World in 2050
The BRICs and beyond: prospects, challenges and opportunities

January 2013

pwc

Contents

1. Summary: the world in 2050

1.1. Key findings

The world economy is projected to grow at an average rate of just over 3% per annum from 2011 to 2050, doubling in size by 2032 and nearly doubling again by 2050.

China is projected to overtake the US as the largest economy by 2017 in purchasing power parity (PPP) terms and by 2027 in market exchange rate terms. India should become the third 'global economic giant' by 2050, a long way ahead of Brazil, which we expect to move up to 4th place ahead of Japan.

Russia could overtake Germany to become the largest European economy before 2020 in PPP terms and by around 2035 at market exchange rates. Emerging economies such as Mexico and Indonesia could be larger than the UK and France by 2050, and Turkey larger than Italy.

Outside the G20, Vietnam, Malaysia and Nigeria all have strong long-term growth potential, while Poland should comfortably outpace the large Western European economies for the next couple of decades.

1.2. Projections to 2050

This report updates our long-term global economic growth projections, which were last published in January 2011. These are based on a PwC model that takes account of projected trends in demographics, capital investment, education levels and technological progress.

Chart 1 shows estimated relative GDP growth rates for the 24 economies in the study over the whole 2011-50 period. We can see that emerging economies tend to grow at 4% per annum or more, while advanced economies grow at around 2% or less – we will continue to live in a two-speed world economy for some decades to come as a catch up process continues.

Chart 1: Breakdown of components of average real growth in GDP at PPP (2011 – 2050)
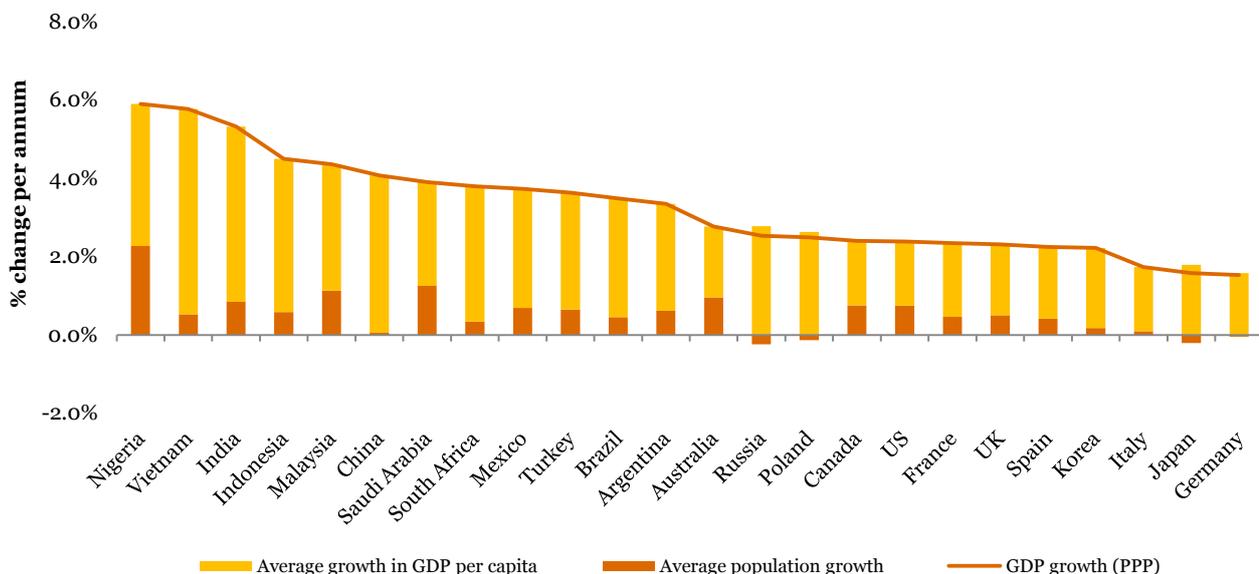
The changing league table of world GDP at PPPs is shown in Table 1 below. Selected countries are marked in bold to highlight notable changes in rankings over time.

Table 1: Actual and projected top 20 economies ranked based on GDP in PPP terms

	2011		2030		2050	
PPP rank	Country	GDP at PPP (2011 US$bn)	Country	Projected GDP at PPP (2011 US$bn)	Country	Projected GDP at PPP (2011 US$bn)
1	US	15,094	**China**	30,634	**China**	53,856
2	**China**	11,347	US	23,376	US	37,998
3	India	4,531	India	13,716	India	34,704
4	Japan	4,381	Japan	5,842	**Brazil**	8,825
5	Germany	3,221	Russia	5,308	Japan	8,065
6	Russia	3,031	**Brazil**	4,685	Russia	8,013
7	**Brazil**	2,305	Germany	4,118	**Mexico**	7,409
8	France	2,303	**Mexico**	3,662	**Indonesia**	6,346
9	**UK**	2,287	**UK**	3,499	Germany	5,822
10	Italy	1,979	France	3,427	France	5,714
11	**Mexico**	1,761	**Indonesia**	2,912	**UK**	5,598
12	Spain	1,512	Turkey	2,760	Turkey	5,032
13	South Korea	1,504	Italy	2,629	**Nigeria**	3,964
14	Canada	1,398	Korea	2,454	Italy	3,867
15	Turkey	1,243	Spain	2,327	Spain	3,612
16	**Indonesia**	1,131	Canada	2,148	Canada	3,549
17	Australia	893	Saudi Arabia	1,582	South Korea	3,545
18	Poland	813	Australia	1,535	Saudi Arabia	3,090
19	Argentina	720	Poland	1,415	**Vietnam**	2,715
20	Saudi Arabia	686	Argentina	1,407	Argentina	2,620

Source: World Bank estimates for 2011, PwC estimates for 2030 and 2050

However, even in 2050 average income per capita will still be significantly higher in the advanced economies than in the emerging economies – the current income gap is just too large to bridge fully over this period.

In contrast to recent arguments by Professor Robert Gordon and some other commentators[1] , we do not expect a significant slowdown in the global pace of technical progress given the scope for further major advances in areas like ICT, biotechnology and nanotechnology, although emerging economies like China and India will play an increasing role in these developments in future decades. This will further fuel their catch-up process with the more sluggish advanced economies.

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[1] As discussed further in Section 4.1 below.

1.3. Opportunities and challenges for business

These projected long-term growth trends pose many opportunities and challenges for businesses in the UK and other Western economies. China, India, Brazil and the other emerging markets highlighted in our study will become not just low cost production locations but also increasingly large consumer markets. At a time when trend annual growth is projected to be no more than around 2% in the advanced economies, companies seeking growth will need to look increasingly to these emerging markets.

At the same time, such markets can be challenging places to do business. It will be important to understand and adapt to local rules, regulations and customs. The right entry strategy and, where appropriate, the right joint venture partner(s) will be crucial, as will good relations with local government and regulatory bodies. In some cases, the optimal production locations may not be the same as the largest consumer markets (e.g. investing in Malaysia, Indonesia or Vietnam as a gateway to China or India, or in Poland as a gateway to Russia).

1.4. Energy use and climate change: too late for 2 degrees?

There are also important challenges for governments, not least regarding natural resource constraints such as those relating to energy use and climate change. As our analysis shows, a 'business as usual' approach based on our GDP growth projections could see global warming of 6°C or more in the long run, while the UN's 2°C objective seems increasingly out of reach given the lack of progress on decarbonisation since 2000.

A more plausible and affordable 'gradual greening' scenario might see decarbonisation at a rate sufficient to broadly offset the effects on emissions of economic growth, so leaving total global carbon emissions in 2050 at similar levels to today. But even this scenario would still be consistent with 4 degrees of global warming in the long run – it may already be too late for 2 degrees as our latest Low Carbon Economy Index report discusses in more detail.[2]

Such climate change will in itself create new opportunities for business, however, for example in mitigating the risks from severe weather events in parallel with developing new greener technologies.

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[2] http://www.pwc.co.uk/sustainability-climate-change/publications/low-carbon-economy-index.jhtml

2. Introduction

2.1. Background on the 2050 reports

In March 2006 we produced a report setting out projections for potential GDP growth in 17 leading economies over the period to 2050[3]. These countries were:

- The G7 (US, Japan, Germany, UK, France, Italy and Canada), plus Australia, South Korea and Spain among the current advanced economies; and

- the seven largest emerging market economies, which we refer to collectively as the 'E7' (China, India, Brazil, Russia, Indonesia, Mexico and Turkey).

There projections were updated in March 2008 and January 2011, expanding the country sample in the latter case to cover all of the G20 economies by adding Argentina, South Africa and Saudi Arabia. We also included Vietnam and Nigeria as potential fast-growing 'wild cards' outside of the G20.

We are now revisiting these long-term GDP projections two years on from our last report and extending the sample to include Poland (as the leading EU economy in the Central and Eastern European region) and Malaysia (as a potential fast-growing medium-sized economy within the Asia-Pacific region that may provide a suitable launch pad for some Western companies investing in the region).

