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INVESTMENT MANAGEMENT

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# GLOBAL GROWTH AND EQUITY RETURNS

## DISCUSSION NOTE

Global economic growth and long-term growth forecasts are trending lower. Slower labour force growth, public debt overhang and declining productivity growth have been put forward as possible explanations. In this note, we explore the relationship between global economic growth and equity returns, and assess whether slower economic growth and lower long-term growth forecasts have any implications for future expected global equity returns.

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# SUMMARY

GLOBAL GROWTH AND EQUITY RETURNS

- We document a positive correlation between global economic growth and equity returns. Years with high global growth are accompanied by high equity returns globally. Global equity returns have also been lowest during periods characterised by slow global economic growth.

- In the long run, cash flows supplied by companies are the ultimate driver of equity returns. We find evidence that growth in earnings per share and dividends per share have been in line with GDP growth over longer horizons. Since 1970, nominal GDP growth in advanced economies has been running at 6.9 percent annually, while average growth in earnings per share and dividends per share has been 6.4 and 6.0 percent respectively.

- Global economic growth has slowed, and long-term growth forecasts point to slower growth over the next decade. In many regions and countries, long-term growth forecasts are at record lows. This does not, however, translate into record-low global growth forecasts, because high-growth economies represent a larger share of total global output than previously.

- Many of the global trends supporting economic growth over the past half-century are diminishing or even declining. Several economies are now aging rapidly. Productivity growth has slowed significantly. High levels of government debt, changing income distribution and slower trade growth are other factors potentially explaining lower long-term global growth forecasts.

- Future growth is uncertain and long-term growth forecasts have historically not been very accurate. In fact, average historical growth has the lowest forecast error in a simple back-test. However, a realisation of slower future global growth would be a concern for long-term investors, as the potential for cash flow growth generated by companies would be limited. Such developments might not be reflected in today's equity prices.

# Introduction

Economic growth has been strong since the 1950s, with global real gross domestic product (GDP) growth averaging around 4 percent. The high growth rates of the past can largely be attributed to several supportive secular trends, such as strong labour productivity growth during the 1950s and 1960s, and rapid growth in the working-age population as baby-boomers entered the labour force starting in the 1970s. During the same period, the pace of globalisation accelerated. Global trade increased rapidly with the re-integration of central and eastern Europe in the early 1990s and China's entry into the World Trade Organization in 2001.

Currently, global economic growth has slowed towards 3 percent. At the same time, long-term growth forecasts have been revised down and are at record lows in many countries and regions. There are several potential explanations for the lower growth rates and downward revisions of long-term growth forecasts. Productivity has slowed significantly across the world, while the working-age population is shrinking in the euro area and Japan. Global trade has slowed markedly, and we are unlikely to get a positive shock similar in magnitude to China's entry into the world economy over the next decade.

It is widely believed that economic growth has a positive impact on equity returns, and the aim of this discussion note is to assess whether slower global economic growth and lower long-term growth forecasts have any implications for future expected global equity returns. There is a vast amount of literature on the relationship between economic fundamentals and equity returns. The existing literature can broadly be divided into two groups. The first group uses fundamental information such as earnings, dividends or economic growth (supply-side models), while the second group has adopted a demand-side approach, trying to estimate expected equity returns based on the payoff required by investors to bear the risk of holding equities (Ibbotson and Chen, 2003). In this note, we rely on the approach taken by the first group[1].

The remainder of this note is structured as follows. We start by looking at global economic growth and equity returns in a historical context[2]. In Section 2, we discuss existing literature on the relationship between economic growth and equity returns, and we conduct our own analysis to assess whether there is a link between global economic growth and global equity returns. In Section 3, we look at different forecasts for long-term growth and assess how accurate forecasts have been historically at predicting actual growth. Then, we briefly describe some of the most important global macro trends that likely are influencing growth forecasts. Finally, we conclude in Section 4.

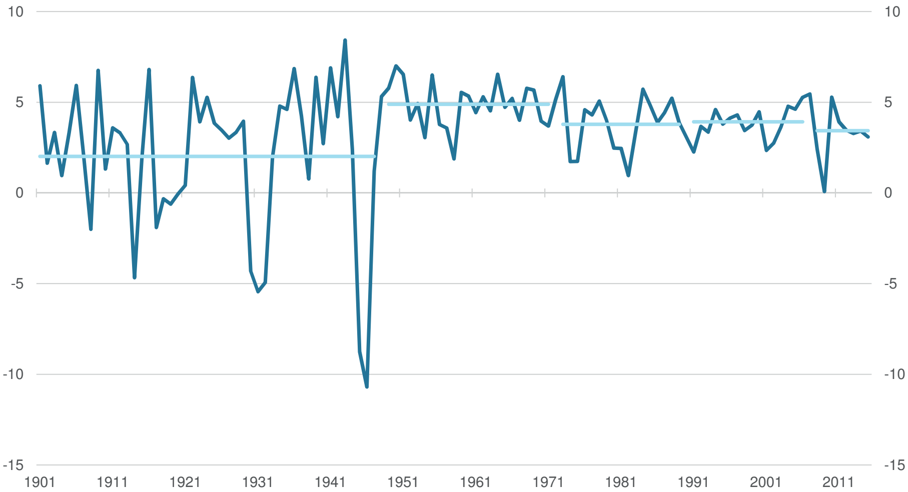
*1 For more details on the large body of literature on demand-side models following the work of Mehra and Prescott (1985), see NBIM Discussion Note 1/2016: The Equity Risk Premium.*

*2 Unless explicitly stated otherwise, all references to GDP growth and equity returns are in real terms.*

# Global economic growth and global equity returns in a historical context

Figure 1 shows global GDP growth since the start of the 20th century. Growth was both lower and more volatile for the first half of the century. The global economy was exposed to several major shocks during this period. In addition, national accounting started evolving in the 1930s, making earlier data less reliable. Global growth has been mostly positive since the Second World War, with the global financial crisis in 2008 and 2009 as the most severe downturn in global economic activity.

*Figure 1: Global GDP growth, year over year*




*Source: Reinhart and Rogoff dataset, PWT 8.1[3] from 1970 and IMF World Economic Outlook April 2016 from 2011. NBIM calculations. The different datasets are not perfectly compatible (different countries and different currency conventions), but the constructed series give a fair picture of the historical trends. Light blue lines represent simple historical averages for 1901-1947, 1948-1972, 1973-1990, 1991-2007 and 2010-2015.*

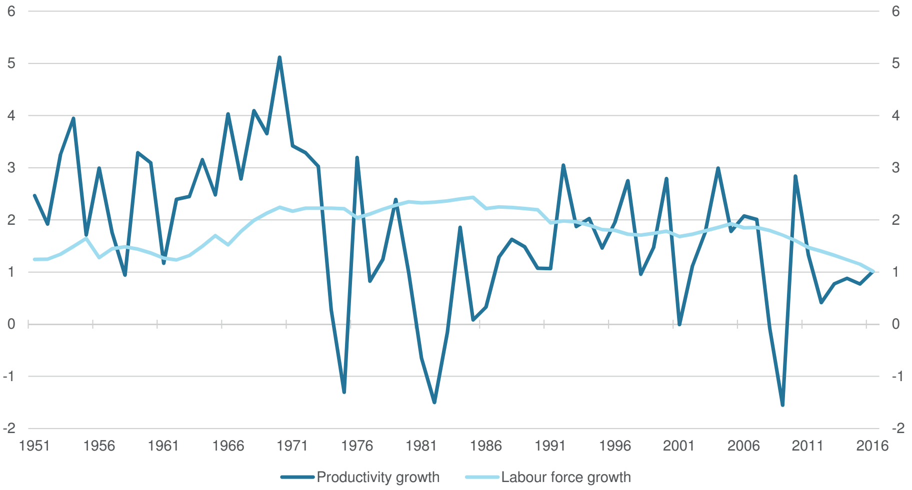
Productivity growth and labour force growth are key determinants of economic growth in the long run, and their historical developments help us to better understand and describe past global economic growth. Growth was particularly fast from 1948 to 1972, a period often referred to as the "golden age" of productivity growth. Robert Gordon has referred to this period as the "one big wave" of innovations, as significant progress was made in the fields of electricity, the internal combustion engine, the petroleum sector and communication (Gordon, 2000 and 2014)[4]. During this period, global productivity growth, measured as global GDP per employed person, averaged close to 3 percent (Figure 2). Global productivity growth slowed significantly after the 1973 oil crisis and the collapse of the Bretton Woods system. Productivity improved again during the 1990s with important innovations in information and communication technology (ICT), before collapsing after the dot-com bubble and the financial crisis. During the ICT

*3 Feenstra, R., Inklaar, R., Timmer, M. (2015): "The Next Generation of the Penn World Table", American Economic Review, 105(10), 3150-3182, available for download at www.ggdc.net/pwt.*

*4 The "golden age" of productivity growth differs between countries, and Gordon uses the US in his empirical work where the period between the 1920s and the 1970s is characterised by rapid productivity growth. Most observers refer to the "golden age" of productivity as the period between 1948 and 1972, when Europe and Japan also experienced rapid productivity growth.*

revolution, productivity growth averaged 2 percent. Average productivity growth has been below 1 percent for the past five years.

*Figure 2: Global productivity growth and labour force growth, year over year*

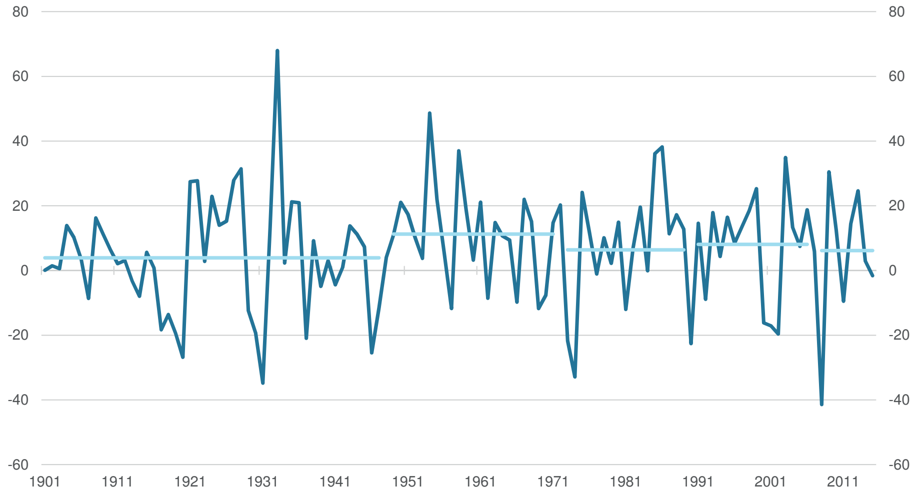



*Source: Productivity growth measured as GDP per employed person, from Conference Board Total Economy database, May 2016 release. Global series weighted according to GDP per capita converted at Geary-Khamis purchasing power parity. Constructed based on 96 countries. NBIM calculations. Labour force data from United Nations Population Prospects, 2015 revision.*

Despite the large decline in productivity growth during the 1970s, global real GDP growth continued to accelerate at an annualised pace of almost 4 percent. Declining productivity growth was largely offset by rapid growth in the working-age population as baby-boomers entered the labour force (Figure 2). Women's participation in the labour market also increased substantially. The global labour force (measured as people aged 18 to 64) grew by 2.3 percent annually from 1970 to 1990. Global labour force growth is still positive, but growth rates are declining rapidly in the developed world in particular.

The fast-growth period starting in the 1950s coincided with high equity returns. Figure 3 shows global real equity returns since the start of the 20th century. As for global economic growth, real equity returns were both lower and slightly more volatile during the first part of the century. Average real equity returns have also gradually declined from very high levels between the 1950s and 1970s towards levels more comparable with the first half of the 19th century over the past five years. It is also worth noting that the simple averages for global real GDP growth and global real equity returns seem to share a similar pattern (see averages in Figures 1 and 3). Many factors have potentially affected global equity prices over the past 60 years, and global economic growth appears to be one of them. In the next section, we address this observation more formally.

