CARNEGIE
ENDOWMENT FOR INTERNATIONAL PEACE

POLICY OUTLOOK

The World Order in 2050

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Summary

- The world's economic balance of power is shifting rapidly, and the trend has only been accelerated by the global recession. China remains on a path to overtake the United States as the world's largest economic power within a generation, and India will join both as a global leader by mid-century.

- Traditional Western powers will remain the wealthiest nations in terms of per capita income, but will be overtaken as the predominant world economies by much poorer countries. Given the sheer magnitude of the challenge of lower-wage competition, protectionist pressures in advanced economies may escalate.

- The global economic transformation will shift international relations in unpredictable ways. To retain their historic influence, European nations will be pressed to conduct foreign policy jointly, an objective implied by their recently ratified constitution, and will need to reach out to emerging powers. Japan and Russia will seek new frameworks of alliances. The largest emerging nations may come to see each other as rivals.

- Absolute poverty will be confined to small pockets in sub-Saharan Africa and India, though relative poverty will persist, and may even become more acute. Carbon emissions are also on a path toward climate catastrophe, and by mid-century may constitute a serious risk to the global growth forecast.

- International organizations such as the IMF will be compelled to reform their governance structures to become more representative of the new economic landscape. Those that fail to do so will become marginalized.

Prior to the Great Recession, the world's balance of economic power, as measured by real gross domestic product (GDP), was gradually shifting to the South and the East. Now, as industrialized countries slowly resume growth along their pre-crisis trajectory but do not fully recover output lost during the crisis, developing countries—whose output losses during the crisis were much lower—will accelerate out of the recession. In the coming years, the most successful developing countries, especially but not only those in Asia, will converge even more rapidly toward their advanced counterparts.

This brief presents GDP projections for the world's major economies—the nineteen nations of the G20 (the European Union is excluded) and several large countries in Africa—through 2050, computed from a standard output model. The projections build on a long history of studies, at least dating back to the early 1970s.[1] The idea of the "Big Five" developing countries—China, India, Indonesia, Brazil, and Russia—and their effects on the world economy through 2020 was introduced in the World Bank's 1997 Global Economic Prospects.[2] Some years later, Goldman Sachs unveiled the BRIC acronym to denote the Big Five, minus Indonesia, which was then in deep crisis (but has since recovered). In the early 2000s, Goldman Sachs[3] and PricewaterhouseCoopers[4] developed their own projections.

Carnegie's forecasts employ a methodology similar to the ones used in these reports, but expand the model in various ways, including adjusting the speed of convergence to high-income status for initial quality of governance, education, business climate, and infrastructure. Carnegie's projections are among the first long-term forecasts to reflect the effects of the Great Recession.

Based on the model, rapid growth in developing countries will result from a high, though slowing, population increase, as well as productivity advances from technology absorption (conditional on the quality of the factors mentioned above). While investment rates in developing countries will also be higher than in industrialized countries, technology will play an increasingly important role relative to capital accumulation in both.

The large shift in economic power implied by these projections will have far-reaching consequences for global economic governance, as well as for relationships among countries and geographic regions. Kenichi Ohmae's 1980s concept of a Triad—a world economy led by the United States, Europe, and Japan—will be eclipsed by a new order consisting of China, the United States, and India. If the members of the European Union act in concert, the EU could join these three countries to become a fourth global power.

Drivers of Growth Favor Developing Countries

Labor Force Growth

Demographic drivers will significantly influence the economic transformation. Over the next forty years, the global labor force will grow rapidly and nearly exclusively in developing countries. These countries will accrue the economic benefits of population growth as their working-age population (people aged 15–59) rises, while that of industrialized countries falls.

In its latest projections, the UN predicts the global population will reach 9.2 billion in 2050, a large rise from the estimated 6.8 billion in 2009 and 2.5 billion in 1950. Concurrently, the global labor force is expected to expand by nearly 1.3 billion. Developing regions will see their workforces expand by 1.5 billion people—more than the total current population of developed regions—while the labor force in developed areas will shrink by over 100 million workers. Developing Africa and Asia will contribute the most to the increase, adding 1.4 billion workers to the global labor force. By contrast, Europe's working-age population will decline by more than 110 million.

The dependency ratio, or the number of people not in the labor force compared to those who are, will dramatically increase in developed regions, with the UN predicting that the working-age population in these areas will fall sharply from 62.8 percent of the total population in 2009 to 52.0 percent in 2050. The same measure will also decline in developing regions, but only modestly, from 61.1 to 59.5.

Thus, population and labor force growth will contribute to global economic growth, but all of the increase will occur in developing countries, shifting economic weight in their favor.

Capital Stock

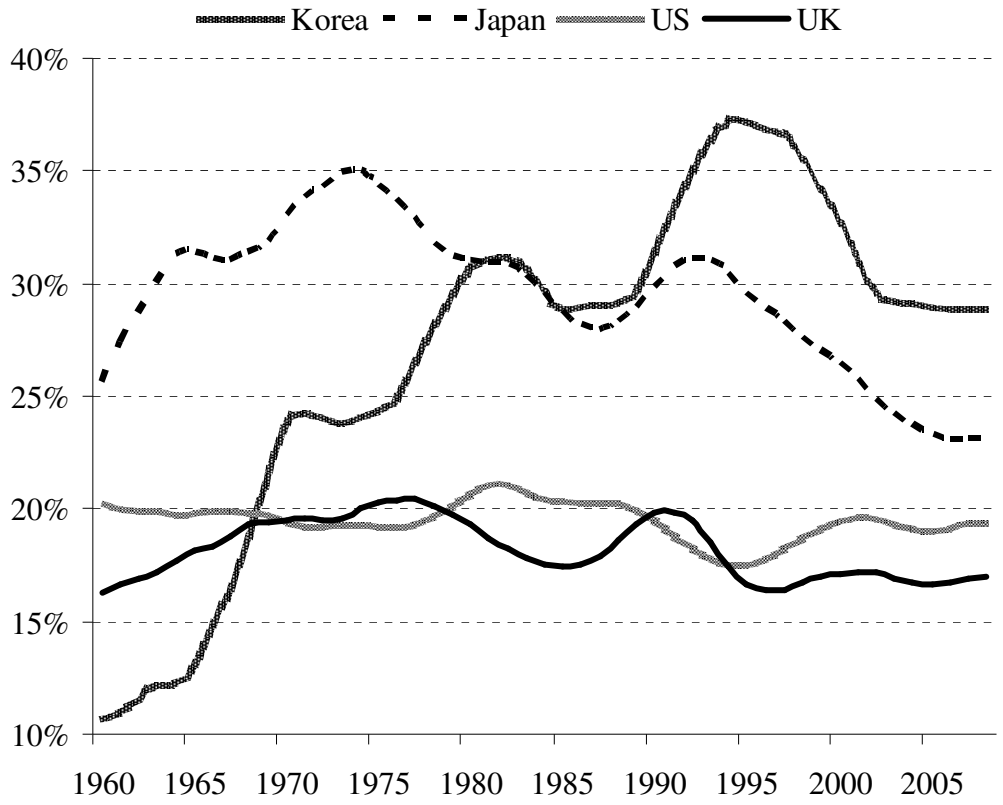
Physical capital stocks will continue to accumulate as incomes rise and savings rates cover depreciation and allow for new investment. However, as the marginal contribution of capital to output declines, the incentive to invest will be reduced. In industrialized countries, savings as a share of GDP will likely decline as populations age and the dependency ratio increases. In developing countries, where capital to output ratios are much lower, capital stocks will rise substantially as the working population increases. China stands out as an exception; despite a shrinking population, investment is expected to remain high.

Historically, developed countries have invested approximately 20 percent of GDP in fixed capital formation each year. Developing countries, on the other hand, have invested significantly more, with investment in some countries peaking around 35–40 percent.

Japan provides a useful case study, as its investment in capital stock can be traced through the different stages of development. Japan's yearly investment rate peaked at 36 percent when its economy was growing rapidly and moderated toward 20 percent in recent years. Korea had a similar experience, with yearly investment peaking at 40 percent in 1992 before declining to just below 30 percent since then.

Investment as a Percentage of GDP

Five-year moving average



Source: IMF.

Over the next forty years, China and India are expected to have the highest average investment rates at 33–34 percent per year. The UK and Germany are projected to invest at the lowest rate, at 17–18 percent per year.