Our analysis suggests that this group of 24 countries, which currently account for more than 80% of total world GDP, should include the 20 largest economies in the world looking ahead to the middle of this century.

2.2. Our modelling approach

We use World Bank GDP data up to 2011 and our own medium term projections for real GDP growth between 2012 and 2017. We then use our long-term economic model to estimate trend growth rates from 2018 to 2050. These longer term trend growth estimates are driven by the following key factors (see Appendix A for more details):

- Growth in the population of working age (based on the latest UN population projections).

- Increases in human capital, proxied here by average education levels across the adult population.

- Growth in the physical capital stock, which is driven by capital investment net of depreciation.

- Total factor productivity growth, which is driven by technological progress and catching up by lower income countries with richer ones by making use of the latter's technologies and processes.

The emerging economies have stronger potential growth than the current advanced economies on most of these measures, although it should be stressed that this assumes that they continue to follow broadly growth-friendly policies. In this sense, the projections are of potential future GDP if such policies are followed, rather than unconditional predictions of what will actually happen, bearing in mind that not all of these countries may be able to sustain such policies in the long run in practice.

There are, of course, many uncertainties surrounding these long-term growth projections, so more attention should be paid to the broad trends indicated rather than the precise numbers quoted in the rest of this report. The broad conclusions reached on the shift in global economic power from the G7 to the E7 emerging economies should, however, be robust to these uncertainties, provided that there are no catastrophic shocks (e.g. global nuclear war, asteroid collisions, extreme global climate change etc) that derail the overall global economic development process on a sustained basis. Such shocks should be distinguished from shorter term cyclical variations, which will inevitably occur to a greater or less degree in all economies, but should not materially alter underlying average trend growth rates over the four decade period that we are considered.

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[3] Some of our earlier World in 2050 series reports are available here: http://www.pwc.com/gx/en/world-2050/index.jhtml

2.3. What has changed since the January 2011 update?

We have made three main changes to the analysis since our last published update in January 2011:

1. We have updated historical data in the model so that the base year is now 2011 rather than 2009. Our medium term projections to 2017 also take account of the slowdown seen in most economies in 2011-12, although this does not have a large impact on the longer term trend growth rates projected by the model for the period beyond 2017.

2. We have added Malaysia and Poland to the analysis and include commentaries by senior PwC economists from these two countries in Section 3.4 below.

3. We have improved the way in which long-run exchange rate trends are modelled. A country's real exchange rate trend is still determined by convergence towards the PPP equilibrium rate as they grow richer, but the basis for this convergence assumption is now anchored more firmly in historic trends.

2.4. Structure of this report

The rest of the report is structured as follows:

- Section 3 summarises the key results of the analysis in terms of projected GDP levels, growth rates and average income trends to 2050.

- Section 4 discusses the potential obstacles to sustained long-term global growth, including in particular the challenge of high energy use and associated climate change risks.

- Section 5 highlights the implications for business of the projected growth trends.

Appendix A provides further details of our methodological approach, including the assumptions made on the key drivers of growth in the model.

Appendix B includes some additional results based on GDP at market exchange rates (MERs). This supplements the material in Section 3, which focuses more on the results for GDP at purchasing power parities (PPPs)[4].

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[4] The reason for focusing on GDP at PPP results is that this avoids uncertainties associated with projecting real exchange rates, as well as providing a better measure of relative living standards across countries. However, MER-based projections are relevant for many business applications, which is why we include more detail on these in Appendix B.

3. Key results

3.1. Relative size of economies

3.1.1. G7 versus E7

In this section, we look at how the relative sizes of different economies are projected by our model to change over time. As Chart 2 shows, our base case projections suggest that the E7 countries will be more than 50% larger than the G7 countries when measured by GDP at market exchange rates (MER) by 2050 and around 75% larger in PPP terms. In contrast, the E7 is currently just under half the size of the G7 economies based on GDP at MERs and just over 80% of the size of the G7 based on GDP measured in PPP terms.

*Chart 2: Relative size of G7 and E7 economies: 2011 and 2050*
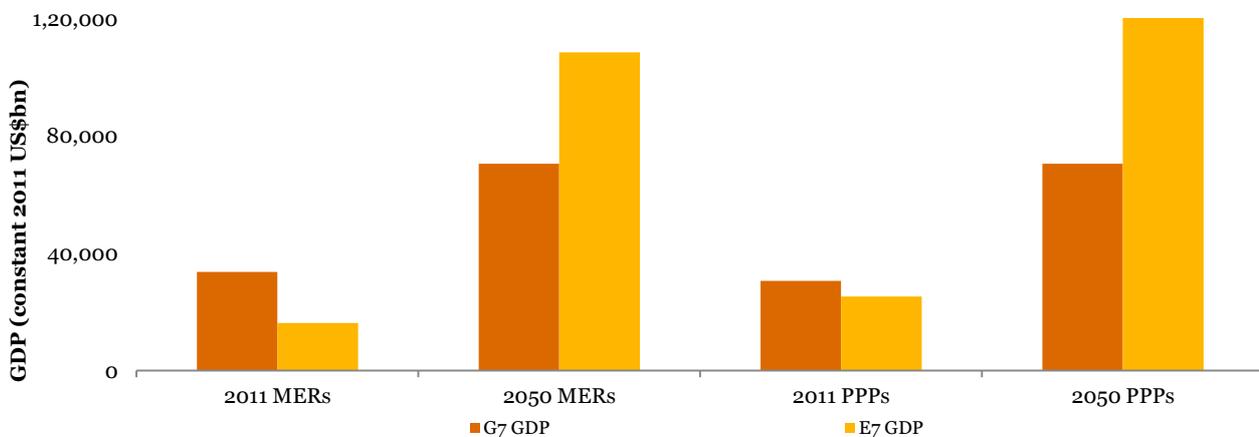
Chart 3: E7 and G7 growth paths in PPP terms
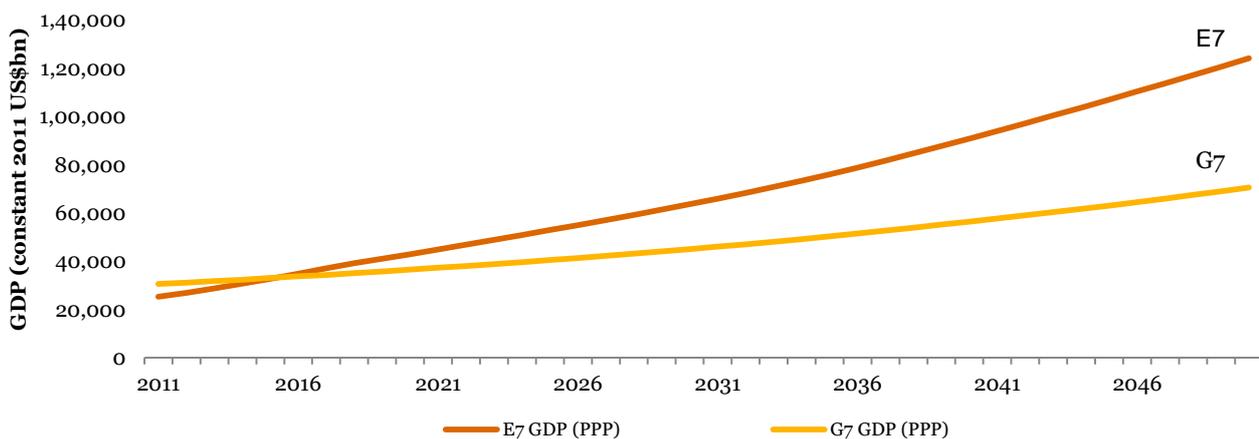
Chart 3 shows that:

- The E7 countries could overtake the G7 countries as early as 2017 in PPP terms. This rapid convergence between these two groups of economies has been accelerated by the fact that the developed countries have been much slower to recover from the recession of 2008-9, whilst the emerging economies have been relatively insulated despite some slowdown in 2011-12.

- The gap between the E7 and G7 countries is projected to continue to widen after 2017 - the E7 countries could potentially be around 75% larger than the G7 countries by the end of 2050 in PPP terms.

Chart 4, which shows the growth paths of the E7 and the G7 in MER terms, paints a similar picture, with the exception that the year in which the E7 overtakes the G7 is pushed back to around 2030, rather than 2017. This is because price levels in the E7 economies are, on average, still well below G7 levels when compared using current market exchange rates – in other words, MERs in the E7 economies are well below purchasing power parity (PPP) levels.

