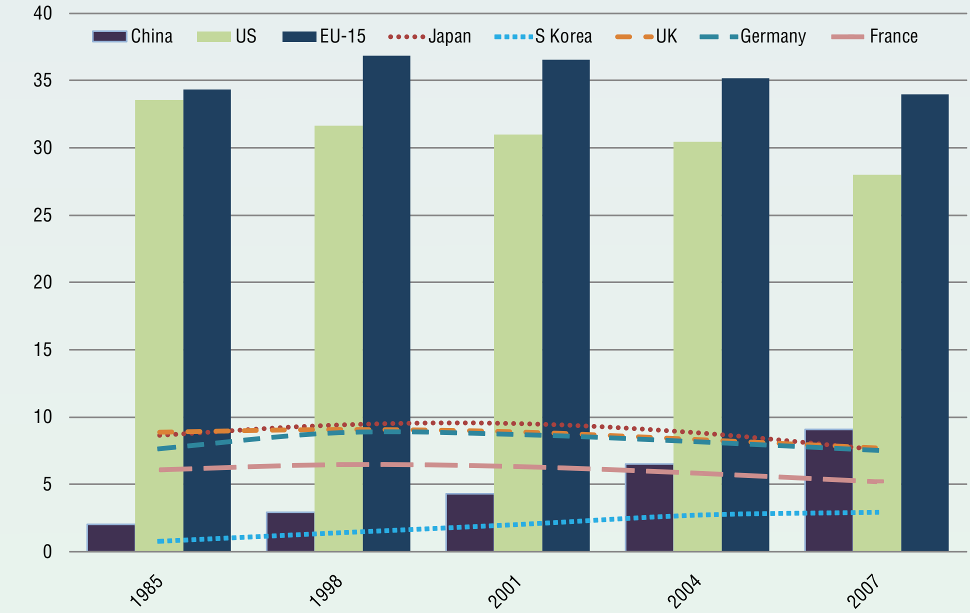
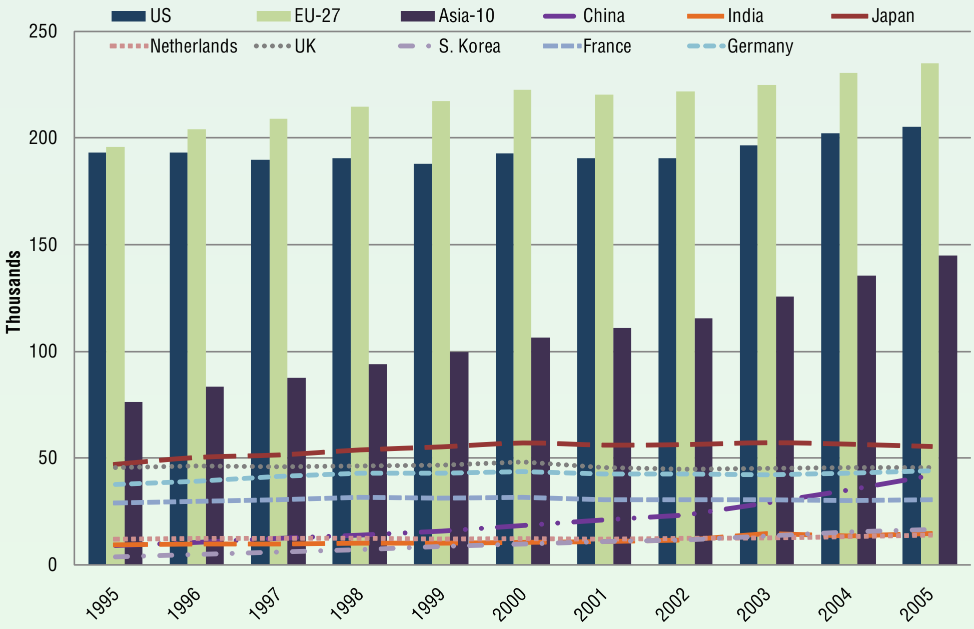


Figure 6 **S&E article output: 1995-2005. Source: NSB**[23]



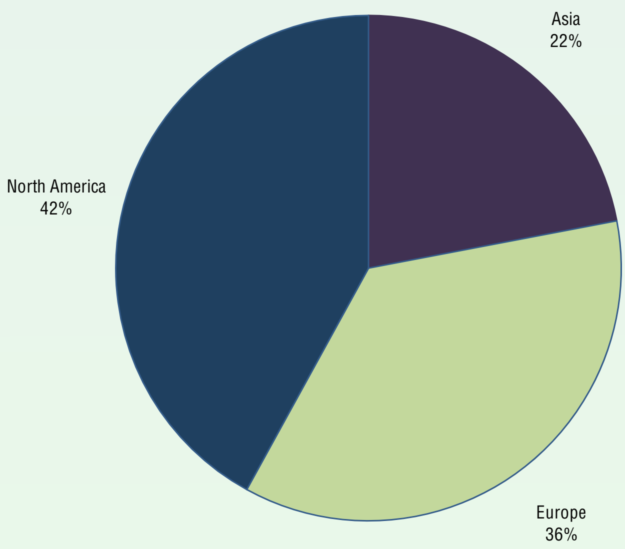
Authoritarian and hybrid regimes with an increasing percentage of their population receiving tertiary degrees find themselves between Scylla and Charybdis, as innovation and economic growth in the Information Age is very much dependent on the free-exchange of ideas between people with the latest technology at their disposal. To put it differently – in the words of the economist Richard Florida – innovation and economic growth depend on the mastering of the three Ts – Talent, Technology and Tolerance.[25] The real dilemma these authoritarian and hybrid regimes face is whether they allow the free exchange of ideas in opting for innovation and economic growth, which may kick start a process of political liberalisation, or whether they will choose to hold onto an authoritarian system, which may hamper innovation and economic growth. How the Chinese government, for instance, solves this dilemma will undoubtedly affect not only China's domestic stability but also its rise towards becoming a global (economic) power.

University Rankings

How do these trends in enrolment rates and scientific publications relate to the quality of the education offered at universities? Centers of excellence are after all often linked to the presence of top universities, think of MIT and Harvard in the US.