Technological Progress and Productivity

Spreading technology will bolster world economic growth. Developing countries will continue to absorb well established technologies, such as electricity and sanitation. While the largest urban agglomerations and elite firms and individuals in developing countries typically have access to such technologies, rural areas and less favored segments of society often do not.

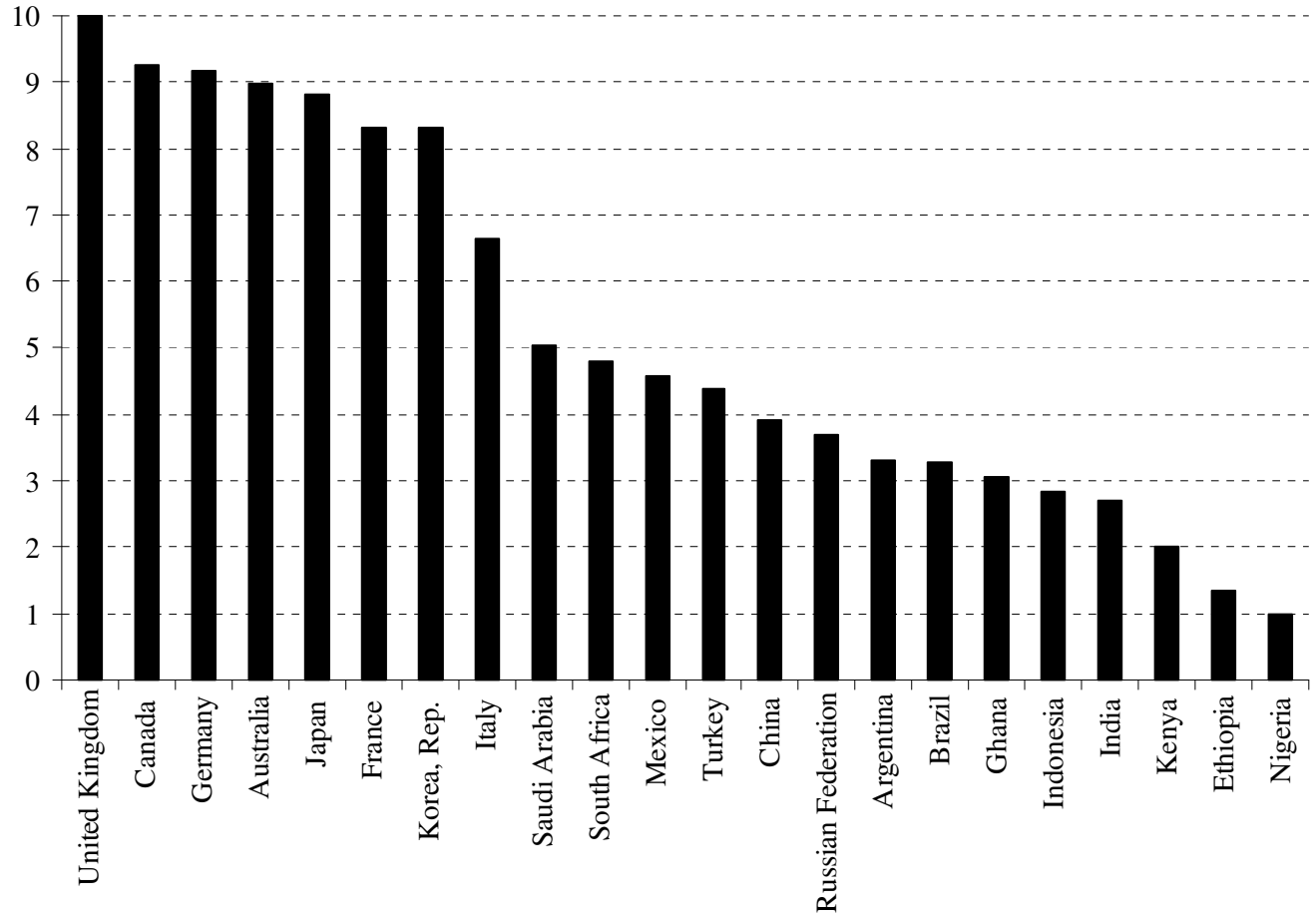
However, newer technologies such as mobile phones and the Internet are spreading rapidly to developing countries, partly because they are relatively inexpensive and require little government expenditure on infrastructure. Though advanced countries will remain the dominant source of cutting-edge technological innovation, a few developing countries with rich pools of highly educated individuals (Russia is a good example) may also innovate at the frontier, and many more developing countries will innovate by modifying technologies to suit local conditions. As described in a comprehensive World Bank report[5] on technology and development, "Part of the strong projected performance for developing countries derives from stronger labor force growth, but much can be attributed to technological progress."

The potential for technological catch-up is greater when productivity and per capita income are low. Thus, convergence of the poorest countries will potentially be the most rapid. However, actual rates of catch-up will depend on each country's ability to adopt and adapt technology—a function of openness, educational attainment, communication and transportation infrastructure, governance, and business and investment environment. Thus, two countries at the same level of income may catch-up at different rates depending on these conditions.

The following chart illustrates the degree to which these factors will hold countries' technological growth below the potential suggested by the income gap alone, with a score of ten representing maximum ability to take advantage of technological catch-up with the United States.

Index of Technological Catch-Up Conditions

0 denotes slowest convergence to the United States, 10 denotes fastest convergence



Note: The index above is an aggregate of indices that measure the following factors: educational attainment, communication and transportation infrastructure, governance, and business and investment environment. The United States has been omitted; the U.S. index score is 10.

Source: World Bank World Development Indicators (2009), authors' calculation.

An examination of the relevant indicators suggests that among developing countries, Russia, China, and Mexico are well prepared for more rapid adoption of foreign technologies, largely because of relatively high levels of educational attainment and supportive infrastructure.

Contrary to India's high-tech image, the speed of convergence (adjusting for initial income) is assumed to be among the lowest in the G20. India exhibits the lowest education indicators and worst business climate in the G20. Indonesia is another country where convergence is slower than income indicates. Education, infrastructure, and governance must be improved before broad-based and rapid technological advancement can occur in India and Indonesia at the same pace as in the best prepared developing countries.

Exchange Rate Appreciation

As productivity in the developing countries increases relative to that in developed countries, wages will increase and the price of nontradables relative to tradables will rise in developing countries, as predicted by the Balassa-Samuelson effect.[6] Additionally, rapid growth in emerging markets will make them more attractive destinations for investment, increasing the capital inflows to these countries. Both of these shifts will put upward pressure on exchange rates in developing countries, and real exchange rates will appreciate.

Though a higher real exchange rate can make the fastest growing developing countries less competitive in basic labor-intensive manufactures, this is, on net, a positive development. A stronger currency implies improved terms of trade and cheaper imports, which both boosts the purchasing power of consumers and lowers the cost of imported inputs for producers relative to the cost of labor. Higher exchange rates can also spur innovation and productivity improvement, since domestic producers must now compete with cheaper imports.

Projections: The "Rise of the Rest"

As developing countries house an increasingly larger share of people, capital, and technology, their share of global GDP will increase, shifting the economic balance of power. Well before mid-century, the United States and the main European powers, long the leaders of the global economy, will be joined in economic size by several emerging markets in Asia and Latin America.

However, as these countries become the world's largest economies, as well as the most populous, they will not rise among the world's richest, breaking the decades-old correlation between economic size and per capita income. This notion of a low- or middle-income country becoming the world's largest economy, introduced as early as 1993 when China was predicted to rise as a world power,[7] now appears increasingly likely. The recent promotion of the G20 as the world's principal economic forum will likely mark the end of wealthy countries' dominance over the world economy and usher in a more integrated and complex economic era.