Chart 4: E7 and G7 growth paths in MER terms
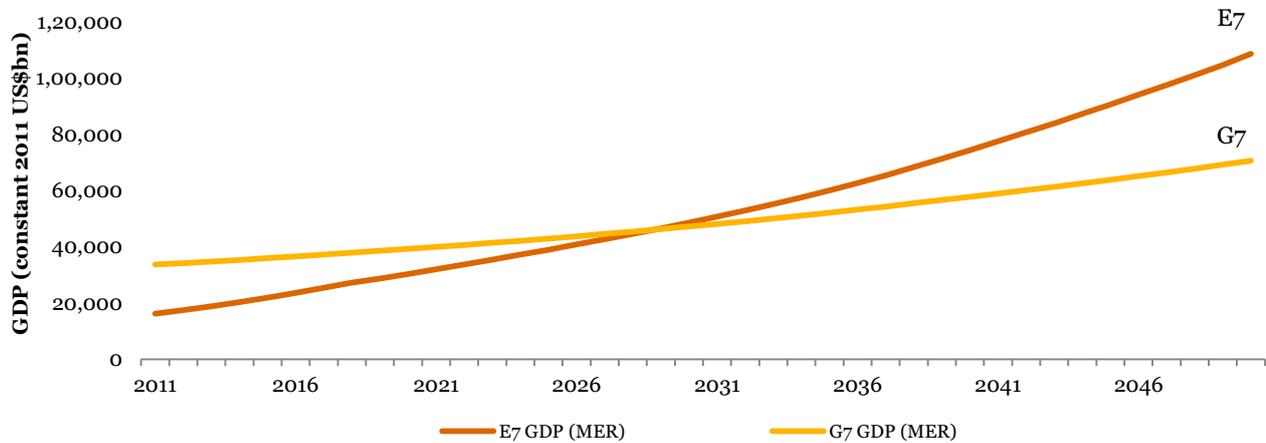
This is a commonly observed phenomenon for emerging economies, but past experience with previously fast-growing countries such as Japan in the 1960s to 1980s or South Korea in the 1970s to 1990s suggests that MERs do tend to converge gradually with PPP rates as economic development continues. This could occur either through nominal exchange rate appreciation, or through relatively high domestic price inflation in the emerging economies, but in either case the result is likely to be long-run real currency appreciation. This effect[5], based on an econometric equation estimated from past data, is incorporated in our model and forms the basis for our projections of GDP in MER terms as shown in Chart 4 above.

However, these real exchange rate projections are highly uncertain in practice, so we put more weight on the PPP results in the rest of this section, with further details on the MER results being included in Appendix B given that these are relevant for many business applications.

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[5] In the academic literature, this is referred to as the Balassa-Samuelson effect and is driven by relatively high productivity growth in the tradables sector feeding through to higher labour cost inflation in the non-tradables sector of emerging economies.

3.1.2. China, US and India likely to be dominant global economies by 2050

Much of the growth that we project to take place within the E7 economies will be driven by China and India. By 2050, China, the US and India are likely to be by far the three largest economies in the world as Chart 5 below illustrates.

Chart 5: Relative GDP at MERs and PPPs in 2050 (as % of US level)
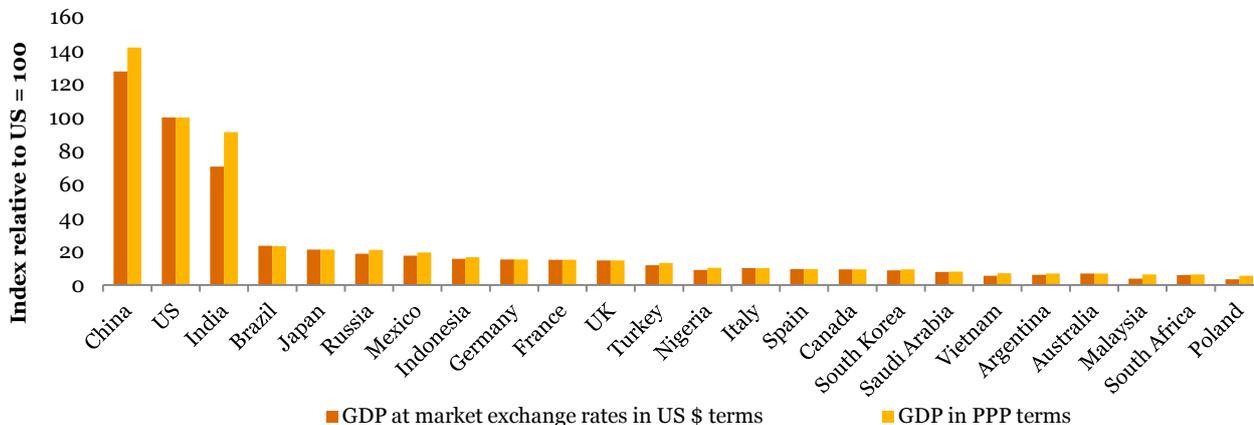
Our model suggests that China could overtake the US by 2017 in PPP terms, and by around 2027 in MER terms (see Chart 6). The MER estimate is, however, subject to our assumptions on the pace of convergence of China's MER with its estimated PPP exchange rate, which we consider to be plausible but nonetheless subject to significant uncertainty.

Chart 6: Projected GDP growth paths of China and the US
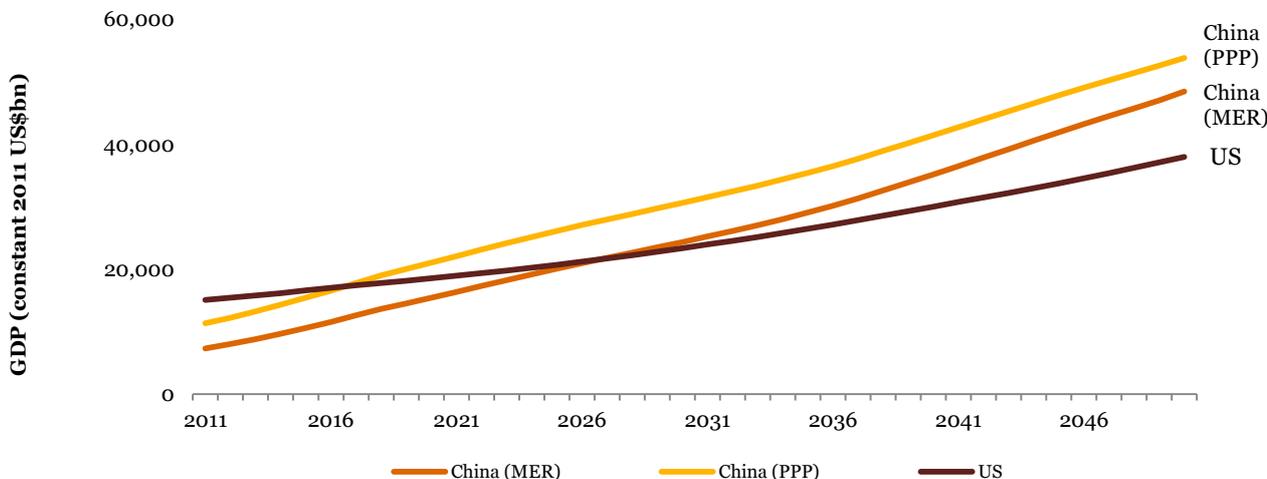
China's growth rate is expected to meet the government's new 7% target for the current decade, but will cool down progressively during the period 2021 – 2050 as its economy matures. A rapidly aging population and rising real labour costs are expected to see China transition from being an export-orientated economy to more of a consumption driven economy. Western companies are also likely see a change in the way they do business in the region – rising costs will mean that many off-shored jobs are likely to exit China over time for other cheaper economies such as Vietnam and Indonesia, whilst Chinese exporters will find themselves competing more on the basis of quality rather than price in their key US and EU export markets.

3.1.3. Beyond the top 3 countries

Table 2 summarises our projections for the largest 20 economies in 2011, 2030 and 2050, measured by GDP at PPPs. Selected countries are highlighted in bold in the table to make the evolution of their GDP rankings over time clearer.

Table 2: Actual and projected top 20 economies ranked based on GDP in PPP terms

	2011		2030		2050	
PPP rank	Country	GDP at PPP (2011 US$bn)	Country	Projected GDP at PPP (2011 US$bn)	Country	Projected GDP at PPP (2011 US$bn)
1	US	15,094	**China**	30,634	**China**	53,856
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12	Spain	1,512	Turkey	2,760	Turkey	5,032
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18	Poland	813	Australia	1,535	Saudi Arabia	3,090
19	Argentina	720	Poland	1,415	**Vietnam**	2,715
20	Saudi Arabia	686	Argentina	1,407	Argentina	2,620

Source: World Bank estimates for 2011, PwC estimates for 2050

As well as the rise in China and India already noted, another notable development projected by our model is that Mexico and Indonesia could rise to be amongst the top 10 largest economies - ranking 7th and 8th respectively by 2050 in terms of GDP at PPPs. Russia could overtake Germany well before 2030 to become the largest European economy, but in the global rankings might then be overtaken itself by Brazil before 2050. Nigeria and Vietnam are projected to move into the top 20 by 2050 at 13th and 19th place respectively. Malaysia remains just outside the top 20 given its relative small population compared to the other emerging economies considered here, but nonetheless has strong growth potential as explore further in Section 3.4.2 below.

