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INTERNATIONALES

No 2006 – 16
October

The Long Term Growth Prospects of the World Economy: Horizon 2050

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SUMMARY

One of the major sources of change in the world economy has come from the rise of large developing countries. The growth generated by these countries could become a much larger force in the world economy than it is now. This study develops long-term scenarios for world economic growth. The latest demographic projections from the United Nations and models of physical capital accumulation and productivity growth are used to map out countries' GDP growth and income per capita until 2050. This allows us to paint a picture of how the world economy might change over the decades to come. The work specifically gauges how large a force the major developing countries, such as China and India, could become over the next 45 years.

The theoretical framework used is the neo-classical growth theory. In this framework, growth stems from three driving sources: labor force growth, capital accumulation and total factor productivity (TFP) growth. An econometric analysis of past performance (1965-2005) is carried out to describe the process by which physical capital accumulates over time. We estimate the parameters of a catch-up model of technology diffusion as generalized by Benhabib and Spiegel (2005). Our model encompasses the notion that human capital plays a positive role in the determination of total factor productivity growth rates through its influence on the rate of catch-up and own innovation.

We then use the projections of productivity growth from this exercise to map out the path of the real exchange rate. Consistent with the Balassa-Samuelson effect, we assume that if an economy experiences higher productivity growth than the US, its equilibrium exchange rate will tend to appreciate. The plausibility of our projections is discussed based on estimates made by other institutions such as Goldman Sachs, the Deutsche Bank and the World Bank.

The results suggest that China's GDP in 2050 could represent 22% of the world (at current US $ and current relative prices). Between 2005 and 2050, China and India could experience a 13-fold and a 10-fold increase in GDP respectively at current real exchange rates. Over the same period, GDP for developed countries would almost double (Germany, France and Japan) and, for some, triple (US). We expect the list of the world's ten largest economies to look quite different in 2050 than in 2005. We do not, however, expect the US to lose the first rank in the world GDP hierarchy in the next 50 years. We anticipate that China's GDP will reach $ 31 compared to $ 38 trillion for the US in 2050. Japan is expected to lose its second position to the benefit of China. South Korea's rank is predicted to improve from 10th in 2005 to fourth in 2050. A similar progression is expected for India, projected to jump from the 13th to the fifth position. In terms of GDP, India could become larger than France in 2025 and larger than Germany in 2039. In 2050 Indian GDP would, however, correspond only to 18% of that of the US.

Of the current G7 (the United States, Japan, Germany, the United Kingdom, France, Italy and Canada) only the US, Japan, Germany and the United Kingdom may remain among the seven largest economies in 2050. China, South Korea and India are expected to overtake France, Italy and Canada before that date.

Today's advanced economies are projected to become a shrinking part of the world economy.

Our projections indicate that in less than 50 years, China and India together could match the size of the US in current dollars (26.6 against 26.9% of the world GDP in 2050). China and India stand out as an engine of new demand growth and spending. Their GDP could grow at yearly average rate of 4.6 and 4.5%, respectively between 2005 and 2050. The largest economies in the world (by GDP) may no longer be the richest (in terms of income per capita), making strategic choices for firms more complex. Accompanying shifts in spending constitute opportunities for companies that will invest in the right markets but challenges for those that will fail to adjust to ongoing changes.

ABSTRACT

This study develops long-term forecasts for world economic growth, based on a production function according to which an economy can grow by (1) deploying more inputs (labor and capital inputs) to production and/or by (2) becoming more efficient, i.e. producing more output per unit of input. An econometric analysis of past performance is carried out to describe the process by which physical capital accumulates over time and to estimate the parameters of a catch-up model of technology diffusion. We moreover account for the modification of real exchange rates against the US dollar.

The results suggest that today's advanced economies are to become a shrinking part of the world economy: in less than 50 years, China and India together could match the size of the US in current dollars (26.6 against 26.9% of the world GDP in 2050). China and India will stand out as an engine of new demand growth and spending, their GDP will grow at yearly average rate of 4.6 and 4.5%, respectively between 2005 and 2050. The largest economies in the world (by GDP) may no longer be the richest (in terms of income per capita).

Classification JEL: O1, O4.
Keywords: Growth projections, Emerging countries, human capital, technology diffusion.

PERSPECTIVES DE CROISSANCE A LONG TERME DE L'ECONOMIE MONDIALE : HORIZON 2050

RESUME

L'économie mondiale a connu des modifications majeures au cours des dernières décennies. Il devrait en être de même pour les décennies à venir. L'étude des perspectives de croissance à moyen et long terme revêt ainsi un attrait certain. Un point crucial de l'exercice consiste à appréhender la croissance générée par les grandes économies émergentes. Nous proposons d'estimer les perspectives à long terme de l'économie mondiale et d'évaluer la réallocation internationale de la demande au cours des prochaines décennies. Nous développons un modèle formel de croissance basé sur des hypothèses explicites quant au processus de développement économique et de rattrapage technologique.

Notre travail se fonde sur un modèle de croissance néoclassique augmenté du capital humain qui apparaît comme le cadre de référence pour une telle analyse. Ce modèle permet de prendre en compte dans les calculs de projection de croissance économique le rôle décisif des facteurs démographiques (croissance de la population, évolution de la population active et du taux de dépendance) mais aussi et surtout de l'éducation, de l'épargne et du rattrapage technologique dans la détermination du potentiel de croissance de chaque économie. Les projections effectuées individuellement pour 170 pays s'appuient sur une spécification simple et cohérente du revenu en fonction du nombre d'heures travaillées, du stock de capital et du niveau de Productivité Totale des Facteurs (PTF). Nous utilisons les projections démographiques les plus récentes que nous intégrons dans un modèle d'accumulation du capital physique. La dynamique d'accumulation du capital physique est élaborée à partir de relations estimées économétriquement sur des données passées sur la période 1980-2000. Nous modélisons la dynamique de croissance de la productivité en s'appuyant sur une logique de rattrapage de la diffusion technologique (Benhabib et Spiegel, 2005). Les paramètres de ce modèle sont estimés sur des données passées sur la période 1965-2005. Notre travail prend en outre en considération les évolutions futures des taux de change par rapport au dollar de sorte à fournir une "image du monde" qui permet la comparaison des niveaux de développement des pays émergents avec ceux des pays développés à l'horizon 2050. Les projections portent sur le long terme à horizon 2050. Elles ignorent en conséquence l'impact du cycle économique et doivent être interprétées comme une "croissance dans la tendance" ou croissance potentielle des économies. Les résultats sont discutés au regard des prédictions réalisées notamment par la Banque Mondiale et les banques d'affaires Deutsche Bank et Goldman et Sachs.

Nos résultats suggèrent que les économies avancées d'aujourd'hui deviennent une composante de moins en moins importante de l'économie mondiale. Nos prédictions indiquent que dans moins de 50 ans, la Chine et l'Inde ensemble seront d'une taille équivalente à l'économie américaine en dollars courants (26,6 contre 26,9% du PIB mondial en 2050). L'importance relative de ces deux pays comme moteur de la croissance

de la demande s'illustre par les taux annuels de croissance du PIB en volume de 4,6 et 4,5% respectivement entre 2005 et 2050. Les plus grandes économies (en termes de PIB) ne devraient plus être les plus riches (en termes de PIB par tête), rendant les choix stratégiques de localisation de plus en plus complexes.

RESUME COURT

Cette étude fournit quelques ordres de grandeur du potentiel de croissance mondiale et de la capacité de rattrapage des grandes économies émergentes. Elle permettra de dessiner les évolutions du taux de croissance du PIB et du niveau de revenu par tête des différentes économies. Les prévisions offriront une "image du monde", elles indiqueront l'évolution des écarts de PIB par tête entre les grandes régions et permettront la comparaison des niveaux de développement des pays émergents avec ceux des pays développés. Nos résultats suggèrent que les économies avancées d'aujourd'hui deviennent une composante de moins en moins importante de l'économie mondiale. Nos prédictions indiquent que dans moins de 50 ans, la Chine et l'Inde ensemble seront d'une taille équivalente à l'économie américaine en dollars courants (26,6 contre 26,9% du PIB mondial en 2050). L'importance relative de ces deux pays comme moteur de la croissance de la demande s'illustre par les taux annuels de croissance du PIB en volume de 4,6 et 4,5% respectivement entre 2005 et 2050. Les plus grandes économies (en termes de PIB) ne devraient plus être les plus riches (en termes de PIB par tête), rendant les choix stratégiques de localisation de plus en plus complexes.

Codes JEL : O1, O4.
Mots-clés : Prédictions de croissance, pays émergents, capital humain, diffusion technologique.

THE LONG TERM GROWTH PROSPECTS OF THE WORLD ECONOMY: HORIZON 2050

Sandra Poncet[∇]

INTRODUCTION

One of the major sources of change in the world economy has come from the rise of large developing countries. The growth generated by these countries could become a much larger force in the world economy than it is now. This study develops long-term scenarios for world economic growth, based on a neoclassical model where growth depends on labor force growth, capital accumulation and productivity catch-up.

Over the long-term, the sole driver of growth of GDP per capita is TFP growth. Most growth projections rely on more or less arbitrary assumptions concerning technological progress. They apply past averages or assume absolute convergence on the United States. However such assumption lacks theoretical and empirical support. For instance, Pritchett (1997) and Easterly and Levine (2001) observe a divergence in income levels. There is no automatism: higher income levels do not fall from heaven like manna but require hard work.

Our objective is to go further than the traditional literature by considering the total number of hours worked instead of the crude value of working age population to account for labor force growth. Moreover we rely on models of physical capital accumulation and productivity growth that are not only theoretically based but also empirically relevant.

Our modeling of physical capital accumulation relies on projected values of investment rates based on econometrically estimated domestic savings behavior. Empirical estimates point to the importance of GDP level and GDP growth as well as a catch-up process relative to the leader economy (Masson et al, 1998).

As for the modeling of TFP growth, we rely on the recent generalization of the Nelson-Phelps catch-up model of technology diffusion by Benhabib and Spiegel (2005). This model explains TFP growth based on two distinct components. The first component suggests that the growth of total factor productivity varies positively with the distance to the technology frontier. The second component of the Nelson-Phelps hypothesis suggests that the rate at which the gap between the technology frontier and the current level of productivity is closed depends on the level of human capital. Benhabib and Spiegel (2005) show that historical experience (1960-1995) supports a logistic diffusion specification that implies that a country with insufficient human capital stock may exhibit slower total factor growth productivity, other things equal. Indeed, they demonstrate that if the human capital

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stock of a follower is low, the logistic diffusion model does not imply catch-up, but a divergence in TFP growth rates.[1]

We confirm the results of Benhabib and Spiegel (2005) with data updated to include the 1995-2005 period. Our model encompasses the notion that human capital plays a positive role in the determination of total factor productivity growth rates through its influence on the rate of catch-up, consistent with the view of human capital as a facilitator of innovation.

We rely on three variations of the benchmark model. The benchmark model assumes no TFP growth. It only allows for labor force growth and physical capital accumulation relying on United Nations labor forecasts and hypothesis of constant investment rate. In a first variant, we opt for a simple scenario of common TFP growth. In a second variant, we project the investment rate by relying on predicted values of investment rates based on econometrically estimated domestic savings rates. Finally, our complete scenario relaxes the hypothesis of constant and common TFP growth and implements a Nelson-Phelps catch-up model of technology diffusion. We use the projections of TFP growth to map out the path of the real exchange rate. Consistent with the Balassa-Samuelson effect, we assume that if an economy experiences higher productivity growth than the US, its equilibrium exchange rate will tend to appreciate. Our strategy is therefore to model GDP in constant US $ and constant relative prices and real exchange rate separately, then to compute GDP at current real exchange rate.

Our final projections suggest that China's GDP in 2050 could represent 21.4% of the world output (at current US $ and current relative prices). Between 2005 and 2050, China and India could experience a 13-fold and a 10-fold increase in GDP respectively at current real exchange rate. Over the same period, GDP for developed countries would almost double (Germany, France and Japan) and, for some, triple (US). We expect the list of the world's ten largest economies to look quite different in 2050 than in 2005. We do not, however, expect the US to lose the first rank in the world GDP hierarchy over the next 50 years. We predict China's GDP to reach $ 31 trillion compared to $ 38 trillion for the US in 2050, pushing Japan out of the second place to the benefit of China. South Korea is expected to improve its position from 10th in 2005 to the fourth in 2050. A similar progression is anticipated for India, whose rank is projected to jump from the 13th to the fifth. India could become larger than France in 2025 and larger than Germany in 2039. In 2050 Indian GDP would, however, only correspond to 18% of that of the US.

Of the current G7 (the United States, Japan, Germany, the United Kingdom, France, Italy and Canada) only the US, Japan, Germany and the United Kingdom may be among the seven largest economies in 2050. China, South Korea and India are expected to overtake France, Italy and Canada before that date.

The paper is organized as follows. Section 1 details the growth model and the assumptions retained concerning TFP growth and capital accumulation. Section 2 presents the

[1] This finding contrasts with the exponential diffusion process, in which the steady state is a balanced growth path with all followers growing at the pace determined by the leader nation that acts as the locomotive.

benchmark scenario that combines the latest demographic projections from the United Nations with constant investment rate and no TFP growth. Our projections take into account the evolving age distribution of the population and age-specific participation rates. Section 3 develops successively the three variants of the models. The first introduces a constant and common TFP annual growth rate of 1.2%. The two subsequent variants model the investment rate and TFP growth following a framework that is coherent with the projection model of GDP. Section 4 discusses the results and applies a simple exchange rate model to provide a ranking of countries at 2050 exchange rate. It also discusses the plausibility of our results.

1. THE MODEL

Our model relies on a simple formulation of the overall level of GDP (Y) in terms of labor input (L), capital input (K) and technological progress (A) or Total Factor Productivity (TFP). We assume that GDP is a simple constant return to scale, Cobb-Douglas production function of these three variables:

$Y = AK^{\alpha}L^{1-\alpha}$, with α the share of income that accrues to capital and Y the real GDP (constant US $ at 2000 prices). We rely on a value of α=1/3 that is a standard assumption in the literature (Benhabib et Spiegel, 2005). Our analysis aims at developing long-term evaluation of GDP for international countries. We ensure the comparability of our estimates in relying on GDPs and capital stocks in constant US $ at 2000 prices. Real GDP in a country in constant 2000 US $ prices is defined as $Y = EY^{LCU} = \frac{SP}{P_{US}} \times Y^{LCU} = \frac{SPY^{LCU}}{P_{US}}$ with E the current real exchange rate, Y^{LCU} the real GDP (constant 2000 local prices in LCU), S the current exchange rate and P and P_{US} the prices in the country and in the US respectively.

Our strategy is therefore to model Y^{LCU} and E separately, then to compute GDP at current real exchange rate $Y = EY^{LCU}$.

1.1. Labor

For L, we go further than the traditional literature by considering the total number of hours worked instead of the crude value of working age population. We take into account evolving age distribution of the population as well as age-specific participation rates. Past values and projections are taken from the ILO and the United Nations.

We compute the total number of hours worked by year and country relying on the following formula:

L = (1-unemployment rate) × active population × number of hours worked per employee

The **volume of the active population** is based on actual data and projections of population by age group (from the UN Medium Variant 1950-2000 and Estimates 2001-2050) and participation rate by age group (from ILO: Total and Economically active Population / Estimates and Projections, 1950-2020, LABORSTA Labor Statistics Database).

Active population figures between 1960 and 2020 by country, year, and age group are computed as the product of annual population by age group (10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64 and over 65 years) and the activity rate of the age group for the corresponding time period (1960, 1970, 1980, 1985, 1990, 1995, 2000, 2005, 2010, 2015 and 2020). The total active population is then obtained as the sum of the active population by age group over all groups:

$$Active\ \ population = \sum_{a:age\ group} pop_a \times participation\ rate_a$$

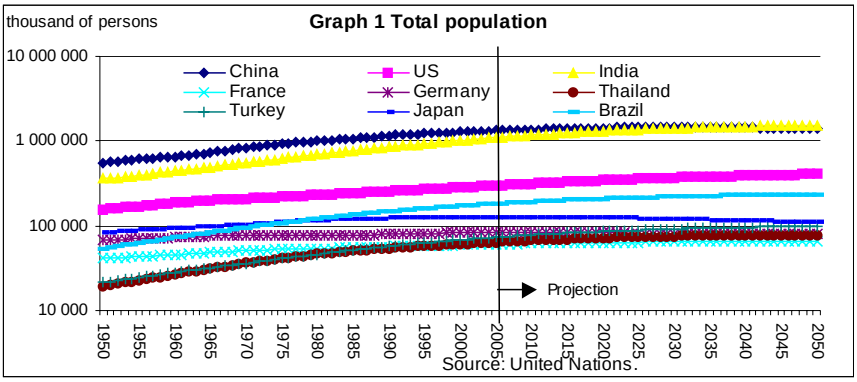
Yearly projections after 2020 follow the same logic. We rely on the UN's yearly projections of population by age group and apply the 2020 ILO projections of the corresponding participation rate. Complementary sources such as the U.S. Census Bureau International and national bureau of statistics are used for countries for which data from the UN or ILO are not available.

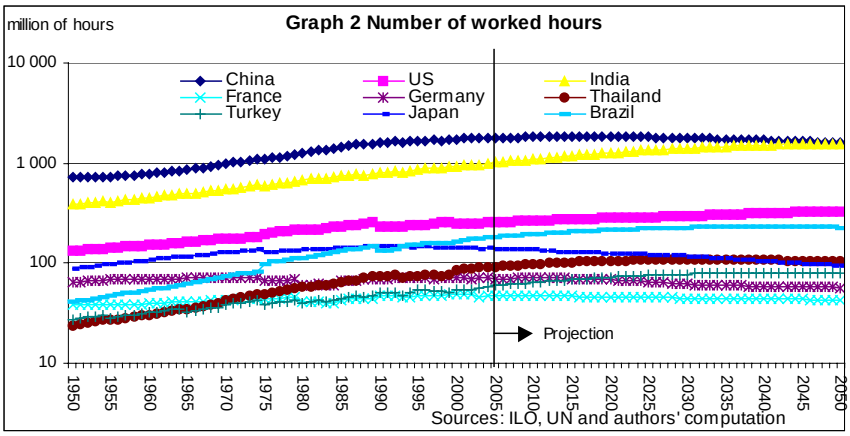
The **number of hours worked per employee** is extracted from ILO. The series (Hours of work) are available yearly from 1960 onwards. Since many observations are missing, a systematic procedure is followed. Missing observations for a given country and year are replaced by the average value for that country over the corresponding five-year period. In case this data is missing, the replacement is based on the regional average over the same sub-period. We rely on a regional decomposition into the ten groups defined by Ingenue team (2005) (Western Europe, Eastern Europe, North America, South America, Chinese world, Indian World, Japan, Russian World, Africa and the Mediterranean World). The composition of these groups is presented in the Appendix A.

Unemployment rate statistics are taken from the ILO. Missing values are handled following the strategy, presented above, of replacing missing values by time consistent and region specific data. Unemployment rates are assumed constant over 2001-2050.

The evolutions of total population and total number of hours worked for a selection of countries (China, India, Turkey, Thailand, Germany, France, US, Japan and Brazil) appear in the Graphs 1 and 2.

Demography is expected to play an important role in the way the world will change. The decline in the working age population is generally projected to take place later in the developing world than in the developed economies and it will be steeper in China than in India or Brazil.





Evolutions of the number of hours worked are very heterogeneous across countries. While the number of hours worked stagnates in France, it declines in Germany, Japan and China and rises continuously in India and in the US. Our computations show that the labor effort in China will reach its peak in 2015 and then decline. In 2050, the labor input would fall back to its 1990 level. The observed inter-country demographic heterogeneity has a significant impact on the computed growth and income prospects.

1.2. Capital

Physical capital stocks are calculated according to the method used by Mankiw, Romer and Weil (1992), Klenow and Rodríguez-Clare (1997), as well as Benhabib and Spiegel (2005). Initial capital stocks in 1960 are calculated according to the following formula :

$$\left(\frac{K}{Y}\right)_{1960} = \frac{I_K / Y}{g + \delta + n} \qquad (1)$$

In this expression[2], $\frac{I_K}{Y}$ is the average share of physical investment in output from 1960 through 2000, *n* represents the average of population growth over that period while *g* and δ represent the average rate of TFP growth and the rate of depreciation, respectively. We assume δ=5% and g=2%, consistent with the literature. We therefore compute

$$K_{1960} = Y_{1960} \times \frac{(I_K / Y)_{1960-2000}}{0.07 + n_{1950-1960}} \tag{2}$$

Given initial capital stock estimates, the capital stock of country *i* in period *t* satisfies:

$K_{i,t} = \sum_{j=0}^{t} (1-\delta)^{t-j} I_{K\,i,j} + (1-\delta)^t K_{i,1960}$, with I_k being the gross fixed capital formation (constant US $ at 2000 prices).

Data for dollar income in real terms (constant US $ at 2000 prices) are computed based on GDPs from the Chelem CEPII database. Note that the evolution of dollar income in constant US $ and constant prices is the same as the evolution of GDP in local currency at constant prices. The data for China have been revised (from 1993 onwards) according to the changes made by the National Bureau of Statistics. This revision corresponds to a 17% re-evaluation of the GDP in 2004.[3]

Table B1 in Appendix B displays the value in constant US $ at 2000 prices of our sample's capital stock in 2005. The hierarchy of the countries in terms of capital stock and ratio of capital stock over GDP is quite coherent with the established literature (World Bank, 2006).

1.3. Total Factor Productivity

Over the past, total Factor Productivity growth is estimated from a Cobb Douglas production function with the capital share set at 1/3 and the labor share set at 2/3. For country *i* in period *t* we have:

$$A_{i,t} = \frac{Y_{i,t}}{K_{i,t}^{1/3} L_{i,t}^{2/3}} \tag{3}$$

[2] This expression is derived as the constant (or steady state) K/Y implied by the capital accumulation equation given a constant I/Y and constant growth rates of Y/L and L. As noted by Klenow and Rodríguez-Clare (1997), results vary little depending on the assumed initial value of K/Y.

[3] See http://www.stats.gov.cn/eNgliSH/newsandcomingevents/t20060110_402300302.htm.

