BANK OF ENGLAND

Staff Working Paper No. 571
Secular drivers of the global real interest rate

Lukasz Rachel and Thomas D Smith

December 2015

BANK OF ENGLAND

Staff Working Paper No. 571

Secular drivers of the global real interest rate

Lukasz Rachel[1] and Thomas D Smith[2]

Abstract

Long-term real interest rates across the world have fallen by about 450 basis points over the past 30 years. The co-movement in rates across both advanced and emerging economies suggests a common driver: the global neutral real rate may have fallen. In this paper we attempt to identify which secular trends could have driven such a fall. Although there is huge uncertainty, under plausible assumptions we think we can account for around 400 basis points of the 450 basis points fall. Our quantitative analysis highlights slowing global growth as one force that may have pushed down on real rates recently, but shifts in saving and investment preferences appear more important in explaining the long-term decline. We think the global saving schedule has shifted out in recent decades due to demographic forces, higher inequality and to a lesser extent the glut of precautionary saving by emerging markets. Meanwhile, desired levels of investment have fallen as a result of the falling relative price of capital, lower public investment, and due to an increase in the spread between risk-free and actual interest rates. Moreover, most of these forces look set to persist and some may even build further. This suggests that the global neutral rate may remain low and perhaps settle at (or slightly below) 1% in the medium to long run. If true, this will have widespread implications for policymakers — not least in how to manage the business cycle if monetary policy is frequently constrained by the zero lower bound.

Key words: Equilibrium interest rate, long-term yields, global saving and investment, global trend growth.

JEL classification: E02, E10, E20, E40, E50, E60, F00, F41, F42, F47, J11, O30, O40.

---

(1) Bank of England and London School of Economics. Email: lukasz.rachel@bankofengland.co.uk, l.p.rachel@lse.ac.uk
(2) Bank of England. Email: thomas.smith@bankofengland.co.uk

The views expressed in this paper are those of the authors, and not necessarily those of the Bank of England or its committees. We would like to thank Scott Simmons for his research assistance during the project and colleagues in the International Directorate for helpful comments. All remaining errors and omissions are our own.

Information on the Bank's working paper series can be found at
www.bankofengland.co.uk/research/Pages/workingpapers/default.aspx

Publications Team, Bank of England, Threadneedle Street, London, EC2R 8AH
Telephone +44 (0)20 7601 4030 Fax +44 (0)20 7601 3298 email publications@bankofengland.co.uk

ISSN 1749-9135 (on-line)

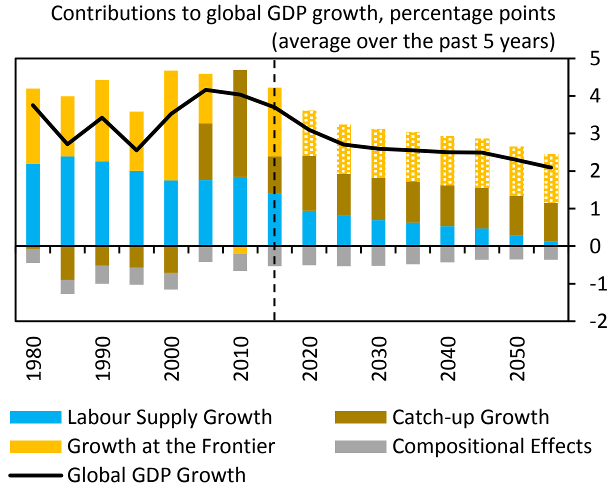
Contents

Executive Summary

Interest rates across much of the world are low. This paper aims to contribute to the wider debate about why that is and what may happen going forward. Our main contributions are twofold: first, we assemble a rich collection of global data to analyse the main secular trends that could be driving the global neutral real rate. Second, we develop a simple accounting framework to quantify the relative importance of these trends in a coherent way. We then use these insights to explain the fall in the global neutral rate in the past, and offer a prediction of how the neutral rate could evolve in the future.

- Since the 1980s, market measures of long-term risk-free real interest rates have declined by around 450bps across both emerging and developed economies. Although there is a lot of variation across countries, the presence of a discernible common trend suggests global factors are at work (**Section A**).
- This decline in global real interest rates has largely occurred against a backdrop of low and stable inflation with little sign of demand overheating. This suggests the sustained fall in long-term market rates is symptomatic of a fall in the global *neutral* rate. The global neutral rate is an important policy variable as it acts as an anchor for a country's equilibrium real rate in the long run (**Section B**).
- The global neutral rate is largely determined by: expectations of global trend growth; and other factors shaping preferences for desired savings and investment. We analyse each in turn. First we use a modified growth-accounting framework to analyse the various secular trends that could be affecting global growth. Then we use a simple saving-investment framework to analyse global shifts in desired savings and investment to analyse how changes in preferences could have affected the neutral rate.
- **Growth:** Although changes in global trend growth are probably the most commonly-cited driver of changes in real interest rates, we find it difficult to account for much (if any) of the pre-crisis fall in global real rates by just appealing to past changes in growth – global growth was fairly steady in the pre-crisis decades. However, the financial crisis is likely to have triggered a wider reassessment of growth prospects and pessimism about the future could be playing an important role in driving the decline in real rates we have seen more recently. Our analysis suggests that slower global labour supply growth (due to demographic forces) and headwinds at the technological frontier (such as a plateau in educational attainment), may cause global growth to slow by up to 1pp over the next decade (**Figure A**). We think this decline could account for about 100bps of the fall in real rates we have seen recently (**Section C**).

Figure A: Global Growth Accounting



	1980 to 2015	2015 to 2030
Change in Global Growth	0.0pp	0 to -1.5pp
Labour Supply Growth	-0.8	0 to -0.5
Catch-Up Growth:	+1.0	-
Growth at the frontier:	-0.2	0 to -1.0
Educational plateau	-0.2	0 to -0.2
Inequality	0.0	0 to -0.6
Fiscal	+0.2	0 to -0.2
Technological progress	-0.2	-

Sources: TED, US Conference Board, IMF, UN and Authors' calculations

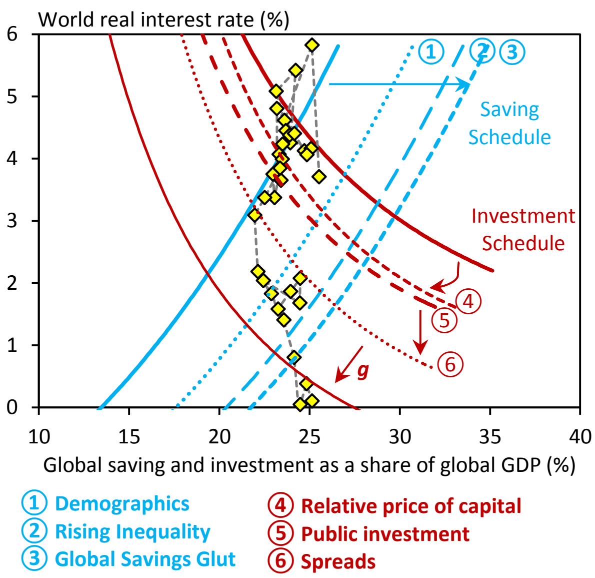
Notes: Global growth is expressed in constant PPP-weighted 1990 dollars. The grey 'compositional effect' bars in the chart show the impact on average global per capita incomes of having high population growth in low-income countries.

- **Preferences:** Shifts in the balance of desired savings and investment appear quantitatively even more important than changes in growth expectations. Our analysis suggests the desired savings schedule has shifted out materially due to demographic forces (90bps of the fall in real rates), higher inequality within countries (45bps) and a preference shift towards higher saving by emerging market governments following the Asian crisis (25bps). If this had been the whole story, we would have expected to see a steady rise in actual saving rates globally. But global saving and investment ratios have been remarkably stable over the past thirty years suggesting desired investment levels must have also fallen. We pin this decline in desired investment on a fall in the relative price of capital goods (accounting for 50bps of the fall in real rates) and a preference shift away from public investment projects (20bps). Also, we note that the rate of return on capital has not fallen by as much as risk free rates. The rising spread between these two rates has further reduced desired investment and risk free rates down (by 70bps). Together these effects can account for 300bps of the fall in global real rates (**Section D**).

- When combined, lower expectations for trend growth and shifts in desired savings and investment can account for about 400bps of the 450bps decline in the global long-term neutral rate since the 1980s (**Figure B**). Moreover, these secular trends look likely to persist (**Figure C**). This suggests that the global neutral real rate may settle at or slightly below 1% over the medium- to long-run (**Section E**).

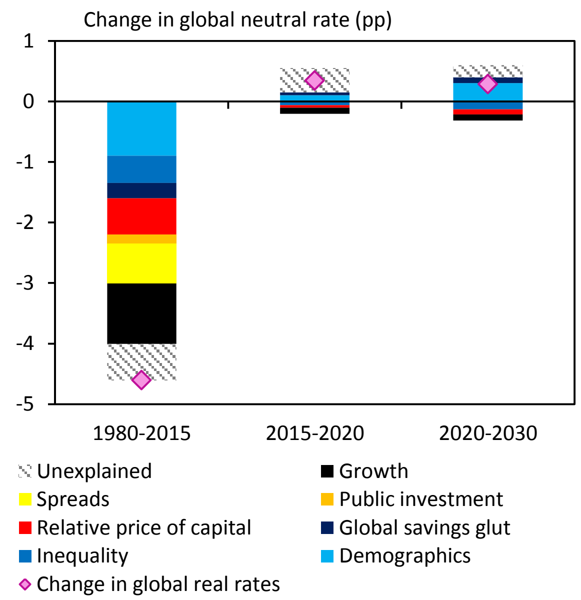
- The policy implications of permanently low real interest rates are extensive. In the face of adverse shocks, central banks are likely to run up against the zero lower bound on nominal interest rates more often, requiring the use of unconventional policy instruments such as quantitative easing (QE). However, uncertainties over the transmission of QE and concerns over the size of central bank balance sheets, might limit the use of such tools in the future. For large adverse shocks, fiscal policy may therefore need to bear more of the burden of business-cycle management. Low rates may also fuel search-for-yield behaviour, posing challenges for macro- and micro-prudential policymakers. More generally, the possibility of the global neutral rate remaining at persistently low levels should motivate a real debate across the policy spectrum on the best approach to stabilise the cycle. (**Section F**).

Figure B: Quantifying shifts in desired savings & investment



Source: Authors' calculations.

Figure C: Secular drivers of global real interest rates



Source: Authors' calculations

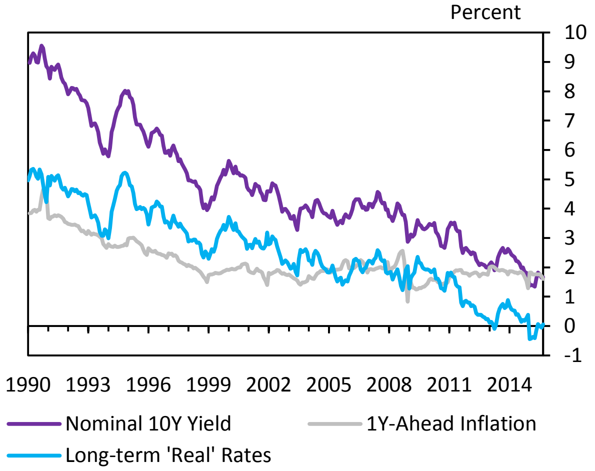
Section A: Setting the scene – what has happened to real interest rates?

The downward trend in long-term risk free interest rates is not a new phenomenon. Alan Greenspan famously highlighted the decline in long-term US bond yields in 2005, which occurred despite the Fed tightening policy. As Greenspan noted, while the downward trend in yields was clear, the explanations for the fall were not – it was a 'conundrum'. Before attempting to shed light on this conundrum, we set the scene by putting the fall in long-term real rates in context. We argue that the high degree of co-movement in rates across countries supports the notion of a global real interest rate. We show that this global rate has fallen by about 450bps since the 1980s.

It is now a relatively well-known fact that nominal yields on long-term bonds in advanced economies have been declining for decades (purple line, **Chart A1**). Falling inflation expectations – linked to the adoption of inflation targeting in the 1990s – explain some of this fall (grey line, **Chart A1**). But it is the decline in real yields (blue line) that has provided the more sustained downward impetus on nominal rates. In many advanced economies, long-term real rates are now around or even slightly below zero.

Nominal rates in emerging markets economies (EMEs) are substantially higher than in advanced economies. But once we adjust for inflation, real yields in EMEs have followed a similar path. Data limitations mean we can only analyse movements over the past decade, but even then we see a decline in real yields up until mid-2013 (**Chart A2**). Since mid-2013, EME yields have picked up. The timing of this increase is linked to the 'taper tantrum' episode, but reflects broader geopolitical concerns and domestic vulnerabilities in some markets, which caused risk premia on EME government bonds to increase. Movements in risk premia – which are not excluded from the simple measures of real rates shown below – can help to explain some of the variation in real rates seen across countries (**Charts A3** and **A4**). Yet even with the substantial heterogeneity across countries, a downward trend in real rates is still visible in nearly all countries in our sample.

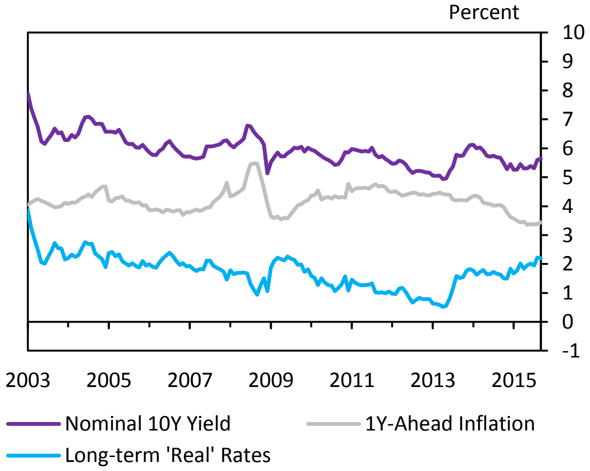
Chart A1: Real rates in advanced economies



Sources: IMF, DataStream, Consensus Economics & Authors' calculations

Notes: Purple line shows the GDP-Weighted average of 10-year sovereign yields for 20 advanced economies (G7, Australia, Austria, Belgium, Denmark, Finland, Ireland, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland). Grey line uses 1-year ahead inflation expectations from Consensus Economics as a proxy for 10-year inflation expectations for each country (again GDP-weighted together). The blue line simply shows the difference – so this measure of real rates does not take account of changes in risk premia.

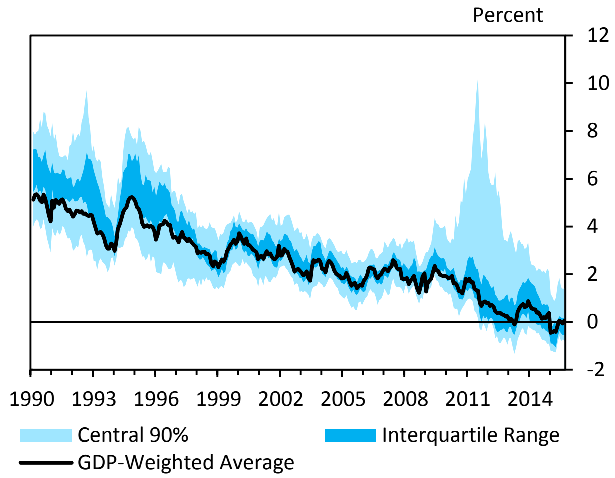
Chart A2: Real rates for emerging economies



Sources: IMF, DataStream, Consensus Economics & Authors' calculations

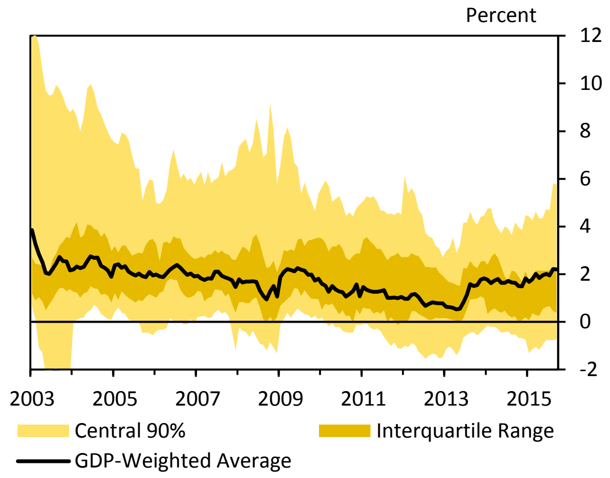
Notes: Purple line shows the GDP-Weighted average of 10-year sovereign yields for 17 emerging economies (BRICS, Chile, Colombia, Czech Republic, Hungary, Malaysia, Mexico, Poland, Singapore, Slovakia, Korea, Taiwan & Thailand). Grey line uses 1-year ahead inflation expectations from Consensus Economics as a proxy for 10-year inflation expectations for each country (again GDP-weighted together). The blue line simply shows the difference – so this measure of real rates does not take account of changes in risk premia.

Chart A3: Range of 'real' rates across AEs



Sources: IMF, DataStream, Consensus Economics & Authors' calculations

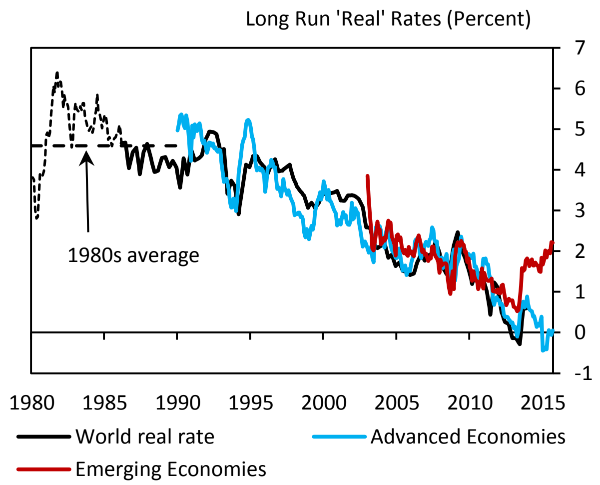
Chart A4: Range of 'real' rates across EMEs



Sources: IMF, DataStream, Consensus Economics & Authors' calculations

Movements in these simple measures of real rates are corroborated by more sophisticated measures (**Chart A5**). King and Low (2014) construct a 'world real rate' based on inflation-linked bonds for the G7 countries (excluding Italy), which should better accounts for changes in expected inflation and be less affected by changes in risk premia. Although the simple EME line diverges a little from the other two metrics over time (compressing during the financial crisis and widening out more recently), the striking feature of **Chart A5** is not the difference between the lines but how closely they co-move. Real rates appear to have fallen across the world. As such, it seems justifiable to talk of a 'global real rate' and that rate appears to have declined by about 450bps over the past three decades. This is at least suggestive that the forces driving the decline in real rates in the UK and other advanced economies may be global in nature, which is motivation enough to analyse the decline in real rates at the global level.

Chart A5: Comparison of real rates in AEs & EMEs



Sources: King & Low, 2014, Consensus Economics, IMF, DataStream and Authors' calculations

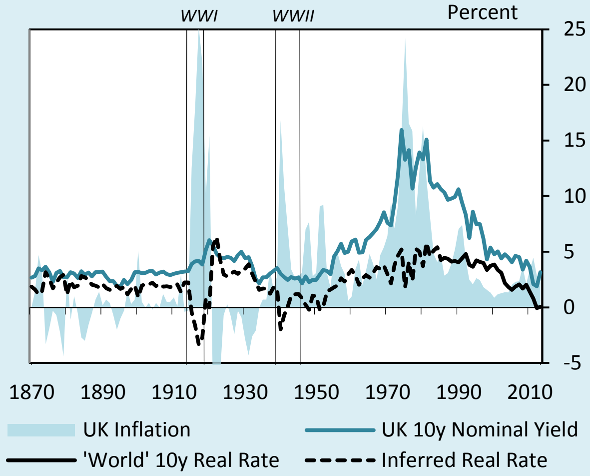
Note: The 'World' real rate (black line) is taken from King and Low (2014) and shows the average 10-year yield of inflation-linked bonds in the G7 countries (excluding Italy) over the period 1985-2013. This line has been extended back to the start of the 1980s (dotted black line) using a simple regression linking it to movements in UK 10-year nominal yields and RPI inflation. The red and blue lines show simpler measures of real rates for different country groups, calculated as the nominal yield on 10-year sovereign bonds minus 1-year ahead inflation expectations from Consensus Economics. Figures have been GDP-weighted together for 20 advanced economies (blue line) and 17 emerging markets (red line).

The rest of this paper therefore considers the competing explanations for what has caused the fall in global real rates over the past 30 years and what that means for policy. But before moving on, we highlight two important contextual points. First, **Box A1** puts the time period of this study into a broader historical context, noting that the persistent downward trend over the past 30 years has been relatively unusual. Second, **Box A2** notes that while risk free interest rates are important – particularly from a policy perspective – they are not the only interest rates that matter for economic agents.

Box A1: Global real rates in an historical context

In this paper we focus our analysis on explaining the long-term decline in real rates seen over the past thirty years. This choice of time period is important as the 1980s marked an historic peak for global real rates (**Chart A1.A**). But if we look further back, we see that real rates began the post-war period at similar levels to those seen today, before rising in the 1960s and 1970s. The low frequency of these fluctuations suggest that secular (rather than cyclical) forces are likely to be responsible for the rise and the subsequent fall in real rates seen over the second half of the 20th Century – a pattern which Eichengreen (2015) describes as a 'reversion to the mean'. Our analysis aims to identify which secular trends can explain the fall over the past thirty years, but a useful avenue for future work would be to take an even longer perspective and try to decompose the drivers of real rates throughout the 20th Century.

Chart A1.A: A long-run estimate of the 'world' real interest rate based on UK data



Sources: King & Low, 2014, Consensus Economics, IMF, DataStream and Authors' calculations

Note: The 'World' real rate (solid black line) is taken from King and Low (and shows the average 10-year yield of inflation-linked bonds in the G7 countries (excluding Italy) over the period 1985-2013. This line has been extended back (dotted black line) using a simple regression linking it to movements in UK 10-year nominal yields (teal line) and RPI inflation (blue area).

Box A2: Which interest rates matter?

Another important point to make up front is that the risk-free rate – the focus of this paper – is not always the most relevant interest rate for economic agents. For example, firms' investment decisions depend on the rate of return on capital, not the long-term risk-free rate on government securities. Although the risk free rate and the rate of return on capital are closely linked, the evolution of the spread between the two is an important factor affecting both rates – a mechanism we explore in more detail in **Section D**. For now though, we focus our attention on risk-free rates as these provide a useful perspective on the level of the equilibrium *policy* interest rate. We turn to the conceptual issues around equilibrium, or neutral, real rates, in **Section B** below.