The UK is expected drop from 9th to 11th place by 2050 given that it is a relatively mature and advanced economy, although it holds its place relatively well against other advanced economies, in part due to relatively favourable demographics by EU standards. By contrast, less favourable demographics holds back Polish growth after 2030, although it should continue to grow relatively strongly for at least the next two decades as discussed further in Section 3.4.1 below.

3.2. Relative GDP growth

Chart 7 shows the annual average real GDP growth rates measured in PPPs[6] for each country for the period from 2011 to 2050, and the contribution to this from average growth in GDP per capita (which can be interpreted as growth in labour productivity) and the average population growth rate over this period.

Chart 7: Breakdown of components of average real growth in GDP at PPPs (2011 – 2050)
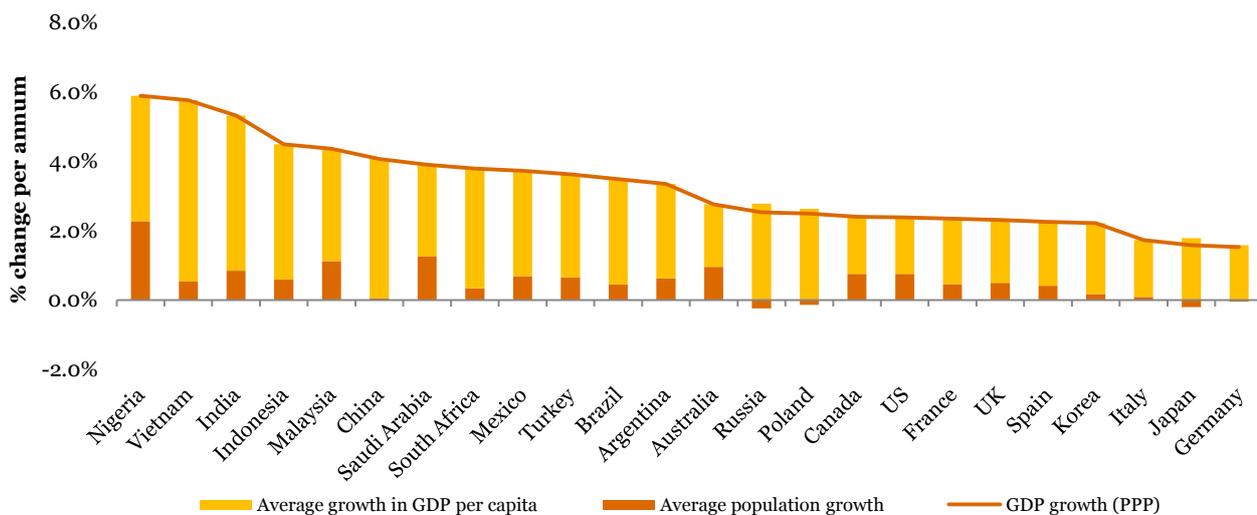

Chart 7 shows that:

- Emerging economies are set to grow much faster than those of the G7 and other current advanced economies for the next four decades.

- Nigeria could be the fastest growing country in our sample due to its youthful and growing working population, but this does rely on using its oil wealth to develop a broader based economy with better infrastructure and institutions (e.g. as regards rule of law and political governance) and hence support long term productivity growth – the potential is there, but it remains to be realised in practice.

- Vietnam is also a potential fast growing economy, although it needs a stronger macroeconomic policy framework to sustain rapid growth in the longer term.

- India, Indonesia and Malaysia also have strong growth potential in the Asian region, both due to their own momentum and the pull from the large Chinese economy (see Section 3.4.2 below for more details on Malaysia).

- As noted above, China's growth rate is expected to cool down after 2020 as its economy matures. Increases in labour productivity will be the main driver of its growth beyond 2020, as the age structure of China's population becomes increasingly less youthful (accentuated by its one child policy for the past 30 years). However, Chinese growth should remain around 3-4% per annum even in the 2040s, still some way above projected US or EU levels.

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[6] We assume that PPPs remain constant in real terms, so that these projections are identical to those for real GDP growth in domestic currency terms. Appendix B contains corresponding MER-based growth projections including estimated real exchange rate changes against the US dollar.

- Many of the current advanced economies will experience extremely low population growth – indeed Japan and Germany will actually experience negative population growth on average during the period to 2050 (this is also true of Russia and, as discussed further in Section 3.4.1 below, Poland).

3.3. Relative income levels

Chart 8 below shows projected GDP per capita in PPP terms for the G7 and E7 economies. Although the E7 countries are set to overtake the G7 countries in terms of their overall size and rates of growth, they are still expected to trail significantly behind the G7 countries in 2050 in terms of GDP per capita.

Chart 8: GDP per capita levels in PPP terms for the G7 and E7 economies
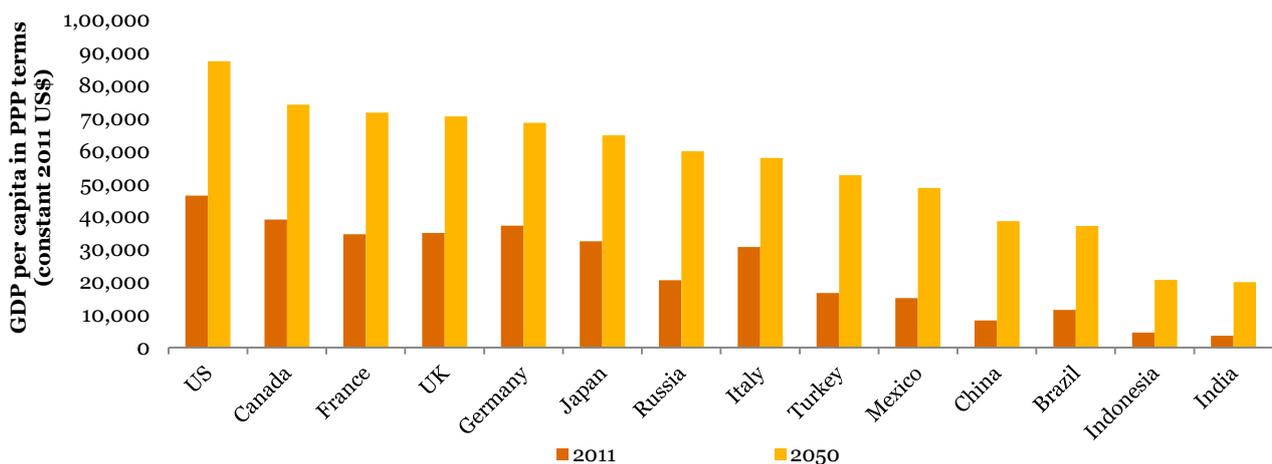
The US is projected to retain its top spot in this group on average income levels in 2050, whilst large emerging countries such as China, Brazil, Indonesia and India still sit at the bottom of the income table. However, the GDP per capita differentials between the two groups of countries are projected to close significantly (e.g. China's GDP per capita as a proportion of US levels is expected to increase from 18% in 2011 to 44% in 2050). The UK is ranked fourth within the G7 countries in terms of projected GDP per capita in 2050, behind the US and, to a much lesser degree, also Canada and France, but still quite highly placed on this measure in global terms.

This analysis makes clear why Western companies should not abandon their home markets in the US and EU, even if these are growing much more slowly on average than the emerging economies. For higher valued products and services, the US and EU markets will still remain attractive locations given their more affluent consumers, although emerging market multinationals can expect to achieve an increasingly strong position in these markets over time as they move up the value chain.

3.4. Focus on Poland and Malaysia

In this edition of the World in 2050 report, we take a deeper look at Poland and Malaysia, which have been added to the study for the first time. The following commentaries are by senior PwC economic experts in these two countries.

3.4.1. Commentary on long-term growth projections for Poland

According to our model projection, Polish GDP will grow at an average real rate of around 2.5% per annum over the period to 2050. This may seem somewhat low given that the average growth rate of the Polish economy since the introduction of market reforms in 1990 has been 3.3% per annum. Taking into account this historical perspective, a growth rate below 3% is generally perceived as disappointing for Poland. Another reason for this perception is that past experience suggests that employment in Poland only starts to rise (on average) when the GDP growth rate exceeds 3%.

On the other hand, past economic research shows that, as an economy gets richer, its growth potential may tend, others things being equal, to decrease. At the beginning of the reform process in 1990, Polish GDP per capita was only 8% of German levels at the market exchange rates of the time and only around 32% in PPP terms after adjusting for price level differences: the corresponding current ratios are 30% and 54% respectively.

There is also a general belief that the post-crisis performance of key Polish export markets in the EU will not be as successful going forward as was the case before 2008.