Table 1 reports the Top 10 countries in terms of TFP growth estimates from 1980 to 1995 and 1990 to 2005. Unsurprisingly, the Asian Tigers, including China, Thailand, South Korea, Singapore, Indonesia and Hong Kong top the list in terms of TFP growth over the period 1980-1995. The results are quite similar to those of Benhabib and Spiegel (2005). Asian countries are less numerous in the ranking over the 1990-2005 period, in line with the Asian crisis. After Equatorial Guinea, China stands out with annual TFP rates above 5%[4].

Table 1: Annual Total Factor Productivity Growth Estimates: Top 10 countries

Country	TFP growth 1980-1995	Country	TFP growth 1990-2005
China. People's Rep.	5.4	Equatorial Guinea	14.5
Thailand	3.2	China. People's Rep.	6.6
South Korea	3.1	Poland	3.7
Botswana	3.0	Bulgaria	3.0
Singapore	2.7	Mozambique	2.8
Luxembourg	2.4	Singapore	2.7
Indonesia	2.4	Mauritius	2.6
Saint Lucia	2.3	India	2.6
Cyprus	2.2	Chile	2.5
Hong Kong	2.2	Cape Verde	2.4

Total factor productivity estimates for 2005 as well as GDP, capital stock and labor input are shown for our entire data set in Table B2 in Appendix B. We compute the GDP-weighted average of the annual TFP growth rate between 1990 and 2005 and obtain a value of 1.3%.

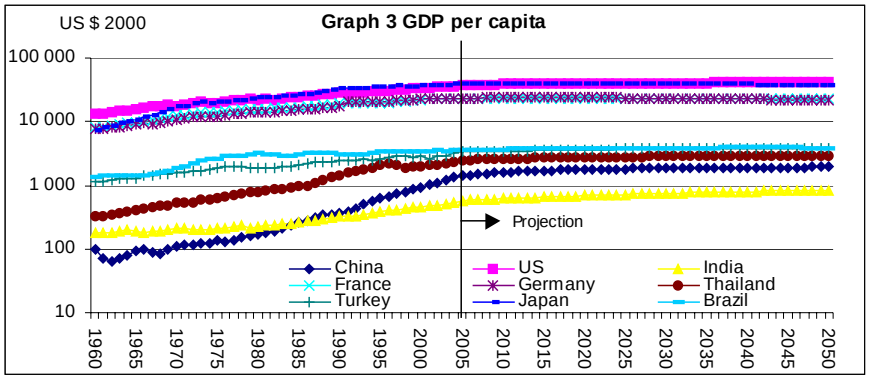
2. BENCHMARK SCENARIO

In order to get a good understanding of our growth projections we need to proceed step by step. It is of primary importance to understand the growth implications of the demographic projections that we model physical capital accumulation and TFP growth. Hence, as a first step, we assume no TFP growth and a constant investment rate.

GDP in real dollar terms is projected from 2005 onwards relying on the expression $Y = AK^{\alpha}L^{1-\alpha}$, with A being constant at its level of 2005, L being the projected value of the United Nations and K being the capital stock that accumulates annually between 2005 and 2050 following the formula: $K_{t+1} = K_t(1-\delta) + s_k Y_t$ and $s_k = \frac{I_{2005}}{Y_{2005}}$.

[4] Equatorial Guinea's recent take-off is rooted in the discovery of oil. As this input is neither accounted for in the labor input nor in the capital input, it is captured in the TFP component.

This exercise allows us to isolate the contribution of demography to our forecasts. Projected GDP per capita for a selection of countries of interest (China, India, Turkey, Thailand, Brazil, Germany, France, US, Japan and Brazil) appear in the Graph 3.

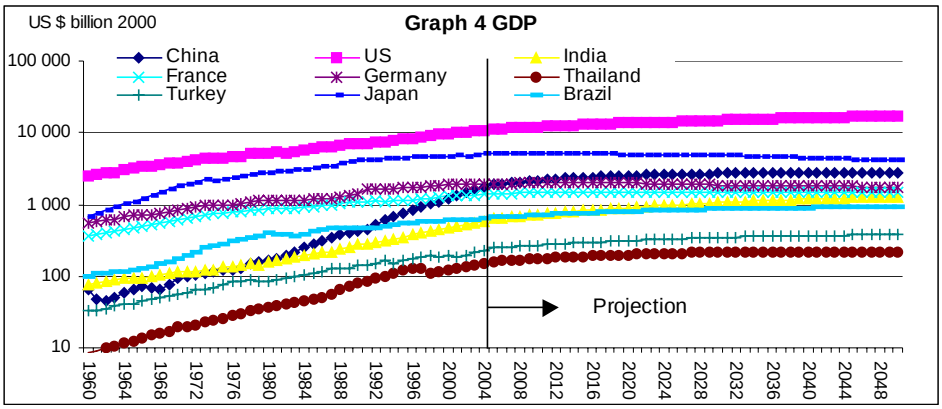


This scenario (of no TFP growth and a constant investment rate) corresponds to a stagnation of GDP per capita in most countries, in sharp contrast with previously experienced continuous growth (Table 2).

Table 2: Projection of annual per capita GDP growth rate (in %)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1970-1980	4.3	2.2	0.8	2.7	2.8	4.3	1.6	3.3	5.9
1980-1990	7.7	2.2	3.6	1.8	2.2	6.1	2.9	3.4	-0.5
1990-2000	10.2	2.2	3.6	1.4	2.5	3.3	1.8	1.2	1.2
2000-2005	8.6	1.6	4.6	1.1	0.6	4.3	2.8	1.6	0.8
2005-2010	2.3	0.7	1.4	0.2	0.5	0.9	0.5	-0.1	0.3
2010-2020	1.1	0.3	1.1	0.0	0.0	0.6	0.5	-0.1	0.3
2020-2030	0.5	0.1	0.9	-0.1	-0.5	0.3	0.3	0.0	0.2
2030-2040	0.2	0.3	0.7	0.0	-0.2	0.1	0.1	-0.4	0.1
2040-2050	0.2	0.2	0.4	0.1	-0.1	0.1	0.1	-0.2	0.0

The projected negative GDP growths of Japan and Germany (Graph 4 and Table 3) are clearly related to their decline in labor input. In China, it seems that the rapidly increasing capital stock due to the high investment rate in 2005 (32%) compensates for the reduced labor input.



GDP and GDP per capita rapidly reach a ceiling in all countries, with the noticeable exception of India. The sustained increase of labor input in India fuels a natural annual GDP growth of 0.7% in the period 2040-2050.

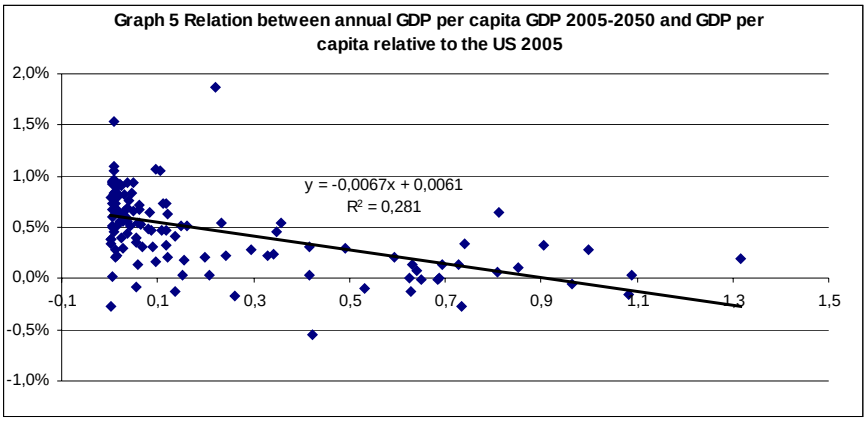
Table 3: Projection of annual GDP growth rate (in %)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1970-1980	6.2	3.2	2.9	3.3	2.8	6.9	4.1	4.4	8.4
1980-1990	9.3	3.3	5.8	2.4	2.3	7.8	5.2	3.9	1.6
1990-2000	11.3	3.3	5.5	1.9	2.9	4.5	3.6	1.5	2.7
2000-2005	9.3	2.7	6.2	1.5	0.6	5.3	4.3	1.7	2.0
2005-2010	3.0	1.6	2.8	0.7	0.5	1.8	1.8	-0.1	1.4
2010-2020	1.5	1.2	2.2	0.2	0.0	1.3	1.5	-0.3	1.1
2020-2030	0.6	0.8	1.6	0.1	-0.6	0.7	1.0	-0.3	0.8
2030-2040	0.1	0.8	1.2	0.0	-0.3	0.3	0.6	-0.8	0.4
2040-2050	-0.1	0.7	0.7	0.0	-0.3	0.0	0.3	-0.7	0.1

Under this first scenario (of no TFP growth and a constant investment rate), India's GDP is expected to double over the next 45 year while China's GDP is predicted to increase by 125% as indicated in Table 3. This increase, though not negligible, falls short of the objective of building a well-off society expounded by Jiang Zemin in his report to the 16th National Congress of the Chinese Communist Party (CPC). The General Secretary of the Communist Party of China told China will strive to quadruple its gross domestic product (GDP) of 2000 by the year 2020 (Table 4).

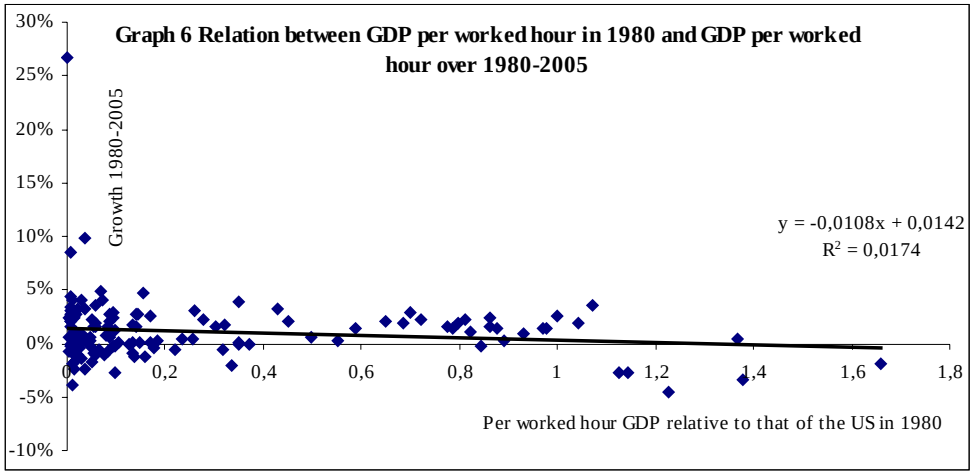
Table 4: Projection of GDP in billion $ (constant US $ at 2000 prices)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1980	170	5 160	155	860	1 120	37	84	2 790	395
1990	413	7 110	273	1 090	1 410	79	140	4 110	461
2000	1 200	9 820	465	1 310	1 870	123	199	4 750	601
2005	1 870	11 200	627	1 410	1 930	159	246	5 170	665
2010	*2 170*	*12 100*	*721*	*1 460*	*1 980*	*174*	*269*	*5 150*	*713*
2015	*2 390*	*12 900*	*814*	*1 480*	*2 000*	*187*	*291*	*5 070*	*759*
2020	*2 530*	*13 600*	*900*	*1 490*	*1 980*	*198*	*312*	*5 000*	*799*
2030	*2 690*	*14 800*	*1 060*	*1 500*	*1 860*	*213*	*346*	*4 830*	*863*
2040	*2 720*	*16 100*	*1 190*	*1 500*	*1 800*	*220*	*367*	*4 460*	*900*
2050	*2 700*	*17 300*	*1 280*	*1 500*	*1 750*	*221*	*377*	*4 140*	*910*

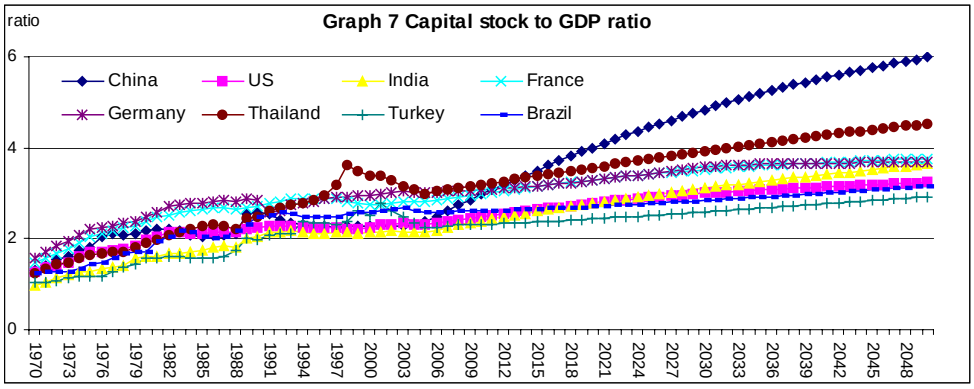


Consequently even in the absence of a TFP-driven catch up, there is an implicit convergence mechanism in terms of GDP per capita due to the evolution of country-specific age distribution, age-specific participation rates as well as investment rates and capital stocks. Some developing countries indeed enjoyed a favorable demographic phase over the past characterized by a low dependency ratio and a high participation rate.

However the pattern of convergence almost vanishes when we rely on the concept of GDP per hour, as illustrated in the Graph 6. A potential explanation is a higher productivity growth in the US and other developed countries.



For most countries, with the exception of China and Thailand, the capital stock to GDP ratio settles around 3.2 (Graph 7) . China's and Thailand's capital stocks increase at a faster rate than their GDPs because of the hypothesis of an unchanged investment rate at its 2005 value. For these countries, investment rates in 2005 are higher than in long run steady state, consistent with the proactive growth strategy pursued by the government.



The projected 6-1 ratio of capital stock to GDP for China in 2050 is clearly not credible, casting doubt on the hypothesis of constant investment rate over time in countries that have a relatively high level in 2005.

To determine more plausible values for capital stock we proceed to the modeling of capital accumulation. Logically, the investment rates for all countries should converge toward their long run equilibrium value in parallel to the international convergence of the ratio of capital stock to GDP.

3. MODELING OF INVESTMENT RATE AND TFP GROWTH

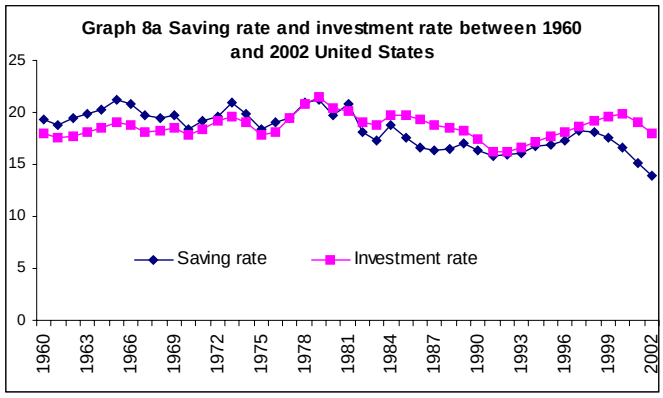
Previous results obtained based on the benchmark model emphasize the inappropriateness of constant investment and TFP growth rates hypotheses. It thus appears necessary to model the evolution of the investment rate and productivity. This means introducing a feed back mechanism: not only do TFP and investment growth contribute to economic growth, they also depend on the level of development thereby achieved.

3.1. Investment rate

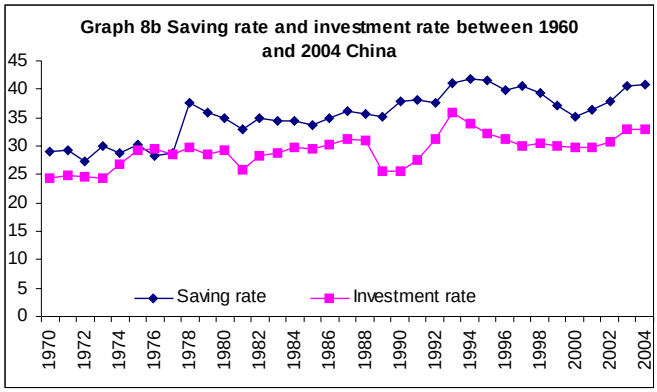
As explained by Germain and Guichard (1998), in the long run (more than a decade), domestic savings is the principal means of financing investment. The reasoning behind this is rooted in the theoretical consideration that an excess of investment over savings represents external debt accumulation. An external debt can only be reimbursed with future surpluses (investment less than domestic saving). Indeed, external debt is useful to absorb shocks but over the long run, investment and savings tend to equalize as shown in the Graphs 8a and 8b that display the evolution of savings and investment rates in the US and in China from 1960 onwards.

The literature on the determinants of savings emphasizes the importance of income level and growth as well as of the catch-up effect relative to the leading economy (Masson et al, 1998). The possibility that income growth raises savings corresponds to the life-cycle hypothesis, which relates savings behavior to successive stages in life: schooling, increased earnings and retirement (Modigliani and Brumberg (1954) and Modigliani and Ando (1957)).

A first determinant that we consider is the age structure, an important component of the life-cycle hypothesis. If a high proportion of the population is of working age, then the economy should have a high rate of savings since workers are providing for their retirement.



Source: World Development Indicators.



Source: World Development Indicators.

Conversely, when this cohort reaches retirement age and starts dis-saving (or at least starts consuming a greater fraction of its income), then the aggregate savings rate should decline. As emphasized by Masson et al. (19998), an extensive literature attempts to link demographic variables to savings behavior. Higher proportions of the young and elderly in relation to people of working age –dependency ratios- are expected to be associated with lower savings rates.

Since our objective is to explain the savings rate evolution as fully as possible, we consider and test various theoretical determinants.

We test the possibility that income growth raises savings. This view again is based on the life-cycle hypothesis, which relates savings behavior to successive stages in life: schooling, increased earnings and retirement. Modigliani (1966) argues that a higher growth rate would, with unchanged savings rates per age group and unchanged population structure, raise aggregate savings by increasing the aggregate income of the working population relative to those not earning labor income (that is, retired persons living off their accumulated assets). Masson et al. (1998) and Carroll and Weil (1994) confirm that lagged values of increases in income growth seem to explain higher savings rates.

We furthermore take into account the possibility that differences in income per capita could be one of the factors that explain the wide range of savings rates around the world. At subsistence levels, there is a low potential for significant savings. As explained by Masson et al. (1998), a rise in income per capita may therefore lead to higher savings rates. As pointed out by Ogaki, Ostry and Reinhart (1995), the process of development initially involves low savings rates, then a period of high growth accompanied by high savings rates, and finally lower savings rates in more mature economies. Thus, we consider a quadratic term in order to account for the fact that savings is likely to decline as income per capita rises and may even become negative for rich countries where investment opportunities and growth are relatively lower.

We test these various determinants using a panel data set of savings rate averages over five year periods in almost 200 countries from 1980 to 2000. We regress savings rates for our sample countries on the following variables: GDP per capita relative to that in the US (at current US $ and current relative prices), GDP growth rate and the dependency ratio (the ratio of people under 20 and over 64 to those of working age: between 20 and 65 years old). Domestic savings rates in % of GDP are taken from the Word Bank Indicators.

The regression results are displayed in Table 5. The first column presents our benchmark model while the second column tests the significance of demographic effects. The introduction of fixed effects by country allows to control for time-invariant country characteristics and to account for a large share of the variance in savings rate across countries. The dependency ratio fails to enter significantly the regression. Other determinants turn out to be significant and have signs that are consistent with intuition. The point estimates of the various coefficients (column 1) as well as the country fixed effects will be used to infer future savings rates over the period 2005-2050. For each country *i* and each 5-year sub-period *t* between 2005 and 2050, we will project the savings rate $S_{k,i,t}$ as:

$$S_{k,i,t} = 0.17 * S_{k\,i,t-1} + 38.04 * \frac{GDPperCAP_{i,t-1}}{GDPperCAP_{US,t-1}} - 8.15 * \left(\frac{GDPperCAP_{i,t-1}}{GDPperCAP_{US,t-1}} \right)^2$$

$$+ 12.38 * \left[\left(\frac{GDP_{i,t-1}}{GDP_{i,t-2}} \right)^{1/5} - 1 \right] + 5.45 + \text{fixed effect}_i \qquad (4)$$

Estimations rely on the Within estimator.

Table 5: Regression results for savings rates.
Panel estimates 5 year sub-periods between 1980 and 2000

Explained Variable: Savings rate	Column 1 Within (Fixed effects by country)	Column 2 Within (Fixed effects by country)
$S_{k,i,t-1}$	0.17***	0.17***
	(0.04)	(0.04)
GDP per capita relative to US $_{i,t-1}$	38.04***	39.79***
	(9.26)	(9.38)
Squared GDP per capita relative to US $_{i,t-1}$	-8.15**	-8.66**
	(3.48)	(3.51)
Average GDP growth rate $_{i,t-1}$	12.38***	12.43***
	(1.52)	(1.52)
Dependency rate of population (share of below 15 and above 60 years old in total population)		-2.91
		(2.47)
Constant	5.45***	8.55***
	(1.51)	(3.04)
Number of observations	658	658
Number of groups	162	162
R^2	0.37	0.37

Heteroskedastic consistent standard errors in parentheses, with ***, ** and * denoting significance at 1%, 5% and 10% confidence level.

Table 6 reports the projected savings rates for a selection of countries of interest. It provides observed saving rates before 2005 and simulated ones based on the above equation after 2005.

The dependency rate and population come from the UN while GDP is projected following the benchmark model developed in the previous section. It is important to note that projected savings rates between 2005 and 2050 depend on the future GDP growth and thus on the hypotheses of TFP growth. In this section, we rely on the assumption of constant TFP at its 2005 value. The use of an alternative hypothesis will undoubtedly affect the projections.

We observe that projected savings rates decline steadily, in line with the decline in economic growth. Indeed, the negative influence of slowed GDP growth on projected savings rates overcompensates the positive influence of increases in the GDP per capita relative to that of the US.