Section B: The global neutral rate as a long-run anchor for R*

This section discusses two conceptual issues central to the current policy debate. First, we argue that market measures of long-term real rates provide a useful guide to deducing the trend in the unobservable global neutral real rate over time. Second, we discuss how the global neutral real rate affects country-specific equilibrium policy rates or R (defined as the real rate that would deliver policymakers' objectives in the medium-term). We argue that the global neutral rate can be thought of as an anchor for equilibrium rates in countries that are economically open. So understanding the evolution of the global neutral rate is an important input when assessing the value of R* in individual countries – including the UK.*

The ultimate purpose of this paper is to contribute to the broader policy debate aimed at understanding the drivers of (unobservable) equilibrium real interest rates across countries. Having a good handle on country-specific equilibrium rates (*R**) is critical to assessing and guiding the stance of monetary policy, and is an important input in devising optimal strategies across fiscal, micro- and macroprudential policy functions (as discussed in **Section E**). But the task of uncovering R* and predicting its future path is as difficult as it is important. Conceptually, two issues need to be clarified to position our analysis within the wider debate:

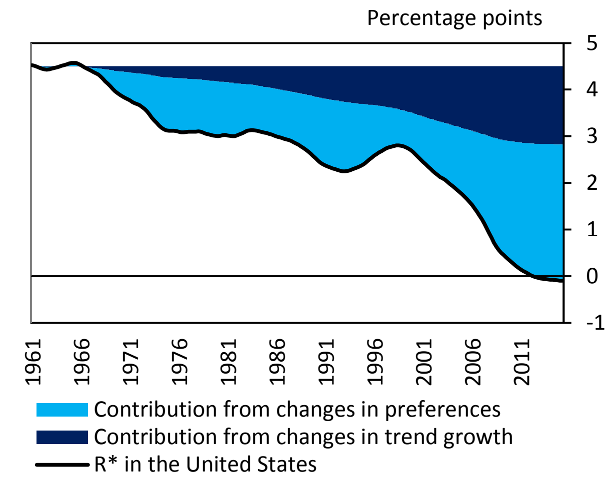
i) Does the decline in observed measures of real rates reflect a fall in the global neutral rate?

One reason market measures of the global real rate may deviate from the long-run equilibrium (neutral) rate is due to cyclical factors. To sidestep this issue, we focus on very low frequency movements in the data. For example, in **Section C** we consider 5-year-averages of the global growth rate and in **Section D** we focus primarily on decade-averages of the real interest rate. Beyond cyclicality, there are other reasons why the *observed* global rate may deviate from the neutral rate – linked to distortions in the market for government bonds. We discuss these issues in more detail in **Box B1** and conclude that such distortions may have played some role in contributing to the decline in *observed* measures of global real rates since the global financial crisis, but other secular trends are likely to have driven the persistent long-term decline.

Another line of argument is that market measures of global real rates based on long-term bond yields have been affected by low short-term interest rates i.e. 'global rates are low because monetary policy is loose'. If this were the case, low rates would not pose a policy dilemma. The solution would be trivial and the downward trend in long rates would simply reverse when central banks tightened policy. But as Broadbent (2014) and Bernanke (2015) have pointed out, this view of the world is unlikely to be correct as the decline in actual real interest rates has occurred against a backdrop of contained inflation with little sign of exuberant demand growth. Indeed, global growth and inflation have, if anything, disappointed in the most recent recovery, despite interest rates being very low. This suggests that observable interest rates have merely followed their unobservable 'equilibrium' counterparts – if policy had been tighter, inflation would have been lower and demand would have been too weak to deliver full employment. Ever looser monetary policy is not the cause, but the consequence of the fall in long-term rates.

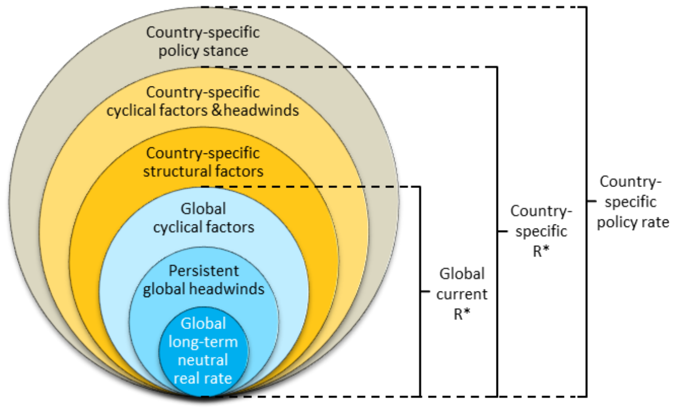
This intuition has been formalised in econometric models, which aim to extract measures of equilibrium interest rate from observed data. Laubach and Williams (2003) perform this sort of exercise for the US and find that US R* has declined by around 450bps since the 1960s, and by around 300bps since the 1980s (**Chart B1**). The authors suggest that secular trends related to changes in trend growth and shifts in saving an investment preferences are responsible for this decline – not monetary policy. We use a similar taxonomy in our analysis at the global level: **Section C** focuses on growth and **Section D** on preferences.

Chart B1: Laubach-Williams estimates of the equilibrium real interest rate in the US



Source: Federal Reserve Bank of San Francisco

Chart B2: Schematic showing the stylised relationship between the global neutral rate and country-specific R*



Notes: The diagram abstracts from the role of term premia.

ii) How is the global neutral rate related to country-specific equilibrium rates and policy rates?

Chart B2 offers a stylised way to think about how the global neutral rate is linked to various other concepts. For a small open economy like the UK, the equilibrium real rate is likely to be influenced or, in the long-run perhaps even wholly determined, by global factors. [1, 2, 3] Hence the global neutral real rate (shown by the dark blue circle at the bottom of **Chart B2**) can be thought of as a basic building block or anchor to which country-specific equilibrium rates will converge in the long-term, absent distortions or shocks.

In reality, plenty of distortions and shocks will drive a wedge between individual-country equilibrium rates (R*) and this long-term anchor. These can be divided into global factors (shown in blue in **Chart B2**) and country-specific factors (shown in yellow). Among the global factors we distinguish between persistent headwinds that can take several years or even decades to subside (such as the global deleveraging process underway since the crisis) and short-run global cyclical factors (such as global credit conditions or levels of confidence).[4] Among the country-specific factors, a country's cyclical position could drive a country's equilibrium rates temporarily higher or lower than the global level. Additionally, a country's structural characteristics – such as its demographic structure, trend rate of productivity growth or quality of its institutions – may drive its equilibrium rate persistently above or below global R*. For completeness, the diagram adds a final layer – the policy stance – which will drive a wedge between the country-specific equilibrium real rate and the actual (real) policy rate.

The role of this paper is to improve our understanding of the drivers of the global neutral rate, which in turn is an important determinant of equilibrium rates across countries and hence an important input when calibrating the appropriate monetary policy stance.

[1] See Mendes (2014) for an intuitive exposition of the model where a small open economy is a price taker in the global market.

[2] It can still be the case that domestic real rates deviate from the global real interest rate in the long run, if domestic output is expected to continually change relative to global trends. This is just a restatement of real Uncovered Interest Rate Parity which allows for real interest rates to differ across currencies even if capital markets are fully open due to Balassa-Samuelson like effects.

[3] Country-specific risk factors have also been found to prevent equalisation of real returns across countries – see Mishkin (1984).

[4] The evolution of the global neutral real rate since the global financial crisis is particularly uncertain because it is too early to tell how much of the most recent decline is cyclical, and hence will prove temporary, or persistent, but not reflective of the long-term neutral rate.

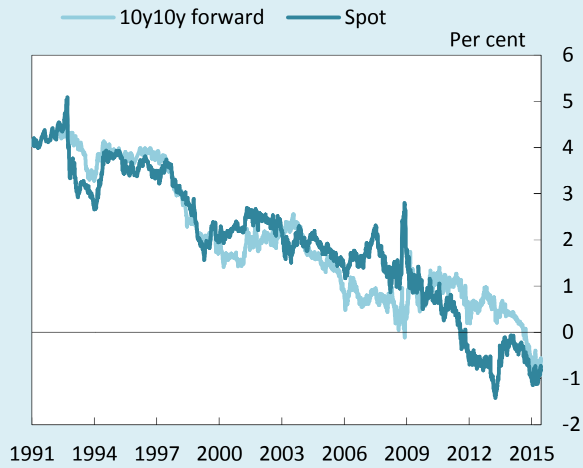
Box B1: Market-specific factors affecting government bond yields

The trend decline in market measures of long-term real rates is at least suggestive that the global neutral real rate may have fallen – motivating our analysis on the determinants of the global neutral rate. However, an alternative hypothesis is that these market measures have been distorted by market-specific factors that have caused the yield on government bonds to deviate from underlying risk-free rates. In this box we explore two potential issues that could be driving a wedge between government bond yields and risk free rates – the role of term premia, and structural changes in the government bond market.

The role of term premia

The analysis in this paper relies on simple measures of long-term rates derived from spot rates on long-term government bond yields. But these spot rates are influenced by term premia – the extra compensation investors require for holding long-term assets over time rather than rolling over short-term exposures. In principle, part of the long-term decline in real rates seen in recent decades could be driven by a fall in term premia, rather than just a decline in expected future interest rates. To account for this change we would ideally use long-term forward rates in our analysis, rather than rely on spot rates. But a lack of historical data on forward rates across countries hinders such analysis.

Chart B1.A: UK 10yr spot and forward real rates



Sources: FAME and Authors' calculations

King and Low (2014) provide some reassurance here though. They highlight that forward and spot rates have tended to follow broadly similar trends for countries where such data are available (**Chart B1.A** shows figures for the UK) – suggesting shifts in term premia have not been a first order issue.

Term structure models could potentially be used to analyse this effect in more detail, by decomposing the change in real rates into changes in expectations of future interest rates and changes in term premia. But we are a little sceptical they are the right tool for the job in this instance. Such models are more naturally suited to decomposing higher-frequency changes in real interest rates, because they tend to assume that the underlying long-run interest rate is stationary. So in a way they assume away the phenomenon that we are trying to explain.

That said, we would not rule out the role of a decline in term premia in driving some of the decline in real rates – particularly early on in the sample. Since the 1980s there have been sizeable shifts in monetary policy regimes around the world, which arguably have lowered uncertainty about future policy rates and brought term premia down. The IMF (2014) point out that many of these regime shifts occurred in the 1980s and early 1990s. As such they appear to be a more plausible explanation for why real rates declined early on – perhaps from around 6% to around 4.5% over the course of the 1980s, but seem less plausible as a sustained driver of the decline since. Our analysis focuses on the 450bps fall in real rates from the late 1980s onwards. Of course, other factors could also have affected term premia over the past thirty years – such as those that have driven an increase in demand for safe assets relative to supply. We discuss these factors below.

Structural changes to government bond markets

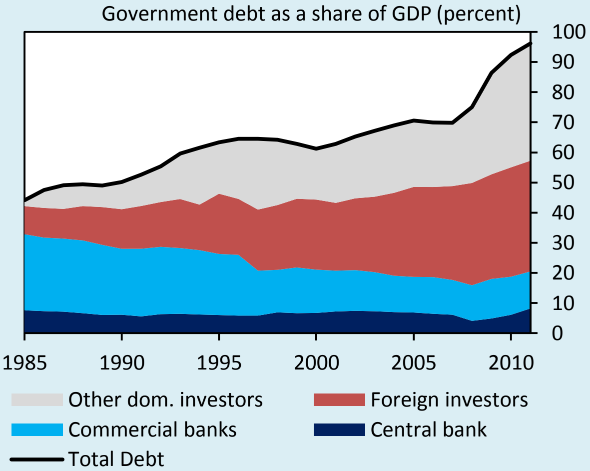
Over the past thirty years (particularly since the global financial crisis), there have been significant changes to the demand for and supply of government bonds that could have affected long-term yields. Five factors have been particularly noteworthy – two on the supply side and three on the demand side:

A. Rising public debt issuance (*supply of safe assets* 🡅);
B. A deterioration in fiscal positions and credit ratings since the crisis (*supply* 🡇);
C. A sustained decline in safe-asset holdings by commercial banks before the crisis (*demand* 🡇), which has reversed since the crisis due to stricter financial regulatory standards (*demand* 🡅);
D. Central bank asset purchases – quantitative easing (*demand* 🡅);
E. Increased demand for advanced economy debt assets from overseas, particularly EMEs (*demand* 🡅).

Supply: IMF research by Ali Abbas et al (2014) highlights the role many of these factors have played over the period 1900-2011. Focusing on the supply side and the last few decades of their analysis, we can see that the amount of government debt issued by advanced economies has increased significantly since 1985 – particularly since the global financial crisis (black line, **Chart B1.B**). However since 2011, the proportion of highly-rated advanced economy debt has fallen sharply as a result of deteriorating fiscal positions and credit rating downgrades (**Chart B1.C**) – reducing the supply of safe assets considerably.

Demand: In the decades running up to the crisis demand for government debt by commercial banks had been in decline (blue area, **Chart B1.B**). All else equal this decline in demand would likely have exerted upward pressure on bond yields. However, this effect appears to have been largely offset by a rise in demand from foreign investors – particularly from emerging markets (red area **Chart B1.B**). Following the Asian financial crisis in 1998, many emerging market governments chose to accumulate foreign currency reserves as a form of liquidity insurance. This rise in demand for reserve assets is likely to have offset the fall in demand for sovereign debt, particularly by commercial banks in the decades before the crisis. The impact of the emerging market savings glut on global real rates is discussed in more detail in **Section D**.

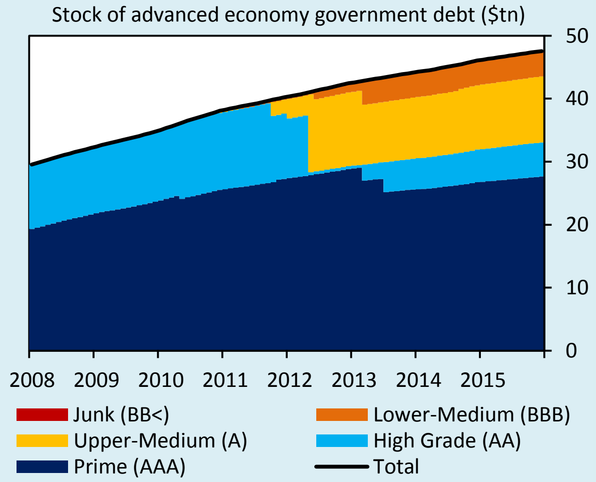
Chart B1.B: Changes in holdings of government debt issued by advanced economies (1985-2011)



Sources: Ali Abbas et al (2014) and Authors' calculations

Note: Data show PPP-weighted averages for 13 advanced economies.

Chart B1.C: Credit rating of advanced economy government bonds (2008-2015)

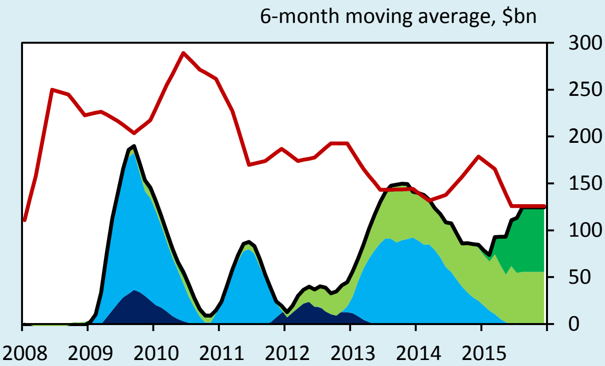


Sources: Fitch, IMF and Authors' Calculations

Notes: Figures show total debt issued by 23 advanced economies, including the US, Japan, Euro Area, and UK. The stock of US agency debt issued by Fannie Mae and Freddie Mac is included with sovereign debt. Debts in local currency have been converted into to dollars at current market exchange rates.

Since the crisis, demand for safe assets from both commercial banks and central banks has increased significantly. Commercial banks have faced a raft of regulatory reforms under Basel III, which require them to hold permanently higher liquidity buffers, often in the form of high-quality government debt. In addition, the world's major central banks have engaged in asset purchases to provide monetary stimulus (**Chart B1.D**). In the UK, the Bank of England's £200bn of asset purchases between March 2009 and January 2010 were estimated to have lowered ten-year UK government bond yields by around 100 basis points (Joyce et al, 2011). In addition, the current stream of asset purchases by the ECB and Bank of Japan is sufficiently large to absorb all net new debt issued by governments in advanced economies (**Chart B1.D**). These effects are likely to have put downward pressure on government bond yields since the crisis. However, while the effect of stricter regulatory standards on commercial banks is likely to be permanent, the effect of central bank asset purchases is a cyclical response and may unwind as advanced economies recover.

Chart B1.D: Flow of debt issuance and central bank asset purchases



Sources: Fed, ECB, BoJ, BoE, IMF and Authors' calculations

Notes: Asset purchases and government debt issuance have been converted to US$ using current exchange rates. For the US, the stock of agency debt issued by Fannie Mae and Freddie Mac is included with sovereign debt.

To sum up, in the decades before the crisis, the supply of high-quality government debt increased steadily. This rise in supply was partly met by increased demand for safe assets by emerging markets governments. But if anything the net supply of safe assets increased during the period, (grey area, Chart B1.B) potentially putting upward pressure on government bond yields and counteracting some of the fall in long-rates observed in the data. Since the crisis, that picture has changed markedly. Deteriorating fiscal positions and ratings downgrades have seen the supply of high quality debt fall sharply, while demand for safe assets has risen as a result of permanent regulatory changes and cyclical central bank action. This suggest that since the crisis it may well be true that the net supply of safe assets has deteriorated (Caballero and Farhi, 2013), and this has contributed to fall in actual real interest rates seen recently. However, we need to appeal to other factors to explain the steady decline in real rates before the crisis and arguably some of the fall since – as highlighted in **Sections C and D** below.

Section C: Global growth and real interest rates

Although changes in global trend growth are probably the most commonly-cited driver of changes in real interest rates, we find it difficult to account for much (if any) of the pre-crisis fall in global real rates by just appealing to past changes in growth – global growth was fairly steady in the pre-crisis decades. However, the financial crisis may have triggered a wider reassessment of growth prospects going forward and greater pessimism about the future could be playing an important role in driving the decline in real rates we have seen most recently. There is a great deal of uncertainty, but we think we can come up with a reasonable case for why global growth could slow by up to 1pp in the decade ahead. The impact of this change in trend growth on real rates depends on the mapping between the two, which is uncertain, but we think it could account for about 100bps of the fall in real rates we have seen since the crisis. Moreover, we expect this effect to persist.

i) A framework to link growth with real interest rates

One of the most commonly cited explanations for the decline in real interest rates is that trend growth has fallen. This line of reasoning was at the heart of Alvin Hansen's secular stagnation hypothesis – Hansen worried that falling rates of technological progress and slowing population growth had reduced the returns to investment, resulting in less demand for capital and a lower interest rate (see **Box C1** at the end of this section for a brief history of the secular stagnation debate).

Often we assume a simple one-to-one mapping from changes in trend growth to the rate of return on capital and real interest rates. But the mapping is actually quite uncertain. Structural models offer some useful insights. For example, in the Ramsey model the first order condition for the optimal consumption path suggests that steady state real rates depend on time preferences, the pace of technological progress and (in some formulations) population growth (**Figure C1**).

FIGURE C1: Linking trend growth to real interest rates

'Neoclassical' formulation: $r^* = q/\sigma + \theta + (\alpha \cdot n)$

Where:

*r**	Real interest rate consistent with inflation at target and zero output gap in the long-run
σ	Household's inter-temporal elasticity of substitution in consumption (preference for smoothed consumption)
q	Rate of labour-augmenting technological change
θ	Household's rate of time preference (patience)
n	Rate of population growth
α	Coefficient on the rate of population growth[a]

[a] The infinite horizon representative agent Ramsey model does not include population growth in the steady state real rate formulation. But there may be good reasons to include it (e.g. see Baker, Delong and Krugman, 2005).

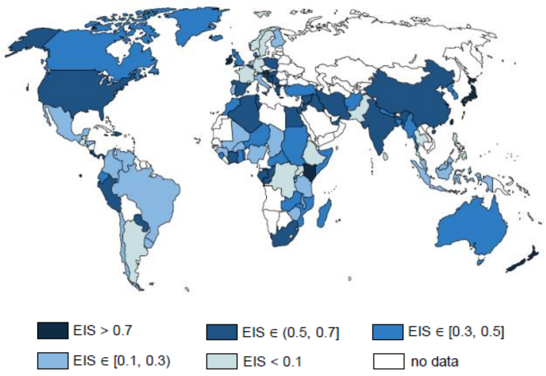
Although simplified, the Ramsey framework is helpful in clarifying the way real rates are affected by the two main components of trend growth (productivity growth and population growth) and in making clear the role of household preferences in affecting that link. Intuitively, productivity growth (***q***) is positively related to real interest rates in the model. The Ramsey-rationale for this is that weaker productivity growth reduces household's expected future income, meaning households have to save more in order to sustain consumption in the future. Higher saving then translates to a higher rate of capital accumulation, which leads to a higher capital-to-output ratio in the long-run and a lower marginal product of capital. Since the real interest rate in the model equals the marginal product of capital, real rates also fall.[5] But what is perhaps more interesting about the Ramsey framework is that the mapping from productivity growth to real rates depends on household preferences for smoothed consumption over their lifecycle (σ).[6]

[5] A shift in household savings is just one mechanism by which productivity changes could feed through to real interest rates. An alternative channel is that weaker productivity growth could affect firms' investment intentions. Weaker productivity growth will mean a lower rate of return and mean firms are less willing to invest at a given interest rate. So in the savings and investment framework we discuss later in Section D, weaker trend productivity growth could shift both the investment schedule in and the savings schedule out.

[6] The other household time preference parameter, θ (household's degree of patience) can also affect real rates. The rationale (as outlined here) is that more patient households are willing to defer more consumption today for a given rate of return in order to consume more in the future (low θ). Put differently, patient households are more willing to save, which results in a lower real interest rate. Since patience does not directly affect the link between trend growth and real rates we do not address this parameter here, but return to it in the general discussion in Section D.