*Figure 3: Global real equity returns, year over year*



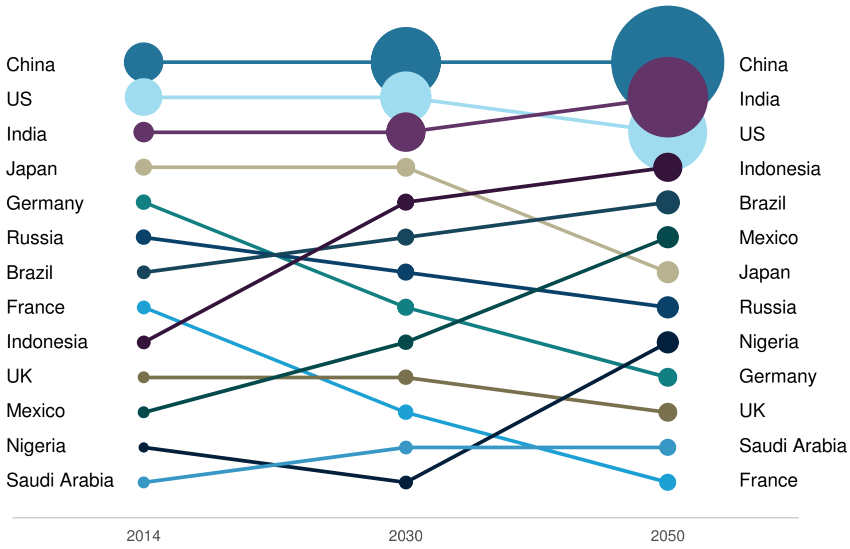

*Source: Dimson, Marsh and Staunton, 2016. Light blue lines represent simple historical averages for 1901-1947, 1948-1972, 1973-1990, 1991-2007 and 2010-2015.*

# The empirical link between economic growth and equity returns

The divergence in growth rates between advanced and developing economies over the past decades has motivated a large part of the existing literature on the link between economic growth and equity returns. Growth forecasts for the next half-century also predict that emerging economies will outgrow developed countries (Figure 4). This way of thinking of returns and growth stems from the neoclassical growth model (Solow, 1956). One key assumption is that capital is subject to diminishing returns, implying that capital should have higher returns in countries with a low per-capita capital stock (typically developing nations). Daly (2010) confirms the theoretical relationship. Cross-country differences in return on capital are positively correlated with GDP per capita growth, but negatively correlated with the level of GDP per capita[5].

*5 With perfect capital mobility, capital should flow into the countries with the highest marginal product of capital until returns are equalised globally. There are, however, empirical shortcomings in this prediction, as highlighted in particular by the Lucas paradox (1990). Observed capital flows are nowhere near what the framework would suggest, which could be explained by large differences in human capital per worker, external benefits of human capital (technology) or constraints on the saver unrelated to return differentials (Lucas (1990) and Daly (2010)).*

*Figure 4: GDP ranking of countries by purchasing power parity*




*Source: 2014 data from IMF World Economic Outlook database, 2030 and 2050 estimates from PWC (2015). PWC uses a model based on trends in demographics, capital investments, education levels and technological progress to estimate GDP in 2030 and 2050 for the 32 largest economies accounting for 84 percent of global GDP.*

The supply-side models for asset returns (see, for example, Diermeier, Ibbotson and Siegel, 1984; Straehl and Ibbotson, 2016) often use the neoclassical growth model as a starting point. Over the long run, equity returns should be close to the economic supply development, which cannot be much different to what is produced by companies in the aggregate real economy. The cash flows that companies supply should be linked to economic activity. MSCI (2010) goes through the dynamics of supply-side models and empirically investigates the different steps. First, economic growth should translate into growth in aggregate corporate profits. Both MSCI and Bernstein and Arnott (2003) conclude that aggregate corporate earnings and GDP growth have been remarkably similar in the US over the last 80 years, with nominal aggregate corporate profits remaining a constant share of nominal GDP since 1929. Ibbotson and Straehl (2016) show that US aggregate total payouts and GDP grew at similar annualised rates of 3.27 percent and 3.36 percent respectively from 1901 to 2014.

Second, aggregate earnings growth should translate into earnings per share (EPS) growth in the listed market. However, a significant contribution to GDP growth comes from the value-added of entrepreneurial capital, new companies, unlisted equities and new share issuance. Most of these contribute to increased aggregate profits, but this is not necessarily accessible to existing shareholders. Dilution of earnings might cause EPS growth to be lower than aggregate earnings growth. MSCI finds that the dilution between GDP growth and EPS growth was 2.3 percent annually for 16 developed economies from 1969 until 2009. This result is similar to Bernstein and Arnott, who find a dilution of GDP per capita growth to dividend growth of 2.4 percent annually since 1900. Ibbotson and Straehl (2016), on the other hand, find no significant evidence that total payout growth per share is structurally lower than GDP per capita growth in the long run. They demonstrate that total payout per share (adjusted for the share decrease from buybacks starting in the 1970s) and GDP per capita grew at approximately the same annualised rate from 1872 to 2014, at 1.67 percent and 1.83 percent respectively.

Over long time periods EPS growth must be the ultimate driver of equity returns. One question is whether a long run relationship between growth and EPS growth manifests itself in a short run or contemporaneous relationship between economic growth and equity returns. Ritter (2005 and 2012) finds that it does not, and documents a negative correlation coefficient between equity returns and GDP per capita growth when using data since 1900 for developed markets and since 1988 including 15 emerging markets. Dimson, Marsh and Staunton (2010), using annualised GDP per capita growth and equity returns over ten-year periods for 44 countries from 1970 to 2009, find no significant link between economic growth and equity returns. This is in contrast to MSCI (2010 and 2011) which shows that long-term trends in real GDP and equity prices are more similar for global equities than for individual markets, but over a long horizon and using aggregated data. Using the same data, the slippage between economic growth and equity prices has also been much less than for economic growth and EPS growth.

The weak contemporaneous empirical relationship between growth and equity returns may reflect the fact that any short-term changes in growth were expected and therefor already discounted, and that the short-term variation in equity returns depends on the variation in the discount rate itself.

It also reflects the forward-looking nature of equity markets, as it is the expectations of future growth that determine stock prices (Siegel, 1998). O'Neill et al. (2011) take the forward-looking nature of equity markets into account and find that changes in Consensus Economics' forecasts two years ahead have a positive and significant effect for all countries in the sample. Dimson, Marsh and Staunton (2010) also show that future growth is not irrelevant, as a US investor with perfect foresight about next year's GDP growth would have achieved outstanding results. But as we will show later, GDP growth is very hard to forecast.

## Empirical analysis of the relationship between global growth and global equity returns

We start by assessing the relationship between global GDP growth and returns in the broadest sense, namely the global return on physical capital as measured in the national accounts. This analysis relates to the return on the entire capital stock and not only listed equities. Thus, we next look at the relationship between the cash flow supplied by listed companies and global economic growth. Finally, we assess the relationship between global GDP growth and aggregated equity returns.

### Global economic growth and return on physical capital

Robert Solow (1956) developed a theoretical framework commonly used for analysing the relationship between economic growth and the return on physical capital. Solow studied a constant-returns Cobb-Douglas function that describes how potential output is determined by different factor inputs (labour and capital) and how efficiently the inputs are used (productivity). The standard Cobb-Douglas production function is defined as:

$$Y = K^{\propto} (AL)^{1-\propto},$$

where Y is potential output, K is the stock of physical capital, L is the labour force, A is labour-augmenting technology and ∝ is the capital share of income[6]. Potential growth will increase if either inputs are increased or the output per unit of input is higher. From the Cobb-Douglas function, the marginal product of capital (r) can be expressed as[7]:

$$r = \frac{\propto Y}{K}$$

Along the steady-state growth path of a closed economy and under the assumptions of constant labour force growth (n), constant labour-augmenting technological change (a), a constant savings rate (s) and constant depreciation $(\partial)$, we know that[8]:

$$\frac{K}{Y} = \frac{s}{n + a + \partial}$$

Under the steady-state growth path, the marginal product of capital equals:

$$r = \propto \frac{(n + a + \partial)}{s}$$

The effect from a permanent shock to the growth rate of the economy, caused by changes in labour force growth or labour-augmenting technology, would then depend on the proportion between the capital share of income and a constant savings rate:

$$\Delta r = \frac{\propto}{s}(\Delta \mathrm{n} + \Delta \mathrm{a})$$

To analyse this relationship more formally, we collect data for 55 countries over the period 1950-2011 from the Penn World Table 8.1 (PWT, 2015)[9]. To get aggregate series on global GDP and global capital stock, we use data measured in purchasing power parity (PPP) terms, which are comparable across countries. The capital stock is estimated by cumulating and depreciating past investments following the Perpetual Inventory Method (PIM)[10]. The PWT dataset also accounts for relative price differences, as the price of installing capital is usually high in poor countries compared to the price of consumption (Caselli and Feyrer, 2005; Hsieh and Klenow, 2007). Another feature of the PWT dataset is time-varying labour shares. Based on data from the PWT, it is straightforward to calculate the marginal product

*6 This version of the Cobb-Douglas production function assumes that technology is labour-augmenting, Y = F(K,LA). If technology is Hicks-neutral, it enters in the form of Y = A x F(K,L). If technology is capital-augmenting it enters in the form of Y = F(KA,L). For the purposes of this note, all three are essentially the same.*

*7 In this note, we interpret r as the return on gross physical capital, including the listed equity market.*

*8 See, for example, Solow (1956), Baker, Delong and Krugman (2005) or Diamond (2000).*

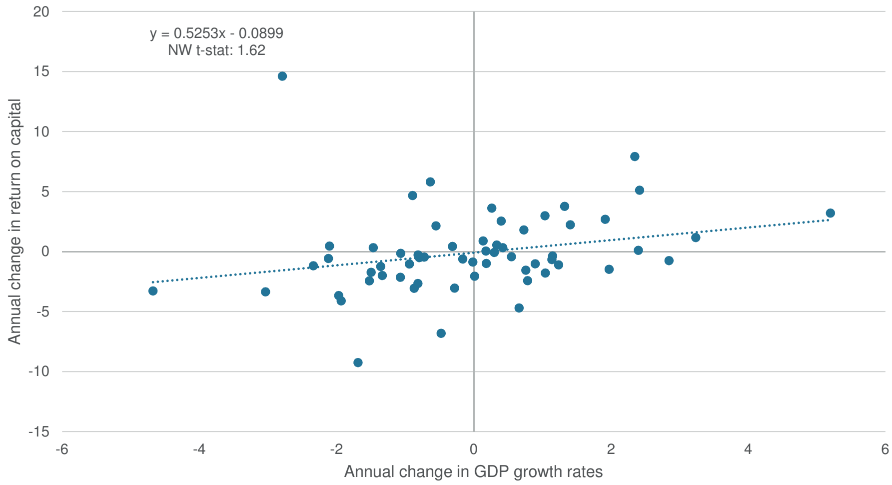
*9 Feenstra, R., Inklaar, R., Timmer M. (2015): "The Next Generation of the Penn World Table", American Economic Review, 105(10), 3150-3182, available for download at www.ggdc.net/pwt.*

*10 Given an initial capital stock (K), investment at constant prices (I) and depreciation rate $(\partial)$, the capital stock for asset **a** in country **i** at time **t** using the PIM is:* $K_{ait} = (1-\partial)K_{ait-1} + I_{ait}$

of capital, which equals the capital share of income (one minus the labour share of income) multiplied with total output relative to the capital stock. The aggregated data confirms the theoretical relationship and the empirical results of Daly (2010) (see Appendix 1). Capital is subject to diminishing returns, both across countries and aggregated across time.

Figure 5 shows the relationship between changes in return on capital and changes in global growth rates from 1952 until 2011. We know that, in steady state, the relationship depends on the ratio between the capital share of income and the aggregated savings rate. Over our sample period, the capital share of income has been larger than the global savings rate, suggesting a larger effect than one-to-one. The coefficient is lower than the theoretical framework would suggest, which potentially can be explained by changes in the depreciation rate, the capital share of income or the aggregate savings rate (see equation above and Baker, Delong and Krugman, 2005). The historical developments in these three variables over our sample period suggest that the capital share of income potentially can help explain the modest sensitivity to growth in the short run. The global capital share of income has increased from 37 to 47 percent in our dataset.