Despite the fast-paced rise of China and India and the lead of Japan and South Korea in total number of S&E graduates, American and European universities still offer the

Figure 7 **Top universities by region. Source: Times QS university ranking**

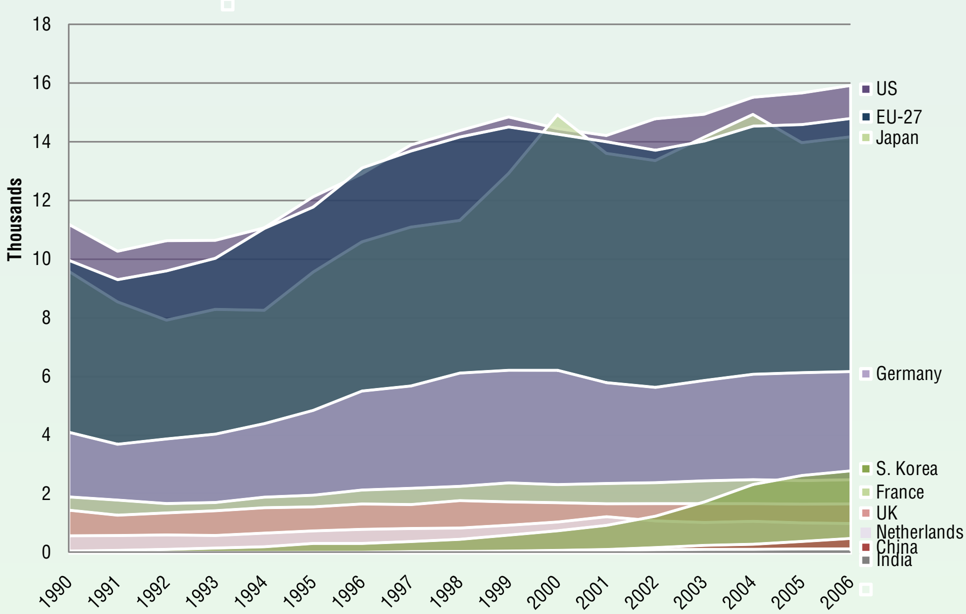


highest quality of education. The top-100 universities ranking by the Times QS 2008 shows that North America – particularly the US – is well represented with 42 universities compared to Europe with 36 and Asia with 22 (see figure 7[26]). In the top-20 of the list, the US presence is even more dominant, with 70% of the universities. This also holds true for universities in the fields of science and engineering, in which the US is still host to 60% of the top universities. The 2008 ranking does not differ much from the one from 2005 – the oldest available ranking.

Triadic Patent Families

Also when considering the number of triadic patent families – an indicator of how actual research gets translated into innovation – a picture emerges of a still nascent multipolar global *knowledge* distribution. Triadic patent families (TPF) are those innovations that have been granted patents by the three major patent offices: the European Patent Office, the Japan Patent Office and the US Patent and Trademark Office.[27]

Figure 8 **Triadic patent families, in absolute numbers: 1990-2006, Source: OECD[28]**



The US and Japan account for the largest share of the TPF with almost 60% of the global total amount (about 15 thousand TPF each). Most of the remaining third is accounted for by European states, leaving China and India with a negligible share. Although India's number of TPF increased tenfold and China's forty-fold since 1990, their numbers are still in the hundreds indicating that a possible shifting balance of knowledge is only in its infant stages, a picture confirmed by the examination of the two innovation and knowledge indices in the first paragraph.

Key Findings & Security Implications

Finding: 'dumbing down' an urban myth

The overall number of persons with a tertiary degree is increasing worldwide, both in the OECD states and in China and India. Assertions of a 'dumbing down of society' are therefore not founded in reality. On the contrary, a massification of intelligence is taking place.

Security Implication: threat to socio-political stability of authoritarian and hybrid regimes

The growing number of citizens around the world with tertiary education may affect the socio-political stability of nation-states with authoritarian or hybrid regimes. Processes of democratisation are oftentimes spurred by and depended on an educated middle class. Harbingers of this trend are observed in states such as Iran and China.

Finding: a changing balance of knowledge

The number of students pursuing S&E-degrees are decreasing in the EU and the US, while China and India, on the other hand, have tremendously increased enrolment rates in these disciplines. The gap in scientific output between China and India and – to a lesser extent – the EU and the US and Japan is narrowing, measured by the number of scientific articles published. Since an increase in scientific publications is generally followed by a surge in innovative capacity and patent applications, it seems inevitable that the technological dominance enjoyed by the US and Japan will come to an end, although judging from the number of patent applications received and the ranking on knowledge and innovation indices, this is not happening as of yet.

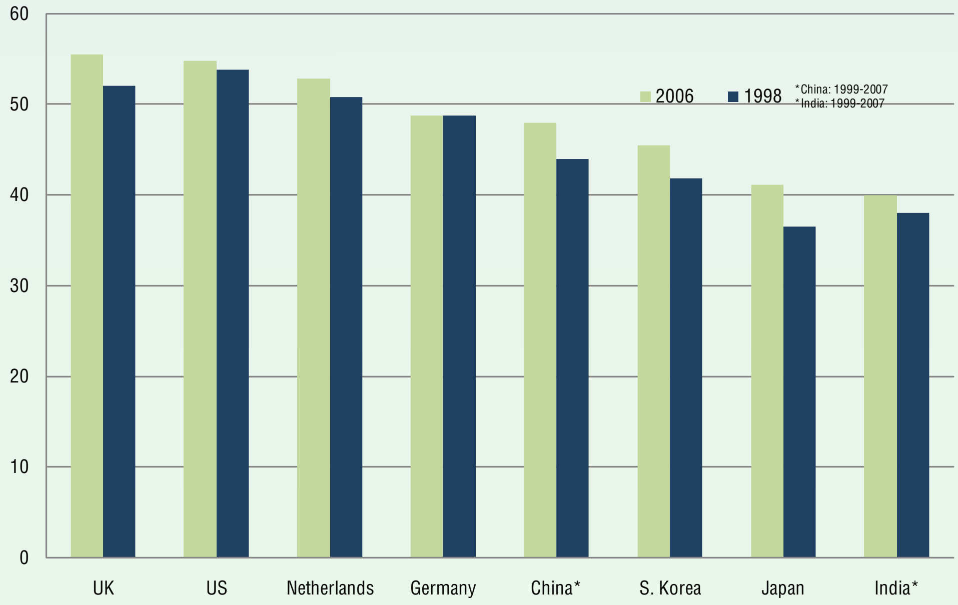
Security Implication: threat to Western economic security & military dominance