Table 6: Projections of savings rate (% of GDP)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1980	34.9	19.8	15.5	22.7	20.7	22.9	11.4	31.7	21.1
1990	37.9	16.3	22.6	22.4	23.8	33.8	20.1	33.8	21.4
2000	35.2	16.6	21.9	22.3	22.1	31.4	17.0	27.7	20.0
2005	*37.6*	*16.7*	*22.6*	*19.1*	*20.2*	*30.2*	*17.3*	*28.4*	*19.9*
2010	*33.2*	*15.9*	*20.2*	*17.8*	*20.2*	*27.8*	*15.6*	*27.8*	*19.2*
2015	*31.5*	*15.5*	*19.3*	*17.2*	*20.2*	*27.0*	*15.1*	*27.5*	*19.0*
2020	*30.7*	*15.3*	*18.9*	*16.9*	*20.1*	*26.7*	*14.9*	*27.7*	*18.8*
2025	*30.3*	*15.2*	*18.7*	*16.7*	*19.7*	*26.5*	*14.8*	*28.2*	*18.8*
2030	*30.1*	*15.2*	*18.6*	*16.5*	*19.1*	*26.3*	*14.7*	*28.3*	*18.7*
2035	*29.9*	*15.2*	*18.4*	*16.2*	*18.7*	*26.2*	*14.5*	*27.8*	*18.5*
2040	*29.8*	*15.2*	*18.3*	*15.9*	*18.6*	*26.0*	*14.3*	*27.1*	*18.4*
2045	*29.7*	*15.1*	*18.2*	*15.5*	*18.3*	*25.9*	*14.2*	*26.5*	*18.2*

We rely on these projections of savings rates to simulate GDP and GDP per capita between 2005 and 2050. Results in terms of GDP and GDP per capita appear in Tables 7 and 8, respectively.

The long-term growth forecasts with and without the evolution of the savings rate are quite similar. The differences (as emphasized by the comparison of the last two lines of Table 7) correspond to a small upward adjustment in projected GDP and GDP per capita for some countries such as Germany (from $ 1750 to 1800 billion) Japan, Brazil and Thailand. For others, we observe a small downward adjustment.

Table 7: Projection of GDP in billion $ (constant US $ at 2000 prices)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1980	170	5 160	155	860	1 120	37	84	2 790	395
1990	413	7 110	273	1 090	1 410	79	140	4 110	461
2000	1 200	9 820	465	1 310	1 870	123	199	4 750	601
2005	1 870	11 200	627	1 410	1 930	159	246	5 170	665
2010	*2 220*	*12 000*	*720*	*1 450*	*2 000*	*178*	*270*	*5 240*	*724*
2020	*2 560*	*13 000*	*873*	*1 460*	*2 030*	*205*	*308*	*5 190*	*822*
2030	*2 670*	*13 800*	*1 000*	*1 450*	*1 930*	*220*	*337*	*5 080*	*891*
2040	*2 670*	*14 800*	*1 100*	*1 430*	*1 860*	*227*	*352*	*4 730*	*931*
2050	*2 620*	*15 700*	*1 170*	*1 400*	*1 800*	*227*	*357*	*4 390*	*940*
2050 with constant investment rate (Table 4)	***2 700***	***17 300***	***1 280***	***1 500***	***1 750***	***221***	***377***	***4 140***	***910***

These minor adjustments in terms of GDP translate into minor adjustments in terms of GDP per capita. As an example, the projected GDP per capita for China in 2050 is 3% lower than the one predicted with constant investment rate ($ 1 881 compared to $ 1 932).

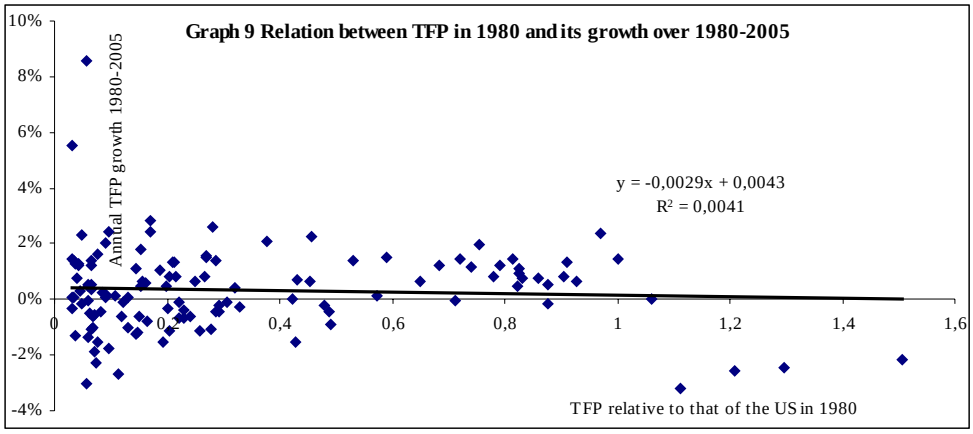
Table 8: Projection of GDP per capita in $ (constant US $ at 2000 prices)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1980	170	22 304	225	15 954	14 297	804	1 829	23 892	3 251
1990	357	27 815	322	19 139	17 689	1 458	2 434	33 252	3 098
2000	940	34 445	457	22 090	22 730	2 013	2 918	37 361	3 499
2005	1 417	37 324	572	23 300	23 430	2 485	3 355	40 424	3 635
2010	*1 628*	*37 971*	*613*	*23 500*	*24 261*	*2 663*	*3 459*	*40 958*	*3 754*
2015	*1 737*	*38 031*	*643*	*23 332*	*24 703*	*2 776*	*3 531*	*40 994*	*3 843*
2020	*1 789*	*37 778*	*665*	*23 033*	*24 713*	*2 845*	*3 591*	*41 285*	*3 917*
2030	*1 842*	*37 373*	*707*	*22 429*	*23 648*	*2 922*	*3 661*	*41 961*	*4 014*
2040	*1 857*	*37 852*	*743*	*22 018*	*23 159*	*2 937*	*3 661*	*40 843*	*4 044*
2050	*1 881*	*38 376*	*764*	*21 779*	*22 806*	*2 945*	*3 655*	*40 005*	*4 032*
2050 with constant investment rate	***1 932***	***42 232***	***833***	***23 306***	***22 144***	***2 866***	***3 853***	***37 761***	***3 905***

This is quite unsurprising given historical evidence showing that the long-term technological progress is the main driver of any growth of per capita output.

As for TFP growth, it is very likely not only that TFP growth is non zero but also that it varies across countries. Graph 9 plots the annual TFP growth between 1980 and 2005 on the vertical axis and TFP relative to that of the US in 1980 on the horizontal axis. The flat relationship highlights two basic features of this historical data. First, there is no systematic convergence in terms of TFP. Second, there is no evidence in the past of common and null TFP growth. TFP growth varies extensively between countries. The two extreme observations on the upper left part of Graph 9 are Equatorial Guinea with 8.5% annual

growth increase in TFP and China with 5.5% annual growth increase in TFP between 1980 and 2005.



It is therefore of primary importance to appropriately model country-specific growth rates of TFP in our effort to project GDP growth over the next 45 years.

3.2. TFP growth

3.2.a) A simple scenario: Common 1.2% TFP growth

Here, we build from the last variant with evolution of investment rate. Before engaging into a full modeling exercise, a useful preliminary benchmark for GDP growth is obtained by applying a constant and common TFP growth rate to the entire sample of countries.

We opt for the popular assumption of long-term TFP growth rate of 1.2%. It lies between the figure of 0.87%, the unweighted average of the annual TFP growth in our sample over the period 1990-2005, and 1.3%, the weighted average (with weights being the TFP value). Our hypothesis excludes de facto the possibility of TFP-driven catch up phenomenon. The common TFP growth indeed induces an homothetic evolution and precludes any change in ranking. Convergence may still occur, however, due to different evolutions in terms of capital accumulation or demography put forward in the benchmark scenario.

Our projection highlights the importance of TFP growth in increasing long-term GDP. The introduction of a 1.2% TFP growth rate induces a doubling of projected GDP in 2050 compared to the benchmark scenario for all the countries under study. A doubling of GDP per capita also follows from the introduction of the constant ad hoc value for TFP growth.

The assumption of common 1.2% TFP growth induces a revaluation of GDP and GDP per capita growth by a factor that is almost equal to the common TFP growth (+1.2%), as shown in the Table 9.

Table 9: Projection of annual GDP per capita growth rate (in %)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1970-1980	4.3	2.2	0.8	2.7	2.8	4.3	1.6	3.3	5.9
1980-1990	7.7	2.2	3.6	1.8	2.2	6.1	2.9	3.4	-0.5
1990-2000	10.2	2.2	3.6	1.4	2.5	3.3	1.8	1.2	1.2
2000-2005	8.6	1.6	4.6	1.1	0.6	4.3	2.8	1.6	0.8
2005-2010	*3.6*	*1.9*	*2.7*	*1.5*	*1.7*	*2.2*	*1.8*	*1.2*	1.6
2010-2020	*2.6*	*1.7*	*2.6*	*1.4*	*1.4*	*2.0*	*2.0*	*1.3*	1.7
2020-2030	*2.0*	*1.7*	*2.5*	*1.4*	*1.0*	*1.8*	*1.9*	*1.5*	1.7
2030-2040	*1.8*	*1.9*	*2.3*	*1.6*	*1.4*	*1.7*	*1.8*	*1.2*	1.7
2040-2050	*1.9*	*1.9*	*2.1*	*1.7*	*1.6*	*1.7*	*1.8*	*1.4*	1.7
2050 with constant investment rate	***0.2***	***0.2***	***0.4***	***0.1***	***-0.1***	***0.1***	***0.1***	***-0.2***	***0.0***
Annual GDP per capita growth 1980-2005	***8.9***	***2.1***	***3.8***	***1.5***	***2.0***	***4.6***	***2.5***	***2.1***	***0.4***

We can conclude from this very simple exercise that an annual increase in TFP by 1.2% appears to be a very conservative value. This is because such a growth rate would produce GDP per capita growth rates over the 2005-2050 period that are in line with the past performance of (lower band) developed countries, but that correspond to a sharp slow-down for emerging countries. Projected average GDP per capita growth rates between 2005 and 2050 for China, India and Thailand would be more than twice lower than their past performance between 1980 and 2005.

Using a common value for TFP growth seems inappropriate in our context since we specifically aim at gauging how large the emerging countries (especially Brazil, India and China) could become over the next 50 years. It is therefore of primary importance to rely on a more elaborated method of projecting TFP growth – one that is not only theoretically based but also empirically relevant. This is easier said than done, and most growth forecasts (Wilson and Purushothaman (2003), Kousnetzoff N, (2004) and Hawksworth (2006) among others) rely on more or less arbitrary assumptions of technological progress. They apply past averages or assume absolute convergence with other countries. The often assumed absolute convergence of income levels between countries (i.e. poor countries' GDP grows faster than that of more advanced countries) also lacks empirical support. Pritchett (1997) and Easterly and Levine (2001) even observe a divergence in income levels. There is no automatism: higher income levels do not fall from heaven like manna - they require hard work.

Our objective is to rely on a model of productivity growth that is theoretically grounded and validated by past data. The next section develops the TFP model that we will rely on to construct our GDP forecasts.

3.2.b) A Nelson-Phelps catch-up model of technology diffusion

We adopt an elaborated projection method for TFP growth based on Benhabib and Spiegel (2005)'s generalization of the Nelson-Phelps' catch-up model of technology diffusion facilitated by human capital. These authors show that historic experience supports a logistic diffusion specification that implies that a country with too small human capital stock may exhibit slower total factor productivity growth than the leader economy.

The model encompasses the notion that human capital plays a positive role in the determination of total factor productivity growth through its influence on the rate of catch-up and its role as a facilitator of own innovation. Country *i* TFP growth $\frac{\dot{A}_{i,t}}{A_{i,t}}$ is specified as a function of country *i*'s stock of human capital and the rate of technology diffusion from the leader country (US) to country *i*:

$$\frac{\dot{A}_{i,t}}{A_{i,t}} = c_i + \alpha H_{i,t} + \beta H_{i,t}\left(1 - \frac{A_{i,t}}{A_{US,t}}\right) = c_i + \delta H_{i,t} - \gamma H_{i,t}\left(\frac{A_{i,t}}{A_{US,t}}\right) \qquad (5)$$

Where $\frac{A_{i,t}}{A_{US,t}}$ corresponds to the distance to the technology frontier, H_{it} is the stock of human capital, $\delta = \alpha + \beta > 0$ and $\gamma = -\beta > 0$.

Our model allows for the level of education H to have two impacts. Not only does it have a direct impact on innovation-related TFP growth; it also affects the rate at which the technology gap $\frac{A_{i,t}}{A_{US,t}}$ is closed, which is imitation-related growth (Aghion et al., 2005).

We estimate Equation (5) on a panel data set over two twenty-year periods, 1965-1985 and 1985-2005, for 105 countries[5]. Human capital, which is proxied by average years of schooling in the population above 15 years of age, was obtained from the updated version of the Barro and Lee (1993) data set[6]. We estimate our regression both with OLS estimators and with fixed effects by region and period. The regression results are displayed in Table 10. In the first column, we report results based on OLS estimates.

[5] A quite important number of countries are dropped from our empirical exercise due to the lack of data on the education level. They include United Arab Emirates, Burundi, Brunei, Czech Rep Slovak Rep., Estonia, Croatia, Kazakstan, Lybia, Latvia, Lithuania, Slovenia, Moldavia, Namibia, Russia, Tadjikistan, Vietnam, Yemen, Angola, Albania, Armenia, Azerbaijan, Burkina Faso, Bahamas, Bosnia and Herzegovina, Belarus, Belize, Ivory Coast, Comoros, Cape Verde, Eritrea, Ethiopia, Gabon, Georgia, Guinea, Equatorial Guinea, Kyrgyz Republic, Cambodia, Lao PDR, Lebanon, Luxembourg, Macao, Morocco, Madagascar, Macedonia, FYR, Malta, Mongolia, Mauritania, Nigeria, Oman, Puerto Rico, Saudi Arabia, Chad, Turkmenistan, Ukraine, Uzbekistan.

[6] Data are downloaded from http://devdata.worldbank.org/edstats/query/default.htm

Table 10: Regression results of TFP growth rates. Panel estimates for two 20 year sub-periods between 1965 and 2005

Explained Variable: Average growth rate of TFP over 20 years	OLS estimates	Within (Fixed effects) by region per sub-period
H : Number of schooling years$_{i,\ t-1}$	3.74*** (0.64)	2.24*** (0.58)
H*TFP relative to the US $_{i,t-1}$	-2.10*** (0.65)	-2.04* (0.99)
Constant	-12.37*** (2.27)	-5.64*** (1.26)
Number of observations	193	193
Number of groups (region & period)		18
R^2	0.19	0.45

Coefficients and standard errors are multiplied by 1000. Heteroskedastic consistent standard errors in parentheses, with ***, ** and * denoting significance at 1%, 5% and 10% confidence level.

The point estimates and significance of the various coefficients are almost unchanged after we introduce fixed effects to capture period- and region-specific TFP growth (column 2).[7] These fixed effects can be interpreted as region-specific exogenous technological progress that is independent of human capital and technology diffusion. The regional fixed effects are extracted for each sub-period and are jointly significant. Region-specific TFP growth during the period 1985-2005 amounts to -0.001% for Africa and ranges from -0.4% for South America to 1.8% for the Chinese World. The corresponding figures are 0.2, 0.4, 1.01, 1.1, 1.3 and 1.4% respectively for the Mediterranean World, Eastern Europe, Western Europe, North America, Japan, and the Indian World.

The theoretical model of TFP growth estimated above suggests that below a certain threshold of human capital relative to the leader nation, a country could find its TFP growth sufficiently slow that it would not exhibit convergence in TFP but would instead fall further and further behind the leader nation over time. We can compute the "catch-up condition", that is, the average number of years of schooling needed to experience faster total factor productivity growth than the United States. It is given by the expression (Benhabib and Spiegel, 2005):

$$H^{*}_{i,t} = \frac{(\delta\text{-}\gamma)\mathrm{H}_{US,t}}{\delta} = \frac{(2.24\text{-}2.04)\mathrm{H}_{US,t}}{2.24} \qquad (6)$$

For this simple computation, we assume that the average number of years of schooling in the US population in 2005 is equal to that of 2000 as computed by Barro and Lee. From this we obtain a threshold education level of 1.08 years. The figure lies above the value of 0.76, the threshold in 1960. These results indicate that the catch-up prerequisite in terms of

[7] The decomposition follows that used in the Computable General Equilibrium INGENUE modeling in CEPII. The composition of these groups is presented in the Appendix A.

education level becomes more and more demanding over time because of the increase in the average number of years of schooling in the United States (from 8.49 in 1960 to 12.05 in 2000).

For each country *i* and sub-period *t* of 20 years between 2005 and 2050, we project the TFP growth rate as:

$$\frac{\dot{A}_{i,t/t-1}}{A_{i,t-1}} = 0.003*\mathrm{H}_{i,t-1} - 0.002* H_{i,t-1}\left(\frac{A_{i,t-1}}{A_{US,t-1}}\right) + \text{fixed effect}_{\text{region-1985-2000}} \qquad (7)$$

The human capital stock H used in the projections is so far held constant at its 2000 level. In a next step we will rely on a simple extrapolation procedure described in Section 4-2.

Since this model of TFP growth applies imperfectly to the case of the leader economy (the US), we opt for fixing the annual TFP growth for the US exogenously. While the projected value from the model of annual TFP growth for the US is around 1%, we increase it to 1.5%, which is the computed average annual TFP growth between 1990 and 2005. The results from the Table 10 (column 2) can be used to construct forecasts of TFP growth for individual countries between 2005 and 2020 (De Gregorio and Lee, 1999).

Table 11 displays the obtained TFP growth rate for a selection of countries. We can observe that simulated TFP growth rates lie above the value of 1.2% used in the previous section. Moreover there is an important heterogeneity between developed countries (for which TFP growth is close to 1.2%) and emerging countries, which enjoy much more rapid TFP increase. China and Thailand stand out in the sample as having among the highest projected TFP growth rates, with almost 2.5% annually over the period 2005-2050. Projected TFP growth for Brazil on the opposite is not different from zero, in line with past values. This low value derives from a negative estimated regional fixed effects and a low human capital stock that precludes rapid catch-up.

Table 11: Projection of annual TFP growth rate (in %)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1975-1985	3.20	0.36	0.23	0.83	0.72	1.41	0.61	1.23	-0.54
1985-1995	5.57	1.48	2.04	0.56	1.86	4.53	0.07	1.39	0.03
1995-2005	5.60	1.78	2.88	1.50	0.76	0.27	2.28	1.21	0.12
2005-2025	*2.58*	*1.50*	*1.95*	*1.12*	*1.41*	*2.58*	*0.61*	*1.41*	*-0.05*
2025-2045	*2.54*	*1.50*	*1.94*	*1.19*	*1.41*	*2.54*	*0.63*	*1.40*	*-0.01*
2045-2050	*2.51*	*1.50*	*1.93*	*1.26*	*1.44*	*2.50*	*0.66*	*1.43*	*0.03*

The modeling of TFP growth translates into drastic modifications of the computed projections of GDP and GDP per capita (Tables 12 and 13). China and Thailand benefit from a five-fold increase in their projected 2050 GDP. Compared to the benchmark scenario, projections for Japanese and Indian GDPs are 4.4 times higher. Relatively lower adjustments apply to Germany, France and Turkey (respectively 2.2, 1.9 and 1.4 times higher).

Table 12: Projection of GDP in billion $ (constant US $ at 2000 prices)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1980	170	5 160	155	860	1 120	37	84	2 790	395
1990	413	7 110	273	1 090	1 410	79	140	4 110	461
2000	1 200	9 820	465	1 310	1 870	123	199	4 750	601
2005	1 870	11 200	627	1 410	1 930	159	246	5 170	665
2010	*2 480*	*13 100*	*798*	*1 540*	*2 130*	*199*	*277*	*5 540*	*711*
2020	*3 960*	*17 600*	*1 260*	*1 800*	*2 500*	*307*	*346*	*6 330*	*792*
2030	*5 880*	*23 300*	*1 910*	*2 090*	*2 810*	*461*	*415*	*7 290*	*852*
2040	*8 390*	*31 000*	*2 800*	*2 450*	*3 270*	*671*	*479*	*8 090*	*887*
2050	*11 800*	*40 900*	*3 940*	*2 890*	*3 880*	*958*	*538*	*9 120*	*898*
Benchmark (Table 4)	***2 700***	***17 300***	***1 280***	***1 500***	***1 750***	***221***	***377***	***4 140***	***910***

If things go according to this scenario, China's GDP is expected to reach $ 12 trillion in 2050 while its GDP per capita would grow to $ 8 456, a six-fold increase compared to 2005. This six-fold increase over 45 years corresponds to a slow down from the 8-fold increase that occurred over the 25 year period between 1980 and 2005. India is expected to benefit from a slower income growth: its GDP per capita could rise 4.5-fold between 2005 and 2050 from $ 572 to $ 2 576. We therefore predict that the gap between China and India will widen over the first half of the 21th century.

As predicted by the Nelson-Phelps' catch-up model of technology diffusion, one-fifth of countries for which TFP in 2005 lagged behind the US engage in a convergence process in terms of TFP. This proportion is in line with the observation over the period 1980-2005: 16 out of the 100 countries in our sample grew faster than the US in terms of TFP. As a consequence, most of the countries covered in our study are expected to suffer from a decline in their level of TFP relative to the US. This evolution is due to their insufficient education levels in 2000 as well as to a low exogenous region-specific TFP growth.

Among the 17 countries for which TFP is expected to catch-up with that of the US, eight did not appear in the list of 16 countries that caught up between 1980 and 2005. Those countries are: the Philippines, Malaysia, Fiji, Indonesia, New Zealand, Romania, Greece and Pakistan.

On the opposite end of the spectrum, thirteen countries in our sample turn out to be caught in a negative TFP growth trap: Rwanda, the Central African Republic, Brazil, Senegal, Sierra Leone, Benin, Gambia, Guatemala, Mozambique, Niger, Haiti, Mali and Guinea-Bissau.