If households are happy to accept large swings in consumption from period to period (σ > 1), then they won't adjust their savings by much in response to changes in productivity growth, so real interest rates will be insensitive to changes in trend productivity growth. But empirical estimates from the literature suggest the opposite is true – households do care about smoothed consumption (σ < 1). One meta-study by Havranek et al (2015) brings together estimates from 169 studies and suggests that the global average for σ is around 0.5, or at the very least less than 1 (**Chart C2**). This suggests that every percentage point fall in trend productivity growth could cause equilibrium real rates to fall by up to twice as much. Put differently, the mapping between productivity growth and real rates is not one-for-one, but potentially one-for-two.

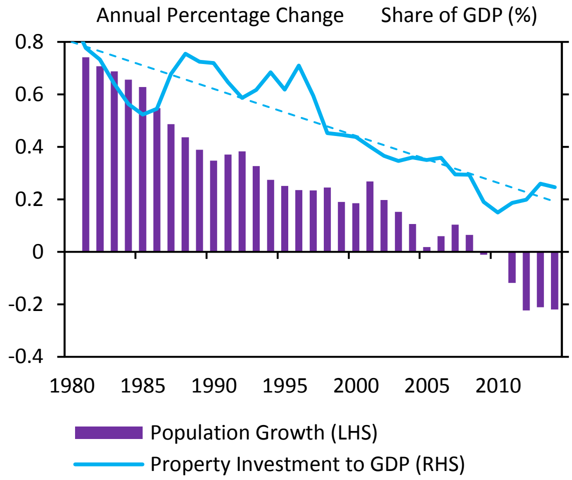
Chart C2: Cross-country estimates of the inter-temporal elasticity of substitution



Source: Havranek et al (2015)

Notes: The map shows average estimates of the inter-temporal elasticity of substitution (σ) across countries, based on 2735 estimates taken from 169 studies. There is large heterogeneity, within and across countries, but the global average is around 0.5.

Chart C3: Slowing Japanese population growth and declining property investment as a share of GDP



Sources: DataStream and IMF WEO

The link between population growth (***n***) and real interest rates is much less certain. The vast majority of structural models do not include population growth as a driver of real interest rates at all (so α =0). This is also the case in the standard formulation of the Ramsey framework, though the reason why population growth is excluded is up for debate. For example, in the Ramsey model the exclusion is largely due to a simplifying assumption – there are infinitely lived households who don't grow in number, only in size. This means that population growth does not result in any new economic agents being born whose preferences haven't been previously taken into account by existing households. This setup differs from say the Diamond Over-Lapping Generations model, where births imply the entrance of new economic decision-makers whose preferences may differ from existing households.

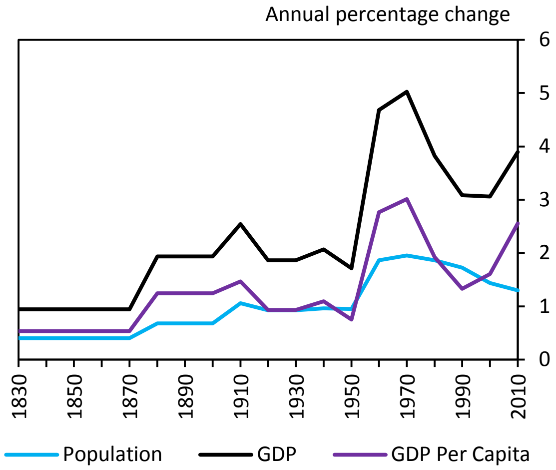
Excluding population growth entirely from the analysis may therefore be an extreme assumption. Indeed, Hansen's original secular stagnation hypothesis emphasised the role of population growth in driving down the rate of return on capital. Baker, Delong and Krugman (2005) have since argued along similar grounds, suggesting that Ramsey's simplifying assumption is artificial because in reality households don't weigh the utility of future generations equally with their own – there is 'imperfect familial altruism'. Baker et al also suggest that in other models (such as the Solow model) population growth should play a role in determining real interest rates. For example, if labour and capital are complements, then slower population growth should reduce the marginal product of capital as firms have fewer workers to get the best out of their machines. As a result, slower population growth should mean the rate of return on capital falls, pushing down real interest rates. Japan also appears to offer an illustrative example of the importance of population growth on investment. Slower Japanese population growth reduced the demand for Japanese property, leading to lower returns to residential investment and a steady decline in the share of residential investment as a share of GDP (**Chart C3**).

Given the uncertainty in the modelling and the lack of empirical estimates for α, we implicitly assume that there is some role for population growth in driving real interest rates but the mapping is likely to be less than one-for-one (α < 1, perhaps between 0 and 0.5).

Since demographic growth (***n***) and productivity growth (***q***) have different roles in driving real rates it makes sense to analyse the two separately. For global productivity growth, we also find it helpful to distinguish between growth at the technological frontier (driven by invention), and growth driven by those countries converging to the frontier (catch-up). With that distinction in mind, the rest of this section is structured as follows: Part 2 focuses on demographic growth; Part 3 on catch-up growth; Part 4 on growth at the technological frontier; and Part 5 brings together the results to identify how much of the fall in real rates can be explained by changes in global growth.

To set the scene, **Chart C4** shows the history of global growth back to 1830 (black line), with the contributions from demographic growth and per capita growth separated out. Such long-run estimates should be treated with caution, but are useful in highlighting how unusually buoyant the post-war period has been. Since the 1980s, global growth has not only been high but also relatively stable, averaging between 3-4% per year. With such persistently high growth rates, it is quite difficult to argue that falling global trend growth over the past thirty years has been the main driver of the sustained decline in real interest rates we have seen. That is not to say growth has played no role though. If global growth is expected to slow in the years ahead, then expectations of that weaker growth could be weighing on real rates now.

Chart C4: Global Growth since 1830



Sources: Maddison (2008), IMF, and UN

Notes: Maddison's estimates are used from 2000 back to 1830. Data for 2010 are from the UN (for population) and the IMF (for GDP per capita).

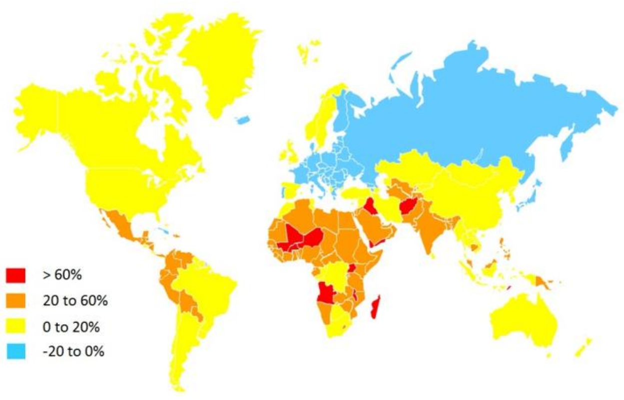
In the rest of this section we aim to decompose the drivers of global growth over the past thirty years in order to predict how growth may evolve over the future. Typically, such growth accounting exercises tend to rely on supply side analysis. However, in order to capture the full sense of the debate, we also analyse some secular demand trends that are arguably so persistent they may affect the supply side.

ii) Demographic growth

The surge in global growth in the post-war years has been partly driven by a demographic boom. A combination of falling mortality rates in emerging markets and a baby-boom in advanced economies saw the global population surge in the second half of the 20th century – contributing almost 2pp to global growth per year at its peak (blue line, **Chart C4**). Looking ahead, the global population should continue to expand (from 7 billion now to just under 10 billion by 2050 according to the UN) but the pace of growth is expected to slow. Put another way, the world has already experienced its peak rate of population growth.

In this paper we focus on population dynamics at the global level, but it is worth noting that different countries are at very different stages in their demographic cycle. Many emerging countries (particularly India and much of Africa) are still adding tens of millions of people to the global population each year while others (like Japan and much of Western Europe), are already in decline. **Chart C5** gives a sense of the dispersion across countries. Overall, the global trend is one of slowing population growth going forward.

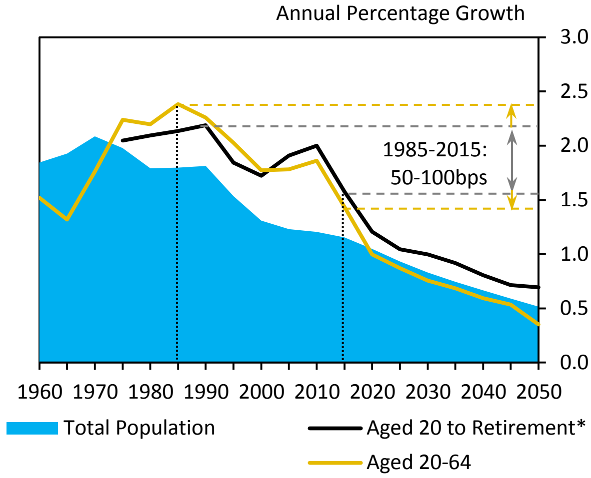
Chart C5: Population growth from 2010 to 2025



Source: UN Population Projections

Notes: Working-age population is defined crudely as those aged 20-64.

Chart C6: Global population and labour supply



Sources: UN Population Projections, OECD, and Authors' calculations

Notes: Black line shows growth in the global working age population, aged 20 to retirement. Retirement ages are calculated using OECD data on average effective retirement ages. Over the future, global retirement ages are assumed to grow by one and a half years every decade to keep pace with expected rises in longevity.

Population growth and labour supply: When it comes to growth accounting, we need to distinguish between growth of the total population and growth of the labour force, as it is the latter that is most closely tied to the input of labour into the production process. Weaker population growth typically feeds through to slower growth in labour supply after 15 to 20 years, reflecting the lags between birth and labour force entry. Given we already know how many people have been born up to this point, we also have a good idea how trends in global labour supply are likely to evolve over the next two decades.

Chart C6 shows that global labour supply growth is in the midst of a sharp slowdown. The gold and black lines show two measures of labour supply: the gold line simply refers to the population aged 20-65, while the black line shows a more sophisticated measure of 'working age' population, which adjusts for variations in retirement ages over time. Together these measures suggest labour supply growth has already slowed by between 0.5pp and 1pp since the mid-1980s and looks set to slow further. In the near-term, other labour market dynamics could offset this trend. A sustained rise in labour force participation driven by: rising female participation; better education (to reduce skills mismatch); or better healthcare (to reduce long-term sickness); could all mitigate the fall. But such factors can only postpone the decline in labour force growth – not prevent it from occurring.

The illustrative figures in Chart C6 mechanically suggest that slower demographic growth has already dampened global growth by around 1pp since the 1980s, and could subtract a further 0.5pp from global growth over the next decade. As discussed earlier, the mapping from labour supply growth to real interest rates is uncertain, but if we follow the framework identified in **Figure C1** and assume $\boldsymbol{\alpha}$ is between 0 and 0.5, this would suggest slowing demographic growth could have accounted for up to 0.5pp of the decline in real rates over the past, and could subtract a further 0.25pp going forward.

Population growth and capital accumulation: The above analysis is a fairly mechanistic description of how population growth can affect real rates by directly affecting labour supply growth. But population growth could have a wider impact on trend growth than that. Kuznets's seminal 1960 paper put forward various hypotheses linking population growth to per capita GDP growth. He echoes Hansen by linking the pace of capital accumulation to labour supply – arguing that in order to maintain output per worker, more capital would be required to support a larger workforce. So, in the absence of resource constraints, rapid population growth should also increase capital accumulation and hence growth.

Population growth and productivity: More innovatively, Kuznets also argued that faster population growth may lead to higher productivity growth. He identified various channels by which this might occur, for example: fast growing populations tend to be younger and hence faster adopters of new products and technology than older populations with entrenched habits, increasing the returns to innovation; faster population growth may also increase the absolute number of innovators/geniuses in the world, which could result in increasing returns to population growth as a result of knowledge spillovers – a bigger group of talented individuals working together should produce more innovations (e.g. Bell Labs) than a smaller number of individuals working alone. But Kuznets also acknowledged that the link between population growth and per capita growth can go the other way, particularly in the face of resource constraints. If population growth cannot be met with an equal or greater rise in the provision of education and other capital, productivity per worker is likely to decline. Scarcity of resources (particularly natural resources) may be a binding constraint here – as the marginal cost of extracting resources rises, productivity growth is likely to fall back. Arguments linking population growth to climate change and to slower economic growth fall under a similar heading.

The main point of highlighting these arguments is not to precisely identify the impact of population change on global growth and hence global real rates. Instead, it is to acknowledge that the link between demographic change and growth is complex. Seen over a long time horizon, there seems to be some positive correlation between population growth and per capita GDP growth (**Chart C4**), but it is unclear which way the causality runs. If Kuznets's reasoning is right, then the current slowdown in population growth could not only affect global growth via labour supply but also via productivity growth. Given that structural models tend to put less weight on demographic growth as an independent driver of real interest rates, this additional link is potentially significant. It suggests that even if we discount the direct effects of demographic growth as a driver of real rates (i.e. assume $\alpha = 0$ in **Figure C1**), then demographic growth could still have an impact on real rates via its effect on productivity. We return to this point in Part IV in the discussion of innovation at the technological frontier.

iii) Catch-up growth

A key driver of economic growth, particularly in the emerging world, is productivity catch-up. As countries accumulate more capital and improve efficiency by adopting the latest technologies from overseas, productivity per worker rises. Economic forecasts based on convergence theory typically assume a smooth rate of catch-up over the future, however, history reveals a pattern that is anything but smooth over the past. Between 1980 and 2010, GDP per capita growth in the US (widely used as a proxy for the technological frontier) was actually faster than the average across the rest of the world in 15 out of 30 years – so the rest of the world spent just as long falling further behind the frontier as catching up. Different regional stories help shed light on why catch-up growth has been so volatile (**Charts C7** & **C8**).

For some regions, particularly Asia, recent history has been a relatively upbeat tale, characterised by a period of steady catch-up during the 1980s and 1990s, interrupted by the Asia crisis in 1998, and then followed by rapid growth this century. China is of course the main player in this story. For Latin America and the Middle East, the story is more mixed. The 1980s and 1990s are largely characterised as a period of deterioration as economies adjusted to the shocks of the Latin American debt crisis, retreat in the oil price and various geopolitical shocks. More recently, the commodity boom has helped pull both regions forward and enabled some catch-up. For Eastern Europe, the past thirty years can be broadly characterised as a period of transition – adjusting to the break-up of the USSR and catching-up thereafter. Africa's story is marred by geopolitical strife – with little growth in real incomes and the continent falling further behind the technological frontier. The story for Western Europe is also one of gradually slipping further from the frontier, partly because the ICT boom appeared to generate faster growth in the US than in Europe.

Chart C7: Regional GDP per capita

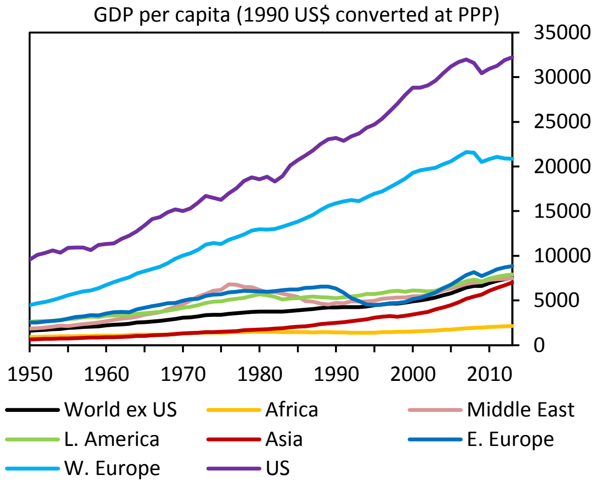
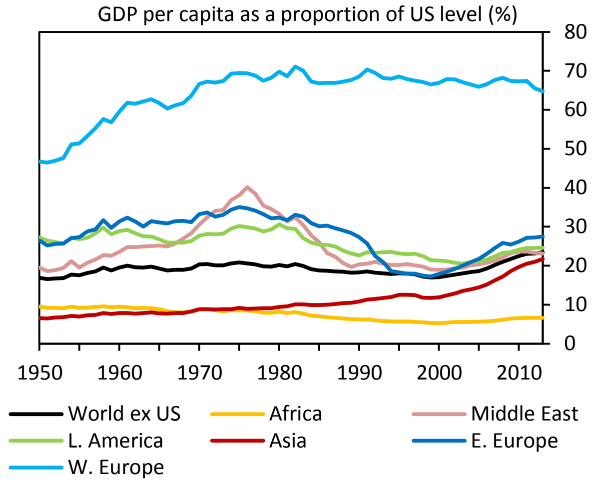


Chart C8: GDP per capita relative to the US

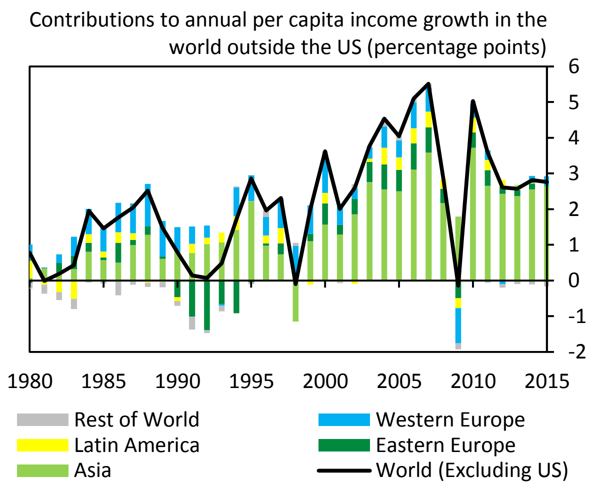


Source: Conference Board Total Economy Database (2013)

Notes: Relative population sizes differ enormously across regions, which matters when considering the pace of catch-up for the world as a whole. Asia accounts for around 55% of the global population, compared with around 8% in each of Western Europe, Eastern Europe and Latin America. The US accounts for 5% of the total, the Middle East a further 3%, and Africa the remaining13% or so.

Chart C9 brings together these different trends to show how important they are in driving GDP per capita growth in the rest of the world outside the US. The dominant role of Asia is evident all the way back to the 1980s, but the acceleration since the turn of the century is particularly striking. **Chart C10** shows how this acceleration in per capita growth has translated into catch-up growth – defined simply as the difference between per capita income growth in the US (blue line) and the rest of world (black line from **Chart C9**). Unlike the steady decline in demographic growth over the past thirty years, catch-up growth has been volatile but tended to increase over the period – adding around 1pp to global growth in recent years, compared with nothing in the early 1980s. Given that catch-up growth has accelerated, it seems implausible that this has been a key driver of the steady decline in real interest rates we have seen.

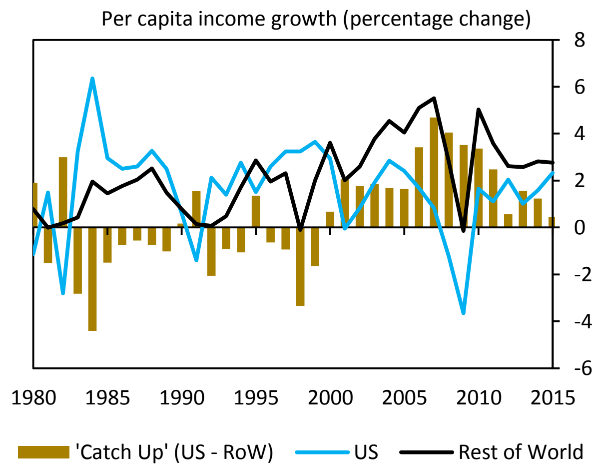
Chart C9: Catch-up growth since the 1980s



Sources: Conference Board TED (2013) and IMF WEO (April 2015)

Notes: Figures are PPP weighted and refer to real GDP expressed in constant 1990-US Dollars.

Chart C10: Catch-up growth since the 1980s



Sources: Conference Board TED (2013) and IMF WEO (April 2015)

Notes: The Rest of World line is calculated as world GDP (excluding the US) divided by global population (excluding US). The gold bars show the difference between US per capita growth and the rest of the world.

The difficult question is what will happen to the pace of catch-up going forward. In order for the recent positive trend to continue, many emerging markets will need to overcome the middle income trap and continue to avoid geopolitical and financial crises. There are some grounds for optimism on that front. The unusually rapid growth of many emerging markets so far this century shows that it is possible for sustained periods of catch-up to take place. In addition, the rising importance of digital technologies in driving innovation, combined with the spread of the internet and other communication technologies (e.g. distance learning), means it is now easier for ideas and skills to be shared across borders more quickly. On the other hand, the mixed performance of the 1980s and 1990s combined with ongoing concerns about the stability of China's financial system and the rise of emerging market indebtedness suggest a more gloomy outlook is possible (at least in the near term).

We take a neutral view and assume the contribution of catch-up growth to global growth remains stable at its average rate of the past 20 years – not as fast as the late-2000s, but not as slow as the 1990s either. This equates to catch-up growth continuing to add 1pp to global growth per year. This means we don't pin the decline in real interest rates on a slowdown in the pace of convergence.

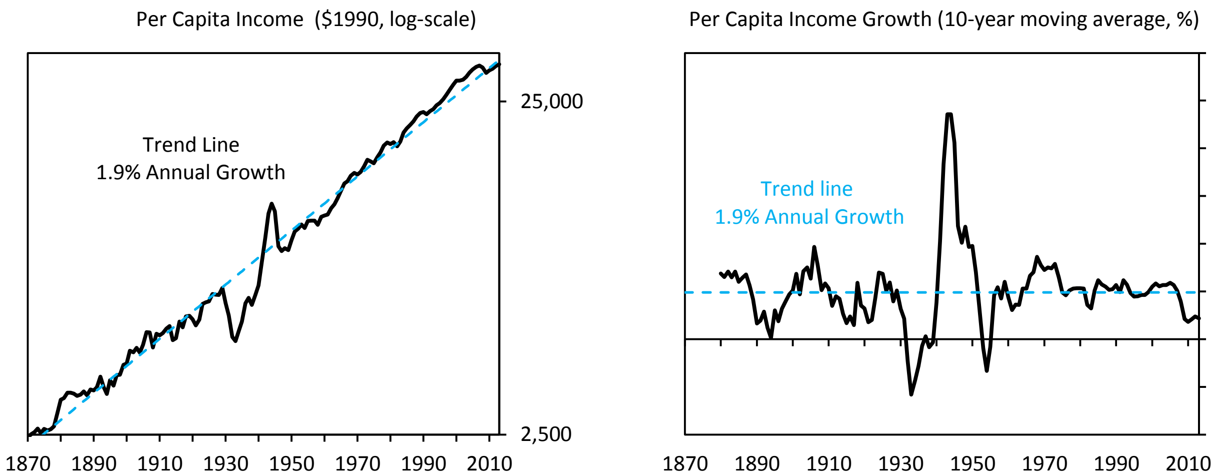
The above judgement is clearly open to debate. But the important thing to bear in mind when it comes to catch-up growth is that there is a finite amount of it, so the question is really over how fast that convergence occurs. If all countries caught up to US per capita income levels it would increase the level of world GDP by 270% i.e. world GDP would be almost four times the size it is now. In growth rate space, if this convergence occurred over a reasonable period (20-200 years), it would add around 130pp to global growth spread out over the convergence period. So if all countries caught up to the US by the year 2100, it would add 1.5pp to global growth on average each year (130pp divided by 85 years), while if it took until the year 2200 it would add 0.7pp to growth each year (relative to a base case with no catch-up). Our judgement assumes that full convergence takes place by around the middle of the 22nd Century.

iv) Growth at the technological frontier

The final component in our analysis of global growth is growth at the technological frontier, which can be proxied as productivity growth in the United States. Concerns about the rate of US growth are prominent at the moment. Gordon (2014a) has championed the view that several structural headwinds will hold back US growth in the future – these include: further falls in the pace of educational attainment; rising inequality; and public indebtedness.[7] Aside from these headwinds, there is also a wide ranging debate over the pace of innovation and whether productivity growth has ground to a halt. Optimists dismiss these lines of argument by pointing to the sustained rise in US per capita income growth over the past 150 years (**Chart C11**) – suggesting that the long-run trend will continue to persist. But such analysis is simplistic. Instead, in this extended section we interrogate the arguments for both structural headwinds and a productivity slowdown to form a view on whether the pace of productivity growth at the frontier has slowed in recent years and could slow further in the future. We begin with the three main structural headwinds highlighted by Gordon.