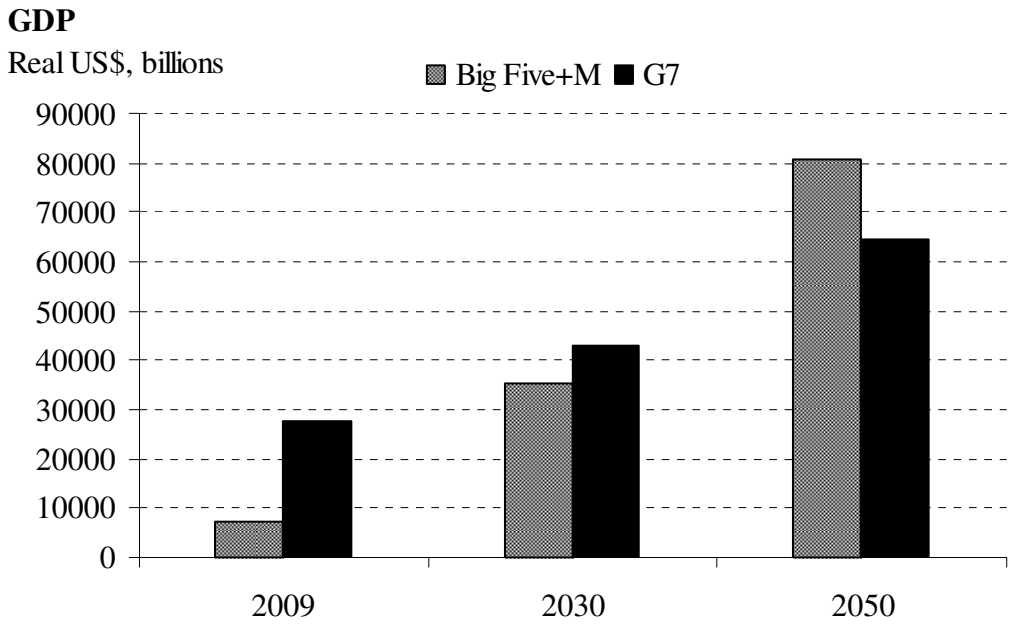
GDP projections from present day through 2050 are made under the assumptions that markets stay open and macroeconomic policies remain sound; additionally, catastrophes—economic, natural, or geopolitical—are assumed not to occur. For these reasons, the projections represent only an educated assessment of the present direction of the international economy.

2050: A New Economic Order

The weight of global economic activity is already shifting substantially from the G7 countries toward emerging economies in Asia and Latin America. Over the next 40 years, this trend is expected to accelerate.

Average Annual GDP Growth Percent change (y/y)				Real GDP 2005 US$		
	Pre-Crisis Trend (1997–2007)	Crisis Years (2007–2009)	Projections (2009–2050)	2009	2030	2050
Argentina	2.6	2.0	4.1	223	527	1267
Australia	3.6	1.5	2.9	787	1501	2257
Brazil	2.8	2.2	4.1	1011	2440	6020
Canada	3.3	-1.0	2.6	1171	2083	3154
China	9.6	8.8	5.6	3335	21479	46265
France	2.4	-1.0	2.1	2203	3323	4528
Germany	1.6	-2.1	1.4	2833	3593	4535
India	7.0	6.3	5.9	1065	5328	15384
Indonesia	2.7	5.0	4.8	354	1073	2975
Italy	1.5	-3.1	1.3	1732	2197	2580
Japan	1.1	-3.1	1.1	4467	5786	6216
Korea	4.3	0.6	2.5	945	2122	2812
Mexico	3.3	-3.1	4.3	866	2397	5709
Russia	5.7	-1.2	3.3	869	2487	4297
Saudi Arabia	3.2	1.7	4.8	348	896	2419
South Africa	3.7	0.4	4.3	271	791	1919
Turkey	4.0	-2.9	4.4	509	1437	3536
United Kingdom	2.9	-1.9	2.1	2320	3597	4997
United States	3.0	-1.2	2.7	12949	22258	38646

The economy of the G20 is expected to grow at an average annual rate of 3.5 percent, rising from $38.3 trillion in 2009 to $160.0 trillion in 2050 in real dollar terms. Over 60 percent of this $121 trillion dollar expansion will come from six countries: Brazil, Russia, India, China, Indonesia (the traditional "Big Five" economies), and Mexico. U.S. dollar GDP in these six economies will grow at an average rate of 6 percent per year; their share of G20 GDP will rise from 19.6 percent in 2009 to 50.6 percent in 2050. By contrast, GDP in the G7 will grow by less than 2.1 percent annually, and their share of G20 GDP will decline from 72.3 percent to 40.5 percent.



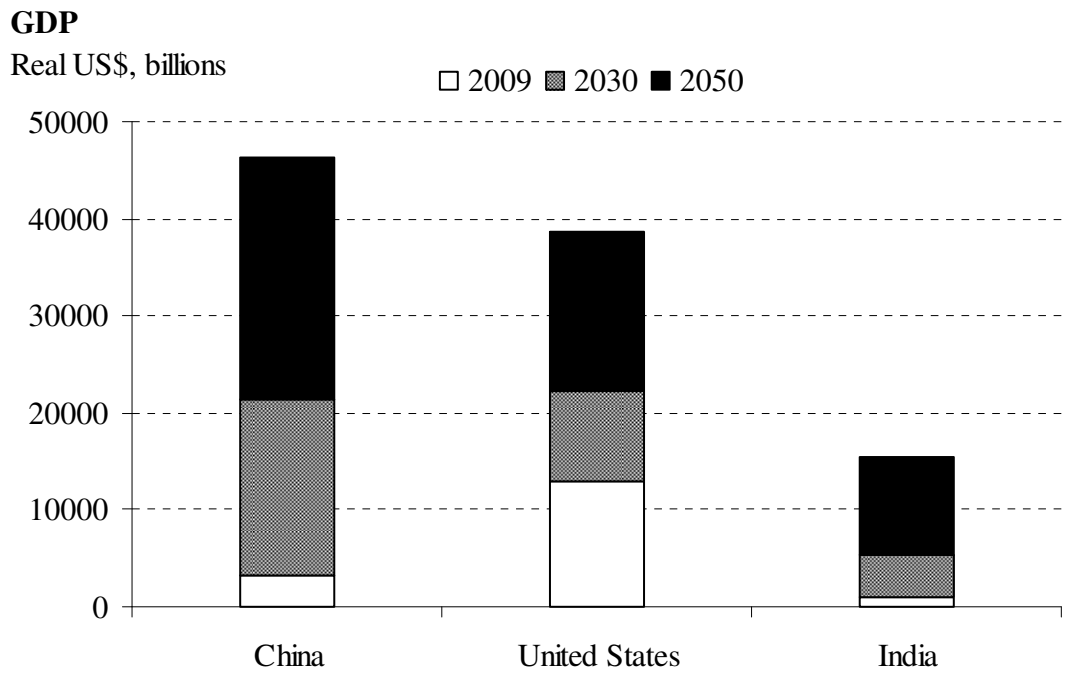
Source: Authors' projections.

In purchasing power parity (PPP) terms, the shift is even greater. Currently, the G7 claims more than half of G20 GDP compared to approximately one third in the Big Five+M economies; in 2050, the Big Five+M economies will be over twice as large as the G7.

The growth predictions presented above are broadly consistent with similar exercises done previously. Projections by PricewaterhouseCoopers[8] in 2010 anticipate comparable growth rates across a subset of the G20; Goldman Sachs[9] in 2007 and others[10] predicted an even stronger shift toward emerging markets. The World Bank's predictions in 2007 also called for a large shift, though a slower one than suggested by the models deployed here.

The New Triad

China, India, and the United States will emerge as the world's three largest economies in 2050, with a total real U.S. dollar GDP of 70 percent more than the GDP of all the other G20 countries combined. In China and India alone, GDP is predicted to increase by nearly $60 trillion, the current size of the world economy. However, the wide disparity in per capita GDP will remain.



Source: Authors' projections.

After nearly a century as the world's preeminent economic power, the United States is projected to relinquish this title to China in 2032. Rapid annual growth of 5.6 percent and a strengthening currency—the renminbi's real exchange rate against the dollar is predicted to appreciate by more than 1 percent per year—will drive China's U.S. dollar GDP up from $3.3 trillion in 2009 to $46.3 trillion in 2050, 20 percent larger than that of the United States in real dollar terms and 90 percent larger in PPP terms.

India is predicted to post the most rapid growth—5.9 percent annually—of all G20 countries, though the modest current size of India's economy will prevent it from surpassing either China or the United States in real U.S. dollar terms. India's PPP GDP, however, will be nearly 90 percent as large as that of the United States. A growing population—India is expected to become the world's most populous nation in 2031—will push U.S. dollar GDP to $15.4 trillion in 2050, over fourteen times its current level.

However, despite these dramatic increases in total GDP, U.S. per capita GDP will be nearly three times that of China and over eight times that of India. U.S. technological advantages will likely help the United States maintain its position as a leader of the international community, but China's and India's much lower per capita income, combined with their very large size, may reinforce their authority in many forums as more representative of the vast majority of the world's peoples.