The changing balance of knowledge may lead MNCs to relocate (more of) their R&D centers to developing states and undermine the competitive edge of those nation-states left with little R&D capacity of their own. The changing balance of knowledge may affect the global military balance as numerous nation-states will master the ability to produce disruptive military technologies. Advances in nano- and information-technology and the convergence of biology and chemistry may affect the balance of power of the future.

The relative knowledge position of states depends, amongst other things, on whether they are able to utilise their human capital to the fullest. The extent to which states are able to overcome barriers to equal gender participation and social upward mobility is relevant in this respect. A comparison of female enrolment rates and potential for upwards mobility may shed some light both on knowledge utilisation of different states and on possible shifts in the composition of their labour pools of the future (in the absence of further obstacles in the way of equal participation). States that are able to create social upward mobility pathways and eliminate gender barriers attain a brain gain and create a competitive advantage vis-à-vis their competitors.

Female Enrolment in Education

Figure 9 **Women in Tertiary Education. Sources: OECD, UIS**[29]



Women tend to be well represented in the graduate population (i.e., enrolled in tertiary education) in Western states, especially in Western Europe, North America and Australia (figure 9). In several states – the Netherlands, the US, Spain – the percentage of female students in tertiary education is even over fifty percent, with Germany as a notable exception with an unchanged 48,8% since 1999. In Asia, Japan and South Korea these rates are much lower. Together with Turkey they have made the biggest strides in increasing female enrolment.

The UK has been especially successful in this regard. With the exception of Australia, all OECD states here considered show an increase in female enrolment in tertiary education. The fact that states with low female participation show a faster increase than other states points toward an international convergence in female enrolment rates.

Socio-Economic Differences & Education: Social Mobility

Despite educational systems in OECD states to which all socio-economic classes have equal access, substantial differences in actual enrolment exist amongst classes, indicating that a parent's socio-economic status influences a student's access higher education.

In Austria, Germany, France, Portugal and the UK, students whose father completed higher education are more than twice as likely to enrol in tertiary education as those students whose father did not.[30] The figures of the Netherlands, Ireland and Spain show just a slight advantage for students with higher educated fathers.

The 2007 report "Intergenerational Transmission of Disadvantage" reviews the social mobility of generations more closely. It shows a strong correlation between the occupational status of the students' parents and the students' performance. The average math scores of students whose parents are in the top and bottom socio-economic quarters (as measured by the OECD index of economic, social and cultural status - the ESCS-index), equals a difference of more than two full points.[31] The United States, Germany and Turkey are among the states that are above this OECD average. The best performing states in this list, showing the least difference in performance by students from so-called low and high socio-economic classes, are Iceland, Finland, Canada, Spain and Ireland. Japan and Korea score again well below the OECD average.

The key implication of knowledge distribution equality relates to the notion that states that are better at creating social upward mobility pathways and eliminating gender barriers, will be able to draw upon a greater labor potential thereby creating a competitive advantage for themselves. Alternatively, those states that fail to do so, will be at a disadvantage even before taking all other factors into account.

Key Findings & Security Implications

Finding: Access to knowledge varies from group to group across states

Women tend to be well represented in the graduate population in OECD states, with Japan and South Korea as notable exceptions to this rule. In some states over fifty percent of the graduate population consists of women, pointing toward a possible shift in the future composition of the labor force. Tertiary enrolment rates of different socio-economic classes vary considerably across OECD states

Security Implication: competitive advantage and brain gain

States that are able to create social upward mobility pathways and eliminate gender barriers attain a brain gain and create a competitive advantage vis-à-vis their competitors

DIFFUSION OF KNOWLEDGE

If the current era could indeed be defined as the Information Age, it would be relevant to examine the extent to which knowledge diffusion is actually taking place on a global scale and whether states have similar access to the Information Age. The sociologist Manuel Castells for instance asserts the rise of a First and a Fourth World to distinguish between those regions in the world that do and those regions that do not take part in the Information Age. Connectedness is crucial in this regard, and the un-connected do not have access to global information flows and cannot participate in the global economy. Within the security domain, strategist Thomas Barnett refers to the difference between connected and unconnected regions as the Core and the Gap, with the people living in the gap not being able to reap all the economic benefits of the Information Age.[32] The distribution of global internet usage may serve as a good indicator of connectedness. Yet, the increase in Internet usage in both the Core and the Gap also significantly affects the status and role of *knowledge* in these societies and carries significant implications for security and business continuity.

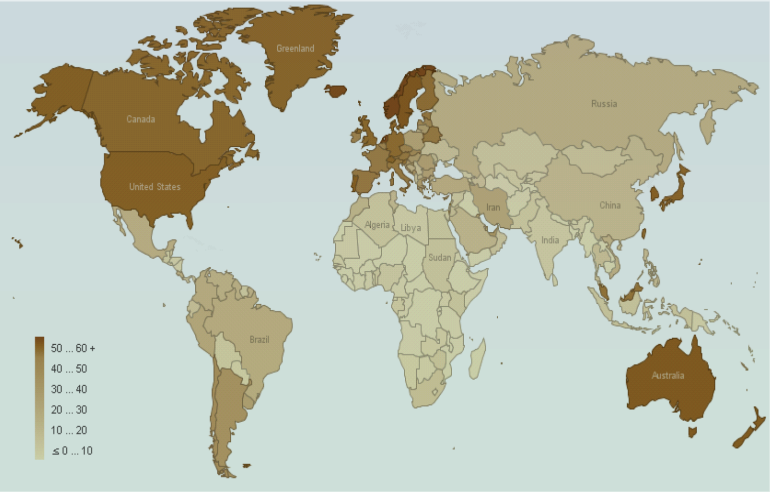
If Internet usage may serve only as a proxy for the actual diffusion of knowledge, trends in the geographical distribution of patent filings and the global technology balance of payments reflect both on global knowledge diffusion and on the states that are recipients and originators of knowledge diffusion. These data provide context and shed – yet again – a different light on the balance of knowledge of the present and the future.