So, in this context, is a projected long-term average growth rate of around 2.5% until 2050 really so disappointing? Let's look at Polish performance in relative terms compared to Germany (see Chart 9 below).

Chart 9: Projected real GDP growth rates for Poland and Germany (% per annum)
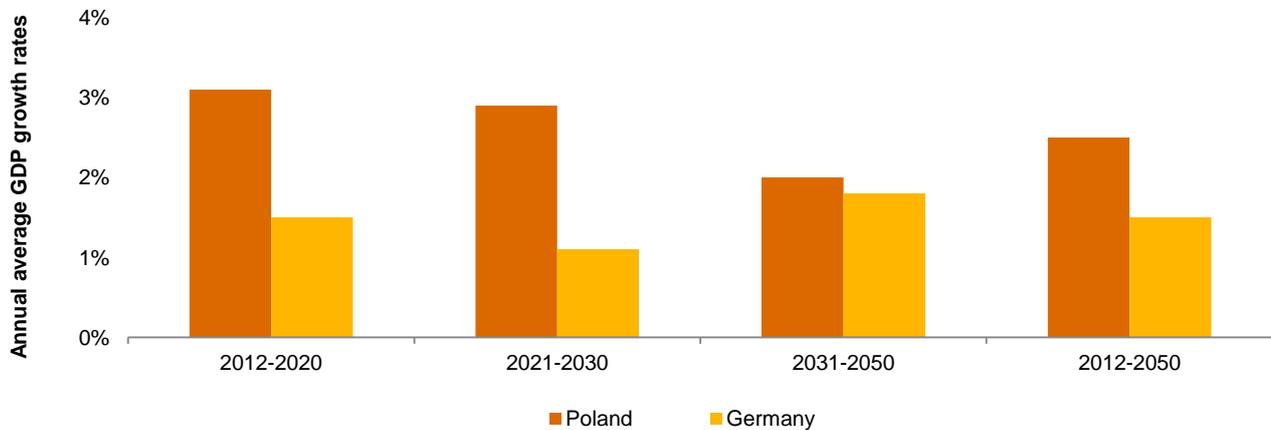
These long-term growth projections can be divided into two periods: before and after 2030. In the earlier period up to 2030, the rate of growth projected for Poland is significantly higher than that for Germany. The average Polish rate is actually projected to be around 3% per annum, only slightly below its historic average since 1990. The break comes in the decades after 2030 when Polish growth rates converge much more closely with those of Germany, while remaining slightly higher. Over the whole period to 2050, however, Polish growth is around 1 percentage point per annum higher than in Germany, which leads to a significant cumulative growth difference (almost 50% in total over the four decades to 2050).

The relatively strong growth potential of the Polish economy over the next 20 years relative to Germany (and indeed other major Western European economies such as the UK and France) results from a number of factors.

First, despite past progress, Poland is still a relatively poor country compared to Germany, while at the same time enjoying full integration with the large EU market. What is even more important, in particular as EU economies have run into trouble in recent years, is that Poland's EU membership provides both actual and perceived institutional stability in terms of factors such as rule of law and political accountability. This means that Poland should remain a relatively fast growing and stable place to invest for many years to come.

Second, the Polish economy is still seriously restructuring. The share of employment in agriculture remains comparatively high at around 12% and this number will be gradually reduced over time, so improving overall average productivity. Tertiary education enrollment in Poland is amongst the highest in the EU, so increasing the probability that the share of skilled and technology intensive production will be increase in the Polish economy. Additionally, at least until 2020, EU funds will continue to flow into Poland, supporting the infrastructure and innovation potential of the country.

The model projections point to a risk that trends could be less favourable after 2030, as the rate of economic growth may slow down and Poland could practically stop catching up with its biggest EU neighbor. Demography is the most fundamental factor here. The number of Polish people of working age (15-64) in 2035 is projected to be 14% below the current figure. Poland has one of the lowest fertility rates in the EU (1.3) and it is still not a sufficiently attractive location to be able to fill this gap with immigration (in fact, Poland is still experiencing net emigration at present, although this could change gradually as its relative income levels increase).

Additionally Poland's long run growth potential could be limited by a relatively low propensity to save. A significant proportion of investment in Poland in recent years has been financed by inflows of foreign capital. The average current account deficit of the Polish economy since 2004 was 4.5% of GDP, but despite this total national investment was of only 21.4% of GDP (as compared to 23.8% in Germany). This is not sustainable if Poland wishes to remain a relatively high growth economy in the long run.

The key message from the analysis is therefore that levels of both national savings and investment will have to increase if the Polish economy is to continue its catch-up process beyond 2030. The power of convergence will only be enough for the next couple of decades.

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3.4.2. *Commentary on long-term growth projections for Malaysia*

The Malaysian economy grew at a steady pace of 5.1% in 2011. Growth was driven by expansion in domestic demand, attributed mainly to household spending and business investment. The 10th Malaysia Plan, which guides the medium-term development of Malaysia from 2011 to 2015, has targeted annual real GDP growth of 6% for the five-year period. Similarly, the Malaysian Government has embarked on an Economic Transformation Programme (ETP) which targets annual real GDP growth of 6% to 2020.

Accordingly, we discuss in this short commentary why we believe that, if government plans can be delivered, Malaysia's growth rate has the potential to outperform the model results, which show 5% average real GDP growth up to 2020 (which is similar to the latest IMF medium term projection to 2017) and around 4.4% real growth for the whole period to 2050.

The Malaysian government has embarked on a major drive consisting of capacity building as well as structural transformation initiatives based on the New Economic Model (NEM). The NEM lays out an overall framework to transform Malaysia from an upper middle income to a high income and fully developed nation by 2020.

In 2010, the Malaysian Government launched two complementary transformation programmes: the ETP and the Government Transformation Programme (GTP). The ETP consists of two parts – the first part is the identification by private and public sector participants of 12 National Key Economic Areas (NKEAs)[7], which are sectors with significant growth opportunities where Malaysia can compete globally. Entry Point Projects (EPPs) have been identified within these 12 NKEAs to spur growth and act as catalysts for investment and growth. This represents the demand side of the ETP. At the same time, 7 Strategic Reform Initiatives[8] (SRI) have been introduced to complement the demand side measures by increasing the competitiveness and growth potential of the Malaysian economy.

Beyond 2020, a good case could be made for continued Malaysian outperformance of the model projections based on three key factors:

1. Malaysia is reaching out to global talent and its own large diaspora through active talent attraction programmes and a commitment to increasing the vibrancy and livability of its key urban areas.

2. The expectation is that a strongly growth-friendly policy environment will continue well beyond 2020.

3. Moving up the value chain, including developing the capacity to innovate, could drive continued strong labour productivity growth in excess of the 3.4% rate projected by the model in 2021-50.

These transformational efforts are showing some early fruits of success – in recent global economic surveys and studies, Malaysia has consistently shown rapid improvement:

1. The World Bank's 2013 Doing Business report showed Malaysia improving to 12th position out of 185 economies, with key highlights including strong investor protection.

2. The World Economic Forum's Global Competitiveness Report 2012-13 ranks Malaysia in the top 10 Asia-Pacific countries and includes a reclassification of Malaysia from an efficiency-driven economy to one transitioning towards an innovation-driven economy.

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[7] Greater KL/KV, Oil and Gas, Financial Services, Education, Tourism, Business Services, Wholesale and Retail, Agriculture, Electrical & Electronics, Communications, Healthcare and Palm Oil & Rubber.

[8] Government's Role in Business, Public Finance Reform, Human Capital Development, Competition, Standards and Liberalisation, Public Service Delivery, Narrowing Disparities and Natural Homes.

4. Potential obstacles to sustainable growth and the climate change challenge

4.1. Potential obstacles to sustainable growth

The growth projections outlined above assume no major global catastrophes and that countries continue to follow broadly growth-friendly policies. Clearly, however, there are many uncertainties surrounding such long-term projections and many challenges that need to be overcome to achieve sustainable global growth at the 3%+ average trend rates indicated by our model.

Some of the risks to the projections relate to economic assumptions in the model. In particular, there could be:

- Diminishing returns to capital investment in emerging economies such as China, as has occurred in the past for Japan: this is already factored into the model to some degree, but could prove to be a more significant effect than we assume, particularly if methods of allocating capital are not improved in emerging economies like China and India, where state banks continue to play a dominant role.

- A slowdown in the rate of progress at the technological frontier, as represented by the US in the model: this has been argued to be a risk by Gordon (2012)[9] , although it seems rather at odds with the accelerating pace of change in ICT and the potential for further rapid progress in areas like nanotechnology and biotechnology over the coming decades. It is possible that measured GDP growth could slow down due to difficulties in measuring technology-related improvements in the quality of some services, but we have not considered this in our model since it would not represent a slowdown in the underlying economic output variable that GDP seeks, however imperfectly, to measure.