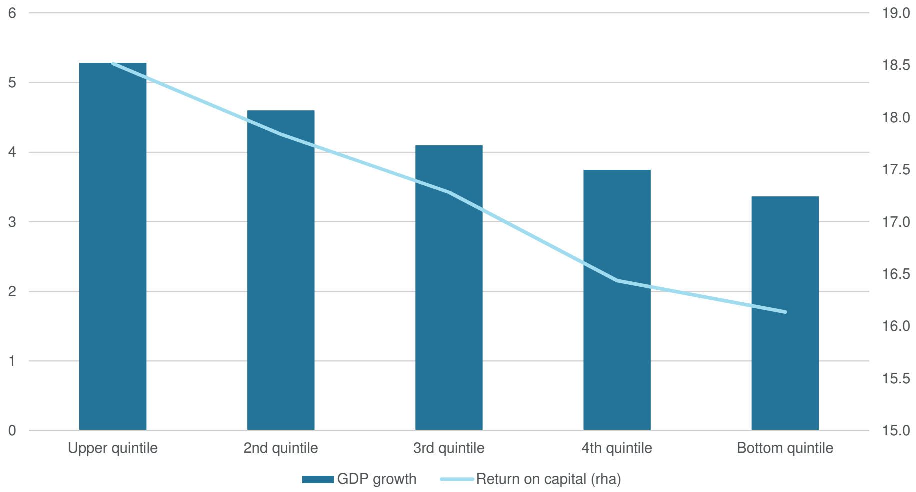
*Figure 5: Annual changes in global GDP growth vs annual changes in return on capital*




*Source: PWT8.1 and NBIM calculations. Annual data from 1952 to 2011. We report the Newey-West (NW) t-statistics.*

It is also worth noting that the framework is mostly relevant on longer horizons, and in Figure 6 we sort data according to five-year average GDP growth. We use overlapping data due to few observations. Over longer horizons, there seems to exist a positive relationship between global growth and the global return on capital and the impact from GDP growth increases compared to when we use annual data. If we sort on annual GDP growth the change between the different quintiles is consistent with an impact of GDP growth on return on capital in the magnitude of 0.30-0.45. The impact increases to above one on average when using five-year overlapping data, which is more in line with what the framework would suggest.

*Figure 6: Average global GDP growth and return on capital, ranked by five-year average GDP growth from 1955 to 2010*




*Source: PWT8.1 and NBIM calculations. 11 observations in each quintile.*

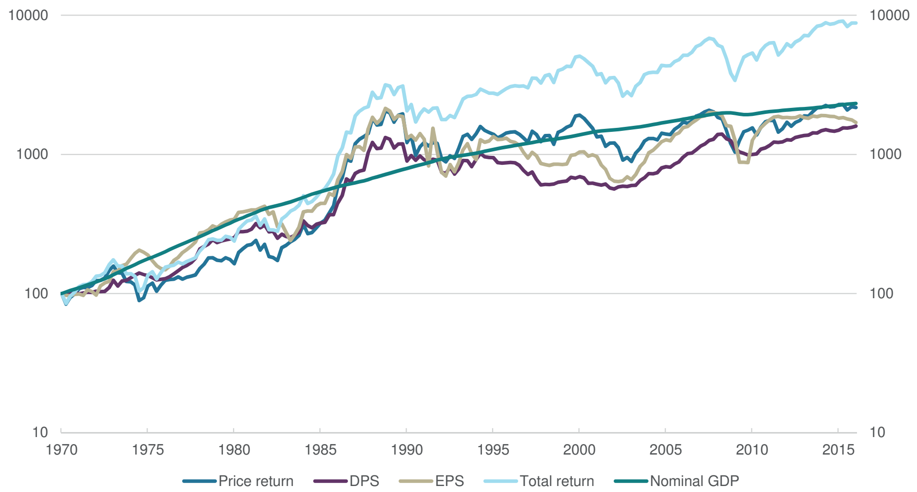
**Global economic growth and cash flows**

In the long run, cash flows supplied by listed companies should be the ultimate driver of equity returns. Furthermore, aggregated cash flows should be linked to economic activity. We therefore look more closely here at the relationship between global economic growth and growth in dividends per share (DPS) and earnings per share (EPS). We use MSCI country index data to estimate earnings and dividend growth. Dividends per share is computed as the product of the country's dividend yield and price index levels, while earnings per share is calculated by dividing index values by their reported price-earnings (PE) ratios[11]. To obtain global series, we apply market capitalisation weights reported by MSCI. The data begin in 1970 and comprise 17 developed countries. Data on developed countries and global GDP growth and inflation are from the IMF International Financial Statistics database, starting in 1969.

Figure 7 shows the historical development in the constructed global MSCI series and nominal GDP for advanced economies. Over long horizons, there is evidence, as expected, that long-run growth in nominal EPS and DPS is in line with nominal GDP growth. Since 1970, nominal GDP growth in advanced economies has been running at 6.9 percent annually, while average growth in EPS and DPS has been 6.4 and 6.0 percent respectively. The deviations in the short term are significant, however, which potentially can be attributed to large compositional differences between listed companies and the economy as a whole, dilution or short-term variations in company profit share relative to the total economy. We also document a positive correlation between annual real global GDP growth and real EPS growth (Figure 8). The relationship is significant, also when controlling for real US dollar returns and lagged PE ratios. Results are similar for DPS growth, as it is evident from Figure 7 that EPS and DPS growth share the same cyclicality.

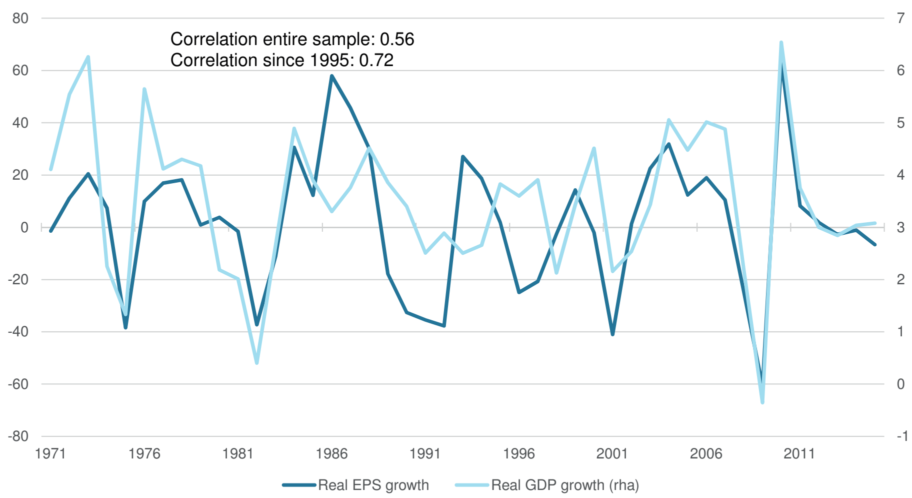
*11 We use price to cash earnings for Austria, Italy and Japan, as price-earnings data are not meaningful.*

*Figure 7: MSCI constructed global series and nominal GDP, indexed to 100 January 1970*




*Source: MSCI equity country index data, quarterly data. Countries: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hong Kong, Italy, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, UK and the US. Nominal GDP for advanced economies from IMF International Financial Statistics database and NBIM calculations. Log-scale.*

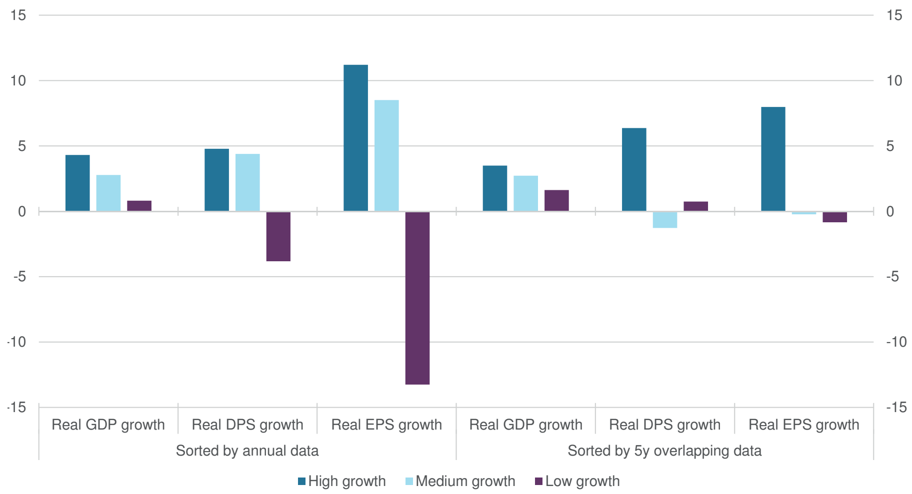
*Figure 8: Annual real EPS growth and real global GDP growth*




*Source: MSCI, IMF International Financial Statistics database and NBIM calculations.*

In Figure 9, we examine whether periods of high, medium and low GDP growth have had any implications for EPS growth and DPS growth. We sort data both on annual GDP growth and on five-year average GDP growth (overlapping observations). Years and periods with high GDP growth have been accompanied by high EPS and DPS growth, while years and periods with low GDP growth have corresponded with negative EPS and DPS growth on average. The results are more evident for EPS growth than for DPS growth, in particular if we use five-year overlapping data, possibly reflecting stable pay out policies and companies smoothing out dividends over the business cycle.

*Figure 9: Average real GDP growth, real EPS growth and real DPS growth, ranked by GDP growth from 1971 to 2015*




*Source: MSCI, IMF International Financial Statistics database and NBIM calculations. 15 observations where we sort on annual GDP and 13 observations where we sort on five-year average GDP growth.*

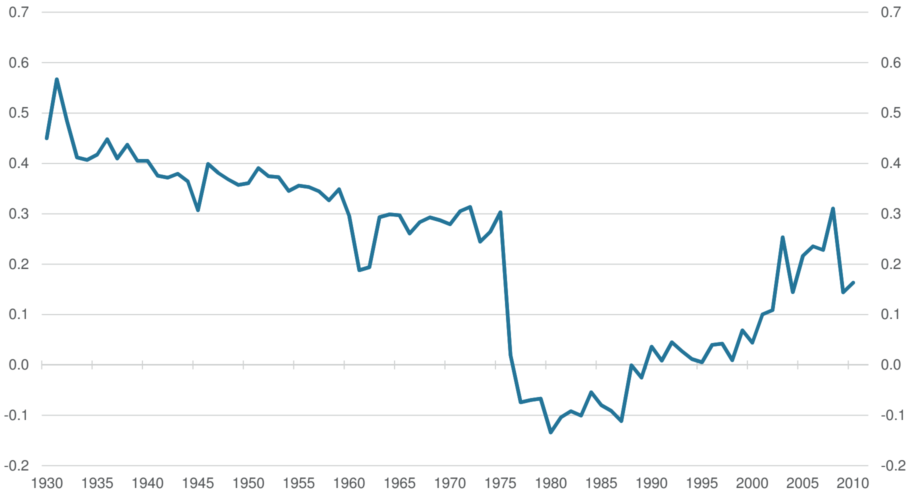
So far, we have documented a positive correlation between global GDP growth and the return on total global capital. The return on capital relates to the entire economy and not just the listed market, but we have also shown that cash flows generated by listed companies are in line with economic activity on long horizons. These cash flows should, in the long run, be the ultimate driver of equity returns. Hence, the final step is to assess whether there is a relationship between global economic growth and global equity returns.

**Global economic growth and global equity returns**

We employ the Dimson-Marsh-Staunton dataset (DMS, 2016) for listed equity returns globally. The dataset starts in 1900 and covers 21 countries[12]. Long-term GDP data are not readily available, and our constructed series covers roughly 60 to 70 percent of global GDP up until the 1970s, and above 90 percent since then. We use a combination of GDP data from the Reinhart and Rogoff dataset and the growth series from PWT 8.1. Figure 10 shows the rolling correlation between the two time series over 30 year windows.