Internet Usage

The use of Internet varies tremendously across different regions. Internet in OECD states – the Core - is generally 60 percent or higher. China and India – previously belonging to the Gap – are catching up with growth rates of over a 1,000 percent compared to the year 2000.[33] At present, over twenty percent of China's population has internet access while still only seven percent of India's population surfs the World Wide Web. Internet usage in Africa – the Gap – is even lower (less than 6 %). Briefly, it may be concluded that a First and a Fourth world exist, although some regions in the Fourth World are rapidly upgrading their levels of connectedness.

Figure 10 **Internet penetration. Source: Internet World Stats**[34]

Internet Penetration by Country, in Percentage of Population: 2008



User Growth: 2000-2008

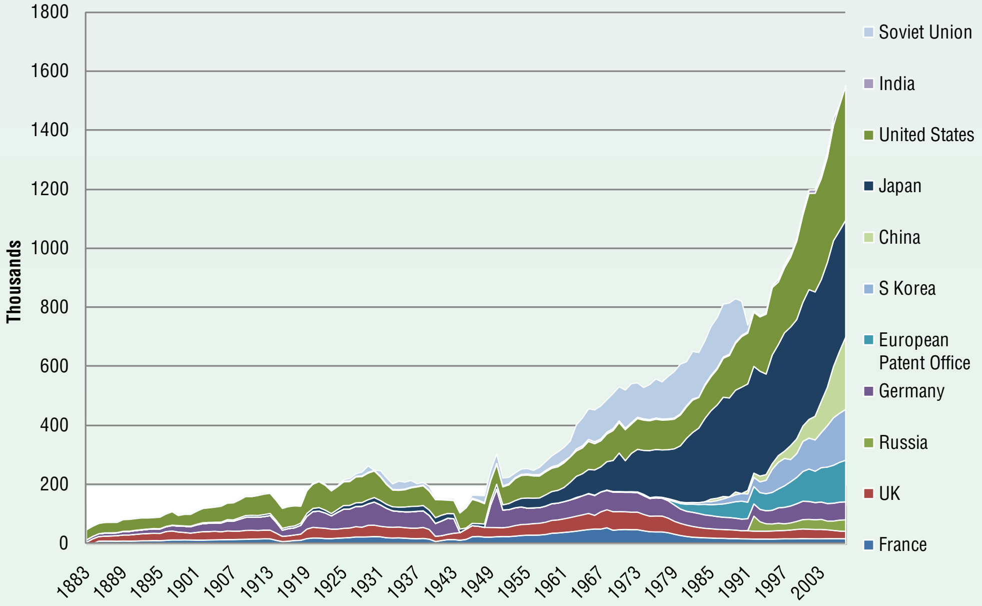
UK	180,7%
US	138,3%
India	1520,0%
China	1224,4%

Access to the worldwide web is instrumental in the diffusion of knowledge and the spread of ideas. This does not necessarily entail the spread of Western ideas, as is sometimes asserted. Websites such as Sina, a Chinese version of YouTube, feature short, patriotic Internet movies such as '2008 China – Stand Up!', that receive millions of hits.[35] Yet, the use of Internet in the spread of revolutionary ideas and the onset and execution of revolutions has been prevalent over the last decade in several instances in former Soviet Union states that have transitioned from authoritarian to democratic regimes.What is more, the rise of Internet websites democratises knowledge to an unprecedented degree in history, taking away the monopoly from the large news organisations and bringing the opportunity to spread ideas to every citizen with an Internet connection. This is not only significantly changing politics in advanced democracies – some outlets claim that the Obama campaign of 2008 is only a harbinger of the things to come – but is expected to significantly alter the media landscape as well. This raises questions for governments, companies, universities and individuals as to what status knowledge will beget in the future. What role will universities have in the accumulation and diffusion of knowledge? Will news organisations lose their role as the fourth pillar of the Trias Politica? How will governments and corporations shape the ways in which news will be diffused? These questions are not only relevant in this regard but will also carry far reaching implications for security and business continuity.

Patent Applications

Turning to the geographical distribution of patent filings an ever changing landscape emerges. Over the last 125 years, patent filings with the largest international patent offices have grown tremendously. Between 1883 and 1950, they exhibited a steady growth, only to be temporarily inhibited by economic depression of the 1930s and the two major wars of the twentieth century. Patent filings increased dramatically after the Second World War. Overall, more patents were filed in a larger number of states, with the impressive rise of Chinese and Korean patent offices over the last two decades.[39]

Figure 11 **Total Patent Applications: 1883-2007. Source: WIPO**



Global Technology Balance of Payments

The global technology balance of payments (GTBP) captures the diffusion of knowledge across boundaries. The GTBP comprise money paid or received for the use of patents, licenses, trademarks, designs, inventions and know-how.[40] Technology balance of payments (TBP) is the term that refers to a state's import of such knowledge; technology balance of receipts (TBR) refers to a state's export of such knowledge. GTBP therefore reflects on the current *balance of knowledge*, by representing the flow of technological know-how and services in and out of states. Even more than patent filings, GTBP data show the increase in diffusion of knowledge around the world as they represent the actual application of knowledge across states.