- Greater protectionism leading to slower catch-up rates for emerging economies in particular. This is always a concern, but so far recent trends suggest that politicians recognise that moving too far in that direction would be self-defeating in the long run, as economies that cut themselves off from global trade and investment tend to grow more slowly in the long run.

Another key challenge, however, relates to potential natural resource constraints on sustainable long-term global growth. In the discussion below, we focus on energy use and climate change as this is most readily quantifiable topic within the framework of our model, but other areas like water, food and biodiversity are clearly also important.

4.2. Energy use and climate change: too late for 2 degrees?

In previous reports in the World in 2050 series[10] we have extended our GDP model to derive projections for energy use and carbon emissions in alternative policy scenarios. This extended model has also been used as the basis for the PwC Low Carbon Economy Index, the latest edition of which was published in November 2012[11]. We have updated these calculations to produce three possible scenarios for global carbon emissions and atmospheric concentrations of greenhouse gases as summarised in Table 3 below.

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[9] R.J. Gordon, 'Is US Economic Growth Over? Faltering Innovation Confronts the Six Headwinds', NBER Working Paper No. 18315, August 2012.

[10] http://www.pwc.com/gx/en/world-2050/rapid-global-growth-moving-to-a-low-carbon-economy.jhtml

[11] http://www.pwc.co.uk/sustainability-climate-change/publications/low-carbon-economy-index.jhtml

Table 3: Three possible scenarios for global energy use and carbon emissions

Average global growth rates (% per annum: 2012-50)	Business as usual scenario	Gradual greening scenario	Green growth scenario
1. GDP	3.1	3.1	3.1
2. Energy intensity	-0.8	-1.4	-2.5
3. Primary energy consumption (= 1 +2)	**2.3**	**1.7**	**0.6**
4. Greener fuel mix effect	0.0	-1.2	-2.0
5. Carbon emissions without CCS (= 3+4)	**2.3**	**0.5**	**-1.4**
6. Carbon capture and storage (CCS) effect	0.0	-0.3	-0.6
7. Carbon emissions with CCS (=5+6)	**2.3**	**0.2**	**-2.0**
8. Implied decarbonisation rate (=1-7)	**0.8**	**2.9**	**5.1**
Atmospheric concentration of greenhouse gases (CO2e parts per million, projected in 2100)	c.1200 ppm	c.700 ppm	c.450 ppm
Long term temperature rise (degrees centigrade)	c.6˚C	c. 4˚C	c. 2˚C

Source: PwC analysis (last two rows are approximate estimates only based on IPCC AR4 report ranges)

The first 'business as usual' scenario projects forward the experience of the 2000-11 period when total global decarbonisation averaged just 0.8% per annum. This was largely due to energy intensity improvements with little progress on a greener fuel mix (and no CCS). This is a pessimistic scenario but could put the world on the path to catastrophic climate change by the end of the century[12].

Our third 'green growth' scenario in the final column of Table 3 is what would be required to keep to the UN target of limiting global warming to around 2˚C – this now requires decarbonisation of over 5% per annum up to 2050, which strains credibility given the lack of progress since 2000 and the generally disappointing outcome of global climate change talks since 2009.

A somewhat more realistic, but still challenging, case is our 'gradual greening' scenario. This assumes energy intensity improvements at around twice the average rate seen since 2000, significant progress on shifting from coal to gas in China and India and, in the longer run, to renewable fuels across the world by 2050, as well as a gradual phasing in of CCS from 2020 onwards. Past studies suggest that this kind of programme, if phased in gradually, should not reduce global GDP in 2050 by more than around 2-3% of GDP, but it does require much greater commitment from all major economies around the world to achieve such an outcome than we have seen in recent years. Even in this case, we might see an eventual rise of global temperatures by around 4˚C, which could have major economic, social and environmental impacts, but would at least stop short of the more catastrophic long-term outcomes that become increasingly likely in the business as usual scenario.

The alternative to decarbonisation would be much slower GDP growth, but the long run price of this would be much higher. The risk is that, if faster progress towards addressing climate change does not begin soon, such restrictions on growth could be forced on future generations. There seems less risk of this due to running out of fossil fuels, given recent increase use of unconventional resources such as shale gas and shale oil (the latter will be the subject of a detailed new PwC research report to be published later in 2013).

Similar considerations apply to other natural resource issues relating to areas such as food, water and biodiversity – acting now in a measured way should be cheaper in the long run than putting off action until later in the century; but in a time of economic austerity in the West and rapid economic development in the East, this is easier said than done. Exploring these issues in detail is, however, beyond the scope of the present report[13].

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[12] Or possibly earlier given the probable rise in the frequency of extreme weather events associated with global warming.

[13] This broader suite of sustainability issues was discussed in detail in the 'Vision 2050' report of the World Business Council for Sustainable Development (WBCSD) to which PwC was a major contributor: http://www.wbcsd.org/vision2050.aspx

5. Implications for businesses

5.1. Opportunities and challenges for Western companies

For companies in the advanced Western economies (the US and the EU in particular), there are clearly both challenges and opportunities associated with our global growth projections. Table 4 below summarises some of these from the perspective of Western companies looking at expanding into emerging economies over the next ten years (looking beyond this timeframe is difficult at the sectoral level).

Table 4: Opportunities and challenges in emerging markets

Opportunities for:	Challenges for:
• Retailers with strong franchise models • Global brand owners • Business and financial services • Creative industries • Healthcare and education providers (e.g. top UK universities) • Niche high value added manufacturers	• Mass market manufacturers (both low-tech and increasingly hi-tech as China and others move up market) • Financial services companies exposed in their domestic markets • Companies that over commit to emerging markets without the right local partners and business strategies

Source: PwC assessment (based on analysis for the UK but potentially applying to advanced Western economy companies more generally)

However, it is difficult to be precise about picking winners and losers at the sectoral level – much will depend on the details of the particular market and how well the company's entry strategy is executed. The higher risks associated with emerging markets also need to be factored into project appraisals and acquisition valuations, as detailed in PwC's quarterly country risk premia analysis[14].

5.2. Increased focus on emerging consumer markets

A recent analysis in our Global Economy Watch report for December 2012[15] throws some further light on this by distinguishing for the period to 2020 between those economies that will remain more focused on low cost production (e.g. Vietnam and Indonesia) and those, such as China, Brazil and Russia, that will become increasingly important as consumer markets as real wages increase and probably also real exchange rates appreciate according to our model.

At the same time, large markets such as China and India can be challenging places to do business. It is important to understand and adapt to local rules, regulations and customs. The right entry strategy and, where appropriate, the right joint venture partner(s) are crucial to success, as are good relations with local government and regulatory bodies. In some cases, the optimal production locations may not be the same as the largest consumer markets (e.g. investing in Malaysia, Indonesia or Vietnam as a gateway to China or India, or in Poland as a gateway to Russia).

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[14] http://www.pwc.co.uk/the-economy/issues/country-risk-premia-quarterly-update.jhtml

[15] http://www.pwc.co.uk/economic-services/global-economy-watch/report.jhtml

Appendices

Appendix A. Drivers of growth

A.1. Model structure

In line with established economic theory and a large number of previous research studies, we adopt a simplified model of long-term economic growth[16] in which the shares of national income going to capital and labour are assumed to be constant[17]. GDP growth in this model is driven by assumptions on four factors, which we discuss in turn below:

- Growth in the labour force, as proxied by UN projections for working age population.

- Growth in the quality of labour ('human capital'), which is assumed to be related to current and projected average education levels in the workforce.

- Growth in the physical capital stock, which is determined by new capital investment less depreciation of the existing capital stock.

- Technological progress, which drives improvements in total factor productivity (TFP).

In addition, as noted above, the model also makes assumptions about future trends in real market exchange rates relative to PPP rates (see Section A2 below for further details).

In applying this approach we take the US as our benchmark economy, as this is assumed to be at the 'global frontier' in terms of technology and so productivity. US GDP growth is modelled in a somewhat simpler manner based on assumed labour productivity growth of 2% per annum and UN working age population projections. As described further below, other countries are then assumed to catch up gradually with US productivity levels over time (at rates that vary by country depending on their circumstances).

One limitation of our model that is worth noting up front is that, although it does allow for linkages between country performance due to shifts in the global technological frontier, it does not allow for performance in one country (except the US) to affect performance in other countries directly. Capturing these inter-linkages would require a much more complex modelling approach covering trade and investment flows between countries. Our approach limits the value of the model for global simulation purposes, but is much more tractable for the purposes of producing long-term growth projections for individual countries. Furthermore, our assumptions are chosen in a manner that is intended to be broadly consistent across countries, so that the projections constitute a plausible 'main scenario' for the world economy as a whole.

A.1.1. Demographics

We use the latest UN projections (2011 revision) for the population aged 15-59 as a proxy for labour force growth. Some economies might be able to achieve faster growth here if they can raise their employment rates, but any such effects are difficult to predict and we have therefore not included them in our base case estimates.