Europe's Changing Role

The next forty years will be a critical period for the European Union (EU) and its 27 members. Germany, the UK, France, and Italy—currently the fourth through seventh largest economies in the world— are expected to grow by only 1.5 percent annually from now until 2050. These four countries' share of G20 GDP is will shrink from 24 percent in 2009 to 10 percent in 2050.

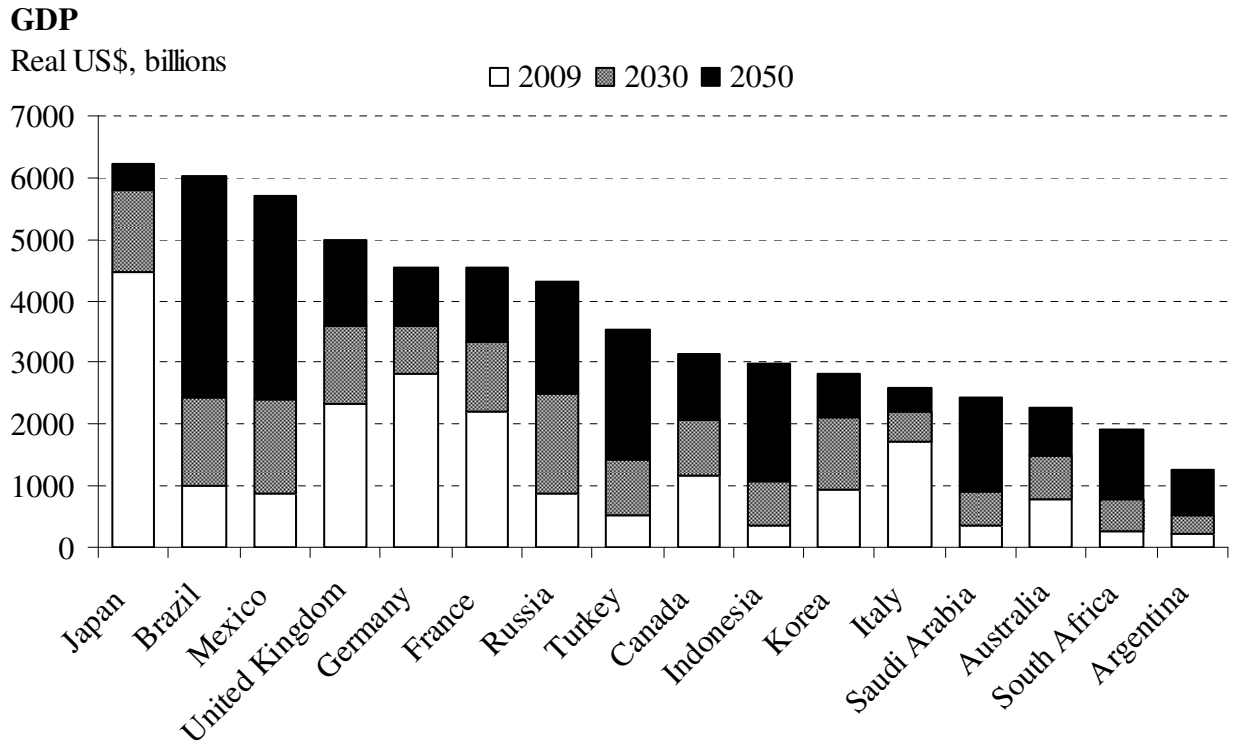
As economic interests shift away from Europe to favor Asia and Latin America, Europe will likely undergo a difficult and turbulent transition. To ease the strain caused by these changes and to retain their historic influence in the world economy, European nations will increasingly need to conduct foreign

policy under an EU banner. In 2009, the total GDP of the EU was over $14 trillion, larger than that of any single country. In 2050, assuming the region follows the 1.5 percent average growth rate of its four largest countries, the EU's real U.S. dollar GDP will increase to $25.8 trillion, placing it among the three largest economies in the world. If they stand alone, Germany, the UK, and France will all be surpassed by China, India, Brazil, and Mexico; Italy will fall even farther behind and be larger than only four other G20 countries.

Despite the recent ratification of the Treaty of Lisbon, however, and the initial success of the single currency among a subset of members, Europeans appears either unwilling or ill-prepared to promote further cohesion. The crisis emerging in Greece—and potentially in other vulnerable countries—has highlighted the shortcomings of a customs and monetary union that still lacks coordinated macroeconomic policies and is far from any kind of fiscal union. Europeans must confront these issues if they are to operate as a credible unified economic block.

New Alliances in a More Balanced World

The economic balance of power within the rest of the G20 will tilt toward emerging markets. Several other emerging economies will add new, authoritative voices to the international dialogue.



Source: Authors' projections.

Real GDP in Brazil and Mexico is expected to increase by over 4 percent per year, nearly matching the GDP of Japan, today's second largest economy, in 2050; Russia and Turkey are both expected to be larger than present-day China.

Russia, historically a great power, may become a political outlier under this scenario. Geographically the largest country and enormously rich in natural resources, its population in 2050 will be down to 109

million from 140 million today. With China, India, and the United States—not only the world's three largest economies in 2050 but also the world's three most populous—to its south and east, pressure may mount for Russia to increase its economic and security ties with Europe and to promote a balance of power among its large neighbors.

Turkey's prospects for joining the EU may be a beneficiary of European concerns to maintain influence in a world of giants. Furthermore, one could imagine Russia becoming a full EU member by mid-century; with Turkey projected to have a smaller population than that of Russia in 2050, it may be easier for Turkey—a Muslim country with a population that will be larger that of any current EU member—to accede.

Japan's influence in Asia will recede further with China's rise and Indonesia's rapid expansion. Japan will grow by a sluggish 1.1 percent per year, the slowest rate of all G20 economies. Japan, Asia's most powerful nation in the twentieth century, will be pressed to develop ever closer economic ties with China, an economy over seven times larger in U.S. dollar terms in 2050, as well as with India, which will be 2.5 times larger. Like Britain in past centuries, it will seek to promote a regional balance of power, implying continued close political and security ties with the United States. China and India, and Russia and China, will compete for commercial and military influence, and may become rivals unless border and trade disputes are managed.

Can Africa Break Through?

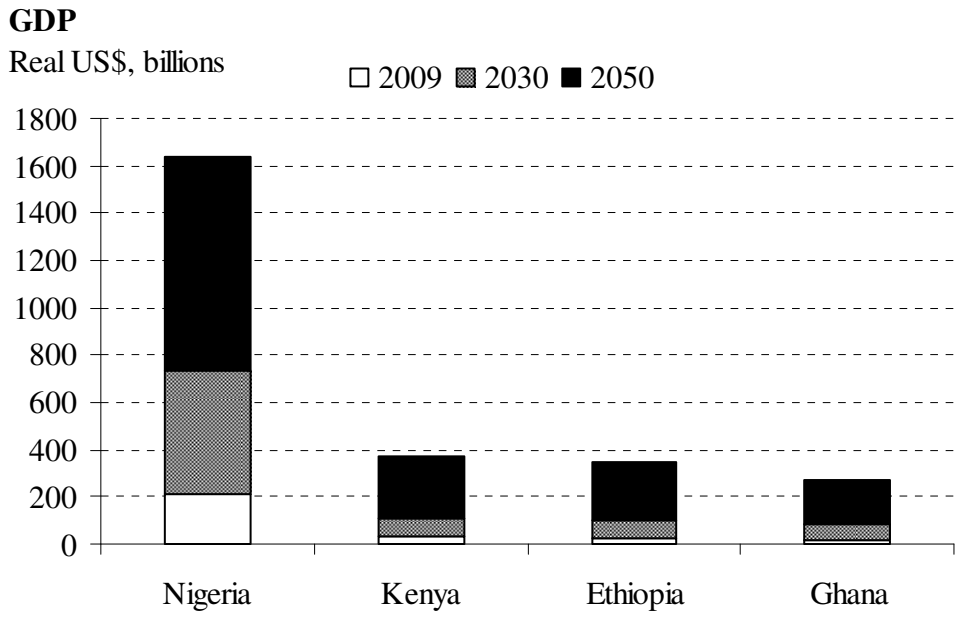
Application of the projection methodology to the four large countries in sub-Saharan Africa (SSA)—Ethiopia, Ghana, Kenya, and Nigeria—suggests that, assuming the absence of major conflicts, these countries could exhibit rapid growth over the next forty years, as they did in the five years preceding the crisis.

Africa's rapidly increasing population will help drive growth in the near term, while large technological improvement can potentially sustain the expansion over coming decades, despite unfavorable (though improving) initial conditions in education, governance, and infrastructure.