*12 Most countries in the DMS dataset are considered developed, with the exception of South Africa. Reliable data for emerging markets are only available for the period after 1987 when MSCI started publishing its EM indices.*

*Figure 10: 30-year rolling correlation between global real GDP growth and global real equity returns*

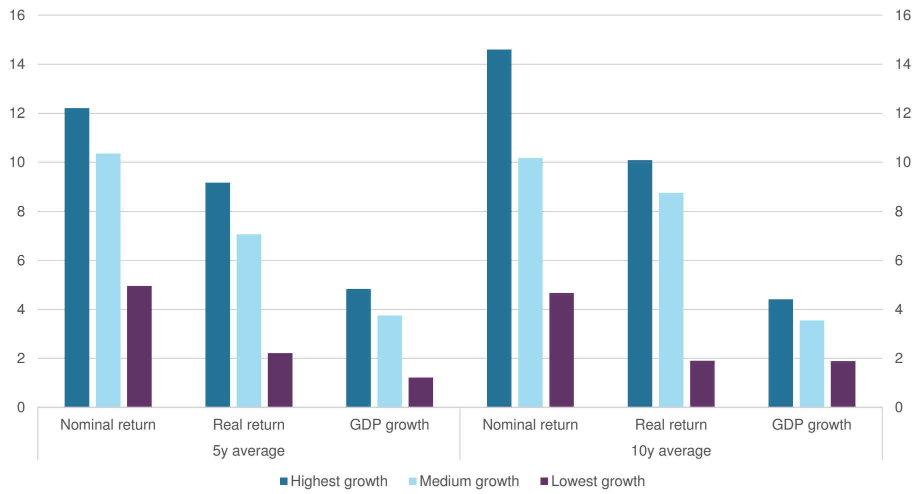



*Source: DMS 2016, Reinhart and Rogoff dataset and PWT8.1. Global GDP growth consists of 30 countries from 1900 and 58 countries after 1970.*

There is a positive correlation between GDP growth and real equity returns in our global dataset. Over the entire sample, the correlation has been 0.25 and statistically significant at the 1 percent level.

In Figure 11, we examine whether periods with high, medium and low growth have had any implications for equity returns. We find evidence that equity returns have been higher in periods with high growth. Periods with medium global growth also coincide with relatively high returns, although lower than for the high-growth periods. Equity returns, both nominal and real, have been lowest in the periods with slow economic growth. It also seems that the growth-return relationship is non-linear and that negative or very low growth rates have a greater impact on equity returns than moderate growth. Figure 11 shows the results for non-overlapping periods, potentially affected by the chosen sample periods. However, the results are similar when using overlapping periods (see Figure 23 in Appendix 2).

*Figure 11: Average equity returns ranked by average GDP growth, 1901-2011 non-overlapping periods*



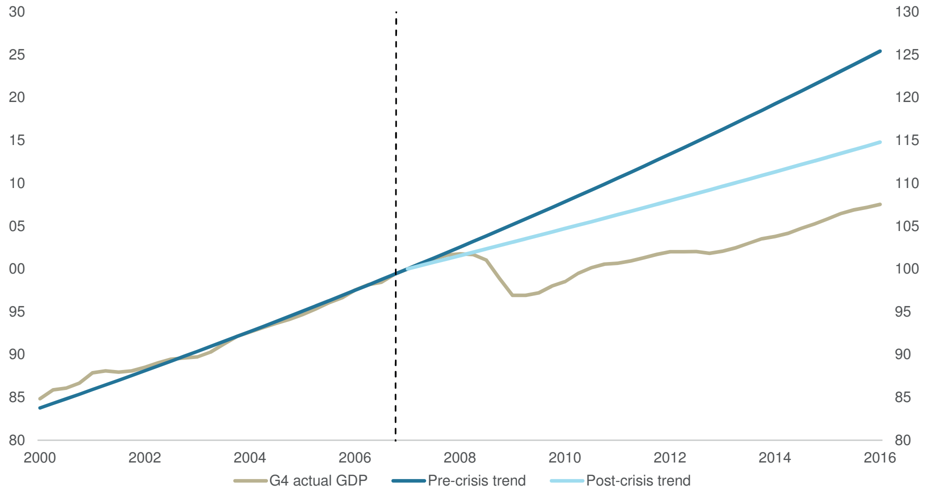

*Note: For the five-year averages, there are seven observations for highest and lowest growth and eight observations for medium growth. For the ten-10 year averages, there are four observations for medium growth and three observations for highest and lowest growth. Source: DMS 2016, Reinhart and Rogoff, PWT8.1 and NBIM calculations.*

It is hard to draw any strong conclusions based on the simple analysis above, but global growth is positively correlated with global real equity returns in our dataset. Our results do not contradict existing empirical work. One of the arguments for the weak empirical relationship between economic growth and equity returns across countries is globalisation. In many countries, the largest listed companies are multinationals that make a large part of their earnings abroad. There are also large differences across countries, partly due to differences in sector composition. Industries like telecoms and utilities tend to be more domestic than basic materials and oil & gas companies. It is not unreasonable that there should be persistent deviations between domestic growth rates and national equity returns, while at the same time a positive relationship globally. Thus, the next step is to have a closer look at global long-term GDP forecasts.

# Forecasts of long-term growth

Long-term growth forecasts are often synonymous with forecasts of potential growth. Potential growth is defined as the rate of output growth that is consistent with stable inflation (IMF, 2015) or the "normal" level that the economy is expected to converge to in the absence of shocks (Bernanke, 2016). In the short and medium term, actual output will fluctuate around potential due to shocks to the economy. The divergence from potential output is referred to as the output gap, and it will typically take time for the economy to return to its potential, partly due to rigid prices and wages. Potential growth differs from the commonly used concept of trend output, which is based on statistical methods (not theory) to calculate different types of trends (for example, simple moving averages or statistical filtering methods). Figure 12 shows a simple linear trend for G4 real GDP since 2000 and illustrates why a simple trend might not be a good benchmark for future growth.

*Figure 12: G4 GDP levels, actual and possible trend lines, GDP-weighted*




*Source: IMF International Financial Statistics database, IMF World Economic Outlook database and NBIM calculations. GDP series are rebased to 100 in Q1 2007.*

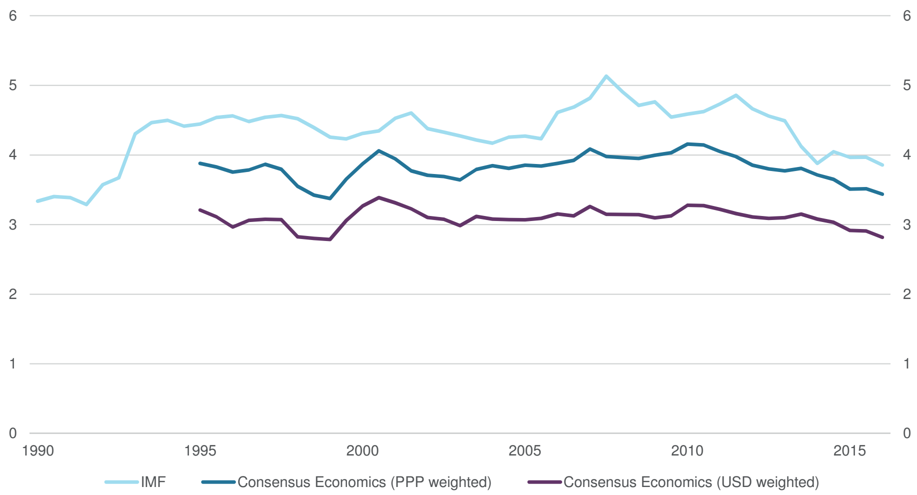
Relative to trend growth before the financial crisis, the negative output gap continues to widen. We would in this situation have expected higher unemployment and, given the size of the output gap, deflation. In reality, we have seen lower unemployment rates and relatively stable inflation, suggesting that output gaps are shrinking and that potential output is in fact lower. Historical or trend growth is not necessarily a good indicator of future long-term growth. One big caveat is, however, that potential output is not observable in real time, and we have to rely on forecasts.

In Figure 13, we report global long-term or potential GDP forecasts from the IMF's World Economic Outlook historical database and Consensus Economics, both at PPP weights. We also show Consensus Economics' forecasts at US dollar weights for comparison. The IMF's forecasts are based on real-time data, while Consensus Economics' forecasts are based on realised purchasing power or dollar weights, potentially distorting our constructed global series[13]. The IMF's global forecasts cover roughly 90 percent of annual world output, while our constructed global Consensus Economics forecasts cover around 75 percent of world output. The main difference in coverage is the inclusion of smaller developing economies, potentially explaining some of the difference between the two. Forecasts of long-term growth or potential output growth have been relatively stable over the sample, but forecasts have gradually declined ever since the global financial crisis. The global growth forecasts are not at historical lows. However, when looking at the details for different countries in the Consensus Economics dataset, it is worth noting that, out of 38 major economies, only Venezuela has a higher growth forecast in July 2016 than in April 2000. Record-low growth forecasts for individual countries do not translate into record-low global growth forecasts, because high-growth economies

*13 Real-time data are defined as the historical observations before they are subject to revision or the forecasts based on such data (Philadelphia Fed, Real-Time Data Research Center).*

currently represent a larger share of total global output than previously. This tendency is particularly evident when comparing forecasts weighted according to GDP measured in dollars versus PPP. For example, China's share of world output is 15 percent in dollar terms and 17 percent when measured with PPP weights[14]. The OECD also publishes growth forecasts for the very long run; in its latest projections, annual global growth is expected to slow from an average of 3.4 percent for the next ten years towards 2 percent approaching the 2050s[15]. The trend in long-term growth forecasts points to slower economic growth ahead, and the next step is to assess how accurate different estimates of long-term growth have been historically.

*Figure 13: Long-term global growth forecasts, year over year*




*Source: IMF World Economic Outlook historical database, IMF World Economic Outlook April 2016 and Consensus Economics. NBIM calculations.*

## Forecast accuracy

We assess the forecast accuracy using US data, due to a broad set of long-term growth forecasts with a relatively long real-time history. There are a number of estimates of long-term growth in the US, and we will for the remainder of this section use forecasts given by the Congressional Budget Office (CBO), the IMF, the Survey of Professional Forecasters (SPF), Consensus Economics and the Federal Open Market Committee (FOMC)[16]. Appendix 3 outlines the details for how the different forecasts are constructed.

Figure 14 summarises the different forecasts for long-term GDP growth. Since 1990, the different forecasts have ranged between 1.8 and 3.4 percent. Projections were relatively stable during the 1990s, averaging 2.4 percent. Actual growth in the same period averaged around 3.2 percent year over year. Growth rates were particularly fast towards the end of the 1990s, sparked by the dot-com bubble and a sharp increase in productivity growth. In the early 2000s, long-term growth forecasts were revised significantly higher,

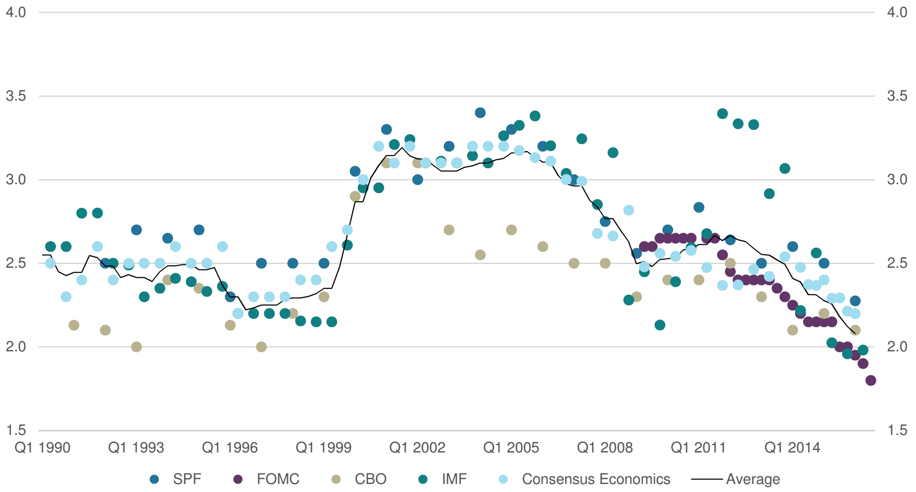
*14 IMF World Economic Outlook database, April 2016.*

*15 OECD database.*

*16 The FOMC started publishing projections for long-term GDP growth in 2009, meaning that we have too few historical data to test the accuracy of the forecasts. We have chosen, however, to include the FOMC's forecasts as a reference point for the discussion of future growth rates.*

averaging 3.1 percent until the financial crisis. Year-over-year growth during the same period was 2.6 percent. Since the financial crisis, there has been a downward trend in long-term growth forecasts, and they currently range from 1.8 percent (median at the FOMC from September) to 2.3 percent (SPF). Since 2010, the US economy has grown at roughly 2 percent per year. Long-term GDP forecasts seem highly adaptive to actual growth.