[7] In Gordon's 2012 paper "Is US economic growth over?" he highlighted six headwinds that will reduce US per capita income growth by 1.6pp per year. In addition to education (0.2pp), inequality (0.5pp) and fiscal pressures (0.3pp) he suggests a decline in average hours worked, globalisation and energy (linked to the costs of dealing with climate change) will each subtract 0.2pp from annual growth in the years ahead. The latter two factors were more speculative and were excluded from Gordon's revised 2014 paper and hence are ignored here. We also exclude the average hours argument as this rests on the assumption that average hours will continue to decline as the population ages and the baby boomers retire. This seems far from assured as average hours in the US have remained broadly flat since 1980.

Chart C11: US Per Capita Income 1870-2013

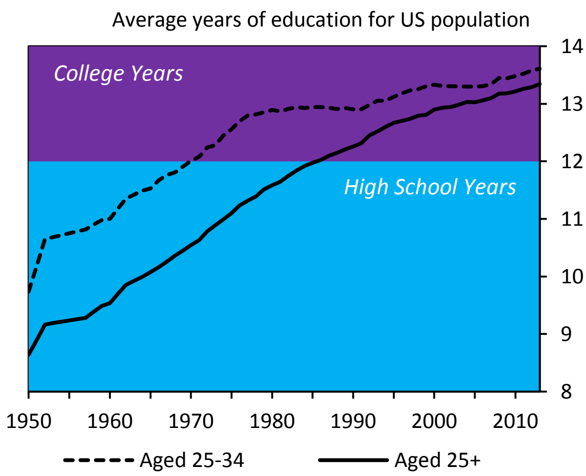


Sources: Maddison (2008), TED US Conference Board

Headwind 1: The Educational Plateau

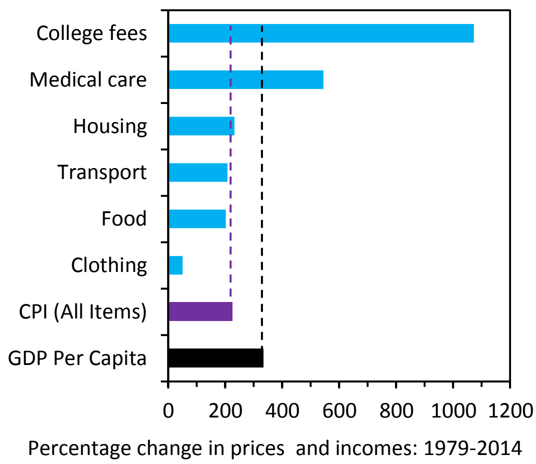
One of the main long-term drivers of US productivity growth has been a sustained rise in human capital per worker. Fernald and Jones (2014) estimate that 20% of the growth in US output per worker between 1950 and 1993 was driven by human capital accumulation. In other words, rising educational attainment added around 0.4pp to per capita income growth each year (on average). Pessimists argue this contribution has fallen in recent years and is set to fall further as US educational attainment plateaus. Their argument is simple enough: the number of years of schooling per worker rose quickly during the 20th Century, but that rate of increase isn't sustainable – years of schooling cannot go on rising forever. Average years of schooling rose by around 0.8 years per decade between 1950 and 1990 (and at a similar rate in the first half of the 20th century according to estimates from Goldin and Katz, 2007). But the most recently educated cohort of workers (the group aged 25-34, who serve as a leading indicator for the educational attainment for the rest of society) have seen their years of schooling rise by only 0.3 years per decade since 1990 (**Chart C12**). These figures suggest the contribution of human capital accumulation to US growth has more than halved from 0.4pp per year to around 0.1-0.2pp. Such figures are similar to those from Jorgenson and Vu (2010), who estimate that human capital's contribution to US growth fell by 0.1-0.2pp since 1995. Put another way, ***the slowing pace of educational attainment may have pushed down growth at the technological frontier by up to 0.2pp.***

Chart C12: Educational attainment of US population



Source: US Census

Chart C13: US inflation and income growth since '79



Sources: US Bureau of Labor Statistics and IMF WEO October 2014

What will happen to growth in human capital going forward? The answer partly depends on what factors have been driving the decline in the past. One of the more persuasive arguments is that the soaring cost of college education has been a major constraint. US college fees have increased by a factor of twelve over the past 35 years, far outstripping the rise in per capita income (**Chart C13**). If we account for rising income inequality as well (a point we will come on to), the differential between income growth and the cost of education is even starker for most households. Without a substantial change in education policy it seems reasonable to assume such trends will persist going forward.[8] More fundamentally, even without this constraint we would expect average years of schooling to plateau eventually. There are only so many years of formal education an individual can accrue before needing to cash in their human capital in the labour market. There may also be diminishing marginal returns to additional years of schooling beyond certain educational levels. If we buy these lines of argument, we might expect human capital's contribution to growth to eventually fall to zero.

But the above analysis is probably too pessimistic (and simplistic). It ignores potential increases in the quantity of human capital made possible by on-the-job training and by the IT revolution. For example, remote learning has almost zero marginal cost but has the potential to increase education levels widely. It is only now beginning to take off. The analysis also ignores potential improvements in the quality of education, which may be more achievable as a result of improved information flows from recent advances in digital communications. The analysis also assumes the pace of human capital at the technological frontier is dictated only by the US education market. But in reality, US citizens could be educated overseas, or well-educated foreigners could drive progress at the frontier.

To sum up on education – there are good reasons to think the pace of human capital accumulation may decline in the future. In many ways the low-hanging fruit has already been picked – high school completion rates have been stuck at their current level for decades. In order to see average years of schooling rise further a bigger proportion of the population needs to attend college, but the soaring cost of higher education makes this prohibitive. Looking ahead, it is possible that the contribution of human capital to growth could be maintained (or even increase), but such progress will require more innovative educational solutions – relying on improving the quality of education, not just the quantity. Overall, a small decline in the pace of human capital accumulation seems most likely. Jorgenson and Vu (2010) draw a similar conclusion, and predict that ***the contribution of human capital accumulation to growth will fall by a further 0.1-0.2pp this decade***.

Headwind 2: Rising Inequality

The rise of income inequality since the 1980s is another key secular trend that may be influencing trend growth. On the one hand, inequality may boost growth by incentivising individuals to work harder and take more risks. Richer individuals also tend to have higher saving rates, so if savings are used for productive investment that too can boost growth. But rising inequality can also harm growth. Three channels are frequently highlighted in the literature:

- Endogenous fiscal policy – Rising inequality may reduce the incentives for businesses to invest, as inequality could lead voters to insist on higher rates of corporate taxation and regulation.
- Under-investment in human capital – With wealth increasingly concentrated among the economic elite and with limited access to credit for the less well off, lower-income households may be unable to afford higher education resulting in less human capital accumulation (similar to Headwind 1).

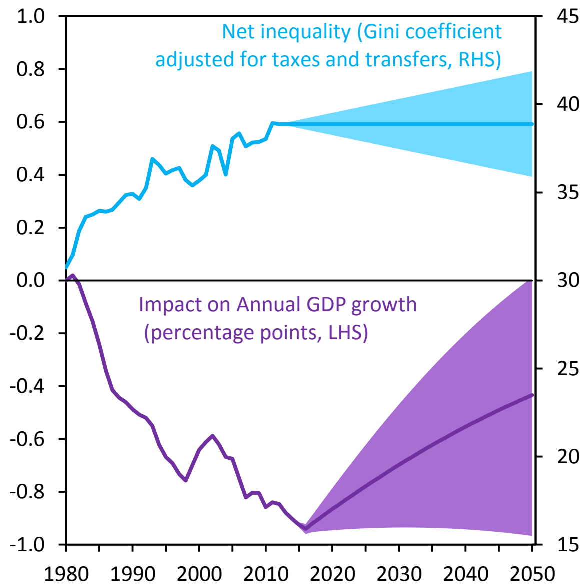
[8] One more radical policy proposal put forward by Harvard's Luigi Zingales (2012) is to encourage equity-funded rather than debt-funded higher education. Where venture capitalists invest in individuals' education for a share of the return on their income that derives from college attendance.

- Less demand for innovation – If the adoption of advanced technologies depends on a minimum amount of domestic demand, inequality can reduce the incentives to innovate as the propensity to consume of the population as a whole will fall as inequality rises. This latter channel is an example of inequality having a persistent impact on demand, which then affects the supply side of the economy.

Empirical studies paint a mixed picture on whether inequality and growth are positively or negatively related.[9] Data constraints are partly to blame for the inconclusive results, but these have eased in recent years and more recent studies by both Ostry et al (2014) of the IMF and Cingano (2014) of the OECD have concluded that the negative effects dominate i.e. rising inequality does lead to slower growth.

Both the IMF and OECD studies have made use of a new database that measures income inequality on a net basis (i.e. after the effects of fiscal redistribution have been taken into account). In terms of scale, the IMF estimate that a 1 point rise in the net Gini coefficient reduces growth by about 0.1 percentage points.[10] So the 8 point rise in the US's Gini coefficient over the past 35 years implies US growth would have been 0.8pp faster in the absence of rising inequality. The OECD use a slightly different approach but find similar results (**Chart C14**). The OECD also find that income inequality takes time to feed through to growth (since their estimates are based on a growth convergence model), so even if inequality stops rising, the drag on US growth is likely to persist for some time (purple and blue lines, **Chart C14**).

Chart C14: US income inequality and growth



Sources: OECD Income Distribution Database and Cingano (2014)

These results raise two questions. First, if inequality has been reducing the pace of per capita income growth in the US by up to 0.8pp per year, how has growth been sustained at its 2% trend? One optimistic interpretation is that other forces driving technological progress have been strong enough to provide an offsetting boost. There may be some truth to this argument – particularly during the ICT revolution of the late-1990s. Another interpretation is that the empirical estimates are over-estimating the size of the effect as they are not controlling for other potential drivers of per capita income growth over time.[11] Another more pessimistic explanation is that the empirical estimates are right, but they have not shown up in the growth statistics because a temporary factor has been providing an offsetting boost – namely a credit boom. The intuition here is that in the face of stagnant real incomes, poorer households have only be able to maintain consumption and living standards by borrowing. So rapid credit growth and rising indebtedness are the mechanism by which growth has been maintained in the face of rising inequality (the "let them eat credit" argument). Summers (2014a) suggests this mechanism has produced successive asset price bubbles that have since taken their toll (e.g. the dotcom bubble and sub-prime housing bubble). Looking ahead, the wave of financial regulation that has come into force post-crisis should reduce the scope for unsustainable credit booms to artificially boost growth and stoke asset price bubbles again. But

[9] Cingano (2014) of the OECD provides a helpful literature review.

[10] The Gini coefficient measures income inequality on a scale of 0 (zero inequality) to 1 (complete inequality) based on gross incomes. The net gini coefficient is an analogous measure but refers to net incomes after taxes and transfers have been taken into account.

[11] For example, in the OECD study by Cingano (2014), the impact of inequality is estimated by including the net gini coefficient in a panel regression along with other growth determinants (human capital, physical capital and lagged income). However, as noted by Durlauf et al (2005) approximately as many growth determinants have been proposed as there are countries for which data are available. So omitted variable bias is a concern with such analysis.

in the absence of such stimulus this could mean that the sustainable pace of growth is now much weaker than recent history would imply.[12] Put differently, the drag from inequality could have been masked in the past by an unsustainable expansion in credit and now that stimulus has been withdrawn, the effects of inequality will be revealed.

The other question that drops out from the above analysis is whether the effects from rising inequality on growth are distinct from the impact of slowing educational attainment. Our sense is that there is considerable overlap between the two – as noted in the literature, rising inequality can cause human capital accumulation to slow and vice versa. If we combine our previous estimate of the slowing pace of educational attainment on growth (0.2pp) and the IMF/ OECD's estimates for the total impact of inequality on growth (around 0.8pp, though highly uncertain), the overlap between the two suggests that ***rising income inequality could have reduced US growth by up to 0.6pp per year***. This is a similar sized effect to the figures suggested by Gordon. If we assume this effect has been masked in the pre-crisis period by an expansion in credit, but will be revealed in the years ahead, then rising inequality could be a key factor that weakens productivity growth going forward.

However, a word of caution is warranted here. Given the wide range of uncertainty over the empirical estimates and the somewhat questionable calibration used by Gordon (2014),[13] we think the above figure is probably an over-estimate of the scale of the effect of inequality on growth. In order to be more convincing the empirical evidence needs to draw a clearer link between rising inequality and labour productivity. So while we agree that rising inequality will probably drag on growth in the years ahead, we think the figures above are an upper bound. Our central assumption is that the scale of the effect is much smaller (a couple of tenths of a percentage point). That is not to say inequality has not had a substantial effect on real interest rates though. As discussed in **Section D** below, rising inequality may have resulted in a significant increase in global saving, which could have put downward pressure on real interest rates.

Headwind 3: Public indebtedness

Another factor that could have artificially boosted growth in recent decades is long-term fiscal expansion. Again, this is an example of a persistent demand trend, which could have affected the supply side of the economy.

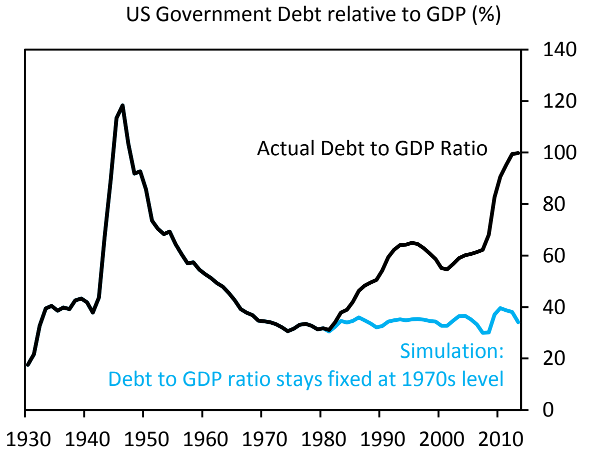
As with rising levels of household debt this could be a symptom of rising inequality i.e. governments having to spend more on welfare to counteract the effect of rising income inequality on the poor. But our sense is that inequality is not the driving force behind the 60pp rise in public debt levels seen in the US over the past thirty years (**Chart C15**). Much of that increase seems to have either occurred during the Reagan and Bush administrations when tax cuts rather than rising welfare payments were more typical, or during the global financial crisis. In the absence of this fiscal support, pessimists argue growth would have been weaker over the past. Looking ahead, the argument is that with debt levels already at high levels there is limited scope for further fiscal expansion to continue to support growth – hence growth will be weaker in the future than it has been.

[12] This argument is similar to those made by Koo (2011) that weak growth now is a result of a period of deleveraging as the economy works off its debt overhang. The implication of the deleveraging story is that growth in the coming years may be temporarily depressed, but it also implies that growth pre-crisis was temporarily inflated. Put differently, the rate of sustainable growth (in both monetary and financial stability terms) is lower than is implied by recent growth rates.

[13] Gordon (2014a) suggests the size of the impact of inequality on growth could be 0.5pp. He derives this figure by comparing growth in per capita incomes of the total population with those of the bottom 99% of the income distribution over the period 1993-2012. By making this comparison Gordon is effectively re-defining the measure of growth we are concerned with – focusing only on the bottom 99% of income earners. While potentially appealing from a societal point of view, this distinction is less useful from a growth accounting perspective and does not independently suggest that per capita growth of the whole population should be weaker. As such we do not find his evidence wholly convincing.

In terms of the scale of this effect, **Charts C15** & **C16** offer a simple thought experiment to try and quantify the size of the US fiscal boost linked to the run up in debt. Instead of the debt-to-GDP ratio rising by over 60pp over the past three decades we assume the ratio was stable at its 1970s level and calculate the corresponding path for government expenditure that would have delivered this outcome. What impact would lower government spending have had on growth? This is a loaded question and cuts to the heart of the debate on fiscal multipliers and the impact of rising debt levels on interest rates noted by Reinhart and Rogoff (2010). In our simulation we take a simplistic approach and just focus on the direct impact of a change in government expenditure on growth. Effectively this assumes a fiscal multiplier of 1 (so that government spending neither crowds out nor incentivises private sector activity) and assumes real interest rates are unaffected by the size of the debt stock. **Chart C16** shows the results – growth would have been 0.1-0.2pp lower on average over the past thirty years. This figure is in line with Gordon's (2014a) estimate (though he doesn't elaborate on how he generated his number). Clearly if you think fiscal multipliers are typically larger than 1 then the effect could be larger still.

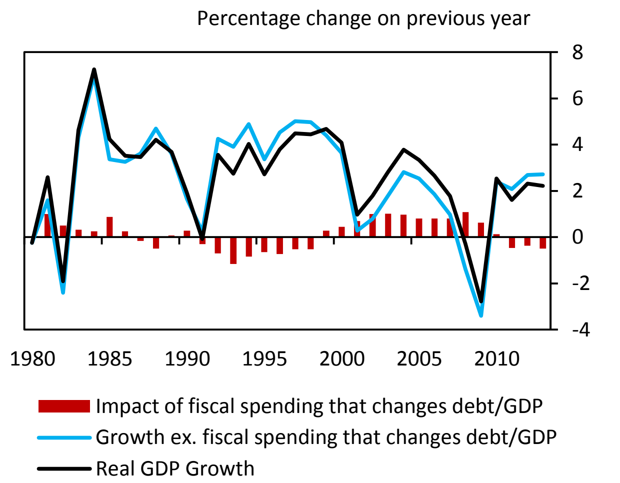
Chart C15: US government debt to GDP ratio



Sources: TreasuryDirect.Gov, Bureau of Economic Analysis & Authors' calculations

Notes: The simulation adjusts the path for US government expenditure from 1980-2013 so as to keep government debt steady as a proportion of GDP. The scenario is simplistic – it assumes a fiscal multiplier of 1 so that changes in government expenditure do not affect private sector activity and assume that the effective interest rate paid on US debt matches its historical trend. So interest rates are not lower as a result of the lower debt stock.

Chart C16: Mechanical Impact of rising government debt on US growth



Sources: TreasuryDirect.Gov, Bureau of Economic Analysis & Authors' calculations

Note: The red bars provides a simplistic illustration of how rising government expenditure – funded by an increase in government debt – has affected US growth over the past thirty years. The blue line shows how growth would have differed if government expenditure had evolved so as to keep the US debt to GDP ratio stable at its 1970s level. The blue and black lines correspond to those in the previous chart.

Again, the above analysis is a relatively simplistic treatment of what is a complex fiscal outlook for the US. The Congressional Budget Office (2014)'s long-term budget projections show that the US debt-to-GDP ratio will remain broadly stable until the end of this decade (based on a relatively optimistic view of current laws), but then will rise steadily higher as a result of the US's ageing population and rising cost of health care. By 2040 the debt-to-GDP ratio is predicted to be 25pp higher than its current level.[14] The outlook for US real rates will depend in part on how the US tackles this fiscal challenge. In the absence of any policy changes, the rise in debt-to-GDP could eventually prompt concerns about debt sustainability and increase the risk of default. In the event of a fiscal crisis, US real rates could rise materially. By contrast, if fiscal policy were tightened enough to keep the debt-to-GDP ratio flat, higher taxes or lower government spending would likely weigh on US growth, putting further downward pressure on real rates (at least temporarily). The CBO estimate such a scenario could reduce growth by 0.1-0.2pp in the first few years of their forecast, though they do not specify a longer-term effect.

[14] The CBO's projections assume a relatively robust rate of both GDP growth (2.3% per year) and labour productivity growth (1.8%). If productivity growth were 0.5pp weaker than is assumed, by 2040 the debt-to-GDP ratio would be a further 20pp higher.

On balance, we think the fiscal expansion of the last thirty years has probably added to US GDP growth and hence boosted living standards. But such stimulus cannot continue indefinitely and comes with a cost – a rising fiscal burden for future generations. This intra-generational transfer, combined with the added fiscal challenge of having to fund healthcare for an ageing population are likely to weigh on US growth in the coming decades. The size of this effect is difficult to judge, not just because of the uncertainty over fiscal multipliers, but also because of the uncertainty linking fiscal policy (which primarily acts on the demand side) to the long-run productive capacity of the economy (via hysteresis). Taking the thought experiment above and the CBO's estimates at face value would suggest ***growth now and in the years ahead could be 0.1-0.2pp lower than in recent decades as a result of less fiscal stimulus***.