All of the countries considered in this study, with the exception of India, are projected by the UN to see a declining share of their total populations in the prime 15-59 working age group between 2011 and 2050. This is the counterpart of the fact that all 24 countries (including India) are projected to see a rising share of their populations aged 60 or over. Korea, Spain, Russian, Japan, Italy and China are expected to see the largest declines in the share of the prime working age group over the period to 2050. Significant ageing effects are

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[16] The model goes back to the Nobel Prize-winning work of Solow (1956, 1957), which has remained the standard academic approach ever since the late 1950s and was later applied empirically by Denison (1985) and many others. A well-known more recent example of a research study on this topic is Wilson and Purushothaman (2003). This applies a similar growth modelling approach to four leading emerging market economies, except that it does not explicitly include human capital in its calculations. Given the importance of this factor, we prefer to make our assumptions on this variable explicit, as in many academic studies (e.g. Hall and Jones (1998) and Barro and Lee (2001)).

[17] More formally, we assume a Cobb-Douglas production function with constant returns to scale.

therefore by no means confined to the existing developed countries, but are also important for some of the major emerging market economies.

If we look instead at expected growth in prime working age populations (see Chart A1), then there are more countries with positive growth rates due either to relatively high birth rates (e.g. Nigeria, India and Turkey) and/or immigration rates (e.g. the US). But all of the major OECD countries in Europe are facing static or declining working age populations (except the UK where it is projected to rise slightly due to immigration) and this is also true of Japan, Korea, China and, in particular, Russia. The impact of a declining, ageing population is particularly significant in restricting Russia's ability to increase its share of world GDP in the long term in a similar way to other large emerging economies. An ageing population also acts as a drag on Chinese growth in the longer term (i.e. after 2020) relative to that of India.

Chart A1: UN estimates of average working age population growth to 2050 (% per annum)
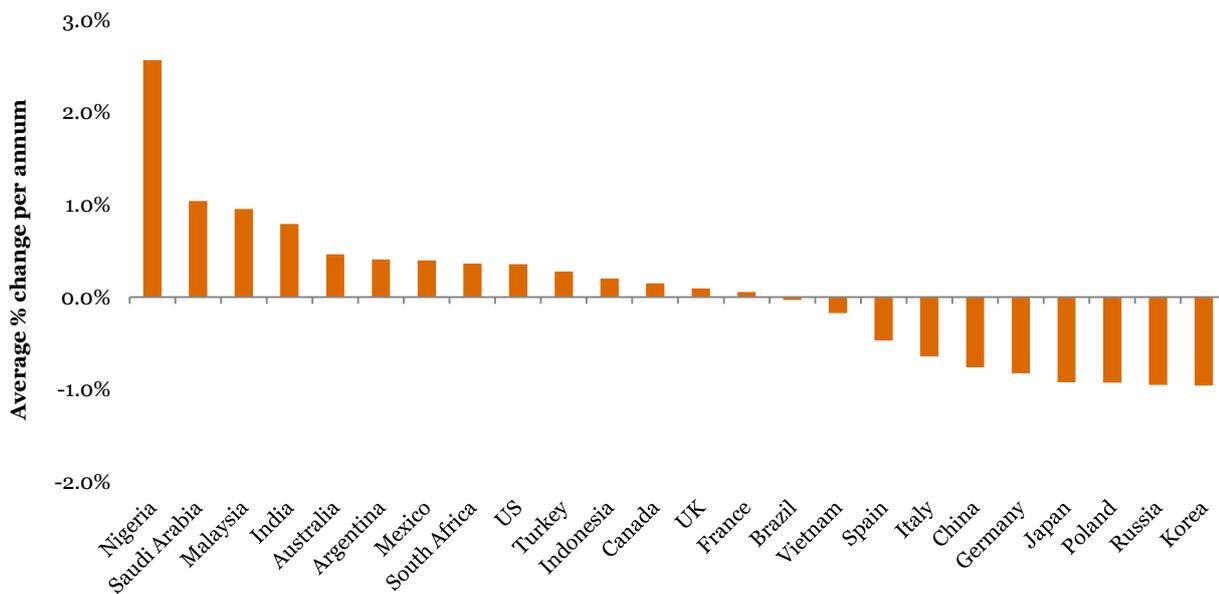
A.1.2. Education

In common with several past academic studies, we have based our estimates of the human capital stock on the data on average years of schooling for the population aged 25 and over from Barro and Lee (2001). We then follow the approach of Hall and Jones (1998), which in turn was based on the survey of international estimates of the returns to schooling in countries at different levels of economic development by Psacharopoulus (1994). Specifically, for the first four years of education, we assume a rate of return of 13.4%, corresponding to average estimates for sub-Saharan Africa. For the next four years, we assume a return of 10.1%, corresponding to the average for the world as a whole. For education beyond the 8th year, we assume estimated OECD average returns of 6.8%. This approach leads to estimates of the stock of human capital per worker as an index relative to the US.

We then assume that the average years of schooling of the over-25 population rises over time in each country at rates derived by extrapolating forward from trends over the past 5-20 years (the weight given to past averages over 5, 10 or 20 years varies across countries depending on what we consider to be the best indicator of underlying trends in education levels in each country). In line with trends over this past period, average years of schooling are assumed to rise at the slowest rate in the US, reflecting their higher starting point. This allows other countries to catch up with estimated average US levels of human capital per worker.

The fastest educational catch-up rates are assumed to be seen in Asian countries such as India and Indonesia, which is consistent with trends in recent periods and is an important factor in their relatively strong projected growth performance. Russia and Poland, with relatively high initial average education levels, make some further progress but have less scope for rapid catch-up in this area.

A.1.3. Capital investment

We began with estimates from King and Levine (1994) of capital stock to output ratios in the mid-1980s. These ratios are projected forward to our 2011 base year using data on investment as a % of GDP from the Penn World Tables (v. 6.1) database up to 2000, supplemented by IMF data for more recent years. We assume a uniform 5% annual depreciation rate of the existing capital stock both in this calculation and in the forward-looking projections, which is consistent with the 4-6% depreciation rates generally assumed in the academic literature. The resulting capital-output ratios in 2011 vary from around 1 in Nigeria to 4.2 in Japan (the UK ratio is 2.5).

Looking forward, we assume that initial average annual investment/GDP ratios, which vary from around 5% in Nigeria to over 40% in China adjust gradually to long run investment levels after 2025 that vary more narrowly from 10% in Nigeria to 25% in China (see Table A1 below).

Table A1: Investment rate assumptions

Investment as % GDP	Initial rate (2012)	From 2025
Japan	30%	25%
Germany	22%	20%
UK	17%	17%
France	24%	20%
Italy	22%	20%
China	41%	25%
Spain	25%	20%
Canada	25%	20%
India	22%	20%
Korea	32%	25%
Mexico	20%	20%
Australia	24%	20%
Brazil	19%	19%
Russia	20%	20%
Turkey	20%	20%
Indonesia	28%	22%
Argentina	14%	15%
Vietnam	29%	25%
South Africa	9%	15%
Saudi Arabia	11%	15%
Malaysia	23%	23%
Nigeria	5%	10%
Poland	20%	20%

Note: Investment rates assumed to adjust smoothly between 2012 and 2025 to long run level shown in final column above.
Source: PwC assumptions informed by historic data from IMF.

These assumptions reflect the view that, with declining marginal returns on new investment over time, the very high investment/GDP ratios seen in China and other Asian emerging markets will tend to decline in the long run as these economies mature (as has happened with Japan since the early 1990s).

In line with similar past studies, we assume for simplicity that capital has a constant 1/3 share in national output, with labour having a 2/3 share.

A.1.4. Technological progress

This factor is assumed to be related to the extent to which a country lags behind the technological leader (assumed here to be the US) and so has the potential for 'catch-up' through technology transfer, conditional upon levels of physical and human capital investment (as set out above) and other more institutional factors such as political stability, openness to trade and foreign investment, the strength of the rule of law, the strength of the financial system and cultural attitudes to entrepreneurship. These latter institutional factors are not readily quantifiable through a single index, but are reflected in our assumptions on the relative speed of technological catch-up in each country.

In some cases (e.g. India, Indonesia and Nigeria), we assume a slower rate of technological progress in the short term, but assume the pace of catch-up accelerates in the longer term as these countries strengthen their institutional frameworks. In the longer term, the rate of catch-up is assumed to converge to an annual rate of 1.5% of the total factor productivity gap with the US, which is in line with the results of past academic research[18] suggesting typical long-term catch-up rates of around 1-2% per annum.