Figure 12 **Technology Balance of Payments: total revenues in billion USD (receipts minus payments): 1981-2007. Source: OECD[41]**

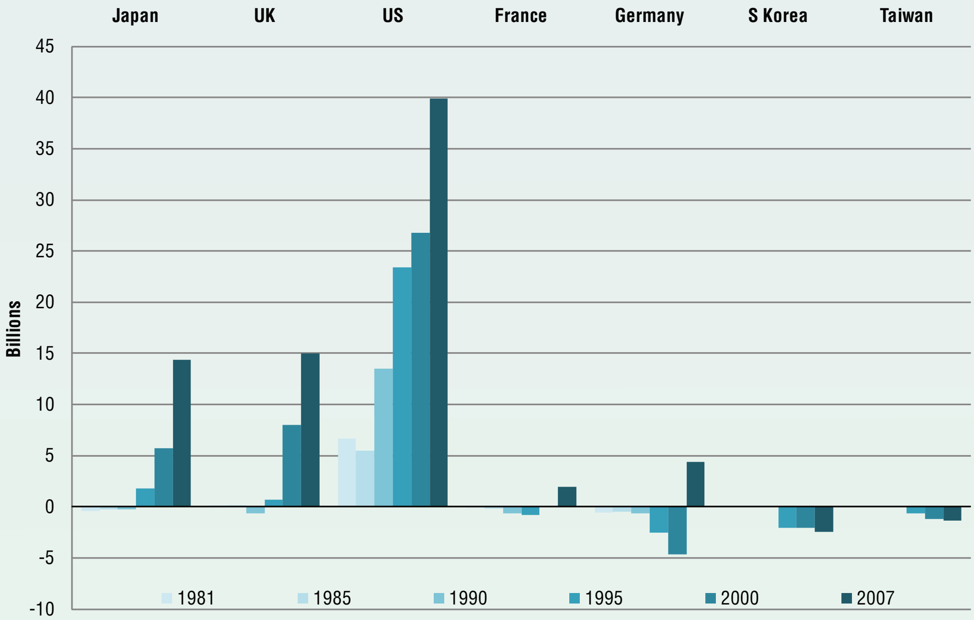


Figure 12 shows the GTBP for individual states (the sum total of money received minus the sum total money paid for licenses, trademarks, designs, etc., in billion USD). The US is the biggest net receiver, making a profit of 40 billion USD in 2007. The only available data for China is of 2004, when its GTBP total amounted to 75 million USD.[42] Compared to the US revenue of that year – 36 billion USD - that is a negligible amount (please note that no data on India were available). These GTBP data show how the current *balance of knowledge* is clearly still in favour of the US.

Key Findings & Security Implications

Finding: the rise of a First and a Fourth World in the Information Age

> The Core and the Gap do not equally participate in the Information Age, although a small but growing part in the Gap is gaining access to the World Wide Web

Finding: The rise of internet websites democratises knowledge to an unprecedented degree in history

Security Implication: a changing political playing field, both for authoritarian and democratic regimes

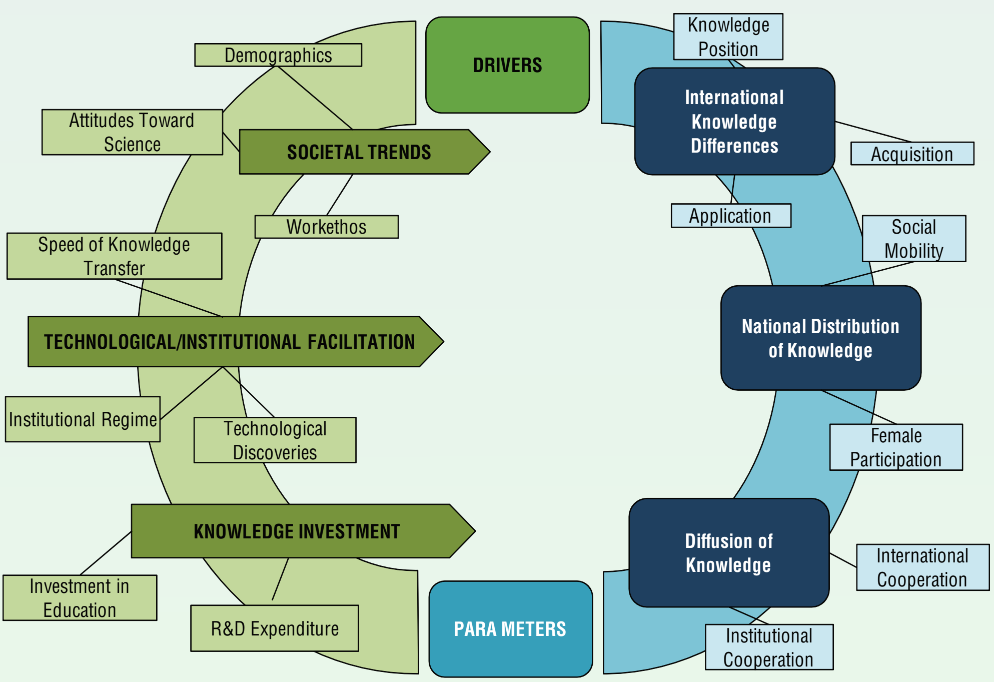
> The spread of Internet may play a salient role in the onset and execution of revolutions over the next decade, while it will dramatically change the political landscape in advanced democracies

Finding: The global technology balance of payments show that Western states are still frontrunners in the development and application of knowledge

Security Implication: a true multipolar distribution of knowledge is still nascent and the West continues to hold a dominant position which may extend to innovation capacity in the military domain as well

The extent to which knowledge is accumulated and distributed & diffused, both nationally and internationally, depends on a diverse amalgam of drivers (see figure-13). These can roughly be distinguished into three categories: societal trends, knowledge investment and institutional frameworks & technological facilitation.