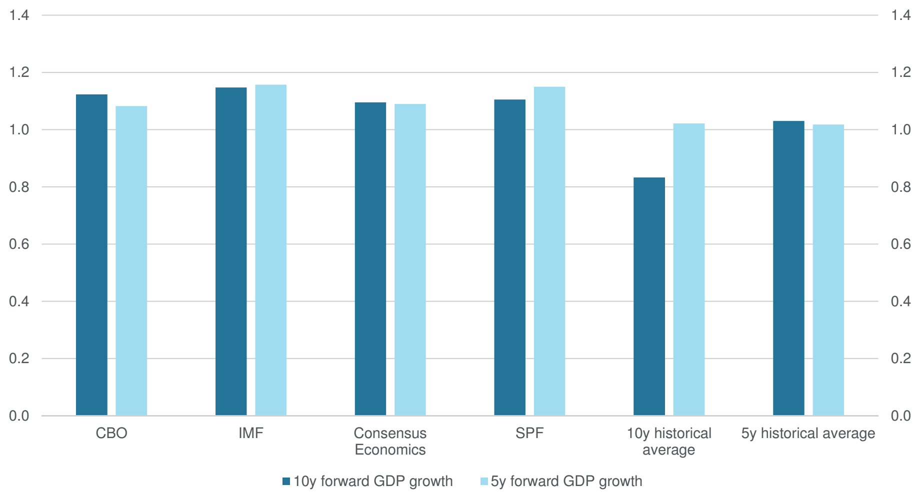
*Figure 14: Long-term US real GDP growth forecasts and four-quarter moving average of forecasts*




*Source: Federal Reserve Bank of Philadelphia, Board of Governors of the Federal Reserve System, Congressional Budget Office, tIMF and Consensus Economics.*

To assess how accurate the long-term forecasts have been historically, we need a measure of realised long-term growth. Since actual potential growth is not directly observable, we use the realised five- and ten-year forward average growth rates from the date of the forecast. It is worth noting that these measures of trend output differ from the economic definition of potential output, since they implicitly assume that the economy on average is at full capacity. Figure 15 shows the mean absolute error of the different GDP forecasts, including some simple estimates calculated as the five- and ten-year historical average growth rates.

*Figure 15: Forecast accuracy for different long-term GDP projections (percentage points, mean absolute error)*




*Notes: Sample 1990 to 2006/2011 for long-term forecast. Trend output calculated by using actual GDP growth from 1990 to 2016. Calculations based on Q1 forecasts (CBO and SPF) or April forecasts (IMF and Consensus Economics).*

The forecast errors over the sample are large, ranging from 105 to 120 basis points for the professional forecasters and from 85 to 105 basis points for the simple benchmarks. The range of forecast errors, however, is relatively narrow compared to the dispersion seen in forecasts over time (see Figure 14). The estimate based on a ten-year backward-looking average has historically been the most accurate in this simple back-test. Of the professional forecasters, the long-term median estimates from Consensus Economics have the lowest mean absolute error, but given the small differences we cannot claim that one forecaster is persistently better than the others. It is also worth noting that the long-term forecasts from Consensus Economics represent a combination of several individual forecasters (many more participants than in the Philadelphia Fed's SPF survey), which historically has helped improve accuracy and reduce forecast errors (Bates and Granger, 1969). The results highlight that long-term GDP growth is hard to predict. However, we should not dismiss the downward trend in global growth forecasts, and, in the next section, we outline potential explanations for the gradual decline in GDP forecasts.

## Possible explanations for lower long-term growth forecasts

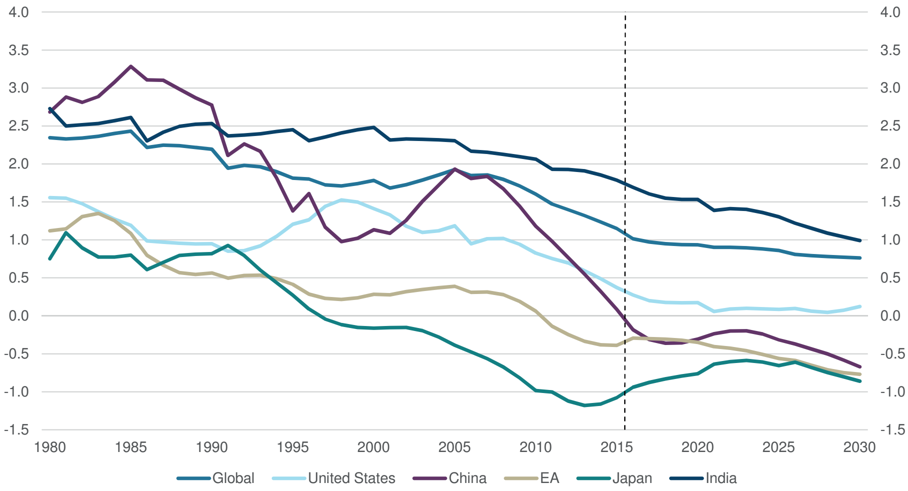
The reason for lower long-term growth forecasts could be that observed global economic growth on average has been lower since the financial crisis compared to earlier periods. Actual growth has also been below expectations for the past six years, and so, professional forecasters have continuously lowered their near-term growth forecasts, potentially also affecting longer-term growth forecasts. We also know that forecasts of potential growth often include assessments about global trends and key growth drivers. Below, we outline four key global trends that might help us understand the decline in growth forecasts: demographics, productivity, public debt and changing income distribution.

### Demographics

Demographic change is a prime example of a slow-moving long-term driver of economic growth. Baby-boomer cohorts born after the Second World War provided a sizeable labour force boost: at its peak, rapid labour force expansion added 2 percentage points to global growth. Between 1980 and 2000, the number of people of working age (18-64) grew by 26.6 percent in the US, by 56.6 percent in China and by 13.8 percent in the euro area (using its 2016 composition).

Some economies are now aging rapidly (Figure 16). The working-age population has been on the decline in Japan since the 1990s. In the euro area, the working-age population started declining nearly ten years ago. Shrinking labour pools are not limited to high-income economies: China's working-age population will shrink by 2.6 percent from 2010 to 2030, a significant reversal from the growth of 56.6 percent for 1980-2000. While the reversals in other economies are less aggressive, they represent a material long-term slowdown in one of the key inputs of an economy. There will also be a greater relative number of elderly, potentially affecting public finances, consumption patterns and productivity. The old-age dependency ratio will more than double in China between 2010 and 2030, growing from 11.8 percent to 26.6 percent. The expected increases are of a similar magnitude in the US and the euro area. The ratio will worsen in the US from 20.6 percent to 35.9 percent, and in the euro area from 29.2 to 45.6 percent – a level where Japan stands today[17]. The direct implication of demographic changes appears to be one of lower potential growth. Achieving the growth rates of the past decades based on factor inputs would require a large acceleration in productivity growth, which is highly uncertain.

*Figure 16: Labour force growth (people aged 18-64), year over year*




*Source: United Nations Population Prospects, 2015 revision. Estimates starting from 2016. Note that EA (euro area) assumes 2016 composition.*

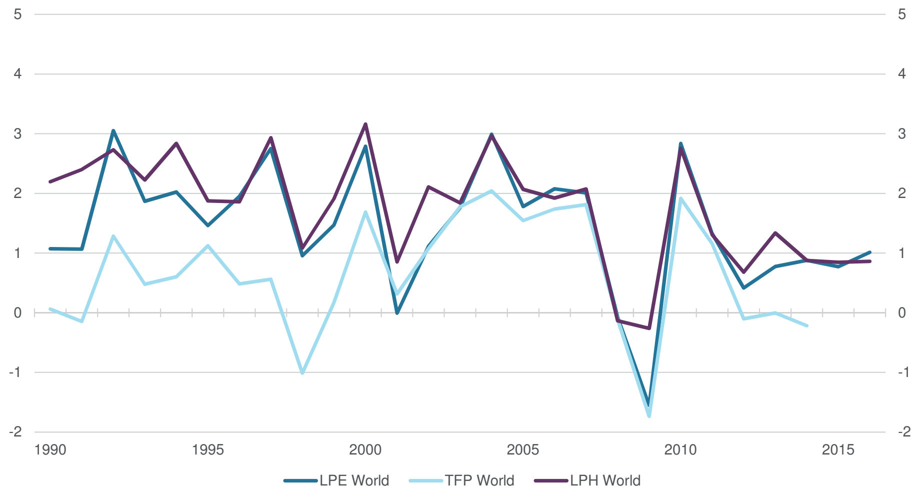
### Productivity

Productivity growth is a key driver of potential growth and of long-term growth forecasts, as economic growth based on expansion of factor inputs is

*17 NBIM calculations based on UN 2015 data.*

subject to diminishing returns (Krugman, 1994). Three productivity measures are widely used in practice, and all three measures of productivity growth have slowed lately (Figure 17)[18]. Global productivity per employed person has slowed to an annual growth rate below 1 percent and remains stagnant below its 1996-2006 average of 1.8 percent. Labour productivity per hour worked has also been trending down, growing at around 1 percent for the past five years. Global total factor productivity growth has fallen from its 1996-2006 level of 0.9 percent into negative territory for the past three years.

*Figure 17: Global labour productivity per employed person (LPE), labour productivity per hour (LPH) and total factor productivity (TFP), year over year*




*Source: Conference Board Total Economy Database, May 2015 and May 2016, and NBIM calculations.*

The existing literature proposes three different explanations for the productivity slowdown. First, the slowdown relates to structural forces, such as a lack of great innovations[19], aging, fewer gains from education and a declining manufacturing sector. Second, the slowdown is driven by cyclical factors such as a lack of capital investment and weak demand after the financial crisis. Third, the slowdown relates mostly to measurement errors, as productivity gains from new technologies such as smartphones, Google or the networking functions of the Internet are not being adequately reflected in the productivity statistics. There is probably some truth to all three explanations. There is little disagreement on the structural factors, but their link to productivity growth is less clear-cut. It is also hard to disagree with the slump in capital investment and slower demand growth, in particular in developed economies. As for measurement errors, there is little consensus in the literature. Many studies fail to explain the productivity slowdown through measurement errors (see, for example, Syverson, 2016), while others admit to some errors in productivity statistics (Byrne, Oliner and Sichel, 2013). There is evidently a disparity between our understanding of productivity growth and its importance (Furman, 2015). Future productivity growth depends partly on the reason for the current slowdown and partly

*18 Labour productivity per worker is defined as GDP per employed person, and labour productivity per hour as GDP per working hour. Total factor productivity is often considered as the growth contribution from new technologies or innovations, or, put differently, the proportion of output not explained by labour or capital.*

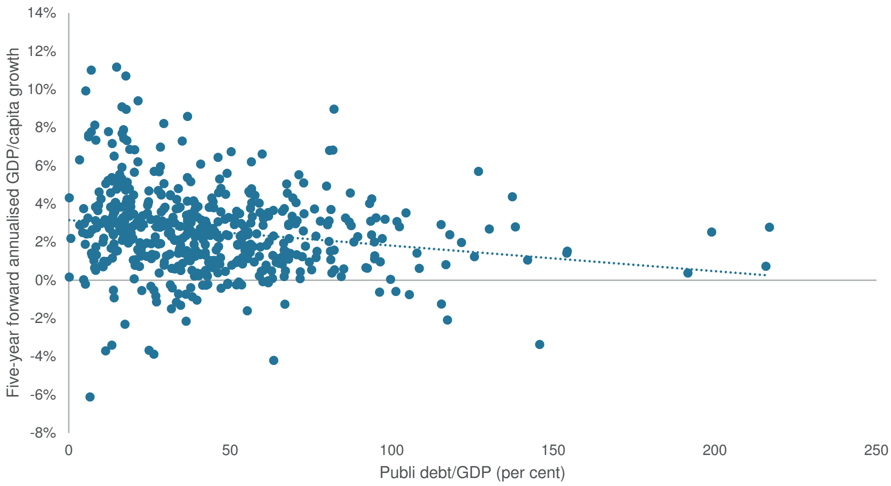
*19 The Gordon view: All great innovations have already been made.*

on what the future potentially brings in the way of new technology and innovations, neither of which are certain.