It is important to stress that this approach is only intended to produce projections for long-term trend growth. It ignores cyclical fluctuations around this long-term trend, which history suggests could be significant in the short term for emerging economies in particular, but which we cannot hope to predict more than a year or two ahead at most. It also ignores the possibility of major adverse shocks (e.g. political revolutions, natural disasters or military conflicts) that could throw countries off their equilibrium growth paths for longer periods of time, but which are inherently impossible to predict. At the same time, our modelling ignores the possibility of a sudden leap forward in the technological frontier (here represented by US labour productivity growth, which as noted above we assume to increase at a steady 2% per annum rate in real terms, reflecting recent historic trends) due to some major new wave of innovation not yet imagined. As discussed in Section 4.1 above, however, it also discounts arguments by Gordon (2012) and others that global technological progress may be slowing down.

A.2. Real exchange rates: PPPs vs. MERs

GDP at PPPs is a better indicator of average living standards or volumes of outputs or inputs, because it corrects for price differences across countries at different levels of development. In general, price levels are significantly lower in emerging economies so looking at GDP at PPPs narrows the income gap with the advanced economies compared to using market exchange rates.

GDP at MERs may be a better measure of the relative size of the economies from a business perspective, at least in the short term. For long run business planning or investment appraisal purposes, it is crucial to factor in the likely rise in real market exchange rates in emerging economies towards their PPP rates. This could occur either through relatively higher domestic price inflation in these emerging economies, or through nominal exchange rate appreciation, or (most likely) some combination of both of these effects.

When estimating GDP at market exchange rates over the period to 2050, a similar methodology is therefore adopted as in the original World in 2050 report where market exchange rates converge to PPP levels at rates which differ across economies. This leads to projections of significant rises in real market exchange rates for the major emerging market economies due to their higher productivity growth rates, although these projected MERs still fall some way below PPP levels in 2050 for the least developed emerging markets. We have, however, updated our methodology here with new econometric estimates of how this emerging market real exchange rate appreciation is related to relative productivity growth.

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[18] As summarised, for example, in Chapter 6 of *Macroeconomics and the global business environment* by David Miles and Andrew Scott (John Wiley & Sons, 2004).

For the advanced economies, we assume that real exchange rates converge very gradually to their PPP rates at a steady pace over the period from 2012 to 2050. This is consistent with academic research showing that purchasing power parity does hold in the long run, at least approximately, but not in the short run.

In Appendix B below, we look in more detail at our results for GDP at MERs, which make use of these assumptions on real exchange rate movements over time (but are also more uncertain than projections at PPPs due to the difficulty of projecting these real exchange rate changes in practice).

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Appendix B. Additional projections for GDP at market exchange rates

Table B1 below summarises our GDP projections for 2011, 2030 and 2050 measured at market exchange rates (MERs). Most of the general findings and observations from Table 2 in the main text (rankings based on GDP at PPPs) continue to hold: China overtakes the US as the largest economy in the world while India moves into clear third place, well ahead of Brazil, which rises into fourth place by 2050. Mexico and Indonesia again take their place within the top 10 rankings by 2050, whilst Nigeria enters the top 20 by 2050, but is not as highly placed as in the PPP rankings (and Vietnam does not make the top 20 by 2050 using MERs).

Table B1: Actual and projected top 20 economies ranked by GDP at MERs

	2011		2030		2050	
MER rank	**Country**	**GDP at MER (2011 US$bn)**	**Country**	**Projected GDP at MER (2011 US$bn)**	**Country**	**Projected GDP at MER (2011 US$bn)**
1	US	15,094	**China**	24,356	**China**	48,477
2	**China**	7,298	US	23,376	US	37,998
3	Japan	5,867	**India**	7,918	**India**	26,895
4	Germany	3,571	Japan	6,817	**Brazil**	8,950
5	France	2,773	**Brazil**	4,883	Japan	8,065
6	**Brazil**	2,477	Germany	4,374	**Russia**	7,115
7	**UK**	2,432	**Russia**	4,024	**Mexico**	6,706
8	Italy	2,195	France	3,805	**Indonesia**	5,947
9	**Russia**	1,858	**UK**	3,614	Germany	5,822
10	**India**	1,848	**Mexico**	2,830	France	5,714
11	Canada	1,736	Italy	2,791	**UK**	5,598
12	Spain	1,491	**Indonesia**	2,465	Turkey	4,486
13	Australia	1,372	Canada	2,414	Italy	3,867
14	**Mexico**	1,155	Spain	2,310	Spain	3,612
15	South Korea	1,116	Turkey	2,106	Canada	3,549
16	**Indonesia**	847	South Korea	2,078	**Nigeria**	3,451
17	Turkey	773	Australia	1,898	South Korea	3,315
18	Saudi Arabia	577	Saudi Arabia	1,434	Saudi Arabia	2,977
19	Poland	514	Argentina	1,052	**Australia**	2,603
20	Argentina	446	South Africa	935	Argentina	2,333

Source: World Bank estimates for 2011, PwC estimates for 2050

Chart B2 below shows annual average growth rates measured in MERs for each country from the period to 2050. It is similar to Chart 7 in the main text, but it also shows the additional contribution of projected real exchange rate movements to the average GDP growth rates measured in constant US dollar terms.

From this chart, we can note the following:

- The projected exchange rate movements from our model give a further boost to real growth in dollar terms for the emerging economies (except Brazil, which actually had a market exchange rate in 2011 slightly above PPP levels,al though it has fallen back since then as capital inflows have eased). This is especially true for countries such as Vietnam and Indonesia, as the real appreciation projected to be experienced by their currencies is enough to push them ahead of Nigeria to become the two fastest growing economies for the next few decades.

- On the other hand, some of the developed economies such as Australia, Japan and those in the euro area are projected to experience gradual real currency depreciation against the US dollar as their market exchange rates are currently estimated by the World Bank to be above PPP rates. This contributes negatively to their projected real GDP growth rates when measured in US dollar terms as compared to the PPP (or domestic currency) projections.

Chart B2: Breakdown of components of average real growth in GDP at MERs (2011 − 2050)
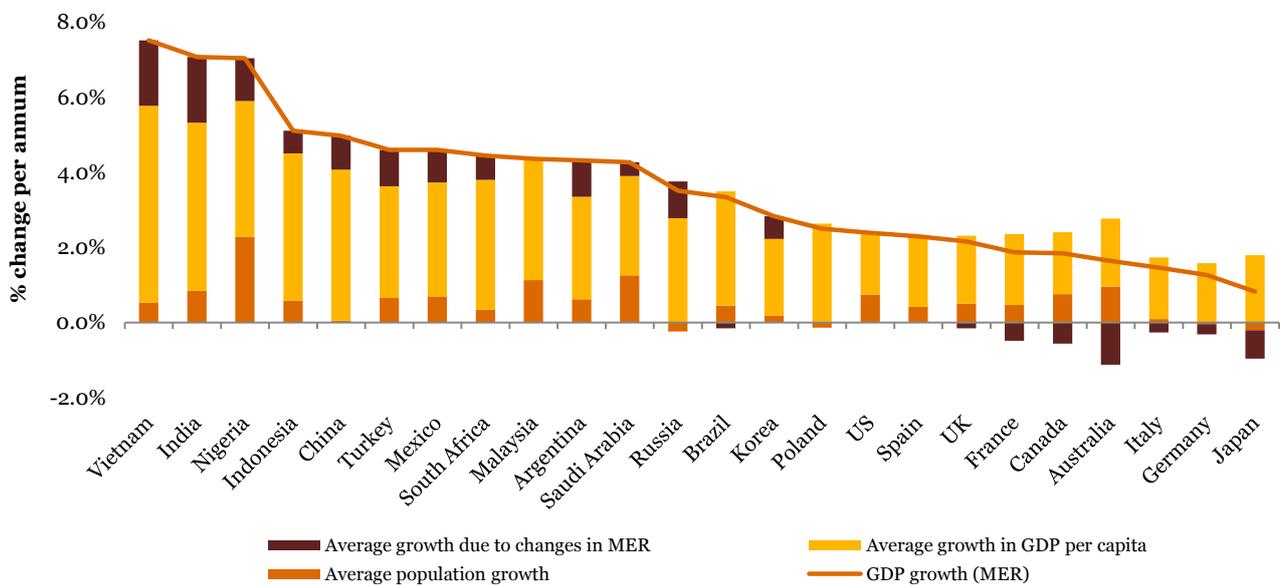
Given the uncertainties involved in any such long-term projections, most attention should be paid to the broad relativities in growth rates shown in the chart above, rather than the precise growth numbers. When applied in a business context, appropriate sensitivity and scenario analysis should be used rather than focusing attention on any single point projection of long-term growth.

PwC Macroeconomics

This report was written by John Hawksworth and Danny Chan of PwC's Macroeconomics team in the UK with additional inputs from Patrick Tay (PwC Malaysia) and Mateusz Walewski (PwC Poland). Our macroeconomics team maintains in-house models of more than 25 leading economies which together account for over 80% of global GDP. For up-to-date projections please see our monthly Global Economy Watch report here: http://www.pwc.co.uk/economic-services/global-economy-watch/index.jhtml

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130107-105940-ET-OS