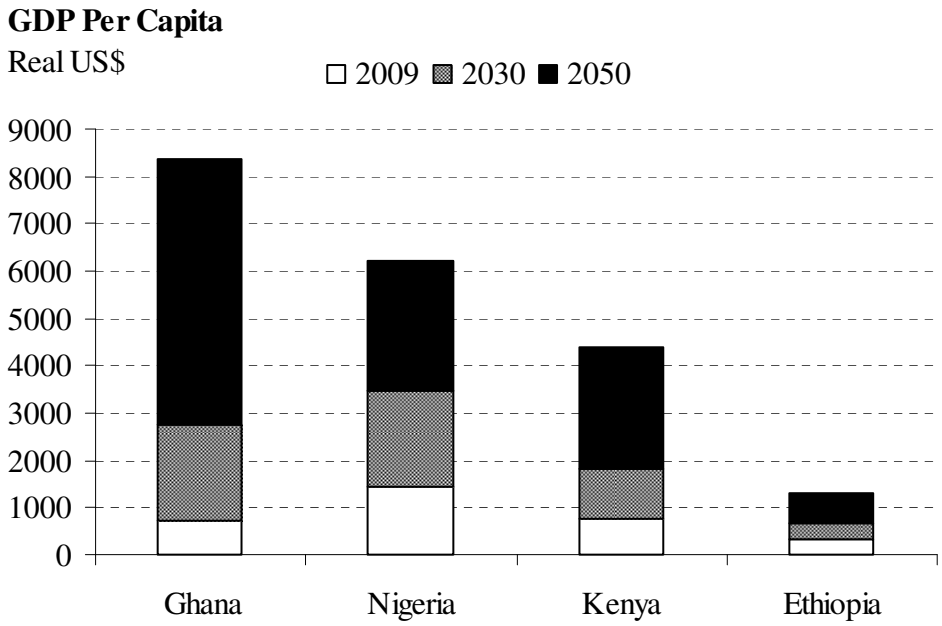
The four countries are projected to grow at an average annual rate of 5.5 percent from now until 2050. Relative to the past twenty years of dismal performance, these growth rates represent a major acceleration, but—with the exception of Kenya—they are not out of line with outcomes since the turn of the century.

Average Annual GDP Growth Percent change (y/y)				Real GDP 2005 US$		
	Pre-Crisis Trend (1997–2007)	Crisis Years (2007–2009)	Projections (2009–2050)	2009	2030	2050
Ethiopia	5.7	9.5	6.5	28	109	366
Ghana	5.0	5.9	6.7[11]	17	91	337
Kenya	3.8	2.1	5.4	30	98	287
Nigeria	7.6	4.4	5.0	213	733	1636

With rapid growth and exchange rate appreciation, Nigeria could surpass the smallest G20 economy in 2005 U.S. dollar terms. Nevertheless, in 2050, per capita income in these countries is expected to be only 13 percent of that in the G20 in U.S. dollar terms.



Source: Authors' projections.

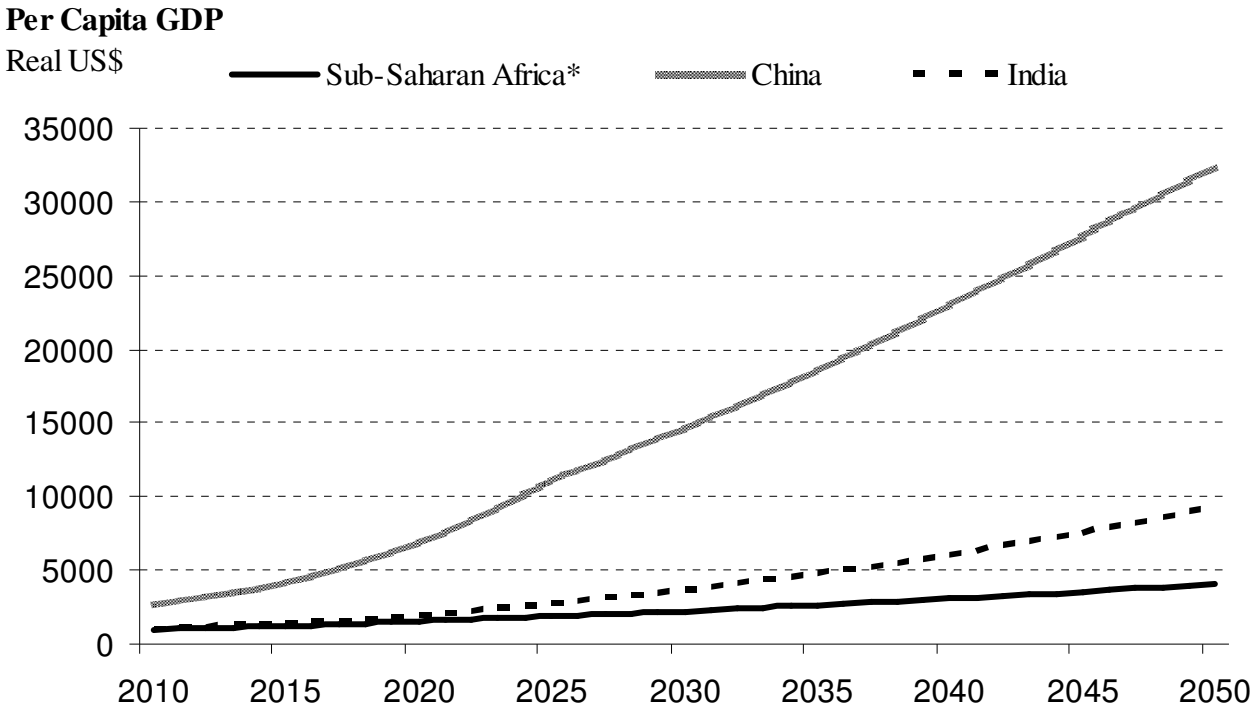


Source: Authors' projections.

Under this scenario, the average per capita income in these countries will be less than half of that of India and a fraction of that in China, raising the possibility that African countries could become competitive with the Asian giants in labor-intensive manufactures, as well as destinations for outsourcing.

The following graph illustrates the projected per capita income of all six countries. As incomes in China (and to some extent India) diverge from those in Africa, China and India could become major export destinations for Africa not only in raw materials, but also in basic manufactures. There is, of course, nothing automatic about this outcome, as the ability to compete in the international market for

manufactures will require a big improvement in the quality and predictability of the business climate and efficient investments in education, which may or may not be forthcoming.



*Note: Weighted average of per capita GDP in Ethiopia, Ghana, Kenya, and Nigeria.
Source: Authors' projections.

The Decline of Poverty

The world in 2050 will also be profoundly different in human terms. Rapid growth in the emerging economies will pull hundreds of millions of people out of absolute poverty, leaving only a small fraction of the G20 population behind. Absolute poverty will, however, remain a significant, though much smaller, phenomenon in Africa.

In 2005, the World Bank estimated that over 1.3 billion people—over one quarter of the world's population—lived in extreme poverty, consuming less than $1.25 a day in PPP terms. Nearly twice this number, or half the world's population, lived on less than $2.00 a day. By 2050, no country in the G20 will have more than 5 percent of the population living in extreme poverty, though significant portions of society will still be living on less than $2.00 a day. (Details outlining the methodology behind these poverty projections[12] are located in the Annex.)

Poverty rates are expected to decline significantly in Indonesia, Brazil, Mexico, and Turkey, but growth in China and India—nations that were home to 48 percent of the world's population living on $1.25 a day in 2005—will be the driving force behind this shift. Over the past 25 years, over 600 million people emerged from poverty in China (excluding China, global poverty has actually increased since 1981); from 2005 to 2050, China and India will be responsible for lifting 600 million more people from the most extreme forms of poverty.