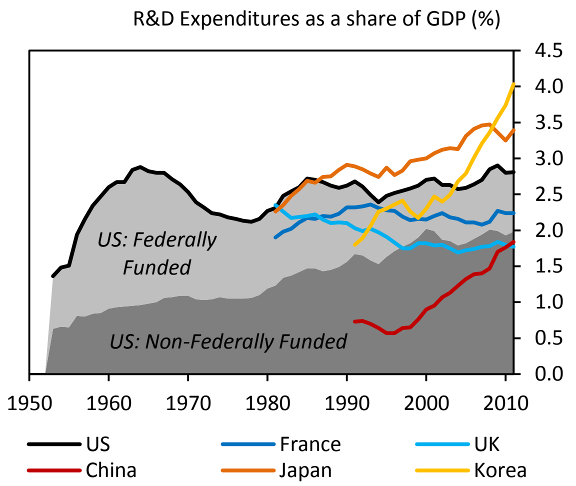
The Pace of Technical Progress

Although the three secular headwinds highlighted above are all important, the more fundamental question when it comes to long-term growth is what will happen to the pace of innovation at the technological frontier. This issue remains one of the most important topics in economics and also one of the most uncertain. Currently, there is a lively debate about whether the pace of innovation is in terminal decline or on the verge of a great acceleration. In this sub-section we discuss the arguments on either side of the debate and analyse how they stack up. But before doing so, we first draw on Fernald and Jones (2014) work to provide an organising framework for thinking about what drives innovation. In their growth accounting model, technical progress is defined by an ideas production function that depends on two inputs: the stock of ideas; and the rate of return on innovation (how much output each idea generates). So how does the evidence stack up on each of these factors?

The stock of ideas – In Fernald and Jones's framework the stock of ideas increases with the number of people doing research and the amount of funding they have at their disposal (proxied by the amount of national income devoted to R&D). The number of researchers is partly linked to the size of the workforce, so Fernald and Jones are effectively building into their model Kuznet's idea that faster population growth can lead to faster productivity growth (See Part II above). They estimate that growth in the number of researchers could have accounted for up to a fifth of the growth in US output per worker between 1950 and 2007 – adding 0.4pp to US growth on average each year. But this effect could halve in size if labour supply growth in the US (and wider world) declines as expected (**Chart C6**). Put differently, demographic trends could indirectly reduce productivity growth at the frontier by up to 0.2pp in the years ahead. This effect is in addition to the direct impact of slower labour supply growth on GDP growth discussed in Part II.

But even though demographic trends may mean the supply of potential researchers is growing less quickly, the flow of new ideas could still be maintained if a larger share of national income (and hence the workforce) is devoted to R&D. In the US, R&D spending has been on a slowly rising trend over the past fifty years (**Chart C17**). There are good reasons to think this trend could continue or even accelerate in the future. First, the historic trend has been driven by private not public funding and hence should be more resilient to fiscal cuts in the future (from Headwind 3 above). Second, other countries (particularly those in Asia) have increased R&D spending rapidly over the past few decades.

Chart C17: R&D spending across countries



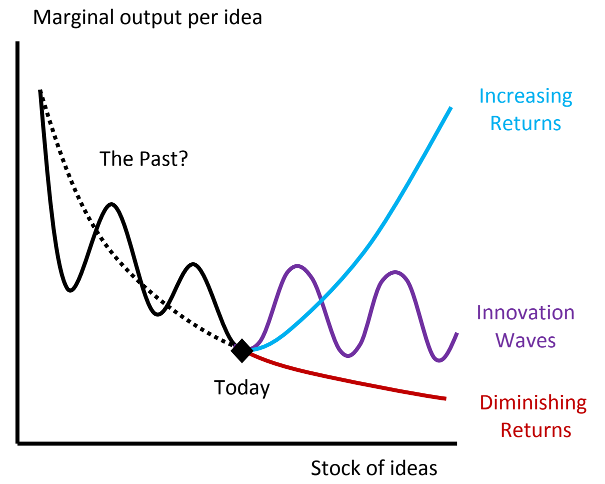
Source: NSF Science & Engineering Indicators 2014

This increase in foreign research will add directly to the global pool of new ideas and help push out the technological frontier.[15] But, by increasing technological competition, greater spending on R&D overseas may also spur US companies to invest more (similar to how the space race resulted in higher public R&D in the 1950s and 1960s). Thirdly, and more speculatively, the rise in the number of tech billionaires could also prompt US R&D spending to accelerate. Having so many high profile examples of self-made inventors (e.g. Bill Gates, Steve Jobs, Elon Musk) may incentivise more companies and individuals to spend time on R&D. Moreover, privately amassed fortunes are not bound by the same constraints as governments, and can be quickly re-deployed to drive innovation elsewhere. Elon Musk provides an anecdotal example of this occurring in practice. Musk has used his Paypal fortune to setup both Tesla Motors (an electric car company) and SpaceX (a reusable rocket company) – to drive innovation forward. In the case of Tesla, Musk has gone even further – giving away his patents to spur development in the electric car sector.

Eventually there will be a limit as to how much R&D expenditure can rise as a share of GDP and hence how much productivity growth can be driven by simply increasing the amount of research underway. But the US does not currently seem to be at that limit. Indeed, at the current juncture there are various reasons to think that R&D spending should continue rising as a share of global GDP. We think this effect should be sufficient to offset the decline in the number of researchers driven solely by demographic factors. As such, we conclude that there is insufficient evidence to think the stock of ideas will grow significantly less quickly in the future than in the recent past.

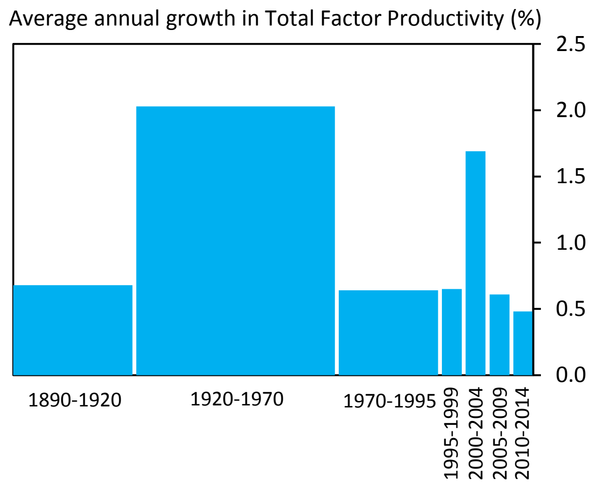
The rate of return on innovation – Given the above, the more pressing question about the future of innovation is not how the stock of ideas will evolve, but how effective those ideas will be in boosting output i.e. how will the rate of return on innovation change? **Chart C18**, which is adapted from Fernald and Jones, offers a simple illustration of the different views of the future on offer. Before running through them, it is worth dwelling on what has happened to productivity over the past – to inform our judgement.

Chart C18: Returns to innovation



Source: Adapted from [Fernald and Jones (2014)]

Chart C19: History of US TFP Growth



Source: Gordon (2014)

Although there remains a lively academic debate, there is an emerging consensus that the history of US TFP growth is better characterised as a series of 'innovation waves' rather than a sustained and steady rise in productivity (as might be inferred from **Chart C11**). Gordon (2014c) is one of the most active economists in this area and his characterisation of history is shown in **Chart C19**. He describes the past 125 years as a

[15] The growth in the number of Chinese PhD graduates is a particularly striking example of the role of R&D spending outside the US adding to the potential pool of new research. In 1978 China produced no science and engineering PhDs, yet by 2010 they produced 25% more than the US.

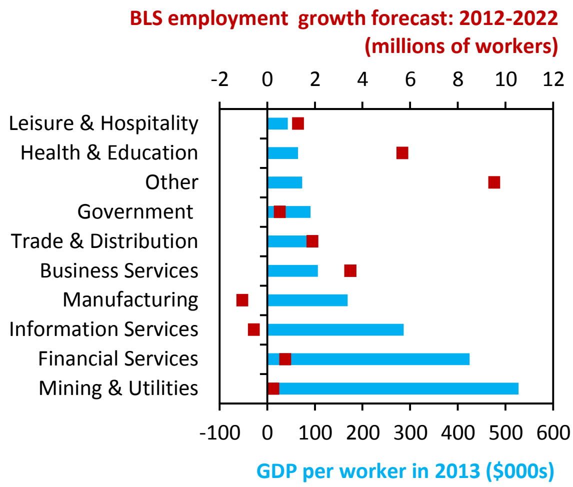
period of two distinct innovation waves – the 'second industrial revolution' from 1920 to 1970 and the ICT revolution of the late 1990s and early 2000s. The 'second industrial revolution' is described as multi-dimensional because it included the widespread adoption of so many different technologies: electricity; the internal combustion engine; indoor plumbing; air travel; TV and radio communications etc. By contrast, Gordon suggests the ICT revolution was more narrowly focussed and hence didn't last as long. During each innovation wave, productivity growth was unusually high as the new technologies were integrated into production processes. But once the efficiency gains from these inventions were fully exploited, the innovation wave subsided and productivity returned to its more subdued historic trend.

Gordon's analysis suggests US TFP growth has been relatively slow for much of the past thirty years i.e. the recent slowdown in productivity is a return to the norm, from unusually high rates of productivity growth during the ICT boom. We largely agree with this description of history, which in turn suggests that a sustained decline in TFP growth over the past thirty years was not one of the main causes of the sustained fall in real interest rates we have seen. The debate is largely over what will happen going forward, and whether greater pessimism about productivity in the future could be weighing on real interest rates now. So how do the arguments stack up?

Pessimistic argument 1: Most employment growth will occur in low productivity sectors

A number of arguments have been put forward to suggest the returns to innovation are in decline (red line, **Chart C18**). One argument, highlighted by Summers (2013), focuses on shifts in employment between sectors and differences in productivity levels. Sectors like manufacturing, extraction and ICT have the highest levels of labour productivity and the fastest rates of productivity growth, but much of the future demand (and hence employment growth) is likely to occur in labour-intensive sectors with low productivity (**Chart C20**). Summers (2013) links this phenomenon to the changing age-structure of the population. As populations age, the demand for health care and social services increases significantly. But such services are difficult to automate, mechanise and replicate, meaning they tend to have lower output levels per worker. As more of the workforce shifts to these sectors, average productivity per worker is likely to fall.

Chart C20: US Employment growth and productivity



Sources: US Bureau of Economic Analysis and Bureau of Labor Statistics

We estimate this sector shift could pull down on US productivity growth by around 0.2pp over the next decade – assuming employment growth evolves according to the BLS's forecast. But there are reasons to be cautious about this line of argument. Reallocation of workers across sectors has been occurring for decades, but in the past has always been offset by productivity gains elsewhere. In the long-run this effect could become more important as the shift in distribution of employment becomes more stark, but for now we see this effect as relatively minor and not vastly different from historic norms.

Pessimistic argument 2: The low hanging fruit has already been picked

The other argument for pessimism is that the most ground-breaking advances in technology, which occurred during the 20th century, cannot be repeated. Gordon (2012) champions this view:

"Speed of travel was increased from that of the horse to the jet plane in a century but this could not happen again. The interior temperature that in 1870 alternated between freezing cold in the winter and stifling heat in the summer reached a year round 72 degrees Fahrenheit (22C) that could not happen again. The US was transformed from 75 per cent rural to 80 per cent urban, and that could not happen again."

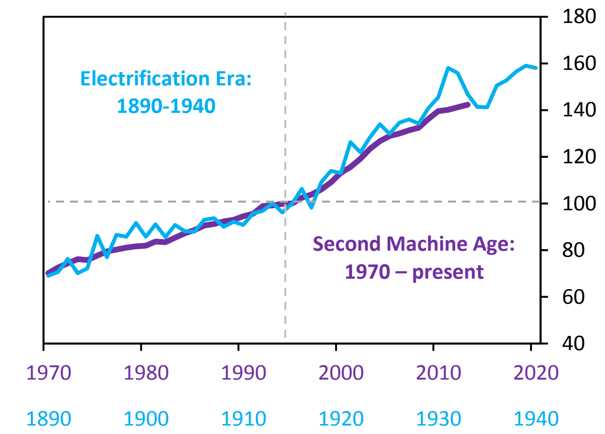
Gordon argues that these advances, which in many cases occurred simultaneously, were responsible for the mid-20th Century boom in productivity growth shown in **Chart C19**. The subsequent slowdown in productivity from the 1970s onwards was a sign of diminishing returns settling in, characterised by "second-round improvements", such as developing short-haul regional jets, extending the original interstate network with suburban ring roads, and converting residential America from window-unit air conditioners to central air conditioning. Gordon then points to the ICT boom as evidence that innovation waves can still occur, but they are shorter-lived and less wide-reaching than the inventions of the past. As a result, Gordon argues that a more sensible forecast for the pace of innovation in the future is the more subdued rate of progress seen for most of the period since the 1970s. He then suggests growth could be even weaker than this trend due to the structural headwinds identified above. In terms of our own view, we largely agree with Gordon's characterisation of history and the near-term outlook for the pace of innovation. Gordon's pessimism accords well with the recent weakness in productivity growth in the US and more broadly around the world. But there are clear upside risks to this view as suggested by the arguments of the more optimistic commentators.

Optimistic argument 1: Recent productivity weakness is a sign of growing pains and will abate

Brynjolfsson & McAfee (2014) seem to largely agree with Gordon's characterisation of the history of US innovation up until the ICT boom, but they take a very different view about the recent productivity slowdown and the direction of travel going forward. They argue that new technologies are often disruptive and take time to be fully integrated into production processes. Indeed, they note that a productivity paradox was also a feature of the second industrial revolution – electricity was first introduced to American factories in the 1890s but it took 20 years for the benefits to show up in labour productivity growth. They argue the same is happening now – the 'second machine age' (or digital revolution) started back in the 1970s, but only started to show up in the productivity statistics during the ICT boom of the late 1990s. The more recent productivity slowdown is therefore just a sign of growing pains as production processes adjust to the new technologies. And, just as was the case in the electrification era, productivity will soon accelerate rapidly.

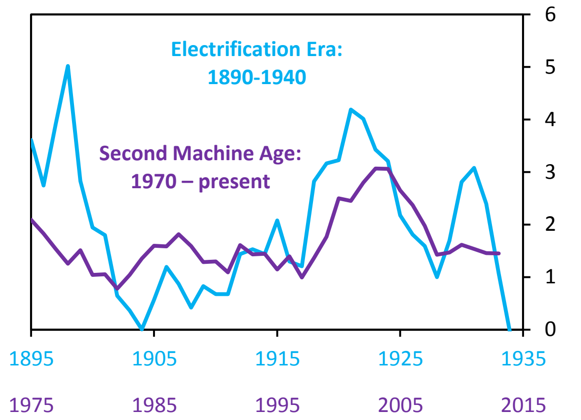
We have attempted to reconstruct the evidence used by Brynjolfsson & McAfee in forming their view (**Charts C21 & C22**). Although the similarities between the 'electrification era' and the 'second machine age' are quite striking on the charts, we have our doubts about the quality of the data for the electrification era, which tends to be based on the manufacturing sector and hence could overstate the productivity gains for the whole economy. Moreover, the productivity boom from the electrification era may have partly been spurred by the need to innovate during the Second World War and Cold War. Such pressure is arguably less acute at the moment. So while Brynjolfsson & McAfee may ultimately be proved right, it is less clear they will be proved right over the next few years. As ever, it remains very difficult to predict surges in innovation.

Chart C21: US labour productivity in different eras



Sources: Brynjolfsson & McAfee '[The Second Machine Age](#)' ,Maddison, Total Economy Database, Wolman (1938) 'Hours of work in American Industry', US Bureau of Labor Statistics

Chart C22: US labour productivity growth

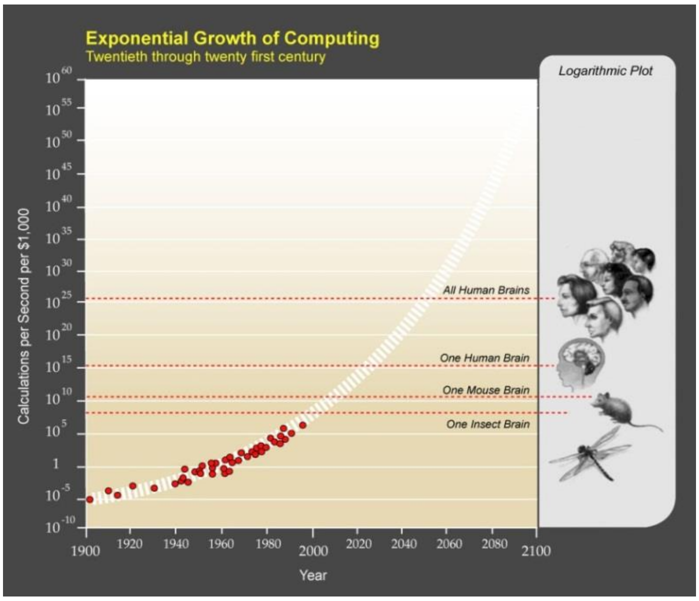


Sources: Maddison, Total Economy Database, Wolman (1938) 'Hours of work in American Industry', US Bureau of Labor Statistics

Optimistic Argument 2: Exponential productivity growth is a possibility – machines making machines

An even more upbeat vision of the future has also been put forward. This argument sounds more science fiction than dismal science, but is based on recent advances in computing power, artificial intelligence and robotics. Together these innovations could mean that at some point in the not-to-distant future computers will overtake humans in their ability to innovate. At that point, which [Kurzweil (2005)](#) refers to as the singularity, productivity could rise exponentially. This argument is partly based on extrapolating trends like Moore's law – the historically reliable rule that the world's maximum computer power doubles approximately every two years.

Chart C23: Exponential growth in computing power



Source: [Kurzweil (2005)](#) – The Singularity is Near (page 118)

Chart C23 takes this rule and maps it into computing power by showing how much $1000 can buy in terms of calculations per second. Currently $1000 can buy the equivalent of one mouse brain or about a thousandth of human level. This doesn't sound like much progress, but in 1985 computers were only a trillionth of the level of the human brain. If the trend continues, $1000 could buy as much computing power as the human brain by 2025, and all human brains by the middle of the century. Sceptics argue that advances in hardware are insufficient to generate a productivity surge because such innovations require advances in artificial intelligence too. Progress on this front is much more difficult to predict, but if it does occur, it could cause productivity growth to surge in a very short period of time. Such a radical event would have wide-ranging consequences for the global economy and wider society. Real rates would also be affected, but predicting even which direction real rates might move is difficult given the wide range of possible outcomes that could result from such a starkly different future.

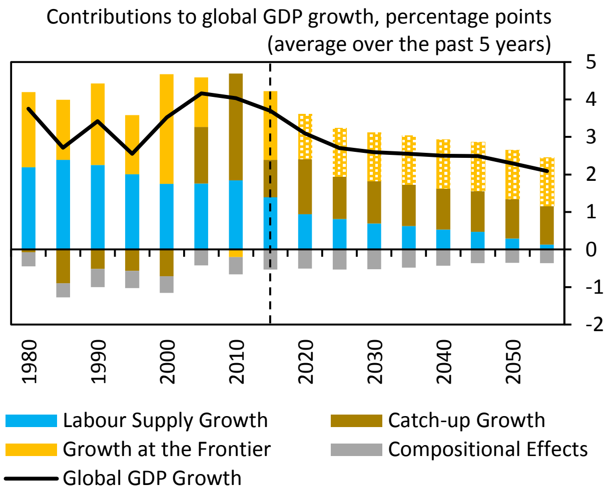
Summing up on the pace of innovation:

Overall, our reading of the above arguments is that Gordon's characterisation of recent history and the near-future is the most compelling. US productivity growth has been weak since the 1970s, was lifted temporarily by the ICT boom, but has since fallen back. In the absence of clear advances in technology, it seems reasonable to assume this trend will continue going forward – particularly given the recent weakness in productivity globally. But the further we peer into the future, the more likely we think Brynjolfsson & McAfee and possibly even Kurzweil are likely to be proved right – suggesting substantial upside risks going forward. Indeed, given the importance of innovation waves in driving productivity trends, arguably policymakers should expend more effort in trying to spot them developing in the future. Assuming a simple fixed trend is a helpful simplifying assumption from a macro-modelling perspective, but is not necessarily a good description of productivity growth over history or the future. In terms of global growth and real interest rates, the above analysis suggests that TFP growth has not slowed materially compared with the 1980s and hence is unlikely to be responsible for the secular decline in real interest rates we have seen over the past thirty years. Going forward, we assume the pace of underlying technical progress will continue at its trend rate,[16] but think that growth at the frontier could be materially weaker as a result of the three structural headwinds identified earlier.

v) Global growth and real interest rates – a summary

Chart C24 and the accompanying table bring together all the above analysis on demographics (blue), catch-up (gold) and growth at the frontier (yellow) into one place. The chart shows global growth averaged over five-year intervals so as to smooth out cyclical variations and provide a simple metric for the underlying trend. As noted earlier, a key feature of **Chart C24** is the pace of global growth in the pre-crisis period. Growth has not changed materially since the 1980s – averaging 3 to 4% per year. In fact, if anything growth in the years before the crisis was actually a little higher than in the 1980s. Consequently, it is difficult to account for much (if any) of the pre-crisis fall in real rates by appealing to past changes in global growth.[17] Yet while growth may not have fallen much over the past, the financial crisis may have triggered a wider reassessment of growth prospects going forward. Greater pessimism about the future could now be playing an important role in driving the post-crisis decline in real rates via an expectations channel.

Chart C24: Global Growth Accounting



	1980 to 2015	2015 to 2030
Change in Global Growth	0.0pp	0 to -1.5pp
Labour Supply Growth	-0.8	0 to -0.5
Catch-Up Growth:	+1.0	-
Growth at the frontier:	-0.2	0 to -1.0
Educational plateau	-0.2	0 to -0.2
Inequality	0.0	0 to -0.6
Fiscal	+0.2	0 to -0.2
Technological progress	-0.2	-

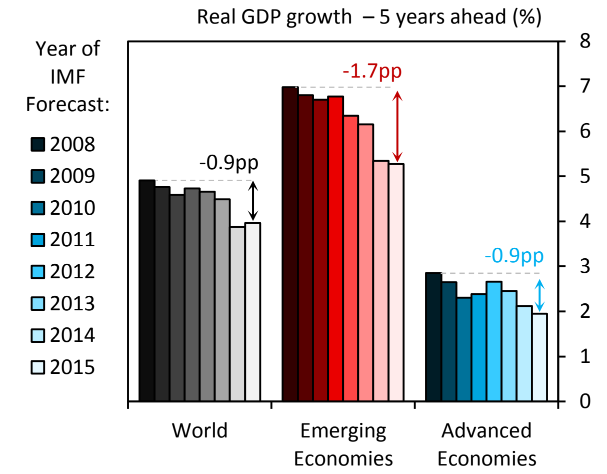
Sources: TED, US Conference Board, IMF, UN and Authors' calculations

Notes: Global growth is expressed in constant PPP-weighted 1990 dollars. The grey 'compositional effect' bars in the chart show the impact on average global per capita incomes of having high population growth in low-income countries.

[16] We define the recent trend as the average pace of US labour productivity growth experienced between 1980 and 2015, excluding the five year period of the ICT boom.