The complete ranking of countries is reported in Table B3 in Appendix B. This table provides the annual TFP growth rate over the period 2005-2050 and contrasts it with that over the period 2000-2005. Annual TFP growth rates above 2% are predicted for 9 countries, all of which are located in Asia: the Philippines, South Korea, China, Thailand, Malaysia, Sri Lanka, Hong Kong, Fiji and Singapore. On the other hand, most countries for which annual TFP growth is lower than 1% are situated in Africa or South America.

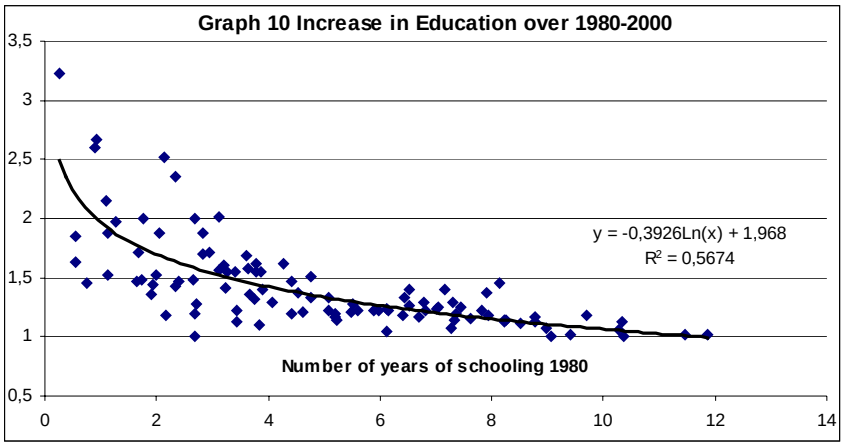
Table 13: Projection of GDP per capita in $ (constant US $ at 2000 prices)

	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
1980	170	22 304	225	15 954	14 297	804	1 829	23 892	3 251
1990	357	27 815	322	19 139	17 689	1 458	2 434	33 252	3 098
2000	940	34 445	457	22 090	22 730	2 013	2 918	37 361	3 499
2005	1 417	37 324	572	23 300	23 430	2 485	3 355	40 424	3 635
2010	1 819	41 690	680	24 949	25 792	2 971	3 555	43 290	3 688
2015	2 270	46 253	810	26 586	28 156	3 563	3 786	46 356	3 735
2020	2 771	51 088	961	28 310	30 391	4 265	4 031	50 361	3 777
2030	4 053	62 798	1 352	32 426	34 437	6 109	4 519	60 247	3 836
2040	5 832	79 189	1 884	37 856	40 736	8 694	4 981	69 934	3 853
2050	8 456	100 072	2 576	44 985	49 036	12 433	5 500	83 074	3 851
Benchmark	***1 932***	***42 232***	***833***	***23 306***	***22 144***	***2 866***	***3 853***	***37 761***	***3 905***

4. FINAL PROJECTIONS AND DISCUSSION

4.1. A comprehensive model of growth

Obviously, our projections suffer from two biases. First, the exercise does not account for **exchange rate evolution**, i.e. appreciation in the case of fast growing economies and depreciation in the case of countries for which TFP growth lags behind the worldwide average. Second, projections assume that **human capital** does not evolve over time. This assumption is inappropriate since historical statistics clearly show that the number of years of schooling increases over time as shown in Graph 10.



4.1.a) Human capital projections

The horizontal axis of Graph 10 presents the education variable in terms of the average number of years of schooling for below 15-year olds (from the Barro and Lee dataset). The vertical axis reports the ratio of the education variable in 2000 to that of 1980. A ratio of 2 means that the average number of years of education doubled over the past twenty years. The graph displays a negative relationship between the initial value and the subsequent growth rate, indicating a catch-up phenomenon. We can thus deduce that the hypothesis of constant education over time is not confirmed by past history. We should therefore introduce the possibility that countries with low human capital converge towards those having higher endowments. This modification may push some of the countries that we identified earlier as being stuck in a negative TFP growth trap out of it. Remember that the initial level of education is a crucial driver for innovation and catch-up toward the leader in our TFP growth projection model.

We next assume that the number of years of schooling evolves in each country between 2000 and 2050 following the same dynamics as it did over the twenty-year period between 1980 and 2000. We rely on the relationship that appears in the previous graph, that is, $\frac{H_{t+20}}{H_t} = -0.3926 \ln H_t + 1.968$, with t between 2000 and 2050. We report the predicted level of the number of years of schooling for our sample in Table B6 in Appendix B. Our projection appears particularly ambitious for several African countries.

We rely on these projections of human capital to update our long-term growth forecasts. The average GDP and GDP per capita growth rates for all countries are adjusted upward. The adjustment is logically greater the lower the initial human capital level and thus the higher the subsequent improvement.

The incorporation of improvements in education into our projections allows China, Thailand, Turkey, Brazil and India to reach a GDP per capita that is around 17% higher than that was previously forecasted holding education constant. China's GDP per capita is set to reach $10 040 (in real terms) by 2050. For Japan and Germany the upward adjustment amounts to 3% against 6% for France.

Projections in terms of GDP and GDP per capita are reported for the entire sample of countries in Tables B7 and B8 in Appendix B. Average annual GDP growth ranges from 6.1% in the case of Philippines to -1.9% in the case of Mozambique.

Again, we can compute the average annual GDP growth rate for our sample. We obtain a rate of 2.6%, which lies below the 3% value - the average annual GDP growth rate experienced by the same sample of countries between 1980 and 2005.

The average annual GDP growth rate of 2.6% uncovers large heterogeneity among countries as well as among regions, as shown in Table 14. Our projections suggest that countries belonging to the Chinese or Indian world[8] benefit from the highest growth rates, respectively 4.5 and 4.1% per annum. These predicted rates, however, are lower than their past performance, respectively 5.4 and 4.9% annually between 1980 and 2005. A similar deceleration in GDP growth rate is expected in all regions except North America, where GDP is expected to grow at a rate of 3.2% in line with past performance of 3%. South America, Japan and Africa are predicted to have an annual GDP growth rate around 1.5%. While this rate derives mainly from demographics and investment forces in Africa and South America, in Japan it is entirely driven by TFP growth.

Our results may appear quite optimistic; however, it is necessary to note that on average the annual GDP growth rate predicted over the period 2005-2050 lies significantly below average growth over 1980-2005. For most regions, predicted annual GDP growth rates in the future corresponds to a downward adjustment from past performance.

Table 14: Region specific results

Region	Annual GDP growth rate	Annual TFP growth rate	Annual GDP growth rate	Annual TFP growth rate
In %	2005-2050		1980-2005	
Africa	1.3	0.5	3.1	0.1
North America	3.2	1.6	3.0	1.0
South America	1.4	0.5	2.3	-0.5
China World	4.5	2.6	5.4	2.2
East Europe	1.5	1.5	1.9	1.1
West Europe	1.9	1.4	2.6	0.9
Indian World	4.1	2.1	4.9	1.5
Japan	1.5	1.5	2.5	1.2
Mediterranean World	2.1	0.9	3.1	-0.5
Entire sample (100 countries)	2.6	1.3	3.0	0.6

One major divergence between the two sub-periods (1980-2005 and 2005-2050) is that future growth will result much more from TFP growth than previously. On average over the period 2005-2050, half of GDP growth is expected to be fuelled by TFP growth (against one fifth over the past 25 years) . This result is in line with the already high capital stocks in 2005 and the fact that for most countries the working-age population is projected to decline after 2005.

[8] Refer to appendix for the list of countries in each region.

4.1.b) Real exchange-rate adjustment

The last modification we make to our projections is the introduction of an exchange rate model to account for exchange rate appreciation or depreciation, which should occur respectively for fast growing economies and for countries with TFP growth below the world average. This adjustment will make our estimates comparable with those made by Wilson and Purushothaman (2003). It transforms our projection from at constant US $ at 2000 prices into current US $ and current relative prices.

Countries could indeed grow richer from appreciating currencies (Miyajima, 2005). This relationship between economic growth and real appreciation is assumed to stem from a tendency for productivity growth in the traded goods sectors to outpace that of goods and services that are not traded internationally (Caramazza and Aziz, 1997).

The Balassa-Samuelson model (Balassa (1964) and Samuelson (1964)) states that real exchange rates will be appreciated in rich countries and will appreciate over time in fast-growing countries. The underlying force that drives the Balassa-Samuelson model is cross-country differentials in tradable-sector productivity. A large body of literature has tested the predictions of the Balassa-Samuelson model. Overall, there is substantial empirical support for the Balassa-Samuelson model, especially in its cross-sectional version.

Currencies tend to appreciate as higher productivity leads economies to converge on Purchasing Power Parity (PPP) exchanges rates. There is a clear tendency toward countries with higher income per capita having exchange rates closer to PPP against the leading country. Asaf (2001) verifies that the process of per-capita income convergence was to a large extent accompanied by convergence of real exchange rates toward absolute PPP. The emerging and developing economies all have exchange rates that are far below PPP rates. These large differences between PPP and actual exchange rates arise from the lower productivity levels in developing economies. As they develop and productivity rises, there will be a tendency for their currencies to increase towards PPP against the leading country.

We rely on a very simple exchange rate model that is based on the hypothesis that over the long term, only productivity differentials play a role in determining real exchange rates (one-to-one relationship). We use the projections of productivity growth from this exercise to map out the path of the real exchange rate. We hypothesize that if an economy experiences higher productivity growth than the US, its equilibrium exchange rate will tend to appreciate.

Specifically, we assume that a positive 1% productivity growth differential relative to the US will raise an economy's equilibrium real exchange rate against the US dollar by 1% (our long-run assumption for US productivity growth is again 1.5%).

$$\dot{E} = \dot{A} - \dot{A}_{US} \tag{8}$$

with E the real exchange rate against the US dollar and dot over the variable is used to denote a time derivative.

This equation can be derived from the traditional expression of Balassa effect:

$$\dot{E} = (1-\gamma)\left[(\dot{p}^N - \dot{p}^T) - (\dot{p}^N_{US} - \dot{p}^T_{US}) \right] \quad (9)$$

where p is the price and where N denotes the non-tradable sector, T denotes the tradable sector, and γ is its share in the economy.

As evidenced in Coudert (2004), the evolution of the relative prices of non-tradable goods can be expressed as: $(\dot{p}^N - \dot{p}^T) = \frac{\alpha^N}{\alpha^T}\dot{\theta}^T - \dot{\theta}^N$ (Obstfeld and Rogoff, 1996), with α^N, α^T the share of labor in the value added of the non-tradable and tradable sectors, respectively and θ the growth rate of TFP. Here we assume that $\alpha^N=\alpha^T$. In absence of productivity growth in the non-tradable sector, Equation (9) becomes:

$$\dot{E} = (1-\gamma)\left[\dot{\theta}^T - \dot{\theta}^T_{US} \right] \quad (10)$$

Since TFP growth $\dot{\theta}$ in an economy is equal to $\gamma\dot{\theta}^T$, Equation (10) can be rewritten as:

$$\dot{E} = \frac{1-\gamma}{\gamma}\left[\dot{\theta} - \dot{\theta}_{US} \right] \quad (11)$$

The one-to-one relationship between $\dot{E}$ and $\dot{\theta} - \dot{\theta}_{US}$ derives from the use of the world average ratio of imports over GDP (around 50%) as a proxy for the share of tradable in the economy γ.

Because currency projections are long-term projections, we ignore the impact of the economic cycle. Effectively, the currencies' path can be interpreted as an equilibrium path. In cases where economies peg their exchange rates (as in China), it is even more important to view the exchange rate projections as an equilibrium real rate. In practice, real exchange rate appreciation might come about through a combination of nominal appreciation and higher inflation, with different mixtures depending on the exchange rate regime.

4.2. Comparison with other studies

Our final GDP projections (into current US $ and current relative prices) for 2050 are reported in Table 15 for a selection of countries. In an effort to compare our projections, we also report the various results for 2020 in Table 16. Our projections can be compared with those made by Wilson and Purushothaman (2003), Goldman Sachs hereafter, and Deutsche Bank Research (2005).

4.2.a) Constant US $ at 2000 prices

The combination of models with estimated investment rates and TFP growth rates provides projections that are very similar to those with TFP growth rate modeling only. This result is

unsurprisingly given the modest impact of the modeling of investment rate and the previous observation that TFP growth in the long run is the main driver of GDP growth.

Table 15: Projections of GDP in 2050

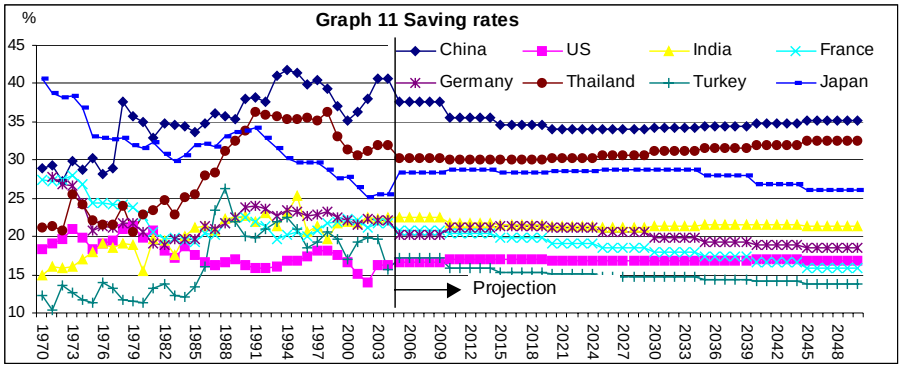
Projection 2050 in billion $ (constant US $ at 2000 prices)	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
GDP (benchmark)	2 700	17 300	1 280	1 500	1 750	221	377	4 140	910
GDP (evolution of investment)	2 620	15 700	1 170	1 400	1 800	227	357	4 390	940
GDP (constant TFP growth 1.2%)	5 380	34 400	2 560	2 950	3 440	439	750	8 110	1 810
GDP (evolution of TFP)	11 800	40 900	3 940	2 890	3 880	958	538	9 120	898
GDP (evolution of TFP & Investment)	12 100	38 600	3 800	2 740	4 020	1 060	501	9 650	887
GDP (evolution of TFP & Investment & education)	14 000	38 600	4 530	2 890	4 120	1 230	584	9 920	1 040
Associated average annual GDP growth	4.6	2.8	4.5	1.6	1.7	4.7	1.9	1.5	1.0
Projection 2050 in billion $ (current US $ and current relative prices)									
GDP (evolution of TFP & Investment & education)	30 900	38 100	6 760	2 550	3 840	2 400	464	9 740	550
Associated average annual GDP growth	5.9	2.8	5.3	1.3	1.6	6.0	1.3	1.4	-0.2
GDP (Goldman Sachs)	53 020	35 165	27 803	3 148	3 603			6 673	26 592
Associated average annual GDP growth	7.2	2.6	8.5	1.8	1.3			0.9	5.4

Table 16: Projections of GDP in 2020

Projection 2020 in billion $ (constant US $ at 2000 prices)	China	US	India	France	Germany	Thailand	Turkey	Japan	Brazil
GDP (benchmark)	2 530	13 600	900	1 490	1 980	198	312	5 000	799
GDP (evolution of investment)	2 560	13 000	873	1 460	2 030	205	308	5 190	822
GDP (constant TFP growth 1.2%)	3 120	16 700	1 110	1 830	2 410	243	382	6 110	978
GDP (evolution of TFP)	3 960	17 600	1 260	1 800	2 500	307	346	6 330	792
GDP (evolution of TFP & Investment)	4 080	17 000	1 240	1 820	2 600	324	342	6 610	810
GDP (evolution of TFP & Investment & education)	4 140	17 000	1 260	1 830	2 610	329	346	6 620	821
Associated average annual GDP growth	*5.4*	*2.8*	*4.8*	*1.8*	*2.0*	*5.0*	*2.3*	*1.7*	*1.4*
Projected GDP Deutsche Bank	4 000	17 710	1 400	1 983	2 413	308	449	6 275	997
Associated average annual GDP growth	*5.2*	*3.1*	*5.5*	*2.3*	*1.7*	*4.5*	*4.1*	*1.2*	*2.8*
Projected GDP (World Bank[9])	4 049	16 645	1 417	2 696	3 478	441	471	7 933	1 488
Associated average annual GDP growth	*7.0*	*3.1*	*5.7*	*2.2*	*1.6*	*4.8*	*4.2*	*1.7*	*2.4*
Projection 2020 in billion $ (current US $ and current relative prices)									
GDP (evolution of TFP & investment & education	6 020	16 800	1 460	1 710	2 450	427	320	6 570	608
Associated average annual GDP growth	6.6	2.8	5.3	1.4	1.9	6.1	1.5	1.6	-0.1
GDP (Goldman Sachs)	10 000	16 415	2 104	1 930	2 524			5 221	6 302
Associated average annual GDP growth	*11.2*	*2.6*	*7.8*	*2.0*	*1.5*			*1.1*	*6.3*

As reported in Graph 11, our projections indicate that savings rates are set to decline slightly for most countries in our sample from 2005 onwards. For some countries, such as India, a slight adjustment upward is expected. The savings rate of the US is predicted to remain constant – from 16.3% in 2003 to 16.9% in 2050. Over the same period, the savings rate of China is set to decline from 40% in 2003 (35.2% in 2000) to 34.2%. The projected rate in 2005 is a little higher than the one obtained based on the modeling of investment only (constant TFP rate of 1.2%) and reported in Table 15. The upward adjustment logically comes from the association of an upward adjustment on GDP after the introduction of the TFP model and a positive relationship between GDP per capita and investment rate (see econometric results in Table 10).

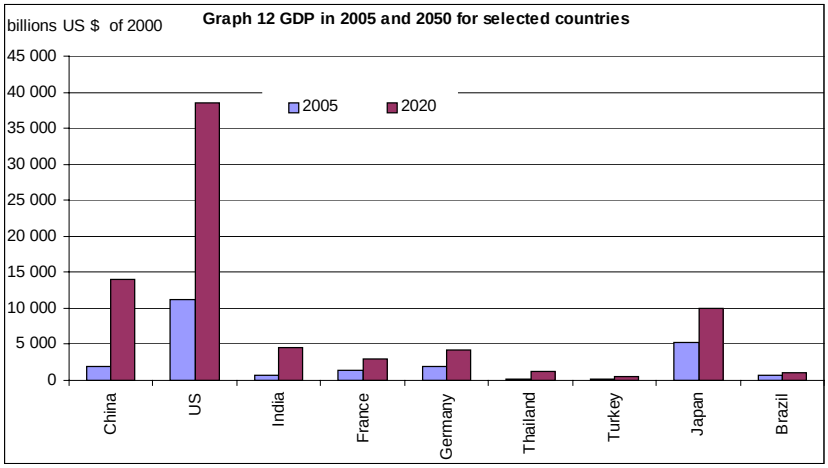
[9] World Bank projections go until 2015. We extended the series until 2020 assuming growth rates between 2015 and 2020 to be equal to those between 2010 and 2015.



The average annual GDP growth and GDP per capita growth for most countries remain virtually unaffected by the introduction of the modeling of savings rate alongside that of TFP growth. China is set to reach a GDP per capita of $ 8 646 by 2050 while that of India should be $ 2 481 (in real terms). The adjustment caused by the modeling of the savings rate is minor, around 2-3% of the projected GDP in 2050.

GDP and GDP per capita projections following this scenario of complete modeling (of both TFP and savings) are reported for the entire sample of countries in the Tables B4 and B5 in Appendix B. Average annual GDP growth ranges from 5.9% in the case of Philippines to -1.5% in the case of Lesotho.

We expect the list of the world's ten largest economies to look quite different in 2050 than in 2005. Based on our GDP projections in real $ terms, we expect the US to keep its leading position but Japan to move down from second rank to the benefit of China (Graph 12).



South Korea is predicted to improve its position from 10th in 2005 to sixth in 2050. A similar progression is expected for India, which is projected to jump from 13th to seventh in our sample. While the United Kingdom improves from fifth to fourth, Germany slips from

third to fifth position, France from sixth to eighth, Canada from eighth to ninth and Italy from seventh to tenth.

The Deutsche Bank relies on an analytical framework similar to ours; however, differences are numerous. Most notably Deutsche Bank relies on extrapolation and trend analysis to determine the likely evolution of the investment ratio and human capital of countries, while we use relationships empirically estimated over the past. Deutsche Bank projections only go until 2020 and apply to less than 40 countries while our projections so far cover 100 countries and go until 2050. However, we obtain quite similar projections, as evidenced in Tables 15 and 16. In fact, our estimates (evolution of TFP) appear quite conservative for developed countries, with the exception of the US, when compared to the World Bank (2006) projections. Those projections indeed are much more optimistic for France, Germany and Japan in 2020. Our projections for emerging countries are very similar to those of the Deutsche Bank, as emphasized by almost equal GDP estimations for China, Indian and Thailand.

Our GDP projections for Brazil turn out to be very pessimistic. We indeed project almost constant GDP over the period 2005-2020. This scenario derives from the combined absence of demography- and investment-driven growth, low education levels and low region-specific TFP growth.

We expect China's GDP to quadruple between 2000 and 2020, consistent with the official target. By 2020, China's GDP could reach $ 4 trillion while the average standard of living in China is expected to exceed the level found today in the upper middle-income developing countries (US $3,000), as defined by the World Bank.

We conclude from this comparative exercise that our modeling of TFP provides quite credible estimates as they are consistent with the remaining of the literature. We can compute a rough measure of the projected world average growth rate between 2005 and 2050 as the weighted average GDP growth rate for our sample of 100 countries. We anticipate that annual GDP growth will be 2.5% in the next 45 years. This figure is a little lower than the figure of 3% that is the growth rate measured between 1980 and 2005 for our sample of countries.

4.2.b) Current relative prices

Once exchange rate evolution are taken into consideration, our estimates can be compared to those made by Goldman Sachs. Goldman Sachs develops a model of real exchange rates that is calculated from the projections of labor productivity growth. It is based on the same assumption as ours of a one-to-one relationship between productivity and real exchange rates. Our projections for the US and Germany follow similar paths. Other countries, however, are characterized by great divergence. One alarming discrepancy is the case of Brazil. Our projections predict that Brazilian TFP will increase only modestly (0.1, 0.4 and 0.7% annual growth rates respectively over the periods 2005-2025, 2025-2045 and 2045-2050). As a consequence, the real exchange rate of this country is expected to depreciate, leading to a 0.2% annual decrease in the GDP. Goldman Sachs projections are based on a

completely different scenario of rapid TFP catch-up that leads to a 5.4% annual GDP increase.