Percentage of Population Living in Poverty

Living under $1.25/day

	2005	2010	2020	2030	2050
China	15.9	7.9	3.1	2.0	1.2
India	41.6	34.5	10.4	4.1	2.5
Indonesia	27.4	18.1	7.4	4.1	2.3
SS Africa	45.8	39.7	26.2	16.1	8.4

Living under $2.00/day

	2005	2010	2020	2030	2050
China	36.3	19.5	5.1	3.2	2.0
India	75.6	64.1	40.5	19.6	4.0
Indonesia	55.9	47.4	29.8	13.0	3.7
SS Africa	69.6	62.5	49.0	35.8	16.9

Economic growth will also bring relief to millions of poor in sub-Saharan Africa, but the region will remain the most impoverished in the world. The benefits of the area's strong growth will be diffused across a rapidly expanding population, holding down per capita incomes in a region where over 50 percent of the population consumed less than $1.25 in 2005. Though the next forty years will bring marked improvements, poverty will remain relatively high: in 2050, 8.4 percent of the population will still live less than $1.25 a day, and 16.9 percent will consume less that $2.00 a day. These trends certainly offer hopeful news for the quality of life among future generations. They do not imply, however, that poverty will no longer be a serious economic and humanitarian concern. $2.00 a day—the higher poverty line used above—will satisfy basic human needs, but such an income still represents a miserable existence. Furthermore, absolute income is not the only measure of the human condition. Both within and across countries, enormous relative income disparities will severely poorest segments of society's political voice, social integration, and access to economic markets and opportunities.

Risks

Barring a nuclear or climate cataclysm, the central message of this brief—economic power will continue to shift to the South and East—is likely to prove robust even in the event of major unexpected shocks, such as wars and global depression. The troubled history of the twentieth century suggests that the advance of globalization and the spread of technology are extremely powerful forces that may be temporarily interrupted and even reversed, but not permanently stopped.

Though the last forty years have been relatively calm compared to the previous forty (which included the Great Depression and the outbreak of World War II), they nevertheless saw the fall of the Berlin Wall, China's explosion onto the world scene, and three major financial crises (the Debt Crisis of the 1980s, the Asian Financial Crisis, and the Great Financial Crisis of 2007–2009). While we cannot know what shocks await us over the next forty years, it is certain that some will occur.

At least four classes of risk could introduce major discontinuities and undermine these projections, slowing (though not stopping) world economic growth and the convergence process in developing countries. Each is addressed briefly.

Geopolitical Breakdown

The projections suggest that the next forty years may witness one of history's greatest shifts in economic and military power. These transitions are rarely easy. Even if major disputes over territory or regional influence are resolved peacefully, economic relations could be undermined by trade disputes, major economic crises, and differences over dealing with climate change and other issues related to the global commons. Because globalization and economic growth do not occur in a vacuum, maintaining the cohesion of the international community is crucial to its continuation. The rise of several developing countries and the fact that, while they attain the status of giant economies, they remain much poorer than advanced nations, could make maintaining cohesion more difficult. Advanced countries will expect more from these emerging powers, from contributions to international institutions, to aid, control of carbon emissions, respect of intellectual property, and contributions to international security and economic sanctions against deviant regimes. But the emerging powers may feel that they have higher domestic development priorities and may counter with demands for greater consideration of these priorities across the spectrum of international collaboration efforts.

In particular, the governance and functioning of the bedrock international institutions—the G20/G8, World Bank, IMF, WTO, Global Stability Board, and the UN—will have to be rethought. It is probably inevitable that, in seeking balance between legitimacy and effectiveness to deal with a wide range of complex international collaboration issues, a "flexible geometry" or plurilateral approach to the issues will become the norm. Illegitimate small clubs of the most powerful (G7), ineffectual universal assemblies (UN, WTO), and overly complex and unaccountable constituency structures will likely be eschewed in favor of more flexible approaches involving a critical mass of players on a given issue or in a particular geographic region.

Financial Crisis and Depression

The world economy's near-death experience in 2009 should be enough to motivate countries to improve regulatory mechanisms and macroeconomic policies, particularly given the world's deep financial integration and the rapidity with which the shock spread. Yet the ability of countries to turn the lessons

of the 2008 financial crisis into effective reforms is suspect for multiple reasons, including the financial industry's powerful vested interest against reform, ideological differences about the appropriate role of regulation, competitive pressures, the difficulties of internationally coordinated action, the complexity of modern financial markets, and weaknesses in the capacity of both domestic and international regulators. Furthermore, the political challenges of dealing with macroeconomic imbalances are formidable.

Arguably, the world economy emerges from the crisis a more, not less, dangerous place. Public debts are large and rising, a huge overhang of liquidity remains, financial sector support policies are difficult to reverse, and moral hazard has greatly increased, particularly in financial institutions deemed "too big to fail." Moreover, these vulnerabilities may increase as the financial industry's risk appetite returns once memories of the disaster fade.

The next set of vulnerabilities may be uncovered in emerging markets, which have become more attractive in the eyes of investors and may have to deal with a wall of inflowing capital in coming years.

Protectionism

A relapse into protectionism may represent the single most important risk to this forecast, since the projections are grounded in assumptions about technological catch-up and increased efficiency which depend crucially on open international markets. As emerging markets rise in importance but remain relatively low-wage economies—China is now both the world's largest exporter and one of the most competitive low-wage economies—they will become too big to ignore, and pressures to protect against them will increase.

Still, given the densely interwoven fabric of today's global economy, and the existence of a vast set of rules and legal redress procedures under WTO and regional agreements, a large relapse into protectionism is not a likely outcome at present. However, several events could impair international markets over an extended period: a deterioration of great power relations to the point of open military or economic hostilities, an economic depression and rise in mass unemployment (narrowly avoided in 2009), or profound divisions over climate change that lead countries to resort to trade sanctions as an enforcement mechanism. The risks to open trade would be compounded if more than one of these events occurred together, as all three sources of risk tend to feed on each other.

Climate Change

Climate change will hurt global growth through effects on health outcomes, agricultural yields, involuntary migration, and the destruction of infrastructure. According to the Stern Review, as extreme climate events grow increasingly common and temperatures rise 2–3 degrees Celsius by 2099—the most likely climate change scenario[13]—the equivalent of a 5 percent reduction in per capita consumption, now and forever, will hit the global economy, with reductions as high as 20 percent possible. Developing countries will bear the brunt of these negative effects, but developed countries will be hurt as well, especially if temperatures rise more than the expected 2–3 degrees Celsius.

While the global economy will inevitably suffer from the climate change that is already occurring, the timing and extent of climate change's most severe effects remains difficult to pinpoint—though most projections suggest that it will take several decades before the economic effects become severe. But what if climate change, which may be subject to large and rapid discontinuities, were to occur sooner? The outcome could be dire.

A few back-of-the-envelope calculations based on the projections above illustrate the potential strain that rapid economic growth could place on the global environment and accelerate the effects of climate change. Assuming that each G20 country's ratio of PPP output to CO_2 and CO_2 equivalent emissions continues on its current gradual decline from its 2005 level, global temperatures increases would be expected to exceed 4 degrees Celsius by 2050. Such an increase would likely have catastrophic consequences for many developing countries and low-lying areas of the world affected by rising sea levels and floods. Even if each country meets the (nonbinding) commitments they put forward at the 2009 Conference of the Parties in Copenhagen by 2020, and then holds emission *levels* (not the ratio of output to emissions) constant from 2020 through 2050—an extraordinarily optimistic scenario—a temperature increase slightly higher than 2 degrees Celsius is still expected, and the consequences outlined above will be realized.

An Alternative, Lower-Growth Scenario

If any or all of these risks are realized, global economic growth will be slower and many of the trends described above will be less pronounced. Nevertheless, the G7 will still see its share of G20 GDP fall by over 30 percent, while the "Big Five+M" economies will see their share double.

In a less favorable scenario, a breakout of trade protectionism—which will slow the diffusion of pre-existing technologies into developing countries and reduce competitive innovation around the globe—can be assumed to lower TFP growth by 25 percent in advanced countries and 35 percent in developing economies. Two financial crises—one in developing countries in 2015 and one in advanced countries twenty years later—will cost those countries experiencing it most directly 8 percent of GDP over two years, in line with the 10 percent average impact of a financial crisis estimated by the IMF.[14]

Even under this scenario of reduced growth, carbon concentrations will still exceed 550 ppm by 2050, resulting in a 3 degree increase in global temperatures. This is assumed to happen before the end of the forecast period, leading to a further loss of 1-2 percent of global GDP[15] by 2050, relative to the baseline scenario in which the effects of climate change are assumed to be felt only in the second half of the century. Developing countries experience higher losses than advanced ones.

Finally, though geopolitical strife will not directly alter the growth projections, it will make the resolution of the issues outlined above more difficult and worsen their effects.