[17] If we go further and recognise that the composition of growth has shifted away from demographic growth (blue bars) to productivity growth (yellow & gold bars) and recall that the link between growth and real rates may be stronger for productivity growth (with a multiplier as high as one-to-two based on the analysis in Part 1) than for demographic growth (perhaps a multiplier of two-to-one), then the shifting pattern of growth may even have put upward pressure on real rates before the crisis.

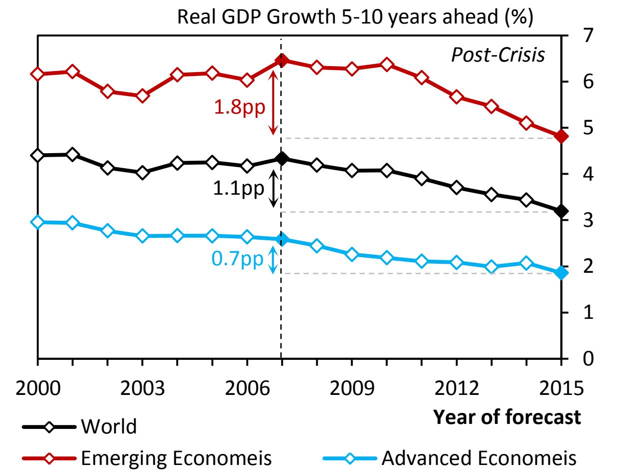
Chart C25: IMF forecasts for long-term growth



Source: IMF World Economic Outlook (April 2008 to April 2015)

Notes: Figures are PPP weighted and refer to real GDP growth five years ahead.

Chart C26: Consensus forecasts for growth



Sources: Consensus Economics and IMF WEO

Notes: Each line shows successive forecast vintages for growth 5-10 years ahead from Consensus Economics. Each country grouping is weighted together using IMF PPP-GDP weights from the period 2005-2015.

Although there is a great deal of uncertainty, if we add up all the factors analysed above, we think we can come up with a reasonable case for why global growth could slow by up to 1pp over the next decade or so. This is similar in scale to the downward revisions to medium-term growth forecasts that the IMF and private sector forecasters have made since 2008 (**Charts C25 & C26**). Depending on the mapping, we think weaker growth prospects could account for up to 100bps of the fall in real rates we have seen post-crisis. Our justification is as follows:

- **Weaker Labour Supply** – Global labour supply growth looks set to slow sharply as the slowdown in global population growth feeds through to the labour force. We think this effect could reduce global growth by up to 0.5pp by 2030 (**Chart C6**). Given the uncertainty over the mapping between labour supply growth and real interest rates (α in **Figure C1**), we think the anticipation of this effect could account for 0-25bps of the fall in real interest rates seen since the crisis.
- **No change in catch-up growth** – We take a neutral view about the pace of catch-up growth going forward and assume it will continue in line with the average experience of the past 5 years – not as fast as the 2000s but not as slow as the 1990s either (**Chart C10**). In other words we do not pin the decline in real rates on a further slowdown in the pace of catch-up growth going forward.
- **Structural headwinds hold back growth at the technological frontier** – Finally, while recognising the upside risks, we assume that the pace of innovation will continue at its recent sluggish rate – consistent with the experience of the past thirty years save for the ICT boom (**Chart C19**). But we think progress at the technological frontier will also be held back by several structural headwinds: the educational plateau; rising inequality; and fiscal drag. Gordon suggests these factors could drag down growth by up to 1pp either by directly affecting the supply side or via demand effects leading to hysteresis. Having interrogated his analysis, we accept the evidence on the educational plateau, but think the headwinds from inequality and fiscal policy are less important given uncertainties over fiscal multipliers and the overlap between the inequality and education arguments. Overall, we judge that growth at the frontier could be 0.5pp weaker. Given the multiplier between productivity growth and real rates could be as high as one-to-two, this effect could be pulling down on real rates by 50-100bps.

Overall, recent declines in global growth expectations could be an important driver of the post-crisis decline in real interest rates we have seen. But to explain the longer-term decline in real rates before the crisis, we need to appeal to other factors – namely the preference shifts described in **Section D**.

Box C1: A brief history of secular stagnation

Alvin Hansen originally coined the term 'secular stagnation' in the 1930s.[18] He was shocked by the US's sudden return to recession in 1937 so soon after the Great Depression. The mid-1930s recovery had proved incomplete, with GDP and employment both failing to return to their pre-crisis peaks. History is littered with false dawns, but in searching for an explanation of the causes of the 1937 recession Hansen produced a gloomy diagnosis. He observed that the short-lived recovery had been driven by transitory factors: a credit surge and rise in federal spending. When these stimuli had played out, the recovery ceased, revealing a stagnant economic backdrop linked to a long-term decline in growth.

In trying to explain this fall into stagnation, Hansen appealed to secular trends – particularly demographics. He estimated that US population growth had halved since the late 19th century, which led to a substantial fall in capital formation. Technological progress needed to accelerate to maintain the economy's previous momentum, but Hansen saw declines in trend productivity growth too. In short, the drivers of long-term growth were coming to an end. Secular stagnation was the resulting fear, whereby slow growth resulted in insufficient investment opportunities to absorb the supply of savings needed to maintain full-employment. (Adapted from Brown's review of Hansen's work, 1989)

As we know, Hansen's gloomy prognosis did not come to pass. The US did not slip into a sustained period of stagnation after 1938. Quite the opposite. The fiscal splurge that accompanied World War II preceded a period of extraordinary productivity growth in the post-war years. When combined with the surge in birth rates during the baby-boom years and rising female labour participation, the result was a sustained pickup in living standards that reversed the secular declines that Hansen had feared. Yet 75 years on, after a financial crisis equal to the Great Depression and several years of sluggish growth, secular stagnation is back. Could Hansen yet be proved right, even if his timing was wrong?

The modern debate over secular stagnation is more nebulous than Hansen's original formulation though just as controversial. Eichengreen describes the term as an economist's Rorschach test (inkblot test) because it is interpreted so differently across the profession. Broadly there are three schools of thought. To some, such as Gordon (2014c), secular stagnation is fundamentally a supply side issue. Structural headwinds such as population ageing and rising inequality are leading to weaker potential growth and lower real interest rates. To others, like Summers (2014a) – who revived the secular stagnation debate in 2013 – the issue is mainly one of demand deficiency. He argues that secular trends, such as slowing population growth and the declining price of capital have led to a fall in demand and a surplus of saving. And, because of low inflation targets and the zero lower bound on nominal rates, real interest rates cannot fall far enough to restore equilibrium. Summers argues that this has been an underlying feature of the US economy for decades, but has been masked by booms built on unsustainable finance – namely the dotcom bubble in the 1990s and the more recent credit boom. Summers (2014b) has also acknowledged the importance of supply-side factors but remains the modern voice of secular stagnation. By contrast, a third group of economists, among them Richard Koo, argue that the sluggish growth we have seen since the crisis is not secular stagnation, but merely part of the normal adjustment process that takes place after a balance sheet recession – a period of deleveraging that weighs on growth, as in Japan. A VoxEU (2014) book provides an excellent summary of the various schools of thought.

[18] The term first appears in Hansen (1934) "Capital Goods and Purchasing Power', Proceedings of the Academy of Political Science 16 (1), but was more widely publicised in Hansen's 1938 Presidential Address to the American Economic Association.

Section D: Desired savings and investment and real interest rates

Under plausible assumptions we think we can account for a further 300bps of the 450bps fall in real rates since the 1980s as a result of shifts in preferences for saving and investment. We think the global desired saving schedule has shifted out due to demographic forces, higher inequality and to a lesser extent the emerging market savings glut. Meanwhile, desired levels of investment have fallen as a result of the falling relative price of capital, declines in public investment, and because of an increase in spreads between risk-free and actual interest rates. We expect most of these forces to persist and some may even build further.

The previous section explored the link between global trend growth and the global neutral rate of interest. But as we have seen, changes in global growth can only explain part of the secular decline in global real rates over the past thirty years – mainly in the post-crisis period. Other factors must also be responsible for driving the long-term decline in the global neutral rate.[19] Since the real interest rate is the price of future consumption expressed in terms of consumption today, shifts in time preferences that describe how households spread consumption over their life cycle will also move real rates around. One way to analyse these preference shifts is via a savings-investment (S-I) framework: given growth expectations, the neutral rate will depend on agents' preferences for both desired savings and desired investment.

In this section we use the S-I framework to analyse how various secular trends have affected the neutral rate at the global level. The section is split into three sub-sections: Part 1 sets out the S-I framework itself; Part 2 uses the framework to calibrate the impact of various secular trends that have shifted the desired saving curve over time; and Part 3 performs the same exercise for the desired investment curve. The aim is to quantify how large, in terms of real rate changes, the various secular trends have been and offers a prediction of how such trends may evolve in the future.

i) A savings-investment framework linking preference shifts with real interest rates

Intuitively, desired saving will tend to rise as real rates increase (the savings schedule should slope upwards), because higher rates generate higher returns on saving and yield higher future consumption. By contrast, desired investment will tend to fall as real rates rise (the investment schedule should slope downwards) because the real rate is a key component of the user cost of capital, so as real rates rise it becomes more costly to invest. These two relationships describe the S-I curves, used to frame this section.

The focus of our analysis here is on changes in desired, rather than actual saving and investment. This distinction is important and is similar to analysing shifts in the supply and demand curves for a particular good (which reflect desired behaviour) as opposed to just focusing on actual sales and purchases (which by definition will be equal). For the world as a whole – as for any closed economy – actual saving and investment will always be equal by identity. But the sensitivity of desired savings and investment (the slopes of the curves) and the forces that shift them (preference shifts) will be key in determining the actual level of saving and investment and the observed real interest rate.

In order to use the S-I framework to quantify changes in real rates, we need to calibrate the slope of both the desired saving and the desired investment curves. Since both curves are unobservable, this raises an empirical challenge. We rely on existing estimates from the literature to guide our calibration of the slopes of both curves (see **Box D1** for details).

[19] Hamilton et al (2015) arrive at a similar conclusion.

Box D1: Sensitivity of desired saving and investment to real interest rates

An important source of uncertainty when using the S-I framework for quantitative analysis is that we do not know the sensitivities of desired saving and investment to real interest rates: the slopes of the savings and investment schedules are unobservable, so we need to rely on empirical estimates.[20]

The key difficulty when estimating these slopes is endogeneity: interest rates and S-I ratios may be driven by common factors. For example, a more optimistic demand outlook would raise investment and interest rates simultaneously. This is why studies that estimate elasticities using time-series correlations can produce a wide range of estimates. To make our exercise robust, we take an average of available estimates from the literature. For the elasticity of saving, this suggests an elasticity of 0.5 (**Table 1**). For the elasticity of investment, we rely on more recent studies that aim to overcome the endogeneity problem by using structural models or by employing cross-sectional data (such as Guiso et al, 2002, Gilchrist & Zakrajsek, 2007 and Ellis and Price, 2003). These tend to find that long-run elasticities are between -0.5 and -1. We assume an elasticity of -0.7; this makes investment more sensitive to interest rates than saving.[21] For simplicity, we also assume the two curves have a constant elasticity (they are not kinked), and that the effective lower bound on real rates is around -2%, consistent with the zero lower bound on nominal rates and the 2% inflation target.[22]

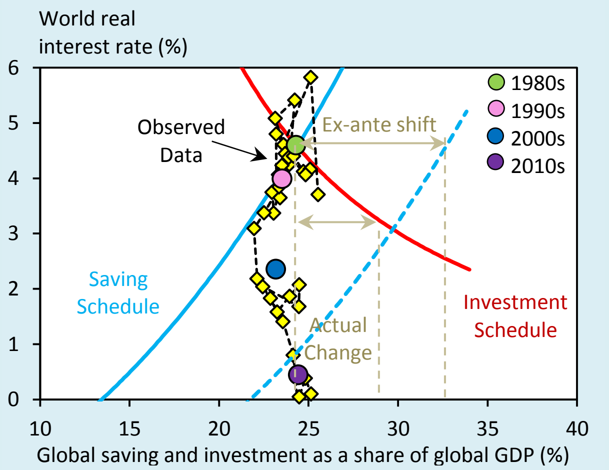
Together, these assumptions form the basis of the slopes of the curves shown in **Chart D1**. We think the slopes have been calibrated based on a fairly neutral reading of the range of estimates in the literature, but we recognise the wide bands of uncertainty. If we are wrong about one of the slopes of the curves – say the investment schedule is shallower – then it becomes more likely that shifts in the investment curve (rather than the savings curve) have been responsible for more of the fall in real rates we have seen. The slopes of the curves thus matter in terms of the relative weight one puts on different explanations for the fall in real rates, but should not necessarily affect our ability to account for the scale of the fall overall.

Table 1: Estimates of the elasticity of saving with respect to the real interest rate

Author of study:	Elasticity
Blinder (1975)	0.03
Boskin (1978)	0.4
Carlino (1982)	0
Carlino & Defina (1983)	0
Gylfason (1981)	0.3
Heien (1972)	1.8
Howrey & Hymans (1978)	0
Summers (1982)	1.3
Taylor (1971)	0.8
Wright (1967)	0.2
Average:	***0.5***

Source: DeFina (1984)

Chart D1: The IS Framework



Sources: IMF, King & Low (2014) and Authors' calculations

Note: Global saving and investment rate are reported by the IMF. The world real rate is taken from King and Low. Specific calibrations of neoclassical or OLG models can deliver very different results.

[20] The less sensitive investment is to interest rates (the steeper the investment schedule), the larger the effect any given shift in the saving schedule on the interest rate will be (and vice versa). This is because any given shift in desired saving will require a larger adjustment in the interest rate to restore equilibrium.

[21] This sensitivity drops to -0.5 when we account for the decline in the relative price of capital goods. See Part 3 of this Section for more details.

[22] The effective lower bound could be a little lower than -2%, because nominal interest rates can be slightly negative and because inflation targets and/or inflation expectations may be higher than 2% at the global level. But we think it is unlikely for global real rates to fall much below -2% for a sustained period. At rates this low, inflation expectations are likely to fall below target levels (as in Japan), providing a floor to real rates. In any case, our results are not sensitive to this assumption.

The goal of our analysis is to estimate the importance of various preference shifts in moving these curves around and driving the fall in real rates. We focus on *ex-ante* shifts in the schedules i.e. shifts that are independent of the moves in the real rate itself. We can then determine the impact on the real rate by comparing the new and old equilibria. Precisely because the real rate adjusts, the *ex-post* change in actual saving or investment will tend to be smaller than the ex-ante, or desired, change. **Chart D1** (shown in **Box D1**) illustrates this with an example: a preference shift increases desired saving for any given interest rate. This shifts the saving schedule to the right. But as the desired level of investment is unchanged (for a given interest rate), this shift would push down on the interest rate until desired investment is equal to desired savings. As a result, the actual increase in saving is smaller than the shift in desired saving.

One striking feature of the data is that despite the 450bps fall in global real rates, global savings and investment have remained fairly stable as a share of global GDP over the past 30 years (yellow diamonds, **Chart D1**). This vertical pattern could suggest that either savings or investment are insensitive to changes in real rates (one of the curves is vertical). While mindful of this possibility, we assume the slopes of the curves match empirical estimates in the literature, which implies that *both* curves must have shifted. Various factors have been put forward to explain such shifts. Our approach is to run through them and try to quantify the size of each effect on real rates. We begin by focusing on trends that have affected the saving schedule.

ii) Trends affecting the saving schedule

We identify three key secular trends which have had a decisive impact on the level of desired savings globally: changes in the demographic structure of the global population, rising inequality, and a preference shift by emerging market governments towards higher saving (the EM savings glut). In each case, we describe how each trend has affected desired global saving and hence real interest rates since the 1980s. We then speculate how this impact could evolve in the future.

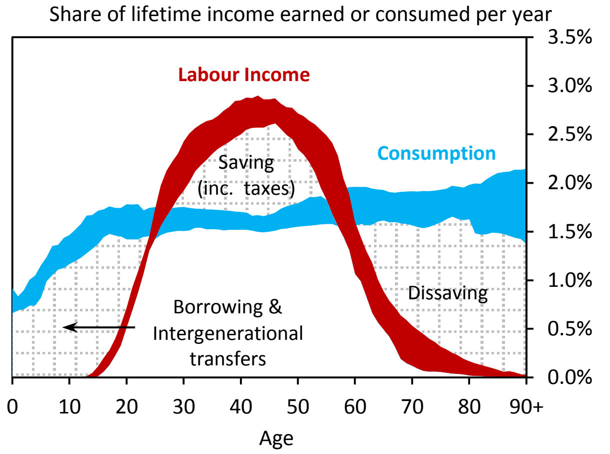
Trend 1: Demographics

Impact over the past thirty years: The life-cycle hypothesis suggests that changes in the age structure of the global population can affect savings behaviour over time. Consumption is fairly stable over the life cycle, but income is hump-shaped, so people of working age are those who tend to save the most (**Chart D2**). Consequently, the greater the proportion of the population that is of working age, the higher the desired level of saving in aggregate is likely to be. Equivalently, the lower the proportion of dependents (those not of working age), the higher desired saving will be (all else equal).[23]

This simple intuition is visible in cross-country data on national saving rates over time (**Chart D3**). There is a negative relationship between the dependency ratio (defined as the proportion of the population not of working age) and national saving rates: every 1pp fall in the dependency ratio translates to around a 0.5pp rise in national saving rates. This relationship is stable through time, suggesting it is robust and can be used to calibrate the ex-ante shift of desired saving caused by demographic changes at the global level.

[23] In our analysis we focus on the flow adjustment to changes in the demographic structure of the population: changes in the flow of desired saving (and the resulting changes in the flow of actual investment). But the impact of ageing population could also come through stock channels, for example if the ageing owners of assets reallocate their portfolios, perhaps away from equities and into fixed income.

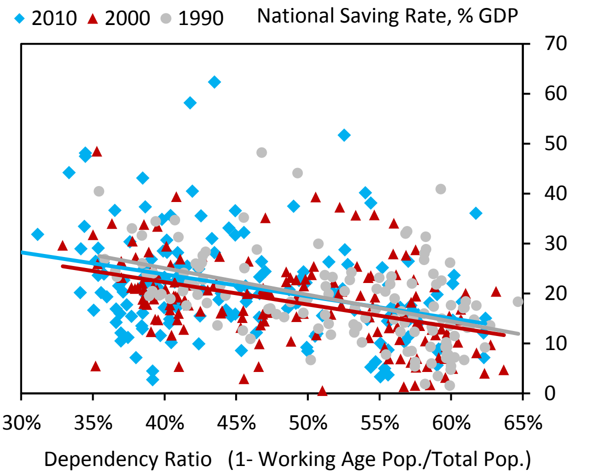
Chart D2: Consumption & income over the life cycle



Source: National Transfer Accounts.

Note: The charts shows data for 23 advanced and emerging economies; the swathes illustrate the observations for 25th-75th percentiles of the distribution.

Chart D3: Saving rates and dependency ratios

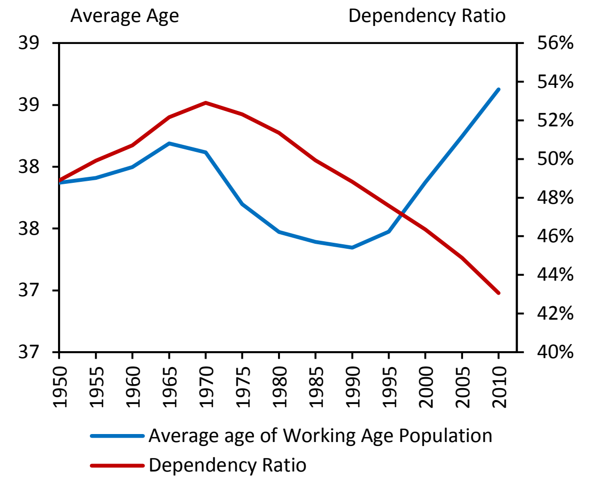


Sources: IMF WEO and UN Population Statistics

Note: The scatter plot shows cross-country values of dependency ratios and saving rates for three different decades. Working-age population is defined simply as those aged 20-65.

Over the past 30 years the proportion of dependents has fallen from around 50% of the global population to 42% (red line, **Chart D4**). The main driver of this decline has been a fall in the proportion of young dependents – reflecting the slowdown in demographic growth discussed earlier (**Section C**, Part II). This effect has more than offset the gradual rise in the proportion of old-age dependents linked to ageing societies (**Chart D5**). Using the estimated cross-country relationship from **Chart D3**, the 8pp fall in the global dependency ratio translates to a 4pp rise in desired savings, for a given real interest rate.

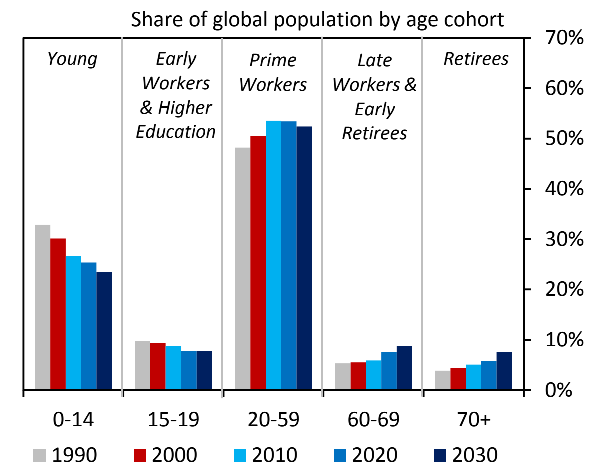
Chart D4: Projections for global ageing & dependency



Source: UN population projections

Notes: The dependency **ratio** is defined as the proportion of the global population that are not of working age (working age = 20-65 years old)

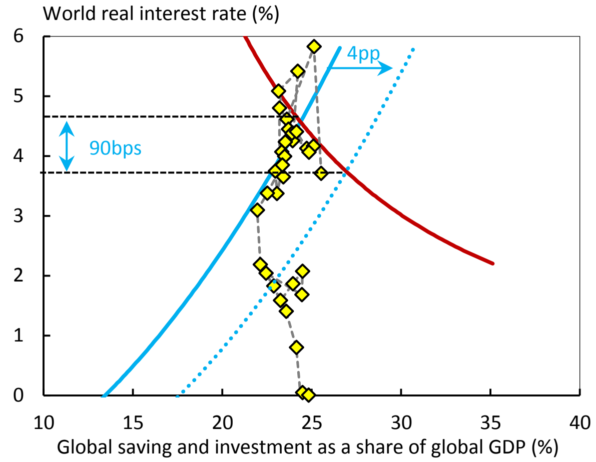
Chart D5: Shifts in global age distribution



Source: UN population projections

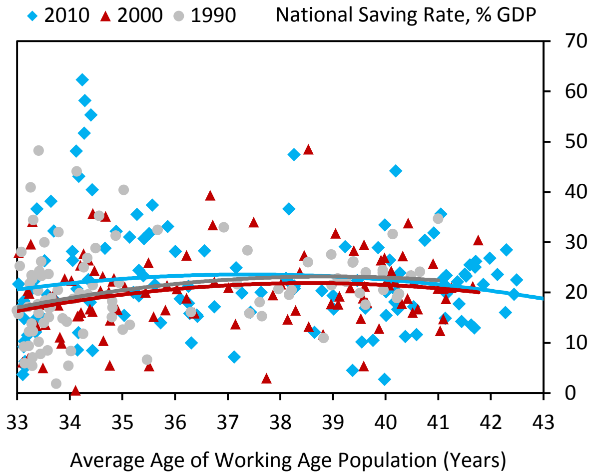
The 4pp rise in desired saving can be illustrated by a rightward shift in the saving schedule (**Chart D6**). The effect on the global real rate can then be easily read off the y-axis of the chart by comparing the two intersection points. This suggests that the impact of the fall in the dependency ratio has been to lower real rates by around 90bps.