Figure 13 **Drivers and Parameters**



Societal Trends

Demographics

Demographics are one of the key determinants of the size of the student population. China and India together account for more than a third of the world population. It is only natural that their student population would outnumber the student population of the West. The Chinese student population (aged 18-23) outnumbers its US and EU counterparts by a ratio of five to one, but is expected to be surpassed by the Indians within a decade.[43]

Over the last few decades, US universities have attracted increasing numbers of foreign S&E students. At present, foreign engineering students now outnumber their US students. The largest groups of these foreign S&E students come from China and India.[44] While many Chinese students tend to pursue a professional career in the West after graduation, Beijing is seeking to lure them back.[45] Of all foreigners, Chinese and Indian postgraduates are most likely to remain in the US – 90% and 85% respectively plan to remain in the US after graduation for at least five years – but these numbers begin to show a downward trend[46] as both India and China are propping up the quality of their educational institutions and research facilities.[47]

> Asian student populations outnumber student populations in the West multiple times while there are signs that the Asian scientific diaspora is planning on returning to their home states

Attitudes Towards Knowledge

The extent to which societies hold knowledge in high regard affects the accumulation of knowledge. Recent polls conducted in the US reveal an attitude towards knowledge and science in which anti-intellectualism (“too much learning can be dangerous”) and anti-rationalism (“there are no such things as evidence or fact, just opinion”) fuse together. Several surveys show that US youth score considerably worse than their peers from other states. They fared worst in answering correctly their own population size, with one third of the respondents estimating it to be between 1 and 2 billion. Not only did Swedish, Japanese and Mexican youth, a.o., score better at estimating their own population size, but they even outperformed American youth on estimating the US population size – with the percentage of correct answers of Swedish youth being twice as high.[48] The same survey showed a significant decline of American youth who labelled basic geographical and cultural skills (such as knowing how to read a map or where other states are located) as necessary or important.

Additionally, a unique longitudinal study comparing survey scores of US youth in 1955 and 2002 reveals that 21st century US students have significantly less general knowledge than the high school graduates of 50 years ago.[49] Essential scientific, civic and cultural knowledge goes lost on those that deem it unimportant.[50]

> The extent to which societies hold knowledge in high regard is crucial to the accumulation of knowledge

Mobility

Social mobility and international mobility facilitate access to and supply of knowledge. Institutional discrimination against women in education and labour, for instance, leaves half of a state's population unexposed to high-level knowledge. The relative ease by which people travel across the world, moreover, lowers the threshold for the best and brightest to seek the finest places of education and research, thus making 'brain drain' a major concern for many states.

> Mobility posing challenges of brain drain and opportunities for brain gain

Work Ethos

If the capitalist' ethos of working, saving and investing for long term benefit really grew out of the Protestant ethic, as postulated by Max Weber, this ethos seems to be somewhat diminishing in the Western world, while it thrives in industrious Asia. Of all the OECD states, South Koreans work by far the longest hours. The five only other economies that surpass the threshold of 2200 annual working hours are all Asian, and include China. Europeans work far fewer hours compared to either Americans or Japanese workers– who are listed in the sub-top – and perform well below the OECD average. For some European states– including the Netherlands – more than 600 hours are lost annually compared to Asia. Labour productivity of US workers is still the highest in the world, but nowhere did the productivity levels increase as fast over the last decade as in East Asia – where worker output almost doubled.[51]

Within the US, Chinese-American students outperform their peers simply by working harder, as one recent study of intelligence shows.[52] Asian-Americans are among the best-performing groups in higher education, accounting for 24% and 22% of respectively Stanford's and Harvard's student body – while only comprising 5% of the total US population.[53]

Asians work the longest hours, European the shortest hours, while Americans are (still) the most productive

Technological Facilitation & Institutional Framework

Speed of Knowledge Transfer

The many opportunities for international cooperation in science and the increased accessibility of knowledge of today are largely due to the speed of knowledge transfers that came with the Internet.[54] International co-authorship of scientific articles almost doubled between 1997 and 2005 while Internet use in the developed world grew from 11% to 56% during that period.[55] Despite its lower Internet penetration (only 22% and 7% of Chinese and Indians respectively have access to Internet)[56] the sheer amount of Asian surfers account for 41% of the world's total Internet use. The frontrunner status of Europe in broadband penetration (23% for Western Europe[57]) is not likely to hold, as broadband access – facilitating videoconferences and other high-traffic functions – is becoming more and more widespread.

The increases in access to and speed of knowledge transfers will not solve the inequality of a Core and Gap world, but will lower the threshold to the diffusion of knowledge

Institutional Regime

A state's institutional regime sets the framework within which R&D takes place in addition to shaping a state's educational framework. In that respect, it forms the backbone infrastructure of a state's knowledge position.

The World Bank KAM methodology (see the chapter International Knowledge Differences) uses as one of the pillars for its Knowledge Index a composite of indicators for a state's economic regime and governance. This pillar includes, among many others, indicators for intellectual property protection, freedom of press, rule of law and the number of days it takes to start a business. The index scores of this particular pillar place the UK and the US in the top of the list, with respectively 9.28 and 9.16 out of a total of 10 points. Several large European states, other than the UK, perform significantly worse, but still better than Asian institutional regimes, that prove to be the least suitable to knowledge application and transfer. The Scandinavian states and the Netherlands feature in the top-5 of the Knowledge Index and score similar on the economic incentive regime index. Germany and especially France perform below Western par with 8.99 and 7.82 respectively. South Korea's score of 5.57 puts it in a whole other league than the Western states, which is even more true for China (4.01) and India (3.67).[58]

> The institutional regimes in the West are at present far better adjusted to facilitate knowledge accumulation and distribution than those in Asia

Knowledge Investment

Investment In Education

Although the quality of education is determined by much more than simply the size of a state's education budget, the latter is generally considered to be one good benchmark by which to measure knowledge inputs. The US invests substantially in education, both relatively, as percentage of GDP, and in absolute terms. Between 2000 and 2009 its education budget increased as a percentage of GDP from 5,4% to 6,1%, thereby performing well above the average of high-income states.[59][60] With a quarter of the almost 900 billion USD education budget reserved for tertiary education, the majority of the money is spent on primary and secondary education.