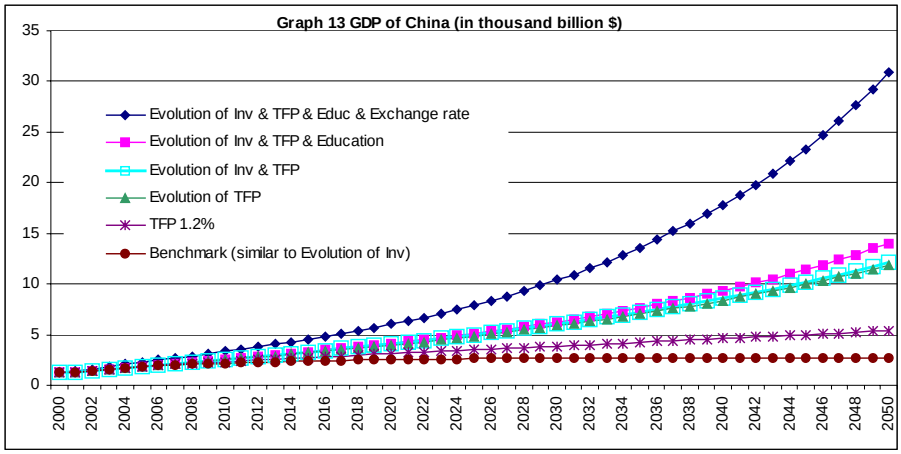
Our projections for India and China are much less optimistic than those of Goldman Sachs, while those for developed countries (France and Japan) are significantly higher. The diverging pattern certainly derives from the ad-hoc assumption made by Goldman Sachs of systematic TFP catch-up depending on the relative GDP gap to the US. This unrealistic hypothesis induces high growth projections for developing countries and low growth projections for developed countries.

Our exchange rate model indicates that the real exchange rates of China, Thailand and India could appreciate by up to 120, 100 and 50% respectively over the next 45 years, averaging 1.8, 1.5 and 0.9% per year respectively. Rising exchange rates could therefore contribute a significant amount to these countries' GDP growth between 2005 and 2050. About 25% of their increased GDP over this period may come from rising currencies, with the remaining 75% due to faster real growth. For China, the contribution of the exchange rate appreciation is even greater, around one third.

Despite this appreciation, exchange rates of these countries will remain far from their PPP level. Over the next 50 years, exchange rate movement could reduce the gap to PPP level by 49, 62 and 28% for these countries respectively.

Table B9 in Appendix B shows GDP and GDP per capita at current US $ and current relative prices in 2005 and 2050. As well, they present the average annual GDP growth rates and exchange rate evolution between 2005 and 2050 for the countries in our sample. These projections of GDP incorporate both growth and currency effects. As such, they constitute the appropriate measure of international purchasing power. The comparison between 2005 and 2050 highlights the substantial international shift in demand. The results indicate that the Philippines and Malaysia have the potential to show the fastest growth over the next 45 years. Growth could be respectively 6.1 and 5.8% per annum in these countries. The relative importance of China and India as an engine of new demand growth and spending is emphasized by the respective 4.6 and 4.5% of expected per annum GDP growth between 2005 and 2050.

Graph 13 summarizes the GDP projections of China for the various variants of our model. It highlights that the incorporation of exchange rate evolutions explains 27% of GDP annual growth and doubles the final GDP projections in 2050.



China has the potential to show the fastest growth among the big emerging countries over the 50 years. Its GDP growth in USD could be around 6.6% annually over the next 15 years and around 5.5% until as late as 2050 if development proceeds successfully.

Our projections indicate that measured by GDP in current $ (at current US $ and current relative prices), China would nevertheless not overtake the US before 2050. In 2050, China's GDP would reach $31 compared to $38 trillion for the US. India would take over France in terms of GDP in 2025 and Germany in 2034. By 2050 Indian GDP would only corresponds to 18% of that of the US.

4.3. World GDP

Projections developed so far only cover 100 countries. We unfortunately cannot build our projections for all countries because of data limitations. For a large number of countries, data on either education (number of years of schooling) or past capital or labor inputs is not available. Since our interest is in how much the world could change over the next 50 years, it is important to obtain a projection of world GDP to compute individual countries' shares in the world GDP. We therefore need to make some assumptions about the missing information for countries that we have not been available to build projections for due to limited data availability.

We follow a systematic rule. Those countries for which the number of years of education was not available (thus preventing us from computing TFP projections until 2050) are assumed to have the same number of years of education as the regional average in 2000. The "Russian World" receives a specific treatment since none of the countries belonging to this region report the data necessary to compute TFP consistently over the period 1985-2005. As such, no region-specific fixed effect could be estimated by the empirical regression of the Nelson Phelps model (Table 10). To cope with this problem, we decide to apply the region specific effect of the Eastern Europe region to countries of the Russian World.

This rule allows us to obtain projections for 41 additional countries on the top of our initial sample of 100 countries. For the remaining countries[10], for which data unavailability is more severe (lack of statistics on savings rates or population projections), we hypothesize that GDP increases over the period 2000-2050 at the average regional rate. By applying this GDP growth rate to the initial GDP in 2000, we can project GDP for 170 countries. We obtain a predicted world GDP[11] in 2050 of $118 trillion (at constant US $ 2000 exchange rate) and $142 trillion (allowing for exchange rate movements), compared to $32 trillion in 2000. This figure allows us to compute the current and projected share in the world GDP for each country. A selection of the results is reported in Table 17.

Table 17: Projected shares in world GDP (in %)

Billion $ (constant US $ at 2000 prices)	China	US	India	Brazil	Russia	France	Germany	Japan	UK
Share in 2005	5	31	2	1.9	1.0	3.9	5.3	14.3	4.5
Predicted share in 2020 based on scenario of evolution of TFP & investment & education	8	31	2.3	1.5	1.2	3.3	4.8	12.0	4.2
Predicted share in 2050 based on scenario of evolution of TFP & investment & education	12	33	3.9	0.9	0.9	2.5	3.5	8.4	3.6
Billion $ (current US $ and current relative prices)									
Share in 2005	6.3	30.6	1.9	1.7	1.1	3.9	5.1	14.3	4.4
Predicted share in 2020 based on scenario of evolution of TFP & investment & education	10.8	30.1	2.6	1.1	1.4	3.1	4.4	11.8	3.9
Predicted share in 2050 based on scenario of evolution of TFP & investment & education	21.8	26.9	4.8	0.4	1.1	1.8	2.7	6.9	2.7

Results suggest that China's GDP could represent 22% of the world GDP by 2050 at current exchange rates. In less than 50 years, China and India together could rival the size of the US in current dollars (26.6 against 26.9% of the world GDP in 2050). These countries together will account for 33% of the world GDP increase ($105 trillion) over the period 2005-2050 (27 and 6% respectively). Of the current G7 (the United States, Japan, Germany, the United Kingdom, France, Italy and Canada) only the US, Japan, Germany

[10] Countries include Afghanistan, Albania, Angola, Bahamas, Bosnia and Herzegovina, Brunei Darussalam, Cambodia, Croatia, Cuba, Djibouti, Eritrea, Iraq, Laos, Liberia, Lithuania, Macau, Moldova, Mongolia, Myanmar, New Caledonia, Oman, Puerto Rico, Slovakia, Solomon Islands, Sudan, Taiwan, Turkmenistan and Viet Nam.

[11] The sum of the GDPs (constant 2000 US$) of the 170 countries in our sample equals the value reported in the World Development Indicators of the world GDP for the year 2000.

and the United Kingdom remain among the seven largest economies in 2050. China, South Korea and India are expected to overtake France, Italy and Canada before that date.

Graphs 14 to 17 help to visualize the coming shifts in regional decomposition of the world GDP[12]. Graphs 14 and 15 present the decomposition of the world GDP expressed in constant US $ at 2000 prices. The share of Western Europe is anticipated to decline progressively from 25% in 2005 to 17% while that of Japan slips from 14% to 8%. North America (that includes also Australia and New Zealand) maintains its share at 35% until 2020 and even gains 2% between 2020 and 2050. The United States accounts for a constant share of 32% of world GDP over the period.

The major shifts between 2005 and 2050 correspond to the expansion of the Indian World (from 3 to 6% of the world GDP) and of the Chinese World from 10 to 22% of the world GDP. This latter progression is only in part due to China, which share of the world GDP is expected to more than double from 5% to 12%. Other countries such as the Philippines, South Korea and Taiwan are expected to grow faster than the world average over the next 45 years.

Graphs 16 and 17 report the decomposition of the world GDP expressed in 2000 current prices and the current exchange rate. Accounting for exchange rate movements speeds up the emergence of China as a major economic power. Its share of the world GDP jumps from 6% in 2005 to 11% in 2020. Chinese GDP is then expected to double to reach in 2050 22% of the world GDP. This evolution occurs at the expense of Western economies: The Western Europe's share declines from 24% to 13% and that of North America (that includes also Australia and New Zealand) declines from 35% to 30%. The weight of Japan is expected to be cut by two: from 14 to 7% over the next 45 years. The main result highlighted by these figures is the anticipated shift in economic power from the West to the East: the weight of the Indian and Chinese worlds together is set to increase from 14% in 2005 to 23% in 2020. If our long-run projections are proven accurate, it should reach 43% in 2050.

Table 18 highlights that the incorporation of the exchange rate changes in our projections should not affect the hierarchy of the top three of the largest economies (at constant US $ at 2000 prices). However, it would induce a decline in the relative position and weight of developed countries such as the United Kingdom, Germany and France.

Before we move to verify the plausibility of our results, it is necessary to acknowledge that projections are the more likely to be proven wrong that they are made over a very far horizon. It is very likely that the TFP growth dynamic and the savings behavior that are identified based on the econometric estimations over the past may hold over the next 15 years. It becomes much more unlikely that they do over the longer run. Energy-related constraints may in fact modify drastically the engine of growth in a decade or two. As such, intermediate projections such as those for 2020 are more likely to be found accurate.

[12] Refer to appendix A for the list of countries included in each region.

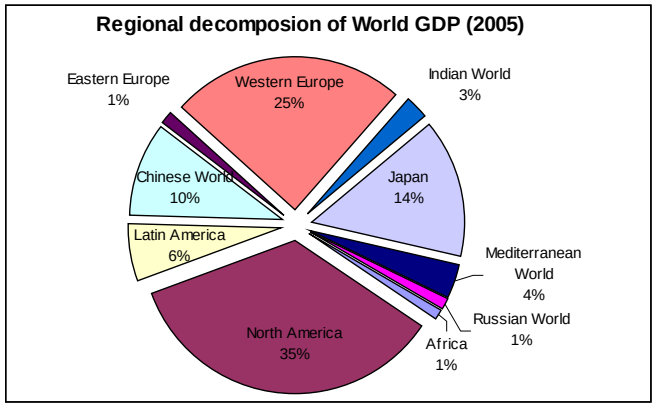
Table 18: Rank of countries in terms of GDP (sample of 170 countries)

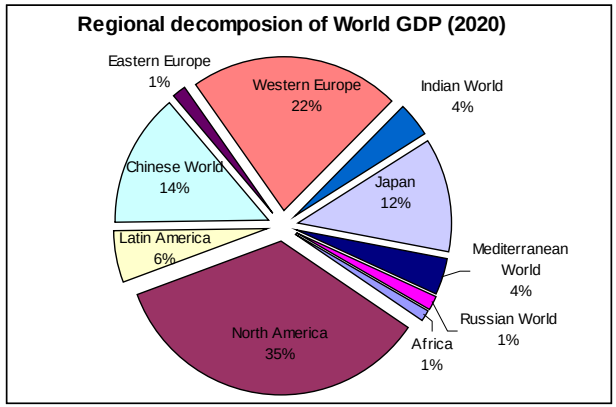
Country	Year 2005	Year 2050	Year 2050: Current US $ and current relative prices
	Real $ terms (constant US $ at 2000 prices)		
United States	1	1	1
China, People's Rep,	4	2	2
Japan	2	3	3
India	13	4	5
United Kingdom	5	5	8
Germany	3	6	7
South Korea	10	7	4
France	6	8	10
Taiwan	17	9	6
Canada	8	10	12
Italy	7	11	15
Russia	16	19	17

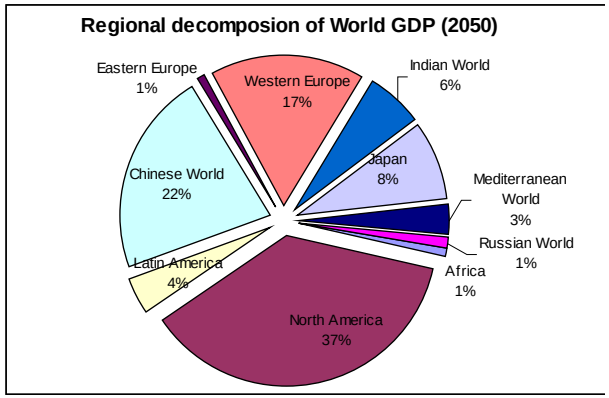
Projections of GDP and GDP per capita for 2020 (in real terms and after accounting for exchange rate movements) are reported for all countries in our sample in Table B10 in Appendix.

Over the next 15 years, the world GDP is expected to grow from $ 36 to 55 trillion in constant US $ at 2000 prices ($ 56 trillion once exchange rate movements are accounted for). China is anticipated to become the third world economic power through higher real growth (5.4% annually) and through appreciation of its currency (1.1% annually). Around one third of the increase in US dollar GDP from China over the period may come from rising currency, with the other two thirds from faster growth. Exchange rate movements would explain 20% US dollar GDP increase for India and Russia.

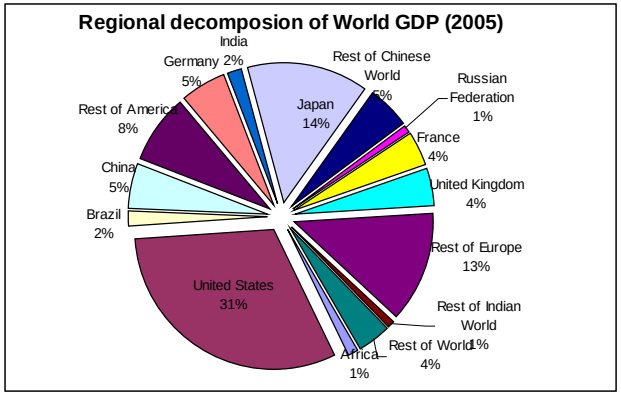
Graph 14: World GDP (constant US $ at 2000 prices) decomposition by region

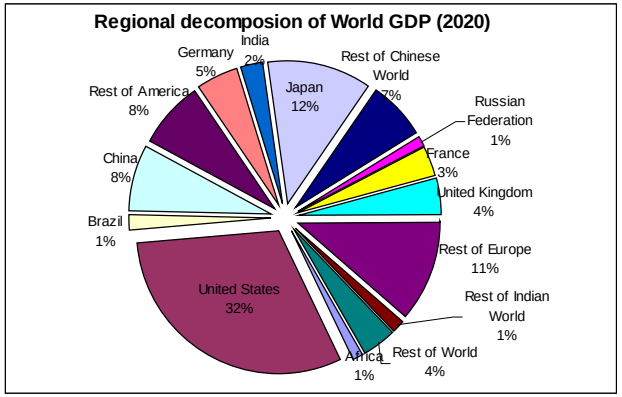


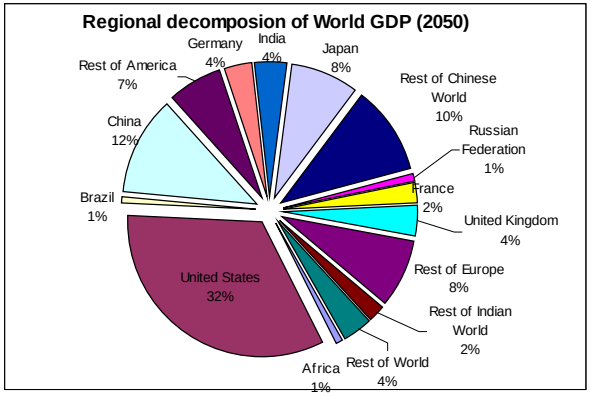




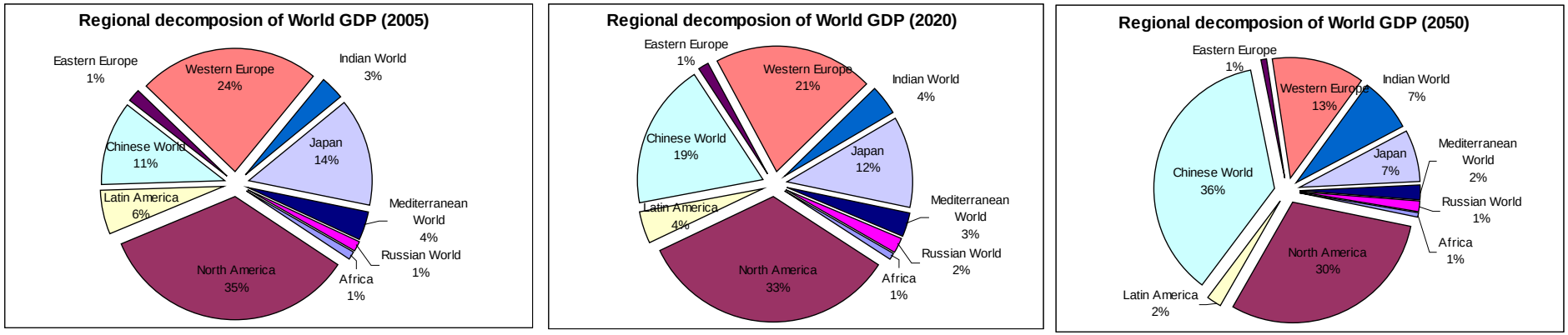
Graph 15: World GDP (constant US $ at 2000 prices) decomposition by largest country and region



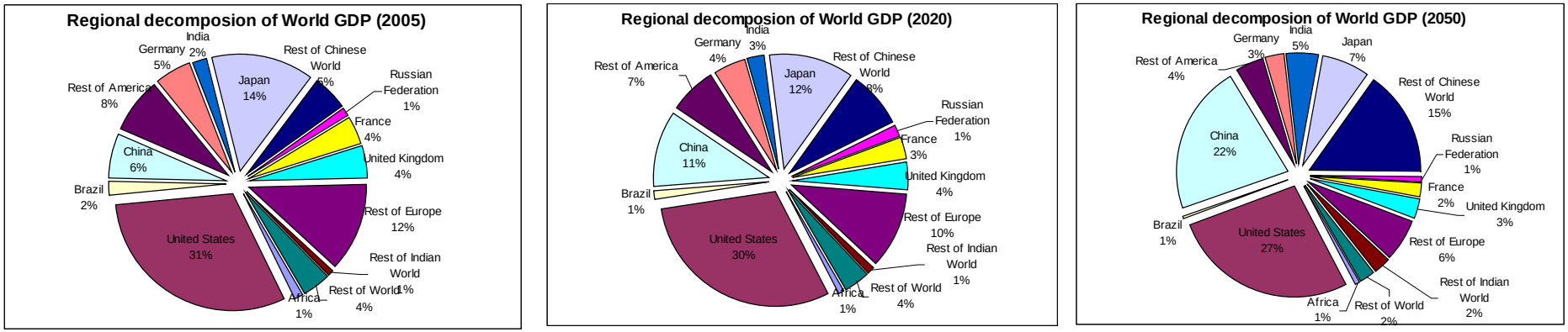




Graph 16: World GDP (current US $ and current relative prices) decomposition by region



Graph 17: World GDP (current US $ and current relative prices) decomposition by largest country and region



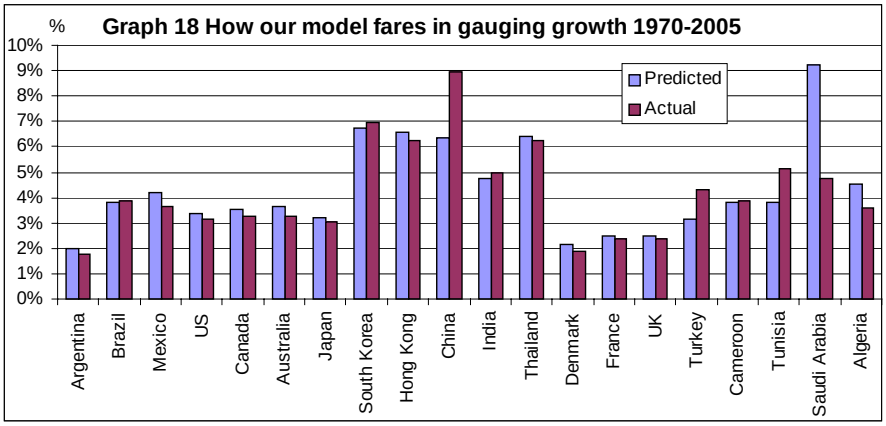
4.5. General Discussion

Our projections may seem dramatic; but over a few decades, the world economy can change a lot. Looking back 30 or 50 years illustrates this point. Thirty years ago, South Korea was just beginning to emerge from its position as a low-income nation and even over the last decade, China's importance to the world economy has increased substantially. Moreover, as already mentioned, cross checks of our forecasts with other projections suggests that our results are plausible (refer to Tables 15 and 16).

A further way to check the plausibility of our projections is to use our methods on historical data and see how well the projections fit current reality. To do this, we look at a sub-set of countries starting in 1970 (for which we have the data necessary for this exercise) and project their GDP growth for the following 35 years.

We apply the same methodology -modeling capital stock growth as a function of the initial levels of capital and investment and then projecting technical progress and savings rates relying on estimated parameters. Because we do not have demographic projections for 1970 (as we do now for the next 45 years), we use actual population data, unemployment, working hours and participation rates. Labor input growth (in hours) is therefore assumed to be perfectly predicted.

The results of this exercise are generally encouraging. Graph 18 reports projected and actual GDP (constant US $ at 2000 prices) for a selection of countries.