Chart D6: Shift of the desired saving schedule due to changes in the composition of the global population



Sources: IMF and [King & Low, 2014](#) and Authors' calculations

Chart D7: Cross-country relationship between saving rates and average age of working population



Sources: UN population projections and IMF WEO

Note: The scatter plot shows cross-country values of national saving rates and the average age of the working-age population for three different decades. Working-age is defined as those aged 15-70.

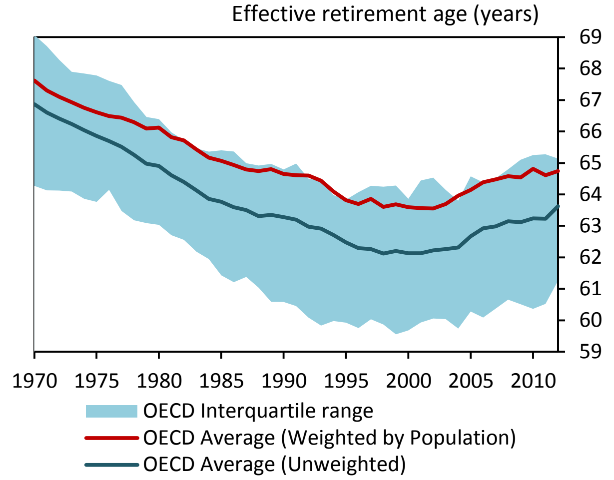
Aside from changes in the global dependency ratio, changes in average age of the working-age population may also shift desired saving. This is because over their working lives, individuals' saving rates tend to rise up to a certain age (**Chart D2** suggests around 40 years old) and then decline beyond that. So we may expect a hump-shaped relationship between average age and saving. **Chart D7** shows an attempt at estimating such relationship. Unlike the relationship between dependency ratios and saving rates, this one is not very robust.[24] And even if taken literally, it suggests that this 'average age' effect is insignificant. The average age of the world's working population has risen from 37.5 to 39 between 1980 and 2015 (**Chart D4**), which would translate to only a slight rise in desired saving, of between 0 to 0.35pp according to the relationship in **Chart D7**. This is a second order effect compared with the 4pp shift due to the 'dependency ratio' discussed above, and does not matter quantitatively for our analysis.

Overall, demographic forces, which have reduced the number of dependents per worker, are likely to have pushed up on desired saving rates, accounting for around 90bps of the fall in global real rates we have seen over the past 30 years or so.

The future of demographics: Looking ahead, the dependency ratio is likely to stop falling or even rise as a growing share of the world's population enters retirement age (**Chart D5**). At face value this suggests that the effects of demographics on desired saving and hence real rates could reverse. But the extent of this reversal is uncertain. Two factors that may limit the extent of the reversal are increases in retirement ages and longevity. Effective retirement ages across countries have been increasing gently over the past 15 years (**Chart D8**). This trend largely reflects changes in old-age participation rates rather than official retirement ages, which have been fairly static. If this trend continues, the average retirement age across the OECD could reach 67 by 2030 – enough to halt any uptick in the dependency ratio (**Chart D9**). In addition, an increase in longevity over and above this increase in retirement age may mean that people of working age choose to save a larger share of their income to fund a longer retirement – temporarily pushing up on saving rates. These two factors suggest that there could be little-to-no reversal of the impact of demographic forces on global real rates in the years ahead.

[24] The relationship is not stable across time, and holds only if we assume that 'working age' is defined as between 15 and 70 – somewhat at odds with standard definitions.

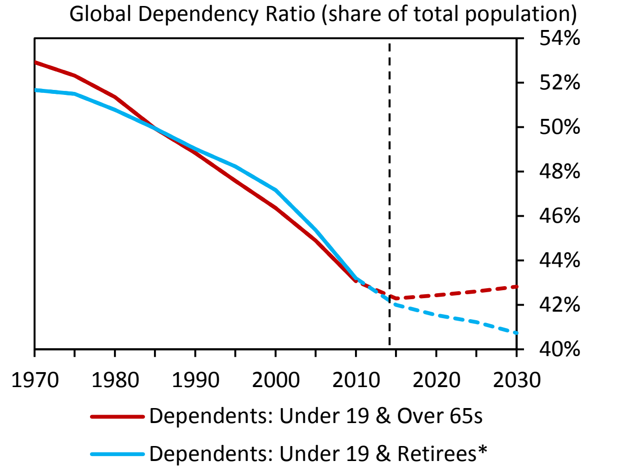
Chart D8: Effective retirement ages in OECD economies



Sources: OECD & UN Population Statistics.

Notes: The OECD use information on participation rates of older workers to work out their effective age of retirement, independent of government-defined retirement ages.

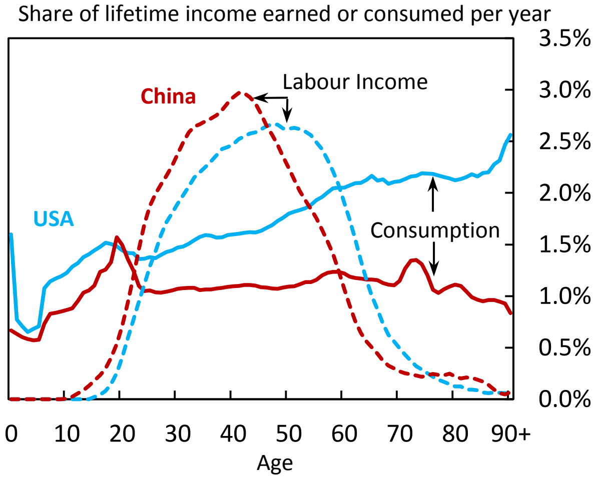
Chart D9: Dependency ratio adjusted for rising retirement age



Sources: OECD, IMF WEO & UN Population Statistics

Notes: The retirement age in the blue line is allowed to vary over time in line with the OECD's data. Between 2010 and 2030, the global retirement age is assumed to rise by one year per decade.

Chart D10: Consumption and income patterns in the US and China



Source: National Transfer Accounts

On the other hand, the shifting composition of dependents from young to old could mean the reversal is larger than suggested by simple dependency metrics. Old age dependents can have much lower net saving rates than young dependents because of the distinct pattern of consumption over the life cycle. **Chart D10** illustrates this effect using data from the National Transfer Accounts. In advanced economies (such as the US), consumption tends to drift up in retirement, particularly in the last few years of life.[25] This is driven largely by greater consumption of healthcare (hospitalisation, emergency procedures, etc.).[26] So in advanced countries, a rising share of retirees will have a disproportionately large *negative* effect on desired saving – implying a faster turnaround in the impact of demographic trends on desired saving globally compared to the simple dependency ratio metrics. To quantify this effect, we use a more nuanced measure similar to the dependency ratio, but which takes into account income and consumption patterns over the life cycle. Lee and Mason (2011) are pioneers in this area of research. They define the 'support ratio' as the *effective* number of producers divided by the *effective* number of consumers, which takes into account differences in income and consumption across the life cycle.[27] Goodhart (2014) presents similar measures for the 18 largest advanced and emerging economies.

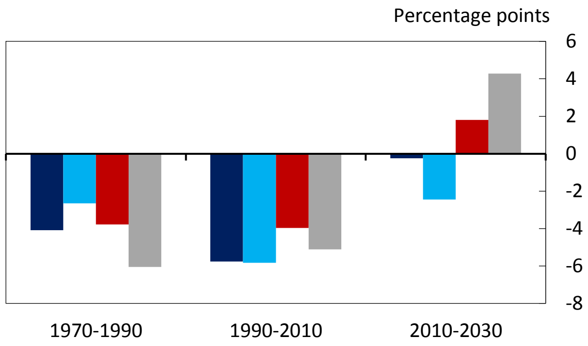
[25] The National Transfer Accounts record total consumption of resources by an individual over their life cycle (i.e. personal consumption plus consumption of public services) and total income (i.e. wages, capital gains and transfers).

[26] This stands in contrast to a more flat pattern in developing world (e.g. China).

[27] A detailed description of these data is available in the NTA Manual 2013: The effective number of producers is a measure calculated to incorporate age-variation in labour force participation, hours worked, unemployment and productivity by using the estimated labour income profile. Similarly, the effective number of consumers takes into account the variation in the consumption profile across the life cycle.

Chart D11 shows how these measures of the support ratio compare to simple measures of the dependency ratio (shown in blue). The PPP-weighted Lee and Mason (2011) measure, in red, is the most comprehensive in terms of global coverage. In line with our findings, changes in this support ratio matched movements in the dependency ratio over the past 40 years – the blue bars and the red bar have been similar up until 2010. This suggests that the shifting composition of dependents has not been an important factor thus far. But the future looks quite different. Unlike the simple dependency ratio metrics, the support ratio looks set to turn around more quickly.[28] This effect is even starker when the analysis is restricted to a narrower set of large countries – as in Goodhart (2014) (as shown by the grey bars, **Chart D11**).

Chart D11: Comparison of the changes in dependency ratios and the support ratio



Sources: UN, OECD and National Transfer Accounts

Note: The most comprehensive, and most informative, is the updated measure from Lee and Mason (2011) which weighs together data for 175 countries using PPP weights (the yellow bar). The orange bar shows the simple average of 18 large economies listed in Goodhart (2014).

To sum up, there is clearly a great deal of uncertainty over the impact of demographic forces on desired saving over the future. On balance, we think that the PPP-weighted support ratio measure provides the best steer. Consequently, we judge that the demographic effect on rates will gradually reverse, though not as sharply as some commentators suggest. ***Quantitatively, the reversal of the demographic effect over the next 20 years is likely to be about half that of the downward drag on real rates over the past 20 years, although of course such predictions are very uncertain.***

Trend 2: Rising Inequality

Impact over the past thirty years: Changes in the distribution of income can affect desired saving because the rich and poor tend to save different proportions of their income. To the extent that the rich save more, rising inequality will result in lower consumption, higher desired saving, and hence a lower equilibrium real rate.[29]

Empirical evidence supports the notion that the rich do save more, although the range of estimates available is relatively limited and primarily covers the US.[30] The seminal contribution is by Dynan et al (2004), who show that average saving rates and marginal propensities to save tend to rise with the level of income (**Chart D12**). This is confirmed by more recent evidence: for example, Cynamon and Fazzari (2014) show that the richest 5% save much more than the rest (with saving rates around 3 times as high), and Saez and Zucman (2014) give a long-run perspective on the high saving rates of the wealthy (**Chart D13**).[31]

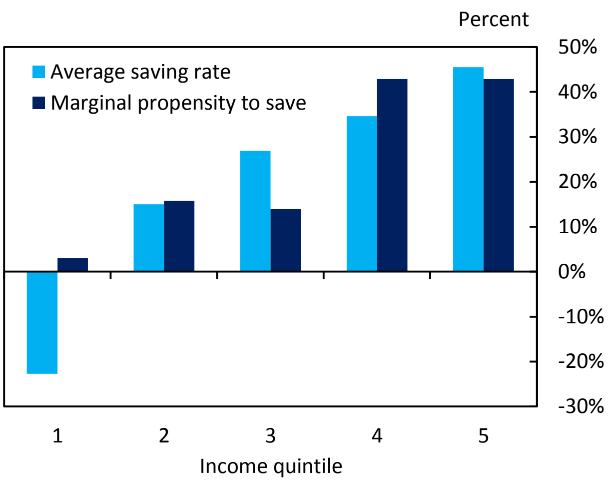
[28] Notably, the focus on the largest countries only delivers the sharpest turnaround (Goodhart (2014)).

[29] This general mechanism has been incorporated in recent models, e.g. in Eggertsson and Mehrotra (2014) and Kumhof et al (2015).

[30] Crossley and O'Dea (2010) provide a UK perspective.

[31] See Carroll (2000) for theoretical explanations of this empirical result.

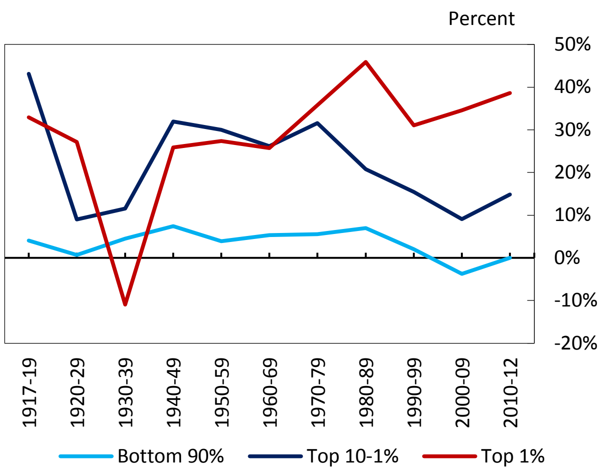
Chart D12: Saving rates by income quintile



Source: *Dynan et al (2004)*

Note: Estimates are for the US.

Chart D13: Saving rates by wealth percentile

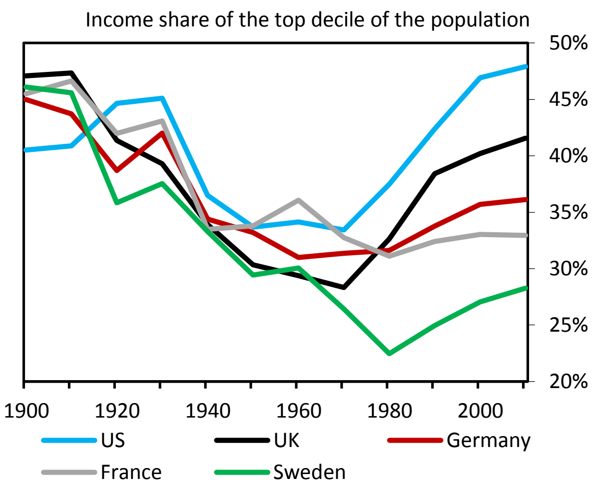


Source: *Saez and Zucman (2014)*

Note: Estimates are for the US

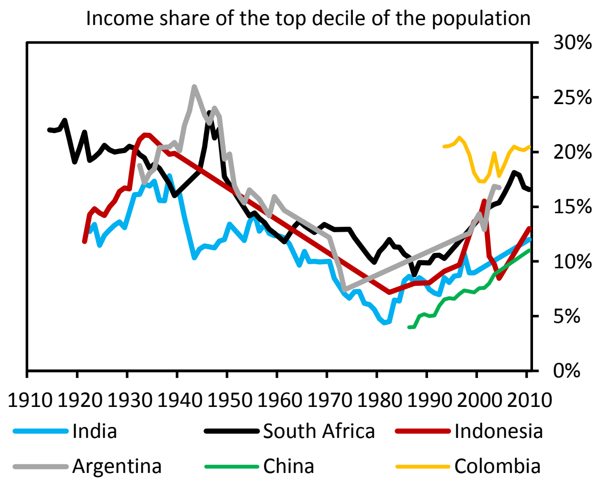
Two global trends have taken hold since the 1980s: inequality between countries has fallen because developing countries, particularly those in Asia, have been catching up on their Western peers (**Chart C8**); but at the same time income inequality within countries has been rising (**Charts D14 and D15**). The relationship between national saving rates and a country's level of development is not clear cut – for example, many Asian economies have very high saving rates despite having relatively low incomes. As such, it is less clear what impact the reduction in inequality between countries has had on global saving rates. By contrast, the relationship between individual saving rates and individual income levels within countries is better established. We therefore focus on calibrating the impact of this latter effect on desired saving rates globally.

Chart D14: Income inequality in major advanced economies



Source: *Piketty (2014)*

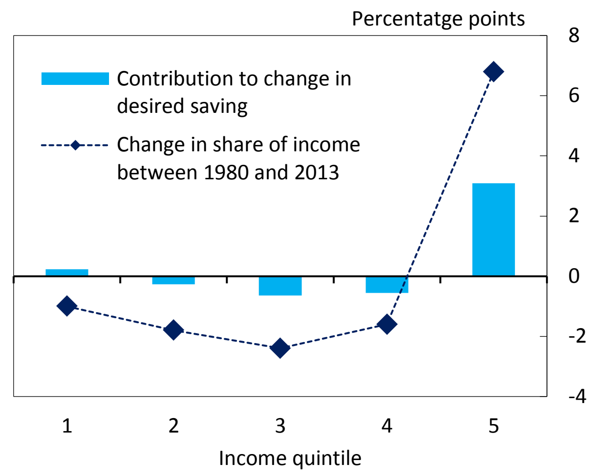
Chart D15: Income inequality in selected emerging economies



Source: *Piketty (2014)*

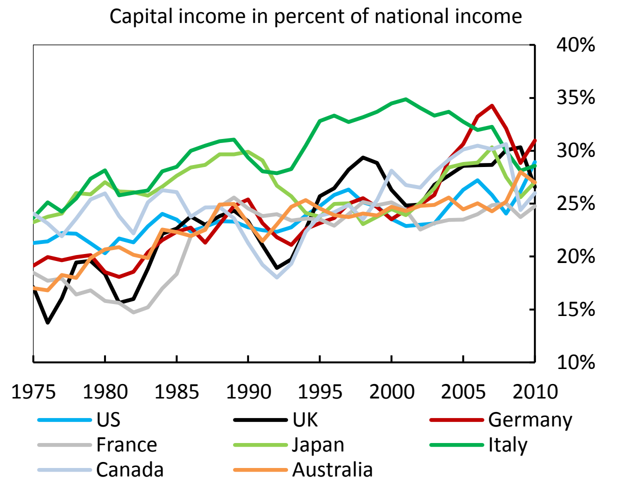
To isolate the effect of rising inequality within countries on desired savings, we perform a thought experiment using US data. First, we take the saving rates from Dynan et al (2004) for different income quintiles (**Chart D12**). Then we combine those saving rates with data from the US Census Bureau showing how income shares across the population have changed since 1980 (blue line, **Chart D16**). Over this period, the richest fifth of the population – who are also the keenest savers – have seen their share of national income rise by around 7pp. On average, this group saves an extra third of their income compared with the rest of the population, so this shift in the income distribution translates to a rise in desired saving of around 3pp (blue bars, **Chart D16**). Changes in the income distribution among the four lower quintiles of the population reduce this figure to a net rise of around 2pp in aggregate, but still suggests a substantial rightward shift in the desired saving schedule. An alternative calibration using data from Cynamon and Fazzari (2014), which is more crude as it relies on much less granular data (the top 5% of the income distribution versus the rest), delivers a very similar impact on desired saving (1.9pp). This shift is approximately half the size of the demographic effect highlighted above, and corresponds to a decline in the global real rate of around 45bps.[32]

Chart D16: Increase in inequality and contribution to the rise in desired saving



Sources: Dynan et al (2004), US Census Bureau and Authors' calculations

Chart D17: Capital shares across selected economies



Source: Piketty (2014)

Our assessment of the effect of inequality relies primarily on US data, which could overestimate the size of the effect at the global level, since the rise in inequality in the US has probably been a little larger than average. But there are also other reasons why inequality may have had a bigger effect on real rates than postulated above:

- The growing importance of capital income: Over the past 30 years, the share of global income earned from owning capital has risen as the labour share has fallen (**Chart D17**). Mechanically, this should push up on desired saving if the propensity to save out of capital income is higher than from labour income – as is often thought. A lack of empirical data on saving rates from these different sources of income prevents detailed analysis of this channel, but we note it as an upside risk.[33]

- Inequality between countries: As discussed above, inequality between countries has been falling as real incomes in the bottom two-thirds of the global income distribution have risen rapidly (**Chart D18**).

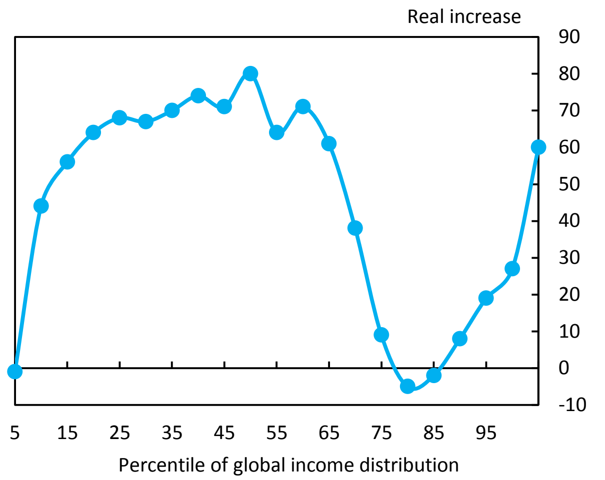
[32] One way of cross-checking this figure is to calculate the size of the monetary policy response that would be required to offset the fall in demand caused by higher saving (as a result of rising inequality). Using the policy multipliers from FRB/US and COMPASS (the forecast models of the Federal Reserve Board and the Bank of England) we find that policy rates would need to fall by around 40-50bps to close the output gap – the same ballpark as delivered by the S-I framework. An alternative cross-check is to use the model developed by Kumhof et al (2015), which explicitly shows the response of the real interest rate to the 'inequality shock'. The rise in inequality over the past 30 years would deliver a fall in the real rate of roughly 70bps in that model – somewhat larger than the 45bps estimated above. But this difference is unsurprising, given the more extreme calibration of saving preferences in the Kumhof et al (2015) model – the bottom 95% of income earners are assumed to save nothing at all.