China also massively increased education spending, ten-folding its education budget between 1990 and 2004. This still amounts to only a tenth of the US budget.[61] China's 2009 budget, however, has set aside close to 200 billion USD for education – a 300% increase since 2004. These increases are also observed by considering investment as percentage of GDP. While China's 2004 education budget amounted to 2.8% of GDP, this year's budget is 4.5% of GDP.[62] For comparison, the British budget of 2009 allocated 144 billion USD to education – comprising 3,9% of its GDP.[63] For India these figures are 8 billion USD and 2,46%.[64]

Investment in R&D

Private and public expenditure on R&D are key drivers of the innovation potential of states.[65] The correlation between monetary input and innovation output is not clear-cut though. The current strong knowledge position of the UK followed a decade-and-a-halve of considerable cutbacks of government spending on science. The consequential resourcefulness and increased investments from industry and the EU presumably resulted in higher quality of R&D.[66]

While the US and EU have consolidated their knowledge investments in R&D over the past decade, China has massively increased its R&D spending. In absolute spending figures, China now ranks second, still trailing the US, but surpassing Japan, who has held this position for over two decades. Japan spends on R&D about half that of the entire EU-15. China's spending as percentage of its total GDP – known as R&D intensity – lags behind the US and most EU states, but Chinese growth is also impressive in this respect.[67] India spends less than one percent of its GDP on R&D, but this still puts it at a respectable 8th place worldwide, just behind South Korea. Both the Chinese and the Indian governments have recently set a R&D intensity target of 2% by 2010.[68] If China succeeds in reaching that target while keeping up its average GDP growth rate of 9%, it could soon surpass the EU-15.

The US and EU have not been increasing knowledge investments in R&D fast enough to prevent China from gaining ground rapidly

CONCLUSION ISSUES TO CONSIDER

A review of the state of knowledge anno 2009 leads to a number of conclusions with far reaching security implications. The following conclusions are amongst the most significant:

- ‘Dumbing down’ is an urban myth and a massification of intelligence is taking place
- The world is experiencing a changing *balance of knowledge,* although a true multipolar distribution of knowledge is still nascent
- A growing gap is emerging between people in the First World that do partake in the Information Age and those in the Fourth World that don’t participate
- The spread of knowledge across different socio-economic and gender groups varies from state to state
- The global spread of Internet affects the status and role of knowledge in societies of both advanced and developing economies

These findings may produce a variety of security implications which have been described in this Future Issue. The most relevant of these implications are:

- The growing number of citizens around the world with tertiary education may affect the socio-political stability of nation-states with authoritarian or hybrid regimes
- The changing *balance of knowledge* may pose a threat to economic security when MNCs decide to relocate (more of) their R&D centers to developing economies and undermine the competitive edge of those states left with little R&D capacity of their own
- The changing *balance of knowledge* may affect the global military balance as numerous nation-states will master the ability to produce disruptive military technologies
- States that are able to create social upward mobility pathways and eliminate gender barriers attain a brain gain and create a competitive advantage vis-à-vis their competitors

In conclusion, the global knowledge landscape is experiencing significant shifts, both with respect to its geographical distribution and to its role and status. These shifts may carry a number of security implications both at the international and the national level for security and business continuity.

ENDNOTES

1. Winston Churchill, Speech at Harvard University, September 6, 1943.
2. ibid.
3. See the debate on http://www.economist.com/debate/overview/137 .
4. Economists claim for instance that a 10 percent increase in the number of foreign graduate students would raise patent applications by 4.5 percent, university-patent grants by 6.8 percent, and non-university patent grants by 5.0 percent. See Wadhwa, Vivek, Saxenian, AnnaLee, Freeman, Richard B. and Salkever, Alex, Losing the World's Best and Brightest: America's New Immigrant Entrepreneurs, Part V (March 19, 2009).
5. http://www.kurzweilai.net/meme/frame.html?m=10 .
6. World Bank KAM: Knowledge Index and Knowledge Economy Index: http://info.worldbank.org/etools/kam2/KAM_page5.asp. The Economist Intelligence Unit, "A new ranking of the world's most innovative countries", 2009. Report can be downloaded here: http://graphics.eiu.com/PDF/Cisco_Innovation_Complete.pdf. Pro Inno Europe: http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=437&parentID=51
7. http://www.eiu.com/index.asp?rf=0.
8. Worldbank, site last visited 20/05/2009: http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/EXTUNIKAM/0,,contentMDK:20584274~menuPK:1433201~pagePK:64168445~piPK:64168309~theSitePK:1414721,00.html
9. The Age of Mass Intelligence, Intelligent Life Magazine, Winter 2008, see: http://www.moreintelligentlife.com/story/age-mass-intelligence.
10. OECD.stats: http://oberon.sourceoecd.org/vl=24624999/cl=27/nw=1/rpsv/dotstat.htm
11. NSF, "Asia's Rising Science and Technology Strength: Comparative Indicators for Asia, the European Union, and the United States", 2007.

12. Mansfield, Edward D. and Jack Snyder. 1995a. “Democratization and the Danger of War.” International Security 20 (Summer): 5-38; Snyder, Jack L. 2000. From Voting to Violence: Democratization and Nationalist Conflict. New York: Norton.

13. Percentages calculated from OECD data: stats.oecd.org .

14. Demos, “The Atlas of Ideas: India, the Uneven Innovator”, 2007.

15. See: Demos, “The Atlas of Ideas: India, the Uneven Innovator”, 2007, p. 11: India’s engineering graduates are approximately 350000.

16. US National Science Board, S&E Indicators, 2008.

17. US National Science Board, S&E Indicators, 2008.

18. Sweijs T. & Chehin, N. ‘The CWC: Past Achievements and Future Challenges - A Review of the Main Conclusions of the OPCW Academic Forum’ at http://www.opcwacademicforum.org/page/355 (September 2007).

19. Office of the Secretary of Defense, Military Power of the People’s Republic of China, 2009 ANNUAL REPORT TO CONGRESS.

20. Chinese State Council Information Office, White Paper on China’s National Defense in 2008, accessible at http://www.china.org.cn/government/central_government/2009-01/20/content_17155577.htm .

21. Zhou & Leyersdorff, “China ranks second in scientific publications since 2006”, ISSI newsletter, nr. 13, March 2008, pp 7-9.

22. Data retrieved from the National Science Foundation, “Science and Engineering Indicators”, 2006: http://www.nsf.gov/statistics/seind06/figures.htm#c5, site last visited 23/05/2009 .