In general, the projected average growth rates over the period are surprisingly close to the actual outcomes. For the more developed countries, where the growth path has been steadier (France, UK, US, Canada, Australia, Japan), the differences between projected and actual growth rates are small. For the developing countries, the range of outcomes is wider. For those countries where policy settings were particularly growth supportive, our method underestimates actual growth performance in some cases quite significantly (e.g. China). Growth in oil producing countries turns out to be pretty hard to predict, as evidenced by differences between actual and projected growth for Saudi Arabia and Algeria.

Overall, the results highlight that our model of projection appears sound. For the world to meet our projections over the next 45 years there is no need for a miracle performance.

CONCLUSION

In this work, we describe the way the world might change over the next 45 years. By setting out clear assumptions about how the process of growth works and then applying a formal framework to generate long-term forecasts, we are able to model each component of GDP growth (employment and capital stock growth as well as technical progress or TFP growth) explicitly.

We use UN demographic projections as well as ILO data on activity rate, unemployment and number of hours worked per capita to forecast employment growth over the long run, assuming that the values for these last three indicators stay roughly stable. We use assumptions based on past econometric regressions for the savings rate to map out the evolution of the capital stock. We model TFP growth based on empirical estimates of a Nelson-Phelps catch-up model of technology diffusion. Historical data verifies the prediction of the model that human capital plays a positive role in the determination of total factor productivity growth rates through its role of facilitator of own innovation and its influence on the rate of catch-up.

We then use the projections of productivity growth from this exercise to map out the path of the real exchange rate. We assume that if an economy experiences higher productivity growth than the US, its equilibrium exchange rate will tend to appreciate.

The results suggest that China's GDP in 2050 could represent 22% of world GDP (at current US $ and current relative prices). Between 2005 and 2050, China and India could experience a 13-fold and a 10-fold increase in GDP respectively at current real exchange rate. Over the same period, GDP for developed countries would almost double (Germany, France and Japan) and, for some, triple (US). We expect the list of the world's ten largest economies to look quite different in 2050 than in 2005. We do not, however, expect the US to lose the first rank in the world GDP hierarchy over the next 50 years. We anticipate that in 2050, China's GDP could reach $ 31 compared to $ 38 trillion for the US, moving Japan down from second position to the benefit of China. South Korea is predicted to improve its rank from 10th in 2005 to fourth in 2050. A similar progression is expected for India - projected to jump from 13th to fifth position. India could become larger than France in 2025 and larger than Germany in 2039. In 2050 India's GDP would, however, correspond only to 18% of the United States' GDP. Of the current G7 (the United States, Japan, Germany, the United Kingdom, France, Italy and Canada) only the US, Japan, Germany and the United Kingdom may be among the seven largest economies in 2050. China, South Korea and India are expected to overtake France, Italy and Canada before that date. Today's advanced economies are projected to become a shrinking part of the world economy.

Our projections indicate that in less than 50 years, China and India together could match the size of the US in current dollars (26.6 against 26.9% of the world GDP in 2050). The largest economies in the world (by GDP) may no longer be the richest (in terms of income per capita), making strategic choices for firms more complex. Accompanying shifts in spending constitute opportunities for companies that will invest in the right markets but challenges for those that will fail to adjust to ongoing changes.

APPENDIX A: REGIONAL DECOMPOSITION

1. "Western Europe": Channel Islands, Denmark, Finland, Iceland, Ireland, Norway, Sweden, United Kingdom, Greece, Italy, Malta, Portugal, Spain, Austria, Belgium, France, Germany (East + West), Luxembourg, Netherlands, Switzerland.

2. ""Eastern Europe": Estonia, Latvia, Lithuania, Bulgaria, Czech Republic, Hungary, Poland Romania, Slovakia, Slovenia, Albania, Bosnia and Herzegovina, Croatia, TFYR Macedonia, Yugoslavia.

3. "North America": Canada, United States of America, Australia, New Zealand, Melanesia, Fiji, New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu, Micronesia, Guam, Polynesia, French Polynesia, Samoa.

4. "Latin America": Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Bahamas, Barbados, Cuba, Dominican Republic, Guadeloupe, Haiti, Jamaica, Martinique, Netherlands Antilles, Puerto Rico, Saint Lucia, Trinidad and Tobago.

5. Japan.

6. "MediterraneanWorld": Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, , Tunisia, Western Sahara, Armenia, Azerbaijan, Bahrain, Cyprus, Georgia, Iraq, Iran, Israel, Jordan, Kuwait, Lebanon, Occupied Palestinian Territory, Oman, Qatar, Saudi Arabia, Syrian Arab Republic, Turkey, United Arab Emirates, Yemen. Turkmenistan, Uzbekistan Kyrgyzstan.

7. "Chinese World": China, Democratic Peoples Republic of Korea, Mongolia, Republic of Korea, Brunei Darussalam, Cambodia, East Timor, Lao Peoples Democratic Republic, Myanmar, Philippines, Singapore, Thailand, Viet Nam.

8. "Africa": Burundi, Comoros, Djibouti, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Réunion, Rwanda, Somalia, Uganda, Tanzania, Zambia, Zimbabwe, Angola, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, Botswana, Lesotho, Namibia, South Africa, Swaziland, Benin, Burkina Faso, Cape Verde, Côte dIvoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo. Sudan

9. "RussianWorld": Belarus, Russian Federation, Ukraine. Kazakhstan, Republic of Moldova.

10. "Indian World": India, Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka, Tajikistan, Indonesia, Malaysia.

APPENDIX B

Table B1: Capital stock and ratio over GDP in 2005 in billion (constant US $ at 2000 prices)

Country	Capital ratio	Capital stock	Country	Capital ratio	Capital stock
United States	2.3	26 000	Costa Rica	2.2	42
Japan	3.8	19 500	Uruguay	2.0	40
Germany	3.0	5 830	Panama	2.7	36
China, P Rep,	3.0	4 780	Jamaica	4.1	33
France	2.8	4 000	El Salvador	2.1	31
United Kingdom	2.3	3 720	Jordan	2.7	29
Italy	2.9	3 310	Trinidad and Tobago	2.7	27
Canada	2.6	2 120	Tanzania	2.2	27
South Korea	3.2	2 030	Iceland	2.6	26
Spain	3.1	1 950	Cyprus	2.3	24
Brazil	2.6	1 720	Cameroon	2.3	24
Mexico	2.4	1 570	Paraguay	2.9	24
India	2.1	1 340	Kenya	2.0	23
Australia	2.8	1 270	Gabon	4.0	22
Netherlands	3.0	1 150	Ivory Coast	2.0	21
Switzerland	3.6	935	Yemen	1.9	21
Belgium	2.8	693	Bahrain	2.1	20
Austria	3.2	663	Honduras	2.0	20
Sweden	2.4	657	Bolivia	2.8	20
Hong Kong	2.8	556	Botswana	2.6	17
Turkey	2.3	554	Ethiopia	2.0	16
Saudi Arabia	2.5	547	Zimbabwe	3.7	16
Norway	2.7	508	Equatorial Guinea	2.9	16
Poland	2.5	488	Nicaragua	3.3	15
Denmark	2.8	485	Ghana	2.2	14
Indonesia	2.6	478	Nepal	2.2	14
Thailand	3.0	477	Mauritius	2.5	14
Greece	3.0	407	Haiti	3.6	13
Venezuela	3.3	395	Congo	3.1	12
Portugal	3.5	388	Mozambique	2.2	12
Finland	2.8	374	Uganda	1.7	12
South Africa	2.5	363	Congo. Dem. Rep.	2.1	11
Iran	2.7	353	Malta	3.0	11
Singapore	3.1	332	Senegal	1.8	10
Malaysia	2.8	314	Zambia	2.4	10
Israel	2.5	304	Papua New Guinea	2.5	9
United Arab Em.	3.0	259	Madagascar	1.9	8
Ireland	2.1	256	Mali	2.3	8
Egypt	2.1	249	Burkina Faso	2.2	8

Country	Capital ratio	Capital stock	Country	Capital ratio	Capital stock
Philippines	2.4	222	Guinea	1.9	7
Algeria	3.3	221	Barbados	2.6	7
Chile	2.4	212	Benin	1.9	6
Colombia	2.1	201	Lesotho	5.3	5
Hungary	3.2	176	Chad	2.0	5
Peru	2.7	168	Rwanda	1.9	5
New Zealand	2.6	162	Swaziland	2.6	4
Romania	3.0	145	Niger	1.6	4
Nigeria	2.5	131	Fiji	1.8	4
Pakistan	1.8	130	Togo	2.5	3
Bangladesh	2.2	130	Malawi	1.8	3
Morocco	2.7	111	Guyana	3.9	3
Libyan Arab J	2.5	106	Mauritania	2.4	3
Kuwait	1.9	82	Belize	2.3	2
Tunisia	2.8	67	Saint Lucia	3.4	2
Lebanon	3.0	58	Cape Verde	2.5	2
Syria	2.7	57	Central African Republic	1.6	2
Dom. Republic	2.6	55	Sierra Leone	1.6	1
Luxembourg	2.4	55	Burundi	1.7	1
Sri Lanka	2.6	51	Saint Vincent & Grenad.	3.6	1
Ecuador	2.6	50	Gambia	2.2	1
Bulgaria	2.7	44	Guinea-Bissau	3.5	1
Guatemala	2.0	43			

Table B2: GDP and its components in 2005 as well as TFP annual growth (1990-2005) in constant US $ at 2000 prices

Country	GDP per capita	GDP: **Y** billion	Capital Stock **K** billion	TFP **A**	**L** thousands hours	ln(A)/ln(Y) in %	TFP growth 1990-2005 %
United States	37 324	11 200	26 000	943	254 000	23	1.5
Japan	40 424	5 170	19 500	712	140 000	22	1.0
Germany	23 430	1 930	5 830	634	69 800	23	1.3
China. People's Rep.	1 417	1 870	4 440	78	1 770 000	15	6.6
United Kingdom	27 199	1 620	3 720	683	60 000	23	1.5
France	23 300	1 410	4 000	683	47 100	23	1.1
Italy	19 813	1 130	3 310	609	44 100	23	0.8
Canada	25 898	828	2 120	716	27 000	24	1.0
Brazil	3 635	665	1 720	172	183 000	19	0.2
South Korea	13 340	643	2 030	352	54 700	22	2.3
Mexico	6 033	642	1 570	260	97 700	20	0.2
Spain	15 505	639	1 950	507	32 000	23	0.7
India	572	627	1 340	57	1 010 000	15	2.6
Australia	22 226	447	1 270	610	17 600	24	1.5
Netherlands	23 546	384	1 150	559	16 800	24	0.2
Sweden	30 165	268	657	770	8 030	25	2.3
Switzerland	36 028	258	935	703	7 267	25	0.4
Belgium	23 869	247	693	723	7 593	25	0.8
Turkey	3 355	246	554	197	59 300	20	1.5
Saudi Arabia	8 700	223	547	414	16 900	23	-0.2
Austria	25 531	207	663	669	6 706	25	1.2
Hong Kong	27 360	196	556	564	8 718	24	1.1
Poland	5 051	195	488	260	29 400	21	3.7
Norway	40 679	186	508	837	4 645	26	1.8
Indonesia	816	184	478	61	238 000	16	1.0
Denmark	31 869	172	485	737	5 102	26	1.6
Thailand	2 485	159	477	100	92 400	18	1.7
South Africa	3 241	147	363	181	38 300	20	1.3
Greece	12 344	136	407	393	10 000	23	1.3
Finland	25 651	134	374	679	4 530	25	2.1
Iran	1 830	129	353	124	56 800	19	0.6
Israel	18 285	122	304	652	4 654	25	2.0
Ireland	30 302	122	256	813	3 653	26	0.8
Venezuela	4 492	120	395	192	24 700	21	-1.6
Egypt	1 558	117	249	121	60 100	19	0.7
Malaysia	4 436	112	314	193	25 000	21	2.1
Portugal	11 040	111	388	338	9 612	23	0.9
Singapore	24 275	106	332	524	4 996	25	2.7
Colombia	2 125	97	201	129	46 100	19	-0.1

Country	GDP per capita	GDP: **Y** billion	Capital Stock **K** billion	TFP **A**	**L** thousands hours	ln(A)/ln(Y) in %	TFP growth 1990-2005 %
Philippines	1 128	93	222	88	73 000	18	1.2
Chile	5 514	89	212	270	13 100	22	2.5
United Arab Emirates	27 602	86	259	576	3 568	25	0.2
Pakistan	458	74	130	58	127 000	16	1.0
Algeria	2 023	67	221	124	26 500	19	-0.6
Peru	2 262	63	168	128	26 900	20	1.4
New Zealand	15 532	61	162	495	3 405	25	1.8
Bangladesh	385	59	130	39	162 000	15	1.7
Hungary	5 684	56	176	265	7 250	23	2.3
Nigeria	411	54	131	48	104 000	16	0.1
Romania	2 170	48	145	123	20 400	20	0.1
Libyan Arab Jamahiriya	7 409	43	106	324	4 640	24	0.5
Kuwait	15 778	42	82	461	3 054	25	0.4
Morocco	1 308	41	111	113	20 800	19	0.1

Table B2bis: GDP and its components in 2005 as well as TFP annual growth (1990-2005) in constant US $ at 2000 prices

Country	GDP per capita	GDP: **Y** billion US$	Capital Stock **K** billion US$	TFP **A**	**L** thousands hours	ln(A)/ln(Y) in %	TFP growth 1990-2005 %
Tunisia	2 419	24	67	161	7 168	21	1.1
Luxembourg	49 172	23	55	1 149	380	30	2.4
Guatemala	1 683	22	43	136	9 887	21	0.4
Dominican Republic	2 356	21	55	146	7 439	21	1.8
Syria	1 137	21	57	89	15 500	19	-0.2
Uruguay	5 817	20	40	281	3 023	24	1.0
Ecuador	1 456	20	50	101	11 900	19	2.1
Sri Lanka	1 006	20	51	77	17 800	18	-0.3
Lebanon	5 135	19	58	236	3 080	23	2.4
Costa Rica	4 360	19	42	196	4 604	22	0.9
Bulgaria	2 049	16	44	158	4 848	22	3.0
El Salvador	2 167	15	31	144	5 755	21	1.3
Panama	4 220	14	36	203	2 901	23	0.5
Tanzania	319	12	27	33	43 700	15	1.0
Kenya	349	12	23	38	34 400	16	-1.2
Yemen	520	11	21	74	12 900	19	-0.5
Jordan	1 850	11	29	139	3 923	21	-0.3
Cote d'Ivoire	620	11	21	66	14 000	18	-0.4
Cyprus	12 755	10	24	417	797	26	2.2
Cameroon	623	10	24	61	14 100	18	0.2
Trinidad and Tobago	7 749	10	27	289	1 264	25	1.3
Iceland	33 827	10	26	660	361	28	1.1
Bahrain	13 054	10	20	462	693	27	2.1
Bolivia	1 065	10	20	85	8 743	19	0.5
Paraguay	1 342	8	24	87	6 071	20	-1.5
Ethiopia	110	8	16	21	62 700	13	1.0
Jamaica	2 974	8	33	138	2 447	22	-0.6
Uganda	258	7	12	34	28 100	15	1.5
Honduras	961	7	20	72	6 751	19	-1.2
Botswana	3 620	7	17	226	1 188	24	1.9
Ghana	289	6	14	35	20 200	16	-0.2
Nepal	237	6	14	31	24 700	15	1.1
Senegal	526	6	10	58	9 166	18	0.5
Mozambique	285	6	12	33	20 100	16	2.8
Gabon	4 000	6	22	170	1 239	23	-0.1
Zimbabwe	421	5	16	42	12 000	17	-2.9
Mauritius	4 353	5	14	205	1 160	24	2.6
Congo. Dem. Rep.	92	5	11	17	49 300	13	-4.0

Country	GDP per capita	GDP: **Y** billion US$	Capital Stock **K** billion US$	TFP **A**	**L** thousands hours	ln(A)/ln(Y) in %	TFP growth 1990-2005 %
Nicaragua	790	5	15	70	4 222	19	0.5
Madagascar	240	4	8	30	19 700	15	-1.6
Equatorial Guinea	8 206	4	16	288	454	26	14.5
Zambia	362	4	10	41	9 736	17	-0.2
Congo	1 009	4	12	79	3 223	20	-0.4
Guinea	417	4	7	44	8 975	17	0.8
Malta	9 102	4	11	355	315	27	0.9
Papua New Guinea	602	4	9	63	4 551	19	1.3
Haiti	411	4	13	38	7 835	17	-2.9
Burkina Faso	245	3	8	31	13 200	16	1.1
Mali	239	3	8	31	12 800	16	1.5
Benin	405	3	6	49	6 000	18	1.2
Chad	296	3	5	39	7 791	17	-0.3
Barbados	9 789	3	7	299	319	26	-0.2
Rwanda	282	2	5	34	8 755	16	0.7

Table B3: Comparison of annual TFP growth rate: Computations 1980-2005 and projections 2005-2050 (in %)

Country	TFP relative to US (2005)	Annual growth 1980-2005	Annual growth 2005-2050	Country	TFP relative to US (2005)	Annual growth 1980-2005	Annual growth 2005-2050
Philippines	9.4	0.1	2.9	Panama	21.5	-0.3	0.6
South Korea	37.4	2.6	2.7	Zambia	4.4	-0.5	0.6
China. People's	8.3	5.5	2.6	Tunisia	17.1	1.0	0.6
Thailand	10.6	2.0	2.5	South Africa	19.2	-0.2	0.6
Malaysia	20.5	1.3	2.5	Zimbabwe	4.4	-1.7	0.6
Sri Lanka	8.2	1.6	2.3	Israel	69.2	1.2	0.6
Hong Kong	59.9	1.5	2.1	Botswana	24.0	2.8	0.6
Fiji	18.6	0.8	2.0	Peru	13.6	-1.1	0.5
Singapore	55.6	2.2	2.0	Mauritius	21.8	2.4	0.5
India	6.0	2.3	1.9	Congo	8.3	-0.1	0.5
Indonesia	6.5	1.4	1.9	Barbados	31.7	-0.2	0.5
New Zealand	52.5	1.4	1.8	Kuwait	48.9	-2.4	0.5
Cyprus	44.2	2.1	1.7	Bahrain	49.0	-0.1	0.5
Romania	13.0	-0.3	1.7	Guyana	7.1	-0.6	0.4
Greece	41.7	0.1	1.7	Ecuador	10.7	-1.1	0.4
Pakistan	6.1	1.2	1.7	Chile	28.6	1.4	0.3
Bulgaria	16.7	1.8	1.6	Kenya	4.0	-0.6	0.3
United States	**100.0**	**1.4**	**1.5**	Lesotho	5.0	0.4	0.3
Australia	64.7	1.2	1.5	Uruguay	29.9	0.0	0.3
Poland	27.5	1.5	1.5	Paraguay	9.2	-1.6	0.3
Netherlands	59.3	-0.1	1.5	Mexico	27.6	-0.9	0.3
Bangladesh	4.1	1.2	1.4	Venezuela	20.4	-1.5	0.3
Germany	67.2	0.8	1.4	Ghana	3.8	-0.5	0.3
Portugal	35.8	0.7	1.4	Bolivia	9.0	-0.6	0.2
Japan	75.5	1.2	1.4	Uganda	3.6	1.3	0.2
Nepal	3.2	1.5	1.4	Cameroon	6.5	0.1	0.2
Spain	53.8	0.7	1.4	Costa Rica	20.8	-0.1	0.2
Hungary	28.1	1.6	1.4	Togo	3.6	-1.5	0.2
Canada	75.9	1.1	1.3	Malawi	2.5	0.1	0.1
Finland	72.1	1.4	1.3	Congo. Dem.	1.8	-3.0	0.1
Switzerland	74.5	0.0	1.3	Colombia	13.7	-0.7	0.1
Iceland	70.0	0.5	1.3	Jamaica	14.6	-0.4	0.1
United	72.4	0.9	1.3	El Salvador	15.3	-0.1	0.1
Sweden	81.6	1.4	1.2	Honduras	7.7	-1.2	0.0
Austria	70.9	0.8	1.2	Tanzania	3.5	0.3	0.0
Italy	64.6	0.5	1.2	Dominican Rep	15.5	0.5	0.0
Belgium	76.7	0.7	1.2	Nicaragua	7.4	-1.2	0.0
Denmark	78.2	0.8	1.2	Rwanda	3.6	-1.0	0.0

Country	TFP relative to US (2005)	Annual growth 1980-2005	Annual growth 2005-2050	Country	TFP relative to US (2005)	Annual growth 1980-2005	Annual growth 2005-2050
France	72.5	0.7	1.2	Central African	3.5	-1.1	0.0
Norway	88.8	1.3	1.1	Brazil	18.2	-0.5	0.0
Papua New	6.7	0.2	1.1	Senegal	6.2	0.2	0.0
Ireland	86.2	2.0	1.1	Sierra Leone	3.0	-2.3	0.0
Jordan	14.8	-1.1	1.0	Benin	5.2	0.5	-0.1
Syria	9.4	-0.8	0.8	Gambia	4.2	0.0	-0.1
Egypt	12.8	0.7	0.7	Guatemala	14.4	-0.6	-0.3
Trinidad and	30.7	-0.4	0.7	Mozambique	3.5	1.4	-0.3
Algeria	13.1	-0.7	0.7	Niger	2.9	-1.4	-0.3
Iran	13.1	0.6	0.7	Haiti	4.1	-2.7	-0.4
Swaziland	13.4	1.1	0.6	Mali	3.3	-0.1	-0.4
Turkey	20.9	1.4	0.6	Guinea-Bissau	1.9	-0.3	-0.4

Table B4: Prediction results (scenario with modeling of TFP and investment rate)