**Public debt**

Public debt can influence the economy in both the short and the long run. The conventional view is that higher debt through fiscal stimulus benefits growth in the short run, but crowds out capital and reduces output in the long run (Kumar and Woo, 2010). Within the empirical literature, the consensus appears to be that high levels of public debt tend to precede periods of lower long-term growth. Reinhart and Rogoff (2010) reignited research on this topic post-crisis, postulating that high public debt levels appeared to have a significantly negative impact on growth, particularly for countries with debt-to-GDP ratios above 90 percent. Cecchetti et al. (2011) and Kumar and Woo (2010) support the finding that high levels of initial public debt appear to have a negative impact on growth over a subsequent five-year period. Some papers publish contrasting results. Pescatori et al. (2014) finds that the negative impact of debt on growth disappears when also controlling for the growth rates of peer countries and the public deficit. The authors claim that only if a country has a large debt burden accompanied by public deficits is there a negative impact on the future rate of growth. Figure 18 shows the relationship between initial public debt and per capita growth for the following five years for 45 countries from 1950 to 2015 (non-overlapping periods). We have also estimated this relationship more formally by controlling for other variables that positively correlate with GDP growth (see Appendix 4). Our results are in line with most existing literature, suggesting that an increase in initial public debt ratios has a negative impact on average GDP per capita growth in the following five years.

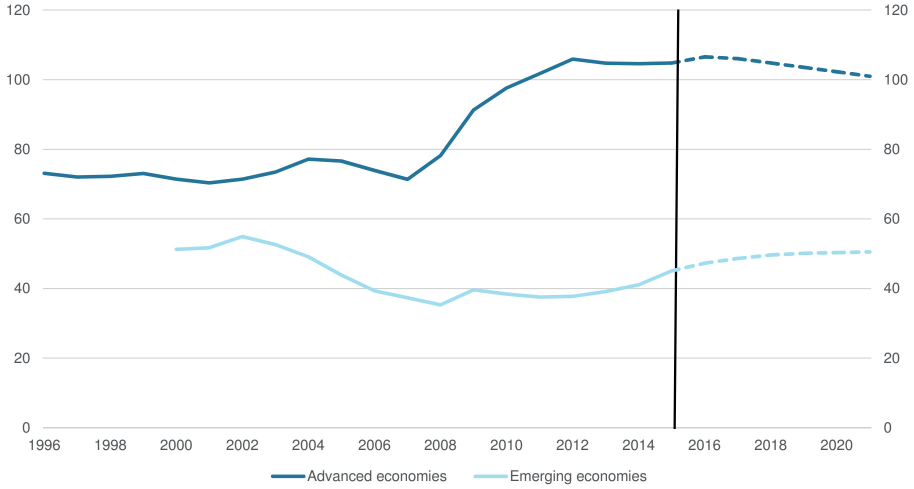
*Figure 18: Public debt to GDP ratios vs five-year subsequent per capita GDP growth for an unbalanced panel of 45 countries from 1950-2015*




*Source: IMF International Financial Statistics database and PWT8.1*

World sovereign debt increased significantly during the global economic and financial crisis. This development was primarily driven by developed countries, where government debt rose from 71 percent of GDP in 2007 to almost 105 percent by end-2015 (Figure 19). Sovereign debt as a percentage of GDP has stabilised at high levels since the European debt crisis. The story is somewhat similar for emerging economies in terms of potential risk stemming from higher real debt-financing costs, although the debt levels are lower as a whole. According to most forecasts, public debt will only decrease very gradually going forward, potentially reflected in lower long-term GDP forecasts.

*Figure 19: Gross government debt as a percentage of GDP*




*Source: IMF World Economic Outlook April 2016, estimates starting from 2016.*

**Changing income distribution**

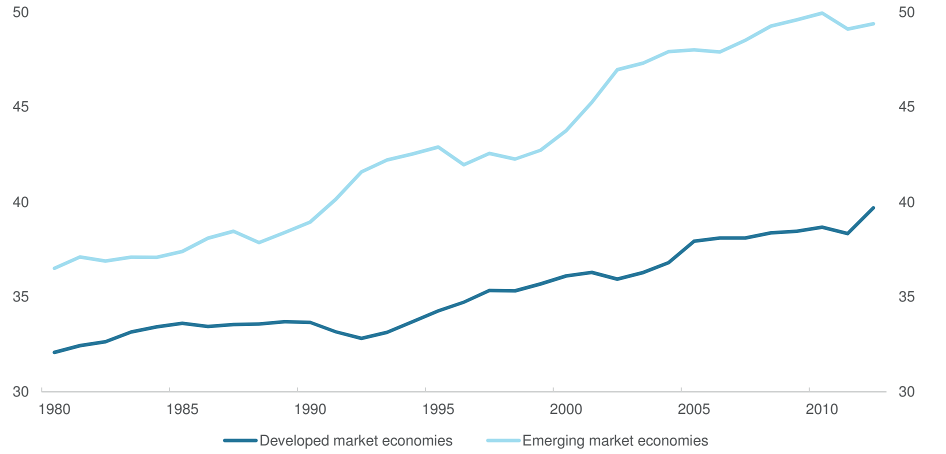
Changes in the income distribution could influence economic growth, but according to theory the effect of income inequality on growth is ambiguous. For example, when voting power is more equally distributed than income, increasing inequality might result in higher voter preference for redistribution. If higher taxes on the rich reduce the incentive to invest, higher inequality could lead to lower economic growth. However, Ostry et al. (2014) find that higher redistribution is not harmful to growth. On the other hand, extreme levels of inequality could result in social unrest and political instability with detrimental effects on growth (Alesina and Perotti, 1996). The marginal propensity to consume also varies over the income distribution, and lower-income households usually consume more out of their current income than higher-income ones (Carroll et al., 2015). There are also theoretical mechanisms through which higher inequality could lead to higher economic growth. First, a higher level of income inequality provides higher incentives to work hard and take on risk (Lazear and Rosen, 1981). Second, if a higher proportion of total income goes to high-income households, this may lead to higher aggregate saving, which in turn could foster higher investment and productivity growth (Kaldor, 1956). A number of empirical papers have concluded that there is in fact a negative relationship between an unequal income distribution and economic growth, especially over the long run[20].

The work of Piketty (2013) and others has emphasised the secular increase in income inequality over the last century. There are a wide range of measures that aim to capture various properties of the income distribution in a society. We will focus on the Gini coefficient, since this is one of the most widely

*20 For a more complete overview of the literature, see Cingano (2014).*

used measures of income inequality, it considers the whole distribution (compared to top 5 or 10 percent measures), and the data availability is generally good across a wide range of countries[21]. Figure 20 shows the development of population-weighted within-country Gini coefficients for emerging and developed economies. Both groups of countries have seen substantial increases in income inequality as measured by the Gini coefficient.

*Figure 20: Population-weighted average within-country Gini coefficients*




*Sources: Solt Database[22] and Datastream*

The literature has identified a number of drivers of inequality, including: technological change that drives up the skill premium, trade globalisation driving down wages of unskilled labour, improving credit markets leading to improved prospects for low-income households, more flexible labour market institutions which may harm the low-skilled, and improving educational opportunities for low-income families in developing countries[23]. Common to most of these drivers is a lack of empirical evidence of the isolated effect on income inequality. Thus, it is difficult to predict the future evolution of income inequality internationally. On the one hand, it seems that technological advances in automation will lead to robots increasingly outcompeting low-skilled labour. On the other, we observe a growing number of disenfranchised voters in the developed world who look to the state to rectify perceived inequality through increased redistribution. The recent uptick in interest around "universal basic income" seems to be one of the results from this.

**Other trends potentially affecting future growth expectations**

There are several other global trends besides the ones described above that are potentially affecting actual growth rates and long-term growth forecasts. For example, the pace of globalisation, one of the main drivers of high growth rates since the 1990s, has slowed. Global trade growth has decreased sharply in recent years, falling from an average annual growth rate of around 6 percent from 1980 to 2007 to less than 3 percent since the

*21 For details on the construction of the Gini coefficient, see Appendix 5.*

*22 Solt, F. (2014): "The Standardized World Income Inequality Database", working paper. SWIID version 5.0, October 2014.*

*23 For a summary of research on these and other drivers, see Dabla-Norris et al. (2015).*

global financial crisis. Many argue that a large part of the slowdown relates to lower global economic growth (see, for example, Bundesbank, 2016) and the slump in investment activity in developed economies. However, the ratio between GDP and global trade has also decreased, suggesting that it could relate to structural forces such as a rise in trade protectionism, companies reaching their optimal level of global value chain integration, or a shift in the importance of services relative to goods.

Climate changes has also been shown to have a negative effect on GDP growth. Physical changes to the environment have already resulted in more frequent and extreme weather events such as storms, flooding, droughts and wildfires, as well as creeping rises in temperatures and sea levels over time[24]. Experts agree that this development is likely to continue and become even more pronounced in the future. The economic consequences are potentially large, as most of the literature on climate change points to a clear negative effect on future GDP growth, in particular in developing nations[25].

# Conclusion

The aim of this discussion note is to explore the relationship between global economic growth and global equity returns, and assess whether slower economic growth and lower long-term growth forecasts have any implications for future global equity returns. We have established a link between economic growth, cash flows generated by listed companies and equity returns globally. We have also shown that long-term global growth forecasts are trending lower, and that there are several possible fundamental drivers behind this development.

We cannot rule out, however, that expectations of lower future growth are already reflected in prices. Larry Summers' secular stagnation hypothesis is gaining traction among policy makers globally, international agencies and market participants: fixed-income markets are pricing very low real short-term interest rates ten years forward for most major economies. Unfortunately, equity markets' pricing of growth is not directly observable.

Future growth is also uncertain and long-term growth forecasts have historically not been very accurate. In fact, average historical growth has the lowest forecast error in a simple back-test. However, a realisation of lower future global growth would be a concern for long-term investors, as the potential for cash flow growth generated by companies would be limited. Such developments might not be reflected in today's equity prices.

*24 National Oceanic and Atmospheric Administration (NOAA), National Centers for Environmental Information (NCEI), http://www.noaa.gov/.*

*25 See, for example, The Stern Review (2006), Dell, Jones and Olken (2008) and Roson and Van der Mensbrugghe (2010).*

# References



Alesina, A., Perotti, R. (1996): "Income Distribution, Political Instability, and Investment", *European Economic Review*, 40(6), 1203-1228.

Arnott, R., Bernstein, P. (2002): "What Risk Premium is 'Normal'?", *Financial Analysts Journal*, 58(2), 64-85.

Baker, D., Delong, J., Krugman, P. (2005): "Asset Returns and Economic Growth", Brookings Papers on Economic Activity 1:2005.

Banerjee, A., Newman, A. (1993): "Occupational Choice and the Process of Development", *Journal of Political Economy*, 101(2), 274-298.

Bansal, R., Kiku, D., Yaron, A. (2010): "Long Run Risks, the Macroeconomy, and Asset Prices", *American Economic Review*, 100(2), 542-546.

Bates, J., Granger, C. (1969): "The Combination of Forecasts", *Operations Research Quarterly*, 20(4), 451-468.

Baum, A., Checherita-Westphal, C., Rother, P. (2012): "Debt and Growth – New Evidence for the Euro Area", ECB Working Paper Series 1450.

Berg, A., Ostry, J. (2011): "Inequality and Unsustainable Growth: Two Sides of the Same Coin?", IMF Staff Discussion Note SDN/11/08.

Bernanke, B. (2016): "The Fed's Shifting Perspective on the Economy and its Implications for Monetary Policy", Brookings Institute, 8 August 2016.

Bernstein, W., Arnott, R. (2003): "Earnings Growth: The Two Percent Dilution", *Financial Analysts Journal*, 59(5), 47-55.