Under these assumptions, G20 GDP will reach $90 trillion in 2050, 44 percent less than in the baseline case. China and India will emerge as two of the three largest economies in the world, but both will remain smaller than the United States in dollar terms; however, China's PPP GDP will still surpass that of the United States to become the largest in the world. The relative weight of emerging markets in the global economy will still rise sharply, with an average annual growth rate of 3.9 percent in the "Big Five+M" compared to 1.3 percent growth in the G7. (For complete results, see Annex Table 3.)

GDP in sub-Saharan Africa, where restraints on trade will stifle technical progress and where climate change will have the greatest impact, will be less than 50 percent that predicted by the baseline scenario, slowing poverty reduction markedly. Average per capita incomes across the region will grow by only 1.6 percent per year, only slightly higher than the 1 percent average income growth in the G7. The 2050 poverty rate in SSA will be near 13 percent—or 90 million people—in the five countries analyzed in the region compared to 8 percent in the baseline. By comparison, 148 million people lived in extreme poverty in these five countries in 2005. The headcount for $2.00-a-day poverty can be expected to be 29 percent in SSA, holding a total 21 of 200 million people below the poverty line, only a small reduction from the 225 million people in 2005.

Slower growth will make the task of climate change mitigation less daunting, but will also reduce the space for making the necessary investments and make other trade-offs more difficult. Upholding the commitments put forth at Copenhagen would require a smaller reduction in emissions-to-GDP ratios, but the cost of these reductions (relative to GDP) may be even greater. Slower growth will also make it more difficult to deal with the fiscal constraints implied by aging in the industrial countries and the debt buildup incurred during the current and future financial crises.

Conclusion

The projections presented above suggest that over the next forty years, low- and middle-income countries in Asia and Latin America will become an immensely powerful force in the world economy. The United States will remain a critical player, but will cede at least partial authority to China. To retain its leadership position, Europe must become more cohesive as its growth slows. International institutions, long governed by the traditional Western powers, will be forced to adjust to this new global economy.

Managing this transition will not be easy in the best of circumstances. Policy makers in capitals from Washington to Beijing to Delhi, Berlin, Tokyo, and Moscow will have to evolve towards very different mindsets, some from superpower status to a shared leadership, others from underdevelopment to great influence. All will be called upon to acquire a more open-minded and collaborative outlook to tackle the planet's shared problems, such as climate change. International institutions will need to evolve to adapt to the redistribution of economic power and to tackle even more complex challenges of coordination.

Failure of countries and institutions to adapt, and occurrence of one or more of the risks outlined above will greatly add to the complexity of the policy challenge and may lead to much less favorable growth scenarios. However, the historical processes described in this brief, driven by globalization and the spread of technology, may be interrupted, but are unlikely to be stopped or reversed.

The Model

As the model aims to project long-term potential output and cannot account for short-term factors, including the effects of the global recession, the projections for 2009 to 2014 are based on the most recent IMF forecast. For the years 2014 to 2025, the projections are an equally weighted average of the model forecast and the pre-crisis trend (1997–2007). This procedure is intended to account for many recent factors that affect long-term growth—such as emergence from major conflict or large-scale structural reform—whose effect can be expected to persist over many years, but which the model does not capture. The projections over 2025–2050 are based solely on this model.

The model is based on the Cobb-Douglas function:

$$Y = AK^{\alpha}L^{1-\alpha}$$

where GDP (Y) is a function of technical factor progress (A), physical capital stock (K), and labor force (L). α represents the income share of capital and is assumed to be 1/3, based on historical evidence. Annual real GDP growth is calculated from the following derivation of the previous equation:

$$y = a + (\alpha)k + (1 - \alpha)l$$

where y, a, k, and l represent the change in Y, A, K and L. Real local currency GDP is transformed into U.S. dollar GDP using a real exchange rate model.

Labor

Projections for the working age population (aged 15–59) are taken from the U.S. Census International Data Base.[16]

Capital Stock

Capital stock growth is calculated using the following formulation:

$$K_t = K_{t-1}(1 - \delta) + I(Y_{t-1})$$

where δ represents a depreciation rate of the capital stock, and I represents the investment rate, as a percentage of GDP (Y). Based on historical evidence, δ is estimated to be 4.5 percent for all countries.

An initial capital stock is estimated using capital stock to GDP ratios provided by King and Levine.[17,18] The growth rate of the capital stock is derived using the equation above, where each country's investment rate is assumed to follow its trend over the past decade until 2020; after 2020, the investment rate is expected to gradually converge towards 20 percent, the average investment rate in advanced economies.

Technical Factor Progress

Annual technical factor progress (TFP) growth in highly developed countries—France, Germany, Italy, Japan, the UK, and the United States—is assumed to be constant at 1.3 percent, which is in line with

previous forecasts and academic research.[3,4,19] For the remaining countries, TFP is a function of two inputs: per capita income and technological convergence conditions, as determined by education and infrastructure, governance, and the business environment. TFP growth (a) and is calculated each year for country *i*, using the following expression:

$$a_t = 0.013 - \beta\left(\ln\left(\frac{IPCi_{t-1}}{IPCUS_{t-1}}\right)\right)$$

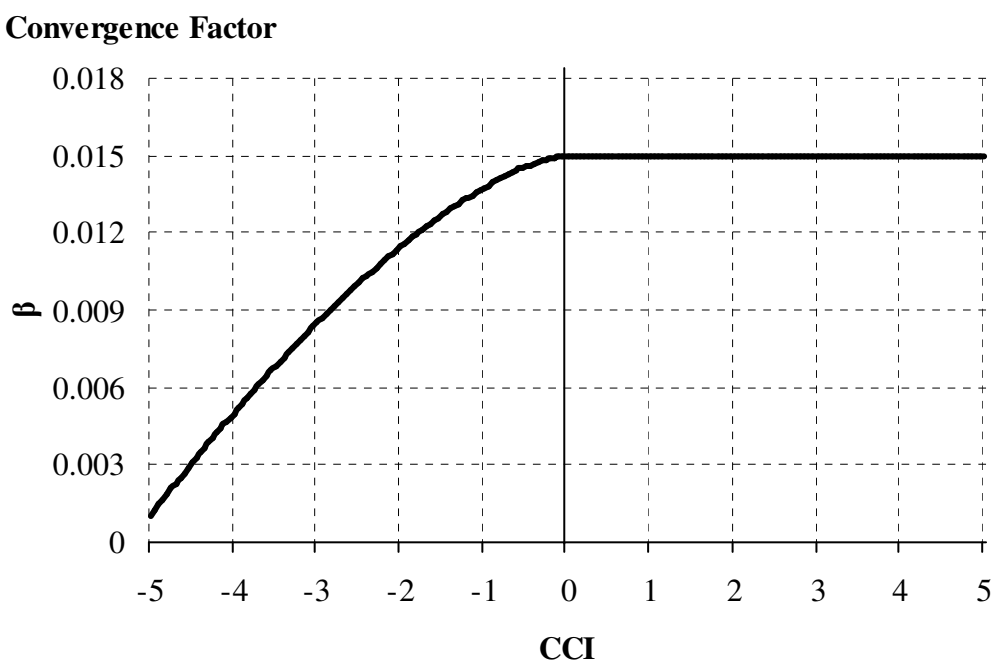
where IPC*i* represents the income per capita for country *i*, and IPCUS represents income per capita for the United States, both expressed in U.S. dollars. Thus, as domestic income per capita increases, TFP growth slows, converging to the highly-developed rate of 1.3 percent. β, the convergence factor, determines the speed at which TFP converges.

The convergence factor varies for each country, and is derived from the Convergence Conditions Index (CCI, shown in Annex Table 1). The CCI is the aggregate of three components: business climate, governance, and education and infrastructure. For each component, an index is calculated using World Bank data; these indices are then standardized with the G20 average as the mean. The CCI is the sum of these three standardized components; thus, the average G20 CCI is 0.

For countries with a CCI greater than 0, β is assumed to 0.015, as suggested by previous projection exercises. For countries with a CCI below 0, β is calculated using the following equation:

$$\beta = \frac{(-CCI)^{1.5}}{-800} + 0.015$$

The following graph illustrates the relationship between the CCI and the convergence factor β:



For all countries, β is assumed to remain constant.

Exchange Rates

The real exchange rate, expressed in terms of local currency per dollar, for each country is calculated as a function of productivity. An examination of the long-term trends in exchange rate changes over the past two decades suggests that a yearly increase in productivity of greater than 3 percent yields a currency appreciation; an increase of less than 3 percent results in depreciation.