23. US National Science Board, Science and Engineering Indicators, 2008.

24. http://www.guardian.co.uk/world/2008/apr/20/india.globaleconomy .

25. Florida, Richard, Talent, Technological Innovation and Economic Growth in China, February 2006, see http://www.rotman.utoronto.ca/userfiles/prosperity/File/Talent_Technological_Innovation_and_Economic_Growth_in_China.w.cover.website.pdf .

26. Times QS University ranking: http://www.topuniversities.com/worlduniversityrankings/ .

27. OECD website: http://www.oecd.org/LongAbstract/0,2546,en_2649_33703_30921914_1_1_1_1,00.html .

28. OECD Factbook 2009: Economic, Environmental and Social Statistics - ISBN 92-64-05604-1 - © OECD 2009.

29. OECD statistics: http://stats.oecd.org/Index.aspx; Unesco statistics (UIS): http://stats.uis.unesco.org/unesco/ReportFolders/ReportFolders.aspx .

30. OECD, "Education at a Glance", 2008: p.136. This report can be downloaded from: http://www.oecd.org/dataoecd/23/46/41284038.pdf .

31. OECD, "Intergenerational Transmission of Disadvantage: Mobility or Immobility across Generations?", 2007: p. 54-5. This report can be downloaded from: http://www.oecd.org/dataoecd/27/28/38335410.pdf

32. http://www.thomaspmbarnett.com/published/pentagonsnewmap.htm .

33. http://www.internetworldstats.com/stats3.htm .

34. Internet World Stats: http://www.internetworldstats.com/ .

35. http://you.video.sina.com.cn/b/12417440-1401913474.html,

36. http://www.internews.org/articles/2005/20051221_shorenstein_anable.pdf; for nuanced discussion on the role of internet in facilitating the spread of democratic ideas in an authoritarian regime, see http://bostonreview.net/BR34.2/morozov.php .

37. http://pewresearch.org/pubs/1192/internet-politics-campaign-2008; http://www.imaginingtheinternet.org/ .

38. http://www.newyorker.com/reporting/2008/03/31/080331fa_fact_alterman?currentPage=2 .

39. WIPO Statistics Database, December 2008.

40. OECD, Main Science and Technology Indicators, 2008.

41. OECD.stats: http://lysander.sourceoecd.org/vl=15849116/cl=26/nw=1/rpsv/dotstat.htm .

42. See Lee & Park, "An International Comparison of R&D Efficiency: DEA Approach", 2005: Appendix A

43. NSB, "Asia's rising science and technology strengths", 2007.

44. NSB, "Graduate Students and Postdoctorates in Science and Engineering: Fall 2006" and "Science and Engineering Indicators, 2008".

45. China Daily, 12-05-2006, available online: http://www.chinadaily.com.cn/china/2006-12/05/content_750826.htm .

46. NSB, "Science and Engineering Indicators, 2006": Figure 3-65 Five-year stay rates for US S&E doctorate recipients with temporary visas, by place of origin.

47. See King, "The scientific impact of nations", 2009: p. 315.

48. National Geographic – Roper, Global Geographic Literacy Survey, 2002.

49. See US National Association of Scholars, site last visited 15-06-09: http://nas.org/polReports.cfm?Doc_id=85

50. Jacoby, S. "The Age of American Unreason", 2008, Pantheon.

51. ILO, KILM 5th Edition, 2007.

52. Prof. Nisbett, R. "Intelligence and How to Get It: Why Schools and Cultures Count", 2009, University of Michigan.

53. Goldsea Asian American Daily, accessed online at 2009-06-03: http://www.goldsea.com/AAU/harstan.html .

54. See OECD, "Science, Technology and industry Scoreboard", 2007: Figure G.5.1.

55. See OECD, "Science, Technology and industry Scoreboard", 2007 and International Telecommunications Union, site last visited 15/06/09: http://www.itu.int/ITU-D/ict/statistics/maps.html .

56. See Internet World Stats, site last visited 15/06/09: http://www.internetworldstats.com/stats3.htm .

57. IDATE, "Broadband coverage in Europe", 2008 survey.

58. See World Bank, KAM, site last visited, 12/06/09: http://web.worldbank.org/WBSITE/EXTERNAL/WBI/WBIPROGRAMS/KFDLP/EXTUNIKAM/0,,menuPK:1414738~pagePK:64168427~piPK:64168435~theSitePK:1414721,00.html

59. US Department of Education, site last visited 14/06/09: http://www.ed.gov/about/overview/budget/index.html and http://www.usgovernmentspending.com/education_budget_2010_2.html .

60. Unicef, "China's Budget System and the Financing of Education and Health Services for Children", 2006.

61. Unicef, "China's Budget System and the Financing of Education and Health Services for Children", 2006.

62. Economic Focus, Mainland China Budget for 2009, available online: http://www.hangseng.com/ermt/eng/fxmv/pdf/ecof_e_20090513.pdf .

63. UK HM Treasury, Budget 2009, available online: http://www.hm-treasury.gov.uk/d/Budget2009/bud09_completereport_2520.pdf .

64. India Ministry of Finance, Budget 2008-2009, site last visited, 15/05/09: http://indiabudget.nic.in/ub2008-09/ubmain.htm .

65. NOWT, “Wetenschaps- en Techniek- Indicatoren”, 2008: p.9.

66. See King, “The scientific impact of nations”, 2009: p. 316.

67. OECD, “Science, Technology and Industry Outlook”, 2006; The Economist, “Economist intelligence unit”, 2009; and Demos, “The Atlas of Ideas: India, the uneven innovator”, 2007.

68. The Economist, “Economist intelligence unit”, 2009.

Future Issue Idiocracy

The Global Redistribution Of Knowledge

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Authors:	Tim Sweijs
	Caspar Egas
	Ramses Alma
Artwork and Design:	Richard Podkolinski
	George Boone

The Hague Centre for Strategic Studies (HCSS)
Lange Voorhout 16
2514 EE The Hague
The Netherlands

Telephone +31(70) 318 48 40
Telefax +31(70) 318 48 50

Email: info@hcss.nl
Website: http://www.hcss.nl