Blackrock (2016): "Productivity Slowdown Puzzle: Structural, Cyclical or Erroneous?", Blackrock Investment Institute.

Board of Governors of the Federal Reserve System (2016): Economic Projections of Federal Reserve Board Members and Federal Reserve Bank Presidents, September 2016.

Bosworth, B., Burtless, G. (1988): "Social Security Reform in a Global Context". In: Federal Reserve Bank of Boston: "Social Security Reform: Links to Saving, Investment, and Growth".

Britten-Jones, M., Neuberger, A., Nolte, I. (2011): "Improved Inference in Regressions with Overlapping Observations", *Journal of Business Finance & Accounting*, 38(5-6), 657-683.

Buffet, W. (1999): "Mr. Buffet on the Stock Market", *Fortune*, 22 November 1999.

Bullard, J. (2016): "A New Characterization of the U.S Macroeconomic and Monetary Policy Outlook", speech for Society of Business Economists, London, June 2016.

Bundesbank (2016): "On the Weakness of Global Trade", Deutsche Bundesbank Monthly Report, March 2016.

Byrne, D., Oliner, S., Sichel, D. (2013): "Is the Information Technology Revolution Over?", *International Productivity Monitor*, 25, 20-36.

Carroll, C., Slacalek, J., Tokuoka, K., White, M. (2015): "The Distribution of Wealth and the Marginal Propensity to Consume", working paper.

Caselli, F., Feyrer, J. (2005): "The Marginal Product of Capital", National Bureau of Economic Research Working Paper 11551.

Cecchetti, S., Mohanty, M., Zampolli, F. (2011): "The Real Effects of Debt", BIS Working Paper 352.

Cingano, F. (2014): "Trends in Income Inequality and its Impact on Growth", OECD Social, Employment and Migration Working Papers 163.

Cochrane, J. (2011): "Inflation and Debt", *National Affairs,* 9, 56-78.

Conference Board (2015): "Productivity Brief 2015: Global Productivity Growth Stuck in the Slow Lane with No Signs of Recovery in Sight".

Congressional Budget Office (2016): "The Budget and Economic Outlook: 2016 to 2026", 25 January 2016.

Dabla-Norris, E., Kochhar, K., Suphaphiphat, N., Ricka, F., Tsounta, E. (2015): "Causes and Consequences of Income Inequality: A Global Perspective", IMF Staff Discussion Note SDN/15/13.

David, J., Henriksen, E., Simonovska, I. (2014): "The Risky Capital of Emerging Markets", University of Southern California and University of California, Davis.

Daly, K. (2010): "Why Doesn't Capital Flow to Where Returns are Highest?", Goldman Sachs Global Economics Paper 205.

Dell, M., Jones, F., Olken, A. (2008): "Climate Change and Economic Growth: Evidence from the Last Half Century", NBER Working Paper 14132.

Diamond, P. (1965): "National Debt in a Neoclassical Growth Model", *American Economic Review*, 55(5), 1126-1150.

Diamond, P. (2000): "What Stock Market Returns to Expect for the Future?", *Social Security Bulletin*, 63(2), 38-52.

Diermeier, J., Ibbotson, R., Siegel, R. (1984): "The Supply of Capital Market Returns", *Financial Analysts Journal*, 40(2), 74-80.

Dimson, E., Marsh P., Staunton, M. (2010): "Economic Growth". In: *Credit Suisse Global Investment Returns Yearbook*, Zurich: Credit Suisse AG.

Easterly, W. (2007): "Inequality Does Cause Underdevelopment: Insights from a New Instrument", *Journal of Development Economics*, 84(2), 755-776.

Easterly, W., Levine, R. (2001): "It's Not Factor Accumulation: Stylized Facts and Growth Models", World Bank and University of Minnesota.

Elmendorf, D., Makiw, G. (1998): "Government Debt", NBER Working Paper 6470.

Feenstra, R., Inklaar, R., Timmer, M. (2015): "The Next Generation of the Penn World Table", *American Economic Review*, 105(10), 3150-3182, available for download at www.ggdc.net/pwt.

Furman, J. (2015): "Productivity Growth in the Advanced Economies: The Past, the Present, and Lessons for the Future", Peterson Institute for International Economics.

Gordon, R. (2000): "Does the 'New Economy' Measure Up to the Great Inventions of the Past?", NBER Working Paper 7833.

Gordon, R. (2014): "A New Method of Estimating Potential Real GDP Growth: Implications for the Labor Market and the Debt/GDP Ratio", NBER Working Paper 20423.

Gupta, A., Melas, D., Suryanarayanen, R., Urban, A. (2016): "Global Markets and Return Drivers", MSCI Research Insight, February 2016.

Hensley, D., Loeys, J., Lupton, J., Borichevska, O. (2016): "Global Growth Volatility Setting New Lows", JP Morgan Economic Research Note, 15 July 2016.

Holston, K., Laubach, T., Williams, J. (2016): "Measuring the Natural Rate of Interest: International Trends and Determinants", Federal Reserve Bank of San Francisco Working Paper 2016-11.

Hsieh, C., Klenow, P. (2007): "Relative Prices and Relative Prosperity", *American Economic Review*, 97(3), 562-585.

Ibbotson, R., Chen, P. (2003): "Long-Run Stock Returns: Participating in the Real Economy", *Financial Analysts Journal*, 59(1), 88-98.

Ibbotson, R., Straehl, P. (2016): "The Long-Run Drivers of Stock Returns: Total Payouts and the Real Economy", working paper.

Ilmanen, A. (2011): *Expected Returns*, Chichester: John Wiley.

IMF (2015): World Economic Outlook, April 2015, chapter 3.

IMF (2016): World Economic Outlook, April 2016.

IMF (2016): World Economic Outlook Database, April 2016.

Inklaar, R., Timmer, M. (2013): "Capital, Labor and TFP in PWT8.0", University of Groningen.

Kaldor, N. (1956): "Alternative Theories of Distribution", *Review of Economic Studies*, 23(2), 83-100.

Krueger, D., Ludwig, A. (2006): "On the Consequences of Demographic Change for Rates of Returns to Capital, and the Distribution of Wealth and Welfare", NBER Working Paper 12453.

Krugman, P. (1994): "The Myth of Asia's Miracle", *Foreign Affairs*, 73(6), 62-78.

Krugman, P. (1994): *The Age of Diminished Expectations*, Cambridge: MIT Press.

Kumar, M., Woo, J. (2010): "Public Debt and Growth", IMF Working Paper WP/10/174.

Lazear, E., Rosen, S. (1981): "Rank-Order Tournaments as Optimum Labour Contracts", *Journal of Political Economy*, 89(5), 841-864.

Lettau, M., Ludvigson, S. (2001): "Consumption, Aggregate Wealth, and Expected Stock Returns", *Journal of Finance*, 56(3), 815-849.

Lettau, M., Ludvigson, S. (2001): "Resurrecting the (C)CAPM: A Cross-Sectional Test When Risk Premia are Time-Varying", *Journal of Political Economy*, 109(6), 1238-1287.

Lettau, M., Ludvigson, S., Wachter, J. (2008): "The Declining Equity Premium: What Role Does Macroeconomic Risk Play?", *Review of Financial Studies*, 21(4), 1653-1687.

Liu, Z., Spiegel, M. (2011): "Boomer Retirement: Headwinds for U.S. Equity Markets?", FRBSF Economic Letter, 22 August 2011.

Lucas, R. (1990): "Why Doesn't Capital Flow from Rich to Poor Countries?", *American Economic Review*, 80(2), 92-96.

McKinsey & Company (2016): "Diminishing Return: Why Investors May Need to Lower Their Expectations".

McKinsey & Company (2015): "Global Growth: Can Productivity Save the Day in an Aging World?".

Milanovic, B. (2012): "Global Inequality Recalculated and Updated: The Effect of New PPP Estimates on Global Inequality and 2005 Estimates", *Journal of Economic Inequality*, 10(1), 1-18.

Modigliani, F. (1961): "Long-Run Implications of Alternative Fiscal Policies and the Burden of the National Debt", *Economic Journal*, 71(4), 730-755.

MSCI (2010): "Is There a Link between GDP Growth and Equity Returns?", MSCI Barra Research Bulletin.

MSCI (2011): "What Drives Long-Term Equity Returns?", MSCI Barra Research Bulletin.

Norges Bank Investment Management (2012): "Economic Growth and Equity Returns", NBIM Discussion Note 5/2012.

O'Neill, J., Stupnytska, A., Wrisdale, J. (2011): "Linking GDP Growth and Equity Returns", Goldman Sachs Monthly Insights, May 2011.

Ostry, J., Berg, A., Tsangarides, C. (2014): "Redistribution, Inequality, and Growth", IMF Discussion Note SDN 14/02.

Owen, A., Weil, D. (1998): "Intergenerational Earnings Mobility, Inequality, and Growth", *Journal of Monetary Economics*, 41(1), 71-104.

Pattillo, C., Poirson, H., Ricci, L. (2011): "External Debt and Growth", *Review of Economics and Institutions*, 2(3), 1-37.

Pescatori, A., Sandri, D., Simon, J. (2014): "Debt and Growth: Is There a Magic Threshold?", IMF Working Paper 14/34.

Piketty, T. (2013): *Capital in the Twenty-First Century*, Cambridge: Harvard University Press.

PricewaterhouseCoopers (2015): "The World in 2050: Will the Shift in Global Economic Power Continue?".

Ponds, E., Severinson, C., Yermo, J. (2011): "Funding in Public Sector Pension Plans – International Evidence", NBER Working Paper 17082.

Poterba, J. (2001): "Demographic Structure and Asset Returns", *Review of Economics and Statistics*, 83(4), 565-584.

Reinhart, C., Rogoff, K. (2010): "Growth In A Time Of Debt", *American Economic Review*, 100(2), 573-578.

Ritter, J. (2005): "Economic Growth and Equity Returns", *Pacific-Basin Finance Journal*, 9(4), 421-434.

Ritter, J. (2012): "Is Economic Growth Good for Investors?", *Journal of Applied Corporate Finance*, 24(3), 8-18.

Roy, A., Punhani, S., Shi, L. (2012): "How Demographics Affect Asset Prices", Credit Suisse Global Demographics and Pensions Research, February 2012.

Saint-Paul, G. (1992): "Fiscal Policy in an Endogenous Growth Model", *Quarterly Journal of Economics*, 107(4), 1243-1259.

Siegel, J. (2000): "Big Cap Tech Stocks Are a Sucker Bet", *Wall Street Journal*, 14 March 2000.

Solow, R. (1956): "A Contribution to the Theory of Economic Growth", *Quarterly Journal of Economics*, 70(1), 65-94.

Solt, F. (2014): "The Standardized World Income Inequality Database", working paper. SWIID version 5.0, October 2014.

Stark, T. (2013): "SPF Panellists' Forecasting Methods: A Note on the Aggregate Results of the November 2009 Special Survey", Federal Reserve Bank of Philadelphia Real-Time Data Research Center.

Stern, N. (2006): *The Economics of Climate Change: The Stern Review,* Cambridge, England: Cambridge University Press.

Summers, L. (2014): "U.S Economic Prospects: Secular Stagnation, Hysteresis, and the Zero Lower Bound", *Business Economics*, 49(2), 65-73.

Syverson, C. (2016): "Challenges to Mismeasurement Explanations for the U.S. Productivity Slowdown", NBER Working Paper 21974.

Takats, E. (2010): "Aging and Asset Prices", BIS Working Papers 318.

Van der Mensbrugghe, D. (2010): "Climate Change and Economic Growth: Impacts and Interactions", International Journal of Sustainable Economy, April 2010.

Viceira, L., Wang, K., Zhou, J. (2016): "Global Portfolio Diversification for Long-Horizon Investors", Harvard Business School, first draft.

Young, A. (1994): "The Tyranny of Numbers: Confronting the Statistical Realities of the East Asian Growth Experience", NBER Working Paper 4680.