Poverty Rates

Poverty rates are projected through 2050 using poverty headcount, income distribution, and initial mean income data provided by the World Bank's PovcalNet. Each year, mean income levels are assumed to increase by 70 percent of the relative increase in per capita GDP (for India, the adjustment is 60 percent), in line with academic estimates. Mean incomes for each decile are then calculated; the headcount index is estimated under the assumption that incomes are distributed uniformly within deciles. This method is similar to that put forth by Ahluwalia, Carter, and Chenery[20] and expanded by Anand and Kanbur.[21]

Emission Projections

Using emissions data provided by the World Bank,[22] the ratio of PPP GDP[23] to carbon and carbon equivalent (CO_2e) emissions is calculated for 1990 and 2005 for each country in the G20. To account for the expected gradual improvements in efficiency, from 2010 to 2030, each country's ratio is estimated to improve by 10.7 percent, or two-thirds of the G20 average total improvement from 1990 to 2005. From 2030 to 2050, each country's ratio is estimated to improve by 5.3 percent, or one-third of the current average.

Applying GDP projections to these assumptions yields yearly G20 emission data. Global emissions are calculated under the simple assumption that the ratio of G20 emissions to world emissions stays constant at 75 percent.[24] Yearly emission data is summed with the current stock of carbon—with both figures adjusted to account for the expected life span of carbon in the atmosphere[25]—to estimate the total carbon level. Carbon concentrations are then estimated;[26] the Stern Review estimates the effects of these concentrations.[27]

The model of proposals from Copenhagen assumes that the thirteen countries in the G20 that proposed action achieve these goals in 2020, following gradual improvements from 2010 to 2020. After 2020, emissions in these countries are held constant. Those countries that did not offer proposals at Copenhagen are assumed to follow the previous model outlined above. Annex Table 2 outlines these commitments.

Notes

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This Policy Outlook expands on the previous article "The G20 in 2050" in Carnegie's *International Economic Bulletin*. Minor modifications have been made to the forecasts to reflect comments received since its publication, but these updates have neither altered the general shape of our projections nor their political implications.

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[10] Robert Fogel,."$123,000,000,000,000*," *Foreign Policy* (January/February 2010), http://www.foreignpolicy.com/articles/2010/01/04/123000000000000?page=0,0.
[11] Ghana's particularly rapid growth will be driven in part by the recent discovery of the Jubilee oil field off Ghana's coast.
[12] Martin Ravallion and Shaohua Chen have pioneered poverty analysis and also developed PovcalNet—a leading source of poverty data, including various methods for estimating future poverty levels. Ravallion's and Chen's projections typically rely on computing poverty elasticities relative to household income growth. This method is more data intensive than the method employed in the text, and is also more appropriate for short to medium term projections. See, for example, Martin Ravallion and Shaohua Chen, "What Can New Survey Data Tell Us about Recent Changes in Distribution and Poverty?", *World Bank Economic Review*, vol. 11, no. 2, (1997), pp. 357-82, and Martin Ravallion, "Can high-inequality developing countries escape absolute poverty?", *Economic Letters* 56 (1997) pp. 51-57.
[13] The majority of models assume that temperatures will rise 2–3 degrees Celsius from pre-industrial levels within the next 50 years and agree that, at any further increase, the negative impacts will be significantly more extreme. IPCC estimates for likely increases from 1999 levels by 2099 range from 1.1 to 6.4 degrees Celsius. Even if all emissions are kept at 2000 levels, temperatures will rise by approximately 0.2 degrees Celsius in the next two decades and then by 0.1 degrees Celsius per decade through 2099.
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[23] For a discussion of using market exchange rates or purchasing power parities in emissions projections, see Stern, p. 182.
[24] Given the expected growth of emerging economies outside of the G20, it is likely that carbon emissions in these economies will increase faster than in the G20, and this ratio will shift away from the G20.
[25] Stern, p. 198. Of the initial carbon concentration of 385 ppm, 70 percent, or 270 ppm, are assumed to remain in 2050, in line with other projections, such as those by the IPCC and Climate Interactive.
[26] The conversion factor is 1 ppm of carbon dioxide = 2.1 billion tons of carbon; there is one ton of carbon in 3.7 tons of carbon dioxide. S. M. Lam, "More Inconvenient Truths," 2007, http://www.princeton.edu/~lam/documents/MoreTruth.pdf.
[27] Stern, p. 195.

Annex

Annex Table 1: Convergence Conditions

Convergence Conditions							
G20	**Paved roads (%)**	**Internet users (%)**	**Enrollment in secondary education (%)**	**Education and Infrastructure Index**	**Business Climate Index**	**Governance Index**	**Total Convergence Conditions Index**
Argentina	30	25.9	78	-0.81	-1.19	-0.91	-2.9
Australia	40	68.1	87	0.17	1.19	1.41	2.76
Brazil	5.5	35.2	79	-1.03	-1.37	-0.54	-2.94
Canada	39.9	72.8	96	0.38	1.25	1.4	3.03
China	70.7	16.1	70	-0.44	-0.71	-1.14	-2.3
France	100	51.2	96	1	0.21	0.91	2.12
Germany	100	72.3	98	1.37	0.35	1.23	2.94
India	47.4	7.2	55	-1.2	-1.53	-0.79	-3.52
Indonesia	55.4	5.8	60	-1.01	-1.19	-1.19	-3.39
Italy	100	53.9	89	0.93	-0.58	0.07	0.42
Japan	79.3	69	99	1	0.73	0.87	2.6
South Korea	88.6	75.9	96	1.21	0.62	0.27	2.1
Mexico	50	22.7	70	-0.67	-0.23	-0.75	-1.64
Russia	80.9	21.1	75	-0.12	-0.96	-1.46	-2.54
Saudi Arabia	21.5	26.4	73	-1.02	0.72	-0.89	-1.19
South Africa	17.3	8.3	72	-1.39	0.05	-0.09	-1.43
Turkey	45*	16.5	69	-0.86	-0.34	-0.65	-1.85
United Kingdom	100	71.7	92	1.26	1.48	1.2	3.94
United States	100	73.5	88	1.23	1.51	1.05	3.78
Africa							
Ethiopia	12.7	0.4	24	-2.35	-0.79	-1.72	-4.86
Ghana	14.9	3.8	45	-1.93	-0.74	-0.51	-3.17
Kenya	14.1	8	43	-1.91	-0.89	-1.4	-4.19
Nigeria	15	6.8	32	-2.09	-1.24	-1.84	-5.16

* Composite index of the three previous indicators.

** Unavailable in WDI; estimated from 2008 Library of Congress Country Profile.

Annex Table 2: 2009 Conference of the Parties Proposals for Emission Reduction

Proposed Emissions Cuts

	By 2020, reduce:
Australia	total emissions by 25 percent relative to 2000 levels.
Brazil	total emissions by 40 percent relative to projected 2020 levels.
Canada	total emissions by 20 percent relative to 2006 levels.
China	emissions-to-output ratio by 40-45 percent relative to 2005 ratio.
European Union	total emissions by 20 percent relative to 1990 levels.
India	emissions-to-output ratio by 20-25 percent relative to 2005 ratio.
Japan	total emissions by 25 percent relative to 1990 levels.
Russia	total emissions by 10-15 percent relative to 1990 levels.
South Africa	total emissions by 34 percent relative to current levels.
United States	total emissions by 17 percent relative to 2005 levels.

Annex Table 3: Projected Growth Under the Low-Growth Scenario

The Low-Growth Scenario

	Average Annual Growth Rate (2009–2050)	Real GDP 2005 US$		
		2009	2030	2050
Argentina	2.8	223	350	615
Australia	2.1	787	1271	1424
Brazil	2.8	1011	1630	2879
Canada	1.8	1171	1759	1965
China	4.1	3335	12510	20438
France	1.4	2203	2898	3035
Germany	0.8	2833	3171	3126
India	4.3	1065	3106	6217
Indonesia	3.3	354	679	1283
Italy	0.7	1732	1945	1803
Japan	0.5	4467	5136	4379
Korea	1.6	945	1775	1727
Mexico	3.1	866	1585	2838
Russia	2.2	869	1660	2204
Saudi Arabia	3.6	348	612	1268
South Africa	3.0	271	513	926
Turkey	3.1	509	934	1707
United Kingdom	1.5	2320	3143	3355
United States	2.0	12949	20136	28774
Ethiopia	5.1	28	70	173
Ghana	5.0	17	52	131
Kenya	3.9	30	62	127
Nigeria	3.9	213	484	848

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