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
United States	11 200	38 600	37 329	94 447	2.8	1.5	2.6	0.7
China	1 870	12 100	1 414	8 673	4.2	2.6	5.4	0.1
Japan	5 170	9 650	40 418	87 949	1.4	1.4	1.7	-0.3
UK	1 620	4 050	27 182	61 210	2.1	1.3	2.2	0.2
Germany	1 930	4 020	23 377	50 793	1.6	1.4	1.6	-0.1
South Korea	643	3 800	13 345	81 864	4.0	2.7	4.4	-0.1
India	627	3 800	572	2 481	4.1	1.9	4.4	0.7
France	1 410	2 740	23 225	42 659	1.5	1.2	1.3	0.1
Canada	828	2 430	25 897	62 172	2.4	1.3	2.9	0.4
Italy	1 130	1 620	19 737	36 100	0.8	1.2	0.9	-0.5
Australia	447	1 460	22 247	57 121	2.7	1.5	2.9	0.5
Mexico	642	1 240	6 035	8 843	1.5	0.3	2.0	0.6
Philippines	93	1 220	1 128	9 609	5.9	2.9	5.8	1.0
Spain	639	1 180	15 516	31 605	1.4	1.4	1.7	-0.2
Indonesia	184	1 130	817	3 846	4.1	1.9	4.8	0.6
Malaysia	112	1 100	4 423	27 812	5.2	2.5	5.7	1.0
Thailand	159	1 060	2 481	13 752	4.3	2.5	4.6	0.4
Netherlands	384	1 030	23 559	60 752	2.2	1.5	2.5	0.1
Brazil	665	887	3 638	3 805	0.6	0.0	1.0	0.5
Hong Kong	196	870	27 291	92 248	3.4	2.1	4.0	0.6
Sweden	268	638	30 130	73 333	1.9	1.2	2.6	0.0
Argentina	293	599	7 453	11 344	1.6	0.5	1.5	0.7
Norway	186	551	40 704	112 572	2.4	1.1	3.9	0.2
Pakistan	74	549	458	1 574	4.6	1.7	3.6	1.7
Turkey	246	501	3 356	5 125	1.6	0.6	1.6	0.6
Belgium	247	496	23 844	48 525	1.6	1.2	1.7	0.0
Ireland	122	442	30 197	88 469	2.9	1.1	4.7	0.5
Singapore	106	439	24 248	96 731	3.2	2.0	4.5	0.1
Iran	129	411	1 825	3 896	2.6	0.7	3.3	0.9
Poland	195	409	5 063	12 392	1.7	1.5	2.6	-0.3
Switzerland	258	405	36 050	69 713	1.0	1.3	0.8	-0.5
Austria	207	357	25 492	48 398	1.2	1.2	1.3	-0.2
Denmark	172	341	31 937	64 670	1.5	1.2	1.5	0.0
Finland	134	327	25 653	66 179	2.0	1.3	2.9	-0.1
Egypt	117	312	1 563	2 449	2.2	0.7	1.4	1.2
Greece	136	276	12 388	28 122	1.6	1.7	1.0	-0.2
Venezuela	120	272	4 505	6 518	1.8	0.3	1.9	1.0
South Africa	147	260	3 243	6 461	1.3	0.6	2.2	-0.3

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
New Zealand	61	255	15 540	56 515	3.2	1.8	3.7	0.3
Bangladesh	59	222	385	872	3.0	1.4	1.7	1.1
Portugal	111	214	11 012	23 708	1.5	1.4	1.1	-0.2
Algeria	67	210	2 023	4 315	2.6	0.7	3.5	0.9
Colombia	97	193	2 125	2 860	1.5	0.1	2.2	0.9
Peru	63	187	2 263	4 549	2.4	0.5	2.8	0.9
Chile	89	176	5 511	8 072	1.5	0.3	2.2	0.7
Czech Rep	65	131	6 343	15 317	1.6	1.4	2.6	-0.4
Israel	122	112	18 250	11 213	-0.2	0.6	-4.3	0.9
Hungary	56	101	5 683	13 308	1.3	1.4	2.1	-0.6
Romania	48	100	2 168	5 536	1.6	1.7	1.4	-0.5
Kuwait	42	85	15 797	17 276	1.6	0.5	1.1	1.4
Syria	21	78	1 137	2 274	2.9	0.8	2.5	1.4

Table B5 : Prediction results (scenario with modeling of TFP and investment rate)

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
Sri Lanka	20	69	1 007	3 235	2.8	2.3	1.8	0.2
Tunisia	24	54	2 420	4 159	1.8	0.6	2.2	0.6
Ecuador	20	45	1 458	2 425	1.9	0.4	2.4	0.7
Panama	14	43	4 204	8 405	2.6	0.6	3.2	1.0
Cyprus	10	39	12 787	43 623	3.0	1.7	3.7	0.2
Costa Rica	19	39	4 368	5 958	1.6	0.2	1.9	0.9
Guatemala	22	37	1 680	1 414	1.2	-0.3	0.0	1.6
Bahrain	10	35	13 058	27 637	2.9	0.5	4.9	1.2
Slovenia	22	31	11 216	20 013	0.8	0.8	2.2	-0.5
Uruguay	20	31	5 804	7 533	1.0	0.3	0.7	0.4
Nepal	6	30	237	588	3.5	1.4	2.6	1.5
Dom Rep	21	27	2 356	2 299	0.6	0.0	-0.3	0.6
Iceland	10	26	33 810	77 483	2.1	1.3	2.2	0.3
Bulgaria	16	25	2 048	4 795	1.0	1.6	1.4	-0.9
Cameroon	10	25	622	998	2.0	0.2	2.6	0.9
Bolivia	10	24	1 065	1 511	2.0	0.2	1.7	1.2
Congo	4	24	1 010	2 227	4.1	0.5	4.9	2.2
Kenya	12	22	350	489	1.4	0.3	1.1	0.7
Uganda	7	21	258	201	2.4	0.2	-0.3	3.0
Paraguay	8	19	1 343	1 561	1.9	0.3	0.6	1.5
Pap New G.	4	19	602	1 674	3.7	1.1	3.9	1.4
Tanzania	12	18	318	266	0.9	0.0	-1.1	1.3
Congo. D Rep.	5	18	92	115	2.7	0.1	2.3	2.2
Trin. and Tob	10	17	7 779	14 252	1.2	0.7	2.7	-0.2
Honduras	7	16	960	1 251	1.8	0.0	1.6	1.2
Jordan	11	13	1 843	1 270	0.4	1.0	-5.0	1.3
Botswana	7	13	3 621	9 349	1.5	0.6	3.1	-0.6
Zambia	4	12	362	637	2.4	0.6	2.0	1.2
Ghana	6	11	289	283	1.3	0.3	-0.7	1.3
El Salvador	15	11	2 161	1 093	-0.7	0.1	-4.3	0.8
Fiji	2	10	2 306	10 629	3.7	2.0	3.9	0.3
Jamaica	8	10	2 973	2 753	0.5	0.1	-0.4	0.7
Mauritius	5	10	4 349	6 516	1.3	0.5	1.9	0.4
Zimbabwe	5	9	420	693	1.1	0.6	0.5	-0.1
Senegal	6	7	526	307	0.4	0.0	-2.7	1.6
Nicaragua	5	6	789	554	0.6	0.0	-2.1	1.4
Niger	2	5	173	100	1.9	-0.3	-0.3	3.2
Mali	3	4	239	94	0.6	-0.4	-3.2	2.7
Mozambique	6	4	285	122	-0.8	-0.3	-4.5	1.1

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
Malawi	2	3	152	134	1.3	0.1	-0.6	1.6
Togo	1	3	271	293	1.7	0.2	0.5	1.5
Benin	3	3	404	170	-0.2	-0.1	-4.9	1.8
Barbados	3	3	9 772	9 926	-0.1	0.5	-0.3	-0.1
Haiti	4	3	412	206	-0.7	-0.4	-3.7	0.8
Rwanda	2	2	282	127	-0.3	0.0	-4.8	1.5
Swaziland	2	1	1 417	1 182	-0.7	0.6	-4.6	-0.3
Sierra Leone	1	1	163	97	0.3	0.0	-2.8	1.5
Central Af R	1	1	240	127	-0.3	0.0	-4.0	1.1
Gambia	1	1	352	207	0.3	-0.1	-2.7	1.5
Guyana	1	1	966	1 168	-0.5	0.4	-0.7	-0.9
Lesotho	1	1	568	370	-1.5	0.3	-5.0	-0.6
Guinea-Bissau	0	0	130	41	-0.2	-0.4	-5.0	2.5

Table B6: Number of years of schooling: past values (Barro et Lee) and projections

Country	1980	2000	2050	Country	1980	2000	2050
United States	11.9	12.1	12.4	Kuwait	4.5	6.2	9.5
Norway	8.2	11.9	12.1	Paraguay	5.1	6.2	9.5
New Zealand	11.5	11.7	11.8	South Africa	3.8	6.1	9.5
Canada	10.3	11.6	11.7	Bahrain	3.6	6.1	9.4
Sweden	9.7	11.4	11.7	Costa Rica	5.2	6.1	9.4
Australia	10.3	10.9	11.5	Swaziland	3.9	6.0	9.4
South Korea	7.9	10.8	11.5	Mauritius	5.2	6.0	9.4
Switzerland	10.4	10.5	11.4	Portugal	3.8	5.9	9.3
Germany	8.8	10.2	11.3	Syria	3.7	5.8	9.2
Russian Federation		10.0	11.2	Bolivia	4.6	5.6	9.1
Finland	7.2	10.0	11.2	Egypt	2.3	5.5	9.1
Poland	8.8	9.8	11.1	Zambia	3.9	5.5	9.0
Denmark	9.0	9.7	11.1	Algeria	2.7	5.4	9.0
Israel	9.4	9.6	11.1	Zimbabwe	2.1	5.4	9.0
Romania	7.8	9.5	11.0	Iran	2.8	5.3	8.9
Czech Republic		9.5	11.0	Turkey	3.4	5.3	8.9
Bulgaria	7.3	9.5	11.0	Colombia	4.4	5.3	8.9
Japan	8.5	9.5	11.0	Jamaica	4.1	5.3	8.9
United Kingdom	8.3	9.4	11.0	El Salvador	3.2	5.2	8.8
Hong Kong	8.0	9.4	11.0	Congo		5.1	8.8
Ireland	7.5	9.4	11.0	India	3.3	5.1	8.8
Netherlands	8.2	9.4	11.0	Tunisia	2.9	5.0	8.7
Belgium	8.2	9.3	11.0	Indonesia	3.7	5.0	8.7
Slovakia		9.3	10.9	Dominican Republic	3.8	4.9	8.7
Cyprus	6.5	9.2	10.9	Brazil	3.1	4.9	8.6
Hungary	9.1	9.1	10.9	Honduras	2.8	4.8	8.6
Argentina	7.0	8.8	10.8	Nicaragua	3.2	4.6	8.4
Iceland	7.4	8.8	10.8	Lesotho	3.8	4.2	8.2
Taiwan	7.6	8.8	10.7	Kenya	3.4	4.2	8.1
Barbados	6.8	8.7	10.7	Iraq	2.7	4.0	7.9
Greece	7.0	8.7	10.7	Ghana	3.4	3.9	7.9
Panama	6.4	8.6	10.6	Pakistan	2.1	3.9	7.9
Austria	7.3	8.4	10.6	Cameroon	2.4	3.5	7.6
Fiji	6.8	8.3	10.5	Uganda	1.8	3.5	7.5
Philippines	6.5	8.2	10.5	Guatemala	2.7	3.5	7.5
France	6.7	7.9	10.3	Togo	2.3	3.3	7.4
Trinidad and Tobago	7.3	7.8	10.3	Malawi	2.7	3.2	7.2
Peru	6.1	7.6	10.2	Congo. Dem. Rep.	2.0	3.0	7.1
Uruguay	6.2	7.6	10.2	Papua New Guinea	1.7	2.9	6.9
Chile	6.4	7.6	10.2	Haiti	1.9	2.8	6.8
Spain	6.0	7.3	10.1	Tanzania	2.7	2.7	6.7
Mexico	4.8	7.2	10.0	Bangladesh	1.9	2.6	6.6

Country	1980	2000	2050	Country	1980	2000	2050
Italy	5.9	7.2	10.0	Rwanda	1.7	2.6	6.5
Slovenia		7.1	10.0	Senegal	2.2	2.6	6.5
Singapore	5.5	7.1	9.9	Central African Republic	1.3	2.5	6.5
Jordan	4.3	6.9	9.9	Nepal	0.9	2.4	6.4
Sri Lanka	5.6	6.9	9.9	Sierra Leone	1.6	2.4	6.4
Malaysia	5.1	6.8	9.8	Benin	1.1	2.3	6.3
Venezuela	5.5	6.6	9.7	Gambia	0.9	2.3	6.2
Thailand	4.4	6.5	9.7	Sudan	1.1	2.1	6.0
Ecuador	6.1	6.4	9.6	Afghanistan	1.1	1.7	5.4
China. People's Rep.	4.8	6.4	9.6	Mozambique	0.8	1.1	4.3
Botswana	3.1	6.3	9.5	Niger	0.6	1.0	4.1
Croatia		6.3	9.5	Mali	0.5	0.9	3.8
Guyana	5.2	6.3	9.5	Guinea-Bissau	0.3	0.8	3.7

Table B7: Predictions (modeling of TFP, investment and education improvement)

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
United States	11 200	38 600	37 329	94 447	2.8	1.5	2.6	0.7
China	1 870	14 000	1 414	10 035	4.6	2.8	5.7	0.1
Japan	5 170	9 920	40 418	90 410	1.5	1.5	1.8	-0.3
India	627	4 530	572	2 958	4.5	2.2	4.7	0.7
UK	1 620	4 200	27 182	63 477	2.1	1.3	2.3	0.2
Germany	1 930	4 120	23 377	52 057	1.7	1.5	1.6	-0.1
South Korea	643	3 870	13 345	83 372	4.1	2.7	4.4	-0.1
France	1 410	2 890	23 225	44 994	1.6	1.2	1.4	0.1
Canada	828	2 440	25 897	62 428	2.4	1.3	2.9	0.4
Italy	1 130	1 740	19 737	38 774	1.0	1.3	1.1	-0.5
Australia	447	1 490	22 247	58 295	2.7	1.5	2.9	0.5
Mexico	642	1 400	6 035	9 984	1.7	0.5	2.2	0.6
Philippines	93	1 370	1 128	10 790	6.1	3.1	6.0	1.0
Indonesia	184	1 350	817	4 595	4.5	2.2	5.1	0.6
Spain	639	1 280	15 516	34 283	1.6	1.5	1.8	-0.2
Malaysia	112	1 240	4 423	31 352	5.5	2.7	5.8	1.0
Thailand	159	1 230	2 481	15 958	4.7	2.8	4.9	0.4
Netherlands	384	1 070	23 559	63 111	2.3	1.5	2.6	0.1
Brazil	665	1 040	3 638	4 461	1.0	0.3	1.3	0.5
Hong Kong	196	894	27 291	94 792	3.4	2.1	4.0	0.6
Pakistan	74	666	458	1 910	5.0	2.0	4.0	1.7
Argentina	293	650	7 453	12 310	1.8	0.6	1.6	0.7
Sweden	268	641	30 130	73 678	2.0	1.3	2.6	0.0
Turkey	246	584	3 356	5 974	1.9	0.9	1.8	0.6
Norway	186	553	40 704	112 980	2.5	1.1	3.9	0.2
Belgium	247	512	23 844	50 091	1.6	1.3	1.7	0.0
Iran	129	483	1 825	4 579	3.0	1.0	3.6	0.9
Singapore	106	464	24 248	102 240	3.3	2.1	4.6	0.1
Ireland	122	452	30 197	90 470	3.0	1.1	4.7	0.5
Poland	195	431	5 063	13 059	1.8	1.6	2.6	-0.3
Switzerland	258	412	36 050	70 918	1.0	1.3	0.8	-0.5
Austria	207	375	25 492	50 838	1.3	1.3	1.4	-0.2
Egypt	117	370	1 563	2 904	2.6	1.0	1.7	1.2
Denmark	172	350	31 937	66 377	1.6	1.2	1.6	0.0
Finland	134	335	25 653	67 798	2.1	1.4	2.9	-0.1
Venezuela	120	312	4 505	7 476	2.1	0.5	2.1	1.0
South Africa	147	300	3 243	7 455	1.6	0.8	2.4	-0.3

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
Greece	136	296	12 388	30 160	1.7	1.8	1.2	-0.2
Bangladesh	59	265	385	1 041	3.4	1.7	2.1	1.1
New Zealand	61	255	15 540	56 515	3.2	1.8	3.7	0.3
Algeria	67	246	2 023	5 055	2.9	1.0	3.7	0.9
Portugal	111	241	11 012	26 699	1.7	1.6	1.3	-0.2
Colombia	97	227	2 125	3 363	1.9	0.4	2.4	0.9
Peru	63	212	2 263	5 158	2.7	0.8	3.0	0.9
Chile	89	196	5 511	8 989	1.8	0.5	2.4	0.7
Czech Republic	65	140	6 343	16 369	1.7	1.5	2.7	-0.4
Israel	122	115	18 250	11 513	-0.1	0.6	-4.2	0.9
Hungary	56	109	5 683	14 363	1.5	1.5	2.2	-0.6
Romania	48	108	2 168	5 979	1.8	1.8	1.6	-0.5
Kuwait	42	96	15 797	19 489	1.8	0.7	1.4	1.4
Syria	21	92	1 137	2 680	3.3	1.1	2.8	1.4

Table B8: Predictions (modeling of TFP, investment and education improvement)

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
Sri Lanka	20	79	1 007	3 745	3.2	2.5	2.0	0.2
Tunisia	24	63	2 420	4 873	2.1	0.9	2.5	0.6
Ecuador	20	53	1 458	2 815	2.2	0.6	2.6	0.7
Panama	14	48	4 204	9 241	2.8	0.8	3.4	1.0
Costa Rica	19	45	4 368	6 895	1.9	0.4	2.2	0.9
Guatemala	22	44	1 680	1 693	1.6	0.0	0.3	1.6
Cyprus	10	41	12 787	46 203	3.1	1.8	3.8	0.2
Bahrain	10	39	13 058	30 866	3.1	0.7	5.1	1.2
Nepal	6	36	237	703	4.0	1.7	2.9	1.5
Uruguay	20	35	5 804	8 454	1.2	0.5	0.9	0.4
Slovenia	22	35	11 216	22 053	1.0	1.0	2.3	-0.5
Dominican Rep	21	32	2 356	2 711	0.9	0.3	0.0	0.6
Cameroon	10	30	622	1 194	2.4	0.5	2.8	0.9
Bolivia	10	28	1 065	1 797	2.4	0.5	2.0	1.2
Congo	4	28	1 010	2 640	4.5	0.8	5.2	2.2
Bulgaria	16	27	2 048	5 138	1.2	1.8	1.5	-0.9
Iceland	10	27	33 810	81 115	2.2	1.3	2.4	0.3
Uganda	7	26	258	252	2.9	0.5	0.2	3.0
Kenya	12	26	350	589	1.8	0.7	1.3	0.7
Paraguay	8	22	1 343	1 833	2.2	0.6	0.8	1.5
Tanzania	12	22	318	321	1.3	0.3	-0.8	1.3
Papua New G	4	22	602	1 989	4.1	1.4	4.1	1.4
Congo. Dem. Rep.	5	21	92	139	3.2	0.4	2.6	2.2
Trinidad and T	10	19	7 779	15 808	1.4	0.9	2.8	-0.2
Honduras	7	19	960	1 496	2.2	0.4	1.9	1.2
Botswana	7	15	3 621	10 654	1.8	0.8	3.3	-0.6
Jordan	11	14	1 843	1 408	0.7	1.2	-5.0	1.3
Zambia	4	14	362	756	2.8	0.9	2.2	1.2
Ghana	6	14	289	344	1.7	0.6	-0.4	1.3
El Salvador	15	12	2 161	1 266	-0.3	0.3	-4.2	0.8
Jamaica	8	12	2 973	3 243	0.9	0.4	-0.2	0.7
Fiji	2	11	2 306	11 764	4.0	2.2	4.1	0.3
Mauritius	5	11	4 349	7 529	1.6	0.8	2.1	0.4
Zimbabwe	5	10	420	822	1.4	0.9	0.8	-0.1
Senegal	6	8	526	374	0.8	0.3	-2.3	1.6
Nicaragua	5	7	789	665	1.0	0.3	-1.8	1.4
Niger	2	6	173	114	2.3	-0.1	0.0	3.2
Mali	3	5	239	107	0.9	-0.2	-3.0	2.7
Malawi	2	4	152	165	1.8	0.5	-0.2	1.6

Country	GDP 2005 Billion $	GDP 2050 Billion $	GDP per capita 2005 $	GDP per capita 2050 $	Annual growth GDP 2005-2050	Annual growth TFP 2005-2050$	Annual growth Capital Stock 2005-2050	Annual growth Labor 2005-2050
Mozambique	6	4	285	134	-0.6	-0.1	-4.5	1.1
Togo	1	4	271	353	2.1	0.5	0.8	1.5
Haiti	4	3	412	244	-0.3	-0.1	-3.5	0.8
Benin	3	3	404	194	0.1	0.2	-4.9	1.8
Barbados	3	3	9 772	10 780	0.1	0.6	-0.2	-0.1
Rwanda	2	2	282	145	0.0	0.3	-4.7	1.5
Swaziland	2	1	1 417	1 361	-0.4	0.9	-4.5	-0.3
Sierra Leone	1	1	163	120	0.8	0.3	-2.3	1.5
Central Afr Rep	1	1	240	158	0.2	0.3	-3.4	1.1
Gambia	1	1	352	248	0.7	0.2	-2.4	1.5
Guyana	1	1	966	1 356	-0.2	0.6	-0.6	-0.9
Lesotho	1	1	568	426	-1.2	0.7	-5.0	-0.6
Guinea-Bissau	0	0	130	44	0.0	-0.2	-5.0	2.5

Table B9: Projections of GDP and GDP per capita at current US $ and current relative prices