# Appendix 1: Diminishing return on capital

*Figure 21: Real GDP per capita and return on capital across countries (average over sample period)*

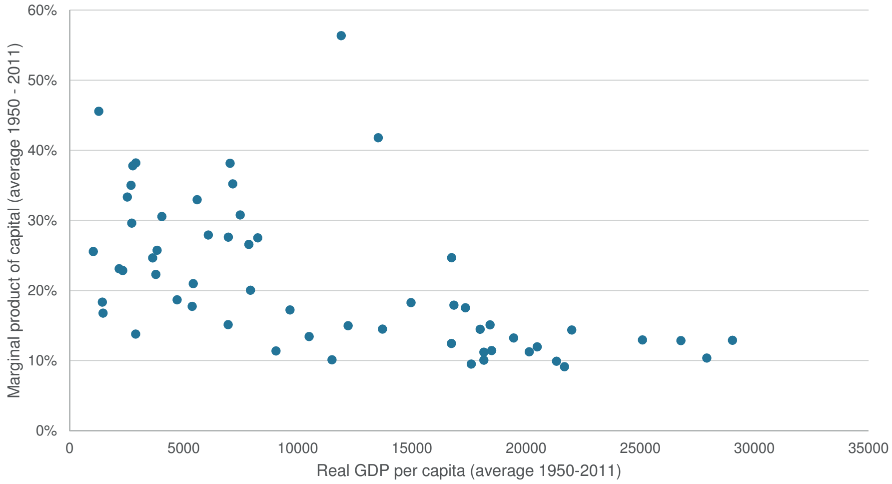
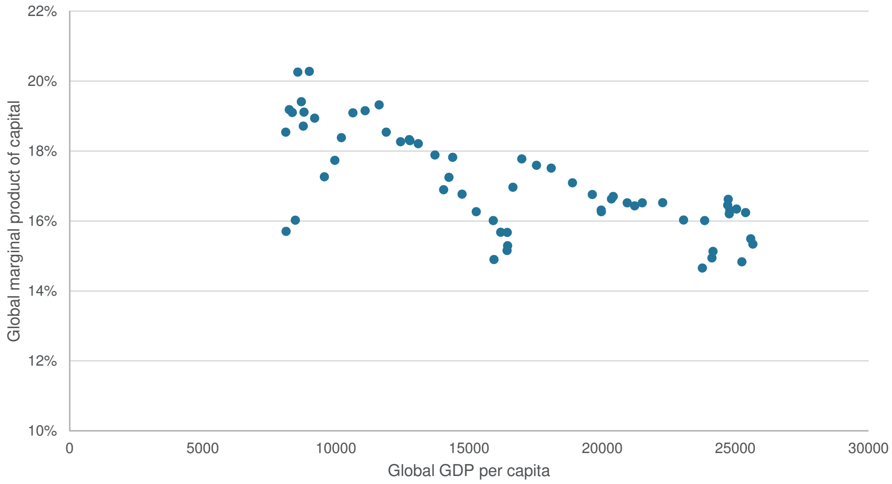


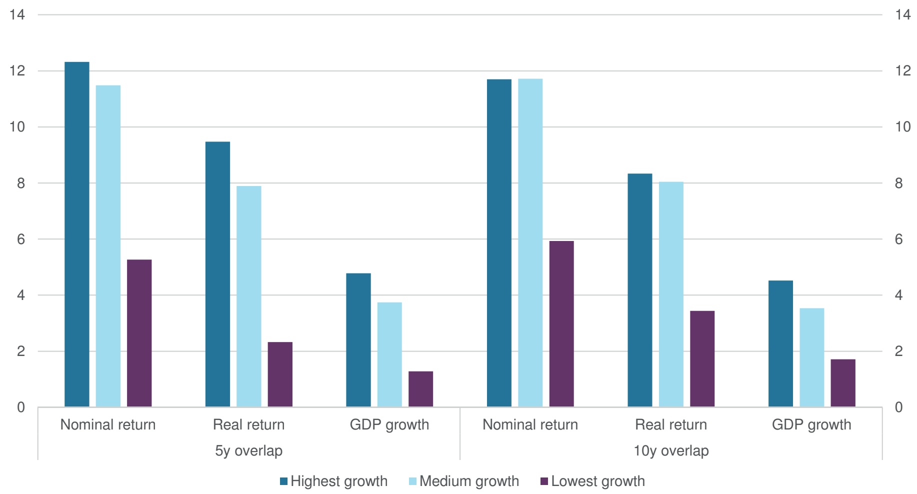

*Figure 22: Real global GDP per capita and global return on capital 1950-2011*




*Source: Penn World Table 8.1 and NBIM calculations.*

# Appendix 2: Average equity returns ranked by average GDP growth

*Figure 23: Average equity returns ranked by average GDP growth, 1901-2011 overlapping periods*




*Note: For the five-year averages, there are 36 observations for highest and lowest growth and 35 observations for medium growth. For the ten-year averages, there are 34 observations for all three growth buckets Source: DMS 2016, Reinhart and Rogoff, PWT8.1 and NBIM calculations.*

# Appendix 3: Details on US long-term growth forecast providers

The CBO has published data on long-term GDP forecasts since 1949[26]. The forecasts are part of its report for the budget and economic outlook ten years ahead. The CBO's projections for the second half of the ten-year period are based on the projected trends of underlying factors, such as growth in labour force, distribution of employment across sectors of the economy, number of hours worked and productivity (CBO, 2016). Of the current 2.1 percent average annual rate of increase in output five to ten years ahead, productivity growth accounts for roughly three-quarters of total output growth. The CBO assumes that total factor productivity in the non-farm sector will gradually return to a rate slightly lower than the average growth rate estimated for 1991-2015[27].

The IMF publishes its forecasts for US long-term growth as part of the World Economic Outlook, which has been issued biannually in April and October since 1990. The growth forecasts are revised in January and July, but these are not included in our dataset. The IMF forecasts growth six years ahead, and we use its forecast for the sixth year as its estimate of long-term growth. These medium-term forecasts are to a large extent shaped by the different country teams' views about potential growth.

The long-term projections from the SPF have been published by the Federal Reserve Bank of Philadelphia (Philadelphia Fed) since Q1 1992. The long-term forecasts are published in Q1 only. The questionnaires are sent to the panellists[28] at the end of January, with the deadline for submissions in mid-February. The long-term GDP projection is the annual average rate of growth in real GDP over the next ten years, including the year of the survey. In 2009, the Real Time Data Center at the Philadelphia Fed conducted a survey on the SPF panellists' forecasting methods (Stark, 2013). Twenty of 25 respondents used mathematical models plus a subjective adjustment, but the forecasting horizon matters. Most reported that they used mathematical models at the shortest horizon (two years out or less), while fewer relied on models when forecasting at the long horizon. The panellists reported that they update their projections frequently.

Consensus Economics publishes long-term forecasts for GDP growth six to ten years ahead. The long-term consensus estimates have been published in April and October since 1990 and quarterly since July 2014. The forecasts are collected from a regular panel, consisting of rating agencies, investment banks, large companies, universities and official institutions, among others.

*26 We use online data since 1991. From 1991 to 2003, the estimates are published in billions of dollars, and we use the average year-over-year growth rate from five to ten years out as the CBO's estimate of the long-term growth rate for the economy. Since 2004, the forecasts have been published twice a year, but for consistency we use the January forecasts. The estimates since 2003 are sometimes given as the average growth rate from five to ten years out, which is comparable with the estimate we use from 1991 to 2003. In 2013, the forecasts were published in February.*

*27 The CBO places more weight on the relatively slow growth of productivity during the recession and recovery than on the fast growth rates of the 1990s and early 2000s.*

*28 The forecasters in the SPF come largely from the business and financial sector, but it also includes consulting firms, universities and other private firms.*

The forecasting method of the different panellists is unknown, but it is reasonable to assume that it is similar to the SPF given the overlap among forecasters.

The FOMC started publishing projections for long-term GDP growth in 2009, meaning we have too little historical data to test the accuracy of the forecasts. We have chosen, however, to include the FOMC's forecasts as a reference point for our discussion of future growth rates. The FOMC's long-term GDP growth forecasts represent the median or central tendency of the members (voting and non-voting) of the monetary policy committee. The forecasting method depends on the different Reserve Bank Districts[29], their econometric models and the governors' assessments. The range of views within the FOMC is wide. On the one hand, the Federal Reserve Bank of St. Louis has abandoned the concept of a single, long-run steady state to which the economy converges (Bullard, 2016). It favours a a regime-based concept of medium- and long-term macroeconomic outcomes and argues that the best we can do today is to forecast that the current regime will persist. On the other, among those who do provide long-run projections, the current forecasts range from 1.6 to 2.2 percent (FOMC, September 2016).

*29 There are twelve different Reserve Bank Districts: Boston, New York, Philadelphia, Cleveland, Richmond, Atlanta, Chicago, St. Louis, Minneapolis, Kansas City, Dallas and San Francisco.*

# Appendix 4: Panel regressions on the link between public debt and GDP growth

We run our panel regressions with a set of variables that have demonstrated an impact on long-term growth. The first column of results below is broadly in line with the rest of the literature, suggesting that a 1 percent increase in public debt levels can be associated with a 1 basis point decline in annual growth over the following five years. The second column of results uses dummy variables for emerging and developed economies dividing them into high-debt (> 90 percent debt to GDP), low-debt (<30 percent debt to GDP) and medium-debt (30 to 90 percent debt to GDP) economies. Using low-debt developed economies as a baseline, the results highlight two key trends. The first is that the impact on growth is negative and greater for higher-debt economies relative to lower-debt economies. Secondly, the impact also appears to be greater for emerging markets relative to developed markets (see Pattillo et al., 2011). For example, high-debt emerging economies grow 3.34 percent more slowly than low-debt developed economies over a five-year period. This might be because weaker institutions in emerging markets lack the credibility to manage large piles of debt, or because emerging market debt issuance has historically had a higher fraction of foreign currency exposure[30].

*Table 1: Baseline regression results using time-fixed effects for an unbalanced panel of 45 countries for the period 1950-2015*

| Dependent variable | Real five-year per capita GDP growth (percent) | | |
|---|---|---|---|
| | (1) | | (2) |
| Initial public debt / GDP | -0.0001*** | **High debt (EM)** | -0.0334*** |
| | | **Medium debt (EM)** | -0.0273*** |
| | | **Low debt (EM)** | -0.0154*** |
| | | **High debt (DM)** | -0.0101*** |
| | | **Medium debt (DM)** | -0.0063*** |
| | | **Low debt (DM)** | omitted |
| Initial GDP per capita ($'000) | -0.0009*** | | -0.001*** |
| Initial openness (percent of GDP) | 0.0081*** | | 0.0062*** |
| Initial years of education for 25+ age group | 0.0013** | | 0.001* |
| Initial dependency ratio | -0.0034 | | -0.0544** |
| Terms of trade change (percent) | 0.1148 | | 0.012 |
| Inflation across period (percent) | -0.0001*** | | -0.0001 |
| Initial primary balance (percent of GDP) | -0.0004 | | -0.0003 |
| Observations | 441 | | 441 |
| R-squared | 0.2830 | | 0.3345 |
| F-test (Prob > F) | 0 | | 0 |

*30 Foreign currency debt might have a greater impact on growth than local currency debt because it grows in value during a recession (when the local currency is weakening) and therefore might amplify the impact of a downturn, creating even more of a negative impact.*

# Appendix 5: The Lorenz curve

The Gini coefficient can be derived from the Lorenz curve (as shown in Figure 24). This curve plots the proportion of the total income of the population (y-axis) that is cumulatively earned by the bottom x percent of the population. A fully equal income distribution would thus be represented by the 45 degree line. The Gini coefficient is defined as the area between the equality line and the Lorenz curve (marked A) divided by the total area under the equality line (A+B). Consequently, this coefficient will always be between 0, which indicates complete equality, and 1 (or 100 percent), which marks complete inequality (as long as all individuals have non-negative incomes).

*Figure 24: Example of a Lorenz curve, representing the cumulative income distribution in a society*


Income inequality can also be measured across countries and has fallen slightly over our sample period, illustrating a certain degree of international income convergence. This calculation method is, however, less relevant for establishing a link between income distribution and economic growth in a given economy. Attempts have been made to construct a "true" global Gini coefficient, taking into account the trade-off between rising within-country and falling across-country income inequality. Milanovic (2012) studied the global income distribution at the household level through individual country household surveys and found that global income inequality was fairly stable between 1988 and 2005. However, such studies are subject to potential problems related to survey comparability.