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	Annual exchange rate change	Annual constant prices GDP growth rate
United States	36 854	93 323	11 100	38 100	0.0	2.8
China. People's Rep.	1 739	22 177	2 300	30 900	1.5	4.6
Japan	40 563	88 747	5 190	9 740	0.0	1.5
South Korea	13 764	147 897	663	6 870	1.2	4.1
India	612	4 417	671	6 760	0.8	4.5
United Kingdom	26 831	57 970	1 600	3 840	-0.2	2.1
Germany	22 291	48 537	1 840	3 840	-0.1	1.7
Philippines	1 116	21 665	92	2 750	1.5	6.1
France	23 010	39 701	1 400	2 550	-0.3	1.6
Thailand	2 724	31 115	175	2 400	1.4	4.6
Canada	24 754	55 325	791	2 160	-0.2	2.4
Malaysia	4 560	53 902	115	2 130	1.2	5.5
Indonesia	852	6 616	192	1 940	0.7	4.5
Italy	18 676	33 704	1 070	1 510	-0.3	1.0
Australia	22 269	58 671	447	1 500	0.0	2.7
Spain	14 704	32 324	606	1 210	-0.1	1.6
Hong Kong	27 151	125 336	195	1 180	0.6	3.4
Netherlands	20 819	57 013	339	967	-0.2	2.3
Pakistan	454	2 373	73	827	0.5	5.0
Mexico	5 554	5 860	591	822	-1.0	1.7
Singapore	23 709	129 479	104	588	0.6	3.3
Sweden	30 739	67 111	273	584	-0.1	2.0
Brazil	3 366	2 360	615	550	-1.2	1.0
Poland	5 484	14 684	211	485	0.2	1.8
Norway	40 697	96 360	186	472	-0.3	2.5
Turkey	3 511	4 747	257	464	-0.3	1.9
Belgium	23 299	43 821	241	448	-0.2	1.6
Argentina	6 700	7 407	263	391	-0.9	1.8
Ireland	30 430	76 113	123	380	-0.4	2.9
Iran	1 802	3 572	127	377	-0.5	3.0
Switzerland	35 023	64 025	251	372	-0.2	1.0
Greece	12 700	35 732	139	351	0.3	1.8
Austria	24 705	44 981	201	332	-0.2	1.3
Finland	25 559	63 570	134	314	-0.1	2.1
Denmark	31 584	58 749	170	310	-0.2	1.6
Bangladesh	388	1 163	59	296	0.2	3.4
Egypt	1 522	2 285	114	291	-0.5	2.6

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	Annual exchange rate change	Annual constant prices GDP growth rate
New Zealand	15 390	64 258	61	290	0.3	3.2
Portugal	10 069	25 667	101	232	-0.1	1.7
South Africa	3 297	5 629	149	227	-0.6	1.6
Algeria	2 017	4 017	66	196	-0.4	3.0
Venezuela	3 570	3 823	95	160	-1.3	2.1
Peru	2 291	3 759	64	155	-0.6	2.7
Romania	2 577	8 241	57	149	0.6	1.8
Czech Republic	6 156	15 978	63	137	0.0	1.7
Sri Lanka	1 013	5 986	20	127	1.1	3.2
Chile	5 496	5 803	89	127	-0.9	1.8
Colombia	1 916	1 830	87	124	-1.1	1.9
Hungary	6 184	15 479	61	117	0.1	1.5
Israel	16 331	7 009	109	70	-1.0	-0.1

Table B9bis: Projections of GDP and GDP per capita at current US $ and current relative prices

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	Annual exchange rate change	Annual constant prices GDP growth rate
Syria	1 003	1 984	19	68	-0.6	3.3
Kuwait	15 039	12 734	40	63	-0.8	1.8
Cyprus	12 688	52 802	10	47	0.3	3.1
Tunisia	2 397	3 659	24	47	-0.6	2.1
Nepal	222	718	6	37	0.0	4.0
Ecuador	1 407	1 826	19	34	-0.9	2.2
Bulgaria	2 247	6 303	17	33	0.4	1.2
Panama	3 761	5 949	12	31	-0.8	2.8
Bahrain	13 099	21 146	10	27	-0.7	3.1
Slovenia	10 626	16 557	21	26	-0.7	1.0
Iceland	34 409	76 901	10	25	-0.1	2.2
Costa Rica	3 853	3 750	17	24	-1.2	1.9
Congo	1 074	2 056	4	22	-0.5	4.5
Guatemala	1 523	788	20	21	-1.5	1.6
Uruguay	5 222	4 883	18	20	-1.0	1.2
Cameroon	663	809	11	20	-0.8	2.4
Papua New Guinea	530	1 684	3	19	-0.2	4.1
Bolivia	1 024	1 096	9	17	-1.0	2.4
Dominican Republic	2 125	1 420	19	17	-1.3	0.9
Kenya	324	375	11	17	-0.9	1.8
Uganda	251	157	7	16	-0.9	2.9
Fiji	2 364	16 480	2	16	0.7	4.0
Trinidad and Tobago	8 188	12 752	11	16	-0.4	1.4
Tanzania	354	209	14	14	-0.9	1.3
Congo. Dem. Rep.	94	87	5	13	-0.9	3.2
Jordan	1 833	1 238	11	13	-0.3	0.7
Paraguay	1 141	1 038	7	13	-1.2	2.2
Botswana	3 897	8 380	7	12	-0.6	1.8
Zambia	368	592	4	11	-0.5	2.8
Honduras	863	800	6	10	-1.2	2.2
Ghana	276	218	6	9	-0.9	1.7
Mauritius	4 542	5 677	6	8	-0.6	1.6
El Salvador	2 034	702	14	7	-1.1	-0.4
Jamaica	2 691	1 754	7	6	-1.2	0.9
Zimbabwe	291	433	4	5	-1.1	1.5
Senegal	523	213	6	5	-1.1	0.8
Nicaragua	713	352	4	4	-1.3	1.0
Niger	166	52	2	3	-1.6	2.2

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	Annual exchange rate change	Annual constant prices GDP growth rate
Malawi	146	99	2	3	-0.9	1.8
Mali	258	53	4	2	-1.5	0.9
Mozambique	339	77	7	2	-1.3	-0.6
Togo	248	203	1	2	-1.0	2.1
Barbados	8 868	6 595	2	2	-0.9	0.1
Benin	396	106	3	2	-1.2	0.1
Rwanda	306	91	3	2	-1.0	0.0
Haiti	326	96	3	1	-1.8	-0.3
Swaziland	1 354	993	1	1	-0.6	-0.4
Sierra Leone	172	72	1	1	-1.1	0.8
Central Af Republic	209	80	1	1	-1.4	0.2
Guyana	893	849	1	0	-1.0	-0.2
Lesotho	603	311	1	0	-0.6	-1.2
Gambia	345	136	1	0	-1.2	0.7
Guinea-Bissau	108	17	0	0	-1.9	0.0

Table B10-1: GDP and GDP per capita: level and growth decomposition between 2005 and 2050

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
United States	37 324	49 351	11 200	17 000	11 100	16 800	48 728	2.8	0.0
Japan	40 424	52 727	5 170	6 620	5 190	6 570	52 294	1.7	-0.1
China	1 417	2 895	1 870	4 140	2 300	6 020	4 215	5.4	1.1
Germany	23 430	31 666	1 930	2 610	1 840	2 450	29 793	2.0	-0.1
United Kingdom	27 199	37 066	1 620	2 310	1 600	2 200	35 271	2.4	-0.2
France	23 300	28 704	1 410	1 830	1 400	1 710	26 852	1.8	-0.4
Italy	19 813	26 172	1 130	1 420	1 070	1 280	23 636	1.5	-0.3
Korea. Rep.	13 340	26 410	643	1 320	663	1 670	33 469	4.9	1.4
Canada	25 898	36 717	828	1 290	791	1 200	34 084	3.0	-0.2
India	572	962	627	1 260	671	1 460	1 114	4.8	0.5
Mexico	6 033	7 334	642	918	591	705	5 636	2.4	-1.2
Spain	15 505	21 954	639	896	606	836	20 493	2.3	-0.1
Brazil	3 635	3 912	665	821	615	608	2 896	1.4	-1.5
Taiwan	14 720	n.a.	337	761	353	940	n.a.	5.6	n.a.
Australia	22 226	31 175	447	701	447	705	31 322	3.0	0.0
Russian Fed	2 481	4 964	351	640	412	785	6 081	4.1	0.3
Netherlands	23 546	32 882	384	558	339	493	29 050	2.5	0.0
Argentina	7 449	9 169	293	416	263	319	7 037	2.4	-1.1
Saudi Arabia	8 700	11 120	223	403	215	334	9 207	4.0	-1.0
Indonesia	816	1 479	184	386	192	435	1 666	5.1	0.5
Sweden	30 165	41 851	268	378	273	368	40 807	2.3	-0.3
Hong Kong	27 360	44 686	196	366	195	406	49 575	4.3	0.7
Turkey	3 355	4 039	246	346	257	320	3 732	2.3	-0.8
Belgium	23 869	31 464	247	330	241	307	29 256	2.0	-0.3
Thailand	2 485	4 570	159	329	175	427	5 944	5.0	1.1
Switzerland	36 028	46 108	258	319	251	300	43 391	1.4	-0.2
Norway	40 679	62 443	186	299	186	280	58 484	3.2	-0.4
Poland	5 051	7 393	195	280	211	305	8 055	2.4	0.0
Malaysia	4 436	8 794	112	278	115	335	10 597	6.2	1.1
Austria	25 531	34 288	207	275	201	255	31 808	1.9	-0.3
Philippines	1 128	2 339	93	240	92	297	2 893	6.5	1.5
Iran. Isl Rep.	1 830	2 698	129	234	127	206	2 376	4.0	-0.7
Ireland	30 302	50 244	122	229	123	213	46 741	4.3	-0.5
Denmark	31 869	41 241	172	225	170	213	38 927	1.8	-0.3
Singapore	24 275	44 236	106	213	104	227	47 199	4.8	0.6
Finland	25 651	35 906	134	190	134	184	34 810	2.4	-0.2

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
South Africa	3 241	4 344	147	190	149	169	3 877	1.7	-0.9
Greece	12 344	17 334	136	188	139	201	18 571	2.2	0.3
Venezuela. RB	4 492	5 419	120	180	95	120	3 605	2.7	-1.2
Egypt. A Rep.	1 558	1 765	117	171	114	150	1 553	2.6	-0.7
Pakistan	458	661	74	150	73	155	682	4.8	0.3
Portugal	11 040	14 687	111	146	101	132	13 323	1.8	0.0
Colombia	2 125	2 585	97	143	87	105	1 899	2.6	-1.4
Israel	18 285	16 270	122	133	109	101	12 377	0.6	-1.1
Chile	5 514	6 706	89	127	89	106	5 613	2.4	-1.2
United Arab Em	27 602	32 805	86	124	83	100	26 300	2.5	-1.2
Algeria	2 023	2 966	67	120	66	107	2 652	4.0	-0.7
New Zealand	15 532	24 422	61	105	61	110	25 615	3.7	0.4
Peru	2 262	3 111	63	105	64	93	2 747	3.4	-0.9
Bangladesh	385	486	59	95	59	96	490	3.3	0.0
Czech Republic	6 342	9 399	65	94	63	90	9 051	2.5	-0.1
Puerto Rico	n.a.	n.a.	71	93	64	70	n.a.	1.9	n.a.

Table B10-2: GDP level and growth decomposition between 2005 and 2050

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
Nigeria	411	519	54	92	54	77	432	3.7	-1.2
Vietnam	510	n.a.	43	86	45	106	n.a.	4.8	n.a.
Libye	7 409	11 370	43	84	45	77	10 364	4.6	-0.9
Ukraine	982	1 862	47	79	63	113	2 663	3.6	0.5
Hungary	5 684	8 357	56	76	61	82	8 961	2.1	-0.1
Kuwait	15 778	17 736	42	65	40	53	14 438	2.9	-1.0
Romania	2 170	2 999	48	64	57	79	3 700	1.9	0.3
Morocco	1 308	1 588	41	62	41	56	1 446	2.7	-0.6
Kazakhstan	1 917	3 817	30	59	40	84	5 469	4.7	0.3
Irak	n.a.	n.a.	31	47	30	41	n.a.	2.8	n.a.
Cuba	n.a.	n.a.	31	41	28	31	n.a.	1.9	n.a.
Oman	7 745	n.a.	23	40	23	35	n.a.	3.7	n.a.
Luxembourg	49 172	70 119	23	39	22	31	57 080	3.5	-1.2
Tunisia	2 419	3 283	24	38	24	33	2 868	3.1	-0.8
Syrian Arab Rep	1 137	1 497	21	38	19	30	1 206	3.9	-0.6
Slovak Republic	4 656	n.a.	25	33	27	35	n.a.	1.9	n.a.
Uzbekistan	612	1 020	16	33	15	27	839	4.8	-0.5
Ecuador	1 456	1 914	20	31	19	25	1 568	3.0	-1.1
Croatia	5 191	n.a.	23	31	24	32	n.a.	1.9	n.a.
Sri Lanka	1 006	1 433	20	30	20	35	1 643	3.0	0.9
Slovenia	11 215	15 785	22	30	21	26	13 484	2.0	-0.7
Costa Rica	4 360	5 491	19	29	17	21	3 985	3.0	-1.3
Myanmar	249	n.a.	13	29	13	35	n.a.	5.6	n.a.
Guatemala	1 683	1 556	22	28	20	19	1 086	1.6	-1.7
Belarus	1 702	2 764	17	26	18	30	3 215	2.9	0.4
Uruguay	5 817	6 717	20	25	18	19	5 056	1.6	-1.2
Dominican Rep	2 356	2 387	21	25	19	18	1 731	1.2	-1.4
Panama	4 220	5 706	14	23	12	18	4 454	3.6	-0.9
Yemen. Rep.	520	617	11	23	10	17	458	4.8	-1.3
Lebanon	5 135	4 643	19	20	19	18	4 006	0.4	-0.8
Bulgaria	2 049	2 944	16	20	17	23	3 316	1.6	0.2
Sudan	475	n.a.	17	19	17	16	n.a.	1.0	n.a.
Lithuania	4 641	n.a.	16	19	17	20	n.a.	1.3	n.a.
Bahrain	13 054	19 704	10	19	10	16	16 868	4.5	-1.1
Cyprus	12 755	19 835	10	17	10	18	20 584	3.5	0.3
Macao. China	n.a.	n.a.	8	17	8	21	n.a.	5.3	n.a.
Cote d'Ivoire	620	765	11	16	9	12	550	2.8	-1.2

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
Cameroon	623	759	10	15	11	13	669	2.6	-1.2
Afghanistan	n.a.	n.a.	8	15	8	17	n.a.	4.3	n.a.
Kenya	349	387	12	15	11	12	305	1.7	-1.1
Iceland	33 827	46 046	10	15	10	14	45 330	2.6	-0.2
El Salvador	2 167	1 827	15	15	14	11	1 388	0.0	-1.4
Trinidad and T	7 749	10 744	10	15	11	14	10 131	2.4	-0.8
Tanzania	319	292	12	15	14	13	261	1.2	-1.4
Bolivia	1 065	1 226	10	14	9	11	978	2.6	-1.2
Angola	1 004	n.a.	15	14	15	12	n.a.	-0.2	n.a.
Latvia	4 402	6 892	10	14	11	15	7 580	2.0	-0.1
Azerbaijan	1 016	1 364	9	14	8	12	1 201	3.0	-0.6
Jordan	1 850	1 727	11	13	11	12	1 598	1.4	-0.5
Réunion	n.a.	n.a.	10.2	12.8	10.3	10.7	n.a.	1.5	n.a.
Brunei	13 022	n.a.	4.9	11.8	5.1	14.6	n.a.	6.1	n.a.
Paraguay	1 342	1 358	8.3	11.4	7.0	8.2	975	2.2	-1.1

Table B10-3: GDP: level and growth decomposition between 2005 and 2050

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
Nepal	237	308	6.2	10.7	5.8	10.0	287	3.7	0.0
Honduras	961	1 103	7.0	10.4	6.3	7.6	804	2.7	-1.4
Estonia	5 244	9 354	6.8	10.2	7.6	12.5	11 508	2.8	0.6
Cambodia	309	n.a.	4.6	10.1	4.8	12.5	n.a.	5.4	n.a.
Uganda	258	210	7.1	9.8	6.9	7.9	170	2.1	-1.2
Ethiopia	110	92	8.1	9.7	8.0	7.9	75	1.1	-1.2
Jamaica	2 974	2 895	8.0	9.1	7.3	6.7	2 130	0.8	-1.4
Gabon	4 000	4 997	5.5	8.9	5.1	6.8	3 811	3.3	-1.3
Botswana	3 620	5 315	6.5	8.9	7.0	8.3	4 991	2.1	-0.9
Congo. Rep.	1 009	1 332	4.0	7.9	4.2	7.4	1 233	4.7	-0.9
Ghana	289	278	6.3	7.9	6.0	6.4	223	1.5	-1.1
Bosnia and Herz	1 384	n.a.	5.8	7.8	5.7	7.5	n.a.	2.0	n.a.
Congo. Dem. R	92	92	5.2	7.8	5.3	6.5	77	2.7	-1.3
Eq Guinea	8 206	10 478	4.3	7.7	8.2	11.9	16 204	4.0	-1.4
Bahamas. The	16 315	n.a.	5.2	7.5	5.2	7.2	n.a.	2.5	n.a.
Mauritius	4 353	5 361	5.4	7.4	5.7	6.7	4 865	2.1	-0.9
Pap New Guinea	602	871	3.6	6.8	3.2	5.7	731	4.3	-0.3
Turkmenistan	1 103	n.a.	5.5	6.3	5.4	5.6	n.a.	0.9	n.a.
Senegal	526	437	5.6	6.3	5.5	5.0	348	0.8	-1.5
Albania	1 543	n.a.	5.0	6.3	5.3	6.6	n.a.	1.6	n.a.
Zimbabwe	421	473	5.5	6.1	3.8	3.7	289	0.8	-0.8
Zambia	362	425	4.0	5.8	4.1	5.2	383	2.5	-0.8
Guinea	417	447	3.7	5.6	3.7	4.7	378	2.9	-1.2
Madagascar	240	205	4.4	5.5	3.8	4.0	148	1.5	-1.2
Nicaragua	790	690	4.5	5.3	4.1	3.9	502	1.1	-1.4
Mozambique	285	219	5.6	5.3	6.6	4.8	199	-0.4	-1.8
Namibia	1 991	2 218	4.1	5.1	3.8	3.9	1 713	1.5	-1.3
New Caledonia	n.a.	n.a.	3.0	5.0	2.9	5.0	n.a.	3.6	n.a.
Macedonia	1 861	2 292	3.9	5.0	3.5	4.4	2 031	1.8	-0.1
Lao PDR	376	n.a.	2.2	4.8	2.3	5.9	n.a.	5.3	n.a.
Malta	9 102	11 371	3.6	4.7	3.2	3.9	9 436	1.8	-0.3
Burkina Faso	245	180	3.4	3.9	3.5	3.4	157	0.9	-1.2
Georgia	834	812	4.2	3.7	5.1	4.1	903	-0.8	-0.5
Fiji	2 303	3 943	2.0	3.7	2.0	4.2	4 430	4.3	0.6
Mali	239	167	3.3	3.7	3.6	3.0	137	0.8	-1.8
Chad	296	260	2.7	3.6	3.1	3.5	249	2.0	-1.2
Tajikistan	246	456	1.6	3.5	2.2	5.1	660	5.6	0.3

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
Haiti	411	328	3.5	3.4	2.8	2.0	198	-0.3	-1.8
Armenia	1 003	1 056	3.1	3.1	4.0	4.2	1 421	0.1	0.2
Benin	405	296	2.9	3.0	2.8	2.3	231	0.3	-1.5
Barbados	9 789	10 498	2.7	3.0	2.4	2.3	8 139	0.7	-1.0
Niger	174	132	2.2	2.9	2.1	2.1	96	1.7	-1.8
Kyrgyz Rep	317	454	1.7	2.8	1.6	2.5	403	3.6	-0.5
Mongolia	447	n.a.	1.2	2.6	1.3	3.2	n.a.	5.3	n.a.
Rwanda	282	216	2.4	2.5	2.6	2.2	189	0.2	-1.4
Malawi	152	131	1.9	2.2	1.8	1.7	103	0.9	-1.3
Moldova	402	n.a.	1.7	2.2	1.8	2.3	n.a.	1.6	n.a.
Togo	271	259	1.4	1.8	1.3	1.4	196	1.7	-1.3
Belize	3 993	4 699	1.1	1.6	1.0	1.3	3 708	2.7	-1.3
Mauritania	383	332	1.2	1.5	1.2	1.2	276	1.6	-1.2
Swaziland	1 413	1 381	1.5	1.5	1.5	1.2	1 170	-0.3	-0.8
Eritrea	173	n.a.	0.8	1.1	0.8	0.9	n.a.	2.1	n.a.

Table B 10-4: GDP: level and growth decomposition between 2005 and 2050

Country	GDP per capita 2005	GDP per capita 2050	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP 2005 (billion $)	GDP 2050 (billion $)	GDP per capita 2050	Annual constant prices GDP growth rate	Annual exchange rate change
	Constant USD at 2000 prices				Current USD & current relative prices				
Central Afr Rep	240	192	0.9	0.9	0.8	0.7	134	-0.1	-1.5
Sierra Leone	163	129	0.9	0.9	0.9	0.8	109	0.2	-1.5
Libéria	n.a.	n.a.	0.7	0.9	0.7	0.7	n.a.	1.5	n.a.
Burundi	109	77	0.8	0.9	0.8	0.7	60	0.4	-1.2
Djibouti	903	n.a.	0.7	0.8	0.7	0.7	n.a.	1.8	n.a.
Lesotho	567	481	1.0	0.8	1.1	0.7	435	-1.6	-1.1
Guyana	966	1 060	0.7	0.8	0.7	0.6	832	0.4	-1.1
St. Lucia	4 566	4 709	0.7	0.8	0.6	0.5	3 257	0.8	-1.3
Cape Verde	1 419	1 106	0.7	0.7	0.7	0.6	951	0.0	-1.3
St. V and the G	3 117	5 040	0.4	0.7	0.3	0.7	5 169	3.7	0.8
Gambia. The	352	294	0.5	0.6	0.5	0.5	229	0.8	-1.5
Solomon Islands	570	n.a.	0.3	0.5	0.3	0.5	n.a.	3.7	n.a.
Comoros	284	215	0.2	0.2	0.2	0.2	169	0.5	-1.2
Guinea-Bissau	130	85	0.2	0.2	0.2	0.1	53	0.0	-1.9

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