[33] The idea of class savings – savings of capitalists vs savings of workers – was a key area of focus for economists in the 1960s (see for example, Pasinetti, 1962 and Kaldor, 1955 & 1966). But there is little empirical evidence measuring saving rates across these different income streams. Piketty (2012) and Bertola et al (2006) provide illustrations in which all labour income is consumed, and only capitalists save (with saving rate on capital income at 20%). Taking these illustrations at face value suggests that the fall in the labour share over the past 30 years would be associated with an increase in desired saving worth 1.2% of GDP (this result would hold as long as the saving rate for capital income is 20pp higher than for labour income). But we think this effect likely overlaps with the other income effect described in the main text.

The impact of this income shift on global saving depends on relative saving rates between lower-income countries who are catching up, and advanced economies. IMF data suggests that national saving rates in advanced economies and emerging economies were virtually identical up until the year 2000, so the effect on global desired saving of emerging markets catching up would have been negligible until then (**Chart D19**). But since 2000, saving rates in emerging markets have actually increased above those in advanced economies. This means that faster income growth in EMEs may have raised global desired savings.[34] We are cautious of including this effect separately as we think it is at least partly driven by cyclical factors and partly related to the EM savings glut story, which we discuss next. To avoid double counting we exclude it from our analysis.[35]

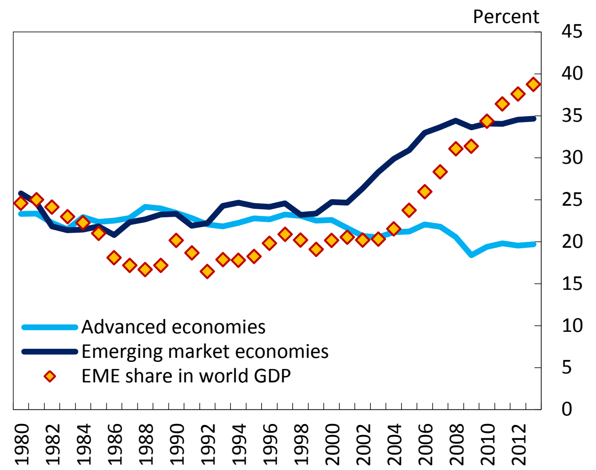
Overall, rising inequality within countries is likely to have pushed up global desired saving by around 2pp and hence account for around 45bps of the fall in the global real rate we have seen – around half as large as the effect from demographics.

Chart D18: Change in real income between 1988 and 2008 across the global income distribution



Source: Milanovich (2012)

Chart D19: Saving rates in advanced and emerging economies



Sources: IMF and Authors' Calculations

Inequality in the future: Most macroeconomic forecasts currently predict the emerging world to continue to catch-up on the advanced world, suggesting that inequality between countries may continue to fall. Although this effect appears to have had little bearing on global desired saving over the past, this need not necessarily be true in the future. For example, if saving rates in emerging markets fell below those in advanced economies, then falling inequality between countries would reduce global saving and unwind some of the effect highlighted above. A full analysis of such scenarios is beyond the scope of this paper. Instead, we choose to focus on the future of inequality within countries and how that affect global saving.

The future of within-country inequality will ultimately depend on policy. Piketty and Saez (2014) point out that "*inequality does not follow a deterministic process. In a sense, both Marx and Kuznets were wrong. There are powerful forces pushing alternately in the direction of rising or shrinking inequality. Which one dominates depends on the institutions and policies that societies choose to adopt.*" So any forecast of inequality will necessarily rely on heroic assumptions about inherently unpredictable political processes. That said, is may still be useful to consider the main *economic* forces that determine income inequality in the long-run, taking policies and political processes and institution as given.

[34] Buiter (2015) makes a similar point.

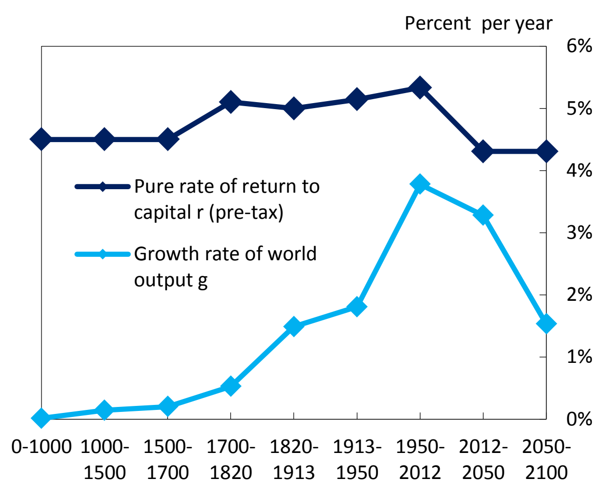
[35] Taken literally, the rise in EMEs' share in world GDP would mechanically push-up on desired saving by around 2% of world GDP. The effect is strongest since 2007. The pick-up is largely driven by China.

The most widely used model for analysing labour income inequality is based on the idea of a race between education and technology (Goldin and Katz, 2007). The basic intuition is more education leads to a rise in the supply of skilled labour, while technological change leads to a rise in the demand for skilled labour. If there is a relative shortage of high-skilled labour, because technological progress races ahead of educational attainment, then inequality is likely to increase as those with the sought-after skills will tend to see their earnings rise relative to the rest of the population. In this context, the recent rise in the cost of education (see **Chart C13**), if not tackled by policy, could potentially represent a rise in inequality of opportunity that may limit educational attainment and hence increase income inequality, probably with a long lag. This mechanism could be further strengthened if the latest technological advances not only increase the demand for skilled workers, but also replace low-skilled jobs – Frey and Osborne (2013) predict that 47% of US employment may be subject to computerisation over the next 20 years.

Other factors may also play a role. For example, further globalisation could make "winner-takes-all markets" more common, raising the share of income accruing to the global 'superstars'. Piketty (2014) also suggests that if the growth rate of labour income declines as global growth falls back (g), but the rate of return on capital (r) is maintained at its historic rate, then inequality is likely to rise further (**Chart D20**).

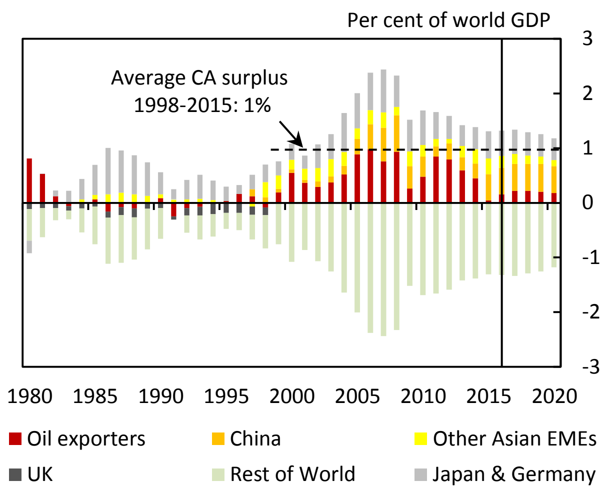
On balance, absent a major policy shift, we judge that labour income inequality is more likely to continue rising than to fall back in the years ahead, but the future path of inequality is very uncertain. Hence our treatment is cautious, assuming only a very gentle increase in inequality going forward.

Chart D20: Rate of return vs. growth rate at the world level, from Antiquity until 2100



Source: Piketty (2014)

Chart D21: Global imbalances



Sources: IMF and Authors' calculations

Trend 3: The emerging-market saving glut

Impact over the past thirty years: Following the Asian crisis in 1998, many emerging markets significantly increased their foreign exchange reserves as a precautionary measure against the future risk of destabilising capital outflows. In tandem, the era of high oil prices prompted an increase in saving among oil producers. Bernanke (2005) suggests these forces represented a preference shift by governments (in Asia), and a shift in circumstances (for oil exporters), that were largely exogenous to the global system. These preference shifts resulted in an increase in desired savings in those countries. To the extent that this increase was not matched by a rise in desired investment, it led to a net increase in global saving. On average, the current account surplus of Asian economies and oil exporters – indicative of the net amount of financial capital that those countries send abroad – has been 1% of world GDP since the late 1990s, around 1pp higher than the roughly-balanced current account pre-1998 (**Chart D21**).

Using the increase in emerging markets' current account surplus as a guide suggests the desired saving schedule has shifted to the right by 1pp as a result of the EM saving glut, which lowers the global real rate by round 25bps. This is only around half of the effect of inequality, and a quarter of the effect of demographics.

The future of imbalances: Bernanke (2015) discusses the future of the emerging market saving glut and concludes that the outlook is mixed. On the one hand, three factors suggest that these imbalances may have run their course: 1) some of the EMEs, particularly China, are rebalancing their economies away from exports toward domestic demand; 2) the buffer stock of FX reserves that emerging markets hold is already sufficiently large, and the build-up of foreign currency reserves is slowing and in some cases now falling; and 3) oil prices have fallen, so we might expect the excess savings from oil producers to decline further from pre-crisis peaks. On the other hand, there are also some new potential sources of the 'saving glut'. For example, Bernanke notes that Germany has the highest current account surplus in the world, and there is a concern this will persist, exerting further downward pressure on global real rates. But to us it is unclear whether Germany's surplus will act as an additional force, or has already been captured by other trends discussed in this paper. For example, if demographic concerns are the primary cause of high German saving, the effects would be captured in the demographic section above. By contrast, if high German savings are a by-product of permanently elevated levels of uncertainty facing German workers following the introduction of structural reforms in 2000s, it could represent an additional force, depressing global real rates even as EMs rebalance. Further research into the drivers of Germany's saving behaviour is warranted in this context.

Overall, we think that the IMF forecast for global imbalances – as shown in Chart D21 – is a reasonable baseline forecast, which suggests a very gradual unwind of the EM saving glut going forward.[36]

iii) Trends affecting the investment schedule

Overall, shifts in desired saving linked to the three trends above can account for around 150bps of the fall in global real rates since the 1980s. If this had been the whole story, we would have expected to see a steady rise in actual saving rates globally. But global saving and investment ratios have been remarkably stable over the past thirty years – as noted earlier. This suggests the desired investment schedule has also shifted. Here we focus on three trends that could potentially explain such a shift: the secular decline in the relative price of capital goods; a preference shift away from public investment projects; and an increase in the spread between the risk free rate and the return on capital.

Trend 4: The falling relative price of capital goods

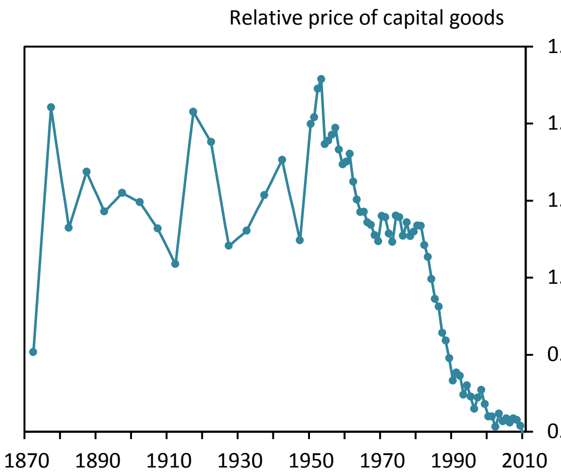
Impact over the past thirty years: Perhaps one of the most pervasive trends that may have affected desired investment expenditure is the 30% decline in the relative price of capital goods since the 1980s (**Chart D22**).[37] Cheaper capital means that a given investment project costs less to pursue, so investment volumes can be maintained by committing a smaller share of nominal GDP. But cheaper capital also incentivises additional investment projects, given the lower cost. The overall impact on capital expenditure is the sum of the two effects – its sign depends on the elasticity of substitution between capital and labour.

[36] As ever there is much uncertainty around this judgement. Indeed, others present compelling alternative forecasts for the future. For example, Speller et al (2011) perform long-run simulations of gross capital flows out to 2050 and predict persistently high current account surpluses in EMEs. They think that even as the Chinese current account shrinks, India's will rise and take over.

[37] IMF (2014a) has examined changes in the relative price of investment in the advanced economies since 1980. The Fund document a downward trend in the relative price of investment that then levels off in the early 21st century. In explaining this movement, the Fund points to the work of Gordon (1990), who emphasizes the role of research and development that is embodied in cheaper, more efficient investment goods.

If capital and labour are easily substitutable, a fall in the relative price of capital goods will induce a lot of additional investment projects, potentially by enough to counter the effect of falling prices and hence maintain investment as a share of nominal GDP. But most empirical work points to the elasticity being smaller than one.[38] The IMF (2014a), for example, asserts that any increase in the volume of investment caused by a decline in the price of capital goods has been insufficient to offset the negative impact on real interest rates. Thwaites (2015) surveys the literature and arrives at a similar conclusion. An elasticity smaller than one means that a fall in the relative price of capital goods will tend to be associated with a shift of the investment schedule to the left (desired investment expenditure is lower for a given interest rate).

Chart D22: Relative price of capital goods

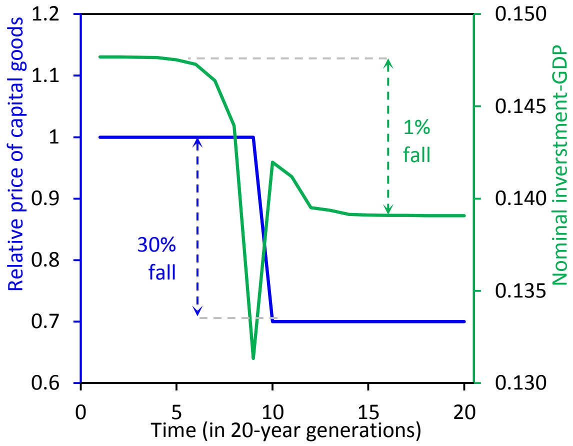


Source: Eichengreen (2015).

Note: Data show the relative price of capital goods compared with consumption goods for 11-now advanced countries.

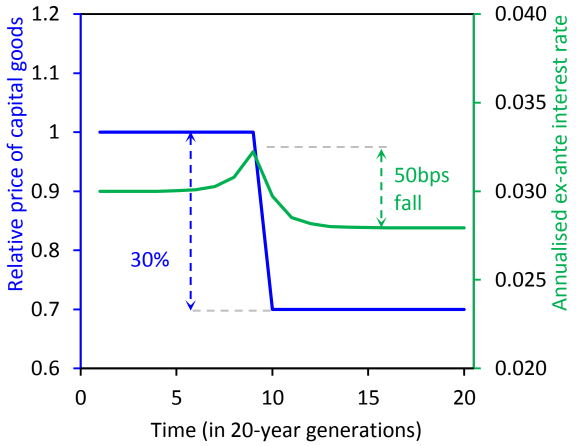
To calibrate the size of this shift, we rely on the model developed in Thwaites (2015). A 30% decline in the relative price of investment lowers the steady-state nominal investment-to-GDP ratio by around 1pp in that model (**Chart D23**). The fall in the relative price of capital goods also has an additional effect, which is to pivot the investment schedule (so that it becomes steeper), as any given amount of real investment now requires less of today's output to be sacrificed. In other words, the opportunity and financial cost of investment become a less important factor in making investment decisions. Desired investment becomes less sensitive to interest rates by roughly the same amount as the fall in relative price of capital goods.[39] **The 1pp shift in the investment schedule, together with a 30% drop in the elasticity of investment with respect to the interest rate, delivers around a 50bps fall in the real rate in the saving-investment diagram.** This is similar to the peak-to-trough fall in the interest rate along the transition path to the new steady state in Thwaites (2015) (**Chart D24**).[40]

Chart D23: Response of investment to a 30% decline in the relative price of capital goods



Source: Thwaites (2015)

Chart D24: Response of the real interest rate to a 30% decline in relative price of capital goods



Source: Thwaites (2015)

[38] Piketty (2014) is a notable exception.

[39] More formally, in the formulation of the user cost of capital, the weighted average cost of capital enters multiplicatively with the relative price of capital goods.

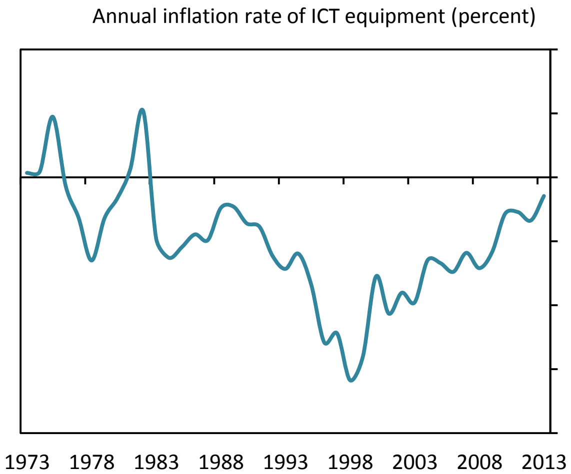
[40] The paper argues that the initially positive response of the interest rate matches what has happened in the real world in the 1970s, when real rates were increasing. Since we are trying to explain the fall in real rates since the 1980s, it is appropriate to compare the decline in the real interest rate since the peak.

The future of capital goods prices: The future of capital goods prices is still being hotly debated and no clear consensus has yet emerged. Eichengreen (2015) argues that further falls are not guaranteed: *"Evidently, R&D is not embodied more easily and fully in investment goods than consumption goods in all times and places. The presumption behind "*the Baumol effect*" – that consumption goods, and in particular that portion provided by the service sector, are difficult to mechanize and therefore become relatively more expensive over time – may not hold in the future as it has in the recent past. Even if the post-1980 decline in the relative price of investment goods is part of the explanation for the concurrent decline in real interest rates, there is no ruling out that it may be reversed in the future."* Others have also noted that the relative price of capital goods has stabilised more recently, taking this as evidence that the ICT revolution has run its course (**Chart D25**).

On the other side of this debate, researchers at the Federal Reserve (Byrne et al, 2013) believe that the price of ICT equipment has been persistently mis-measured. In their view, statisticians struggle to capture the higher capability of the latest technologies such as quad-core processors. Byrne et al's quality-adjusted estimates suggest that microprocessor prices continue to fall at a rate of around 30% a year (**Chart D26**). Furthermore, Thwaites (2015) argues that the effect on real rates can build for a long time even after capital goods prices stop falling.

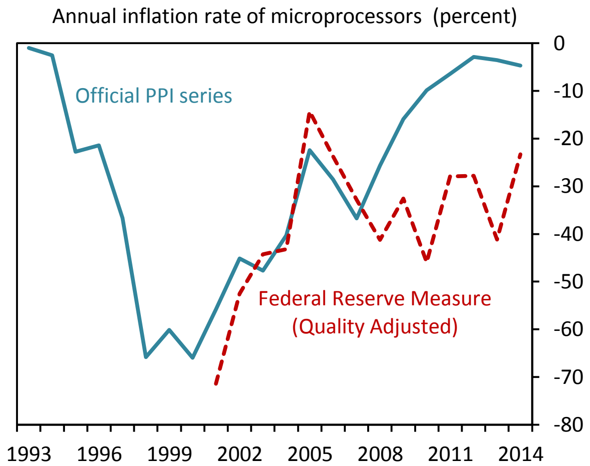
Overall, it seems reasonable to assume some further contribution from the decline in the relative price of capital goods to lower rates, albeit at a diminished magnitude compared with the past.

Chart D25: Price deflator for US ICT investment



Sources: Gordon (2014b) and Bureau of Economic Analysis

Chart D26: The price of microprocessors in the US



Sources: Byrne et al (2013) and Bureau of Economic Analysis

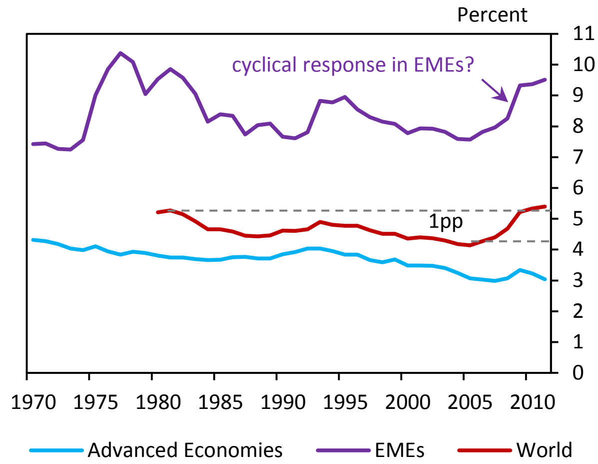
Trend 5: Lower public investment

Public investment has been on a declining trend as a share of global GDP since the 1980s (see IMF, 2014b). Assuming this trend is independent of the others highlighted above, it begs the question what factors could have driven the fall. One possibility is that there has been a preference shift. This could be because political views have become more polarised, thus making it difficult to agree and implement large-scale public investment projects. Or it may be because voters have shifted their preferences away from large governments. Either way, the result of this shift has been to lower the global investment-to-GDP ratio by around 1pp between 1980 and 2007 (**Chart D27**). Since then, public investment in emerging economies – particularly China – has accelerated rapidly, unwinding this long-term decline. However, we think much of this recent pickup is a cyclical response to weakening demand during the Global Financial Crisis. We therefore expect this to reverse and the downward secular trend to eventually reassert itself.

Consequently, we think lower public investment has shifted the desired investment curve to the left by around 1pp, lowering real rates by around 20bps – a relatively small effect.

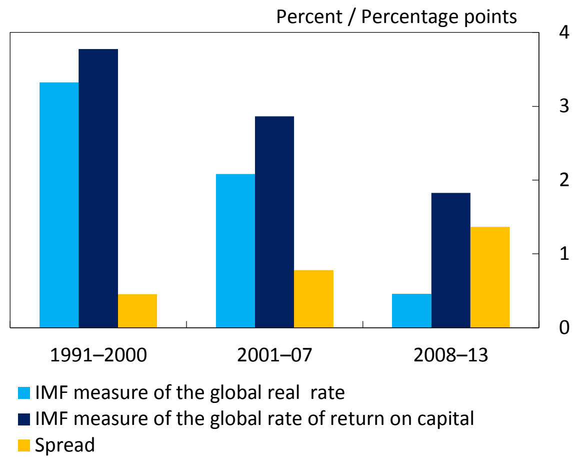
An alternative interpretation of the recent movements, is that higher public investment in EMEs is currently pushing up on the global real rate (relative to pre-crisis), and if that unwinds, the global real rate will fall further. The difference between these two explanations comes down to whether the shift away from public investment has already affected global rates, or whether this is still to come. In either case, given the size of the effect is relatively small, this channel is not a major driver of movements in the global real rate.

Chart D27: Public investment in advanced and emerging economies



Source: IMF (2014b)

Chart D28: IMF measures of the global risk free rate and rate of return on capital



Sources: IMF (2014a) and Authors' calculations

Trend 6: A rise in the spread between the risk free rate and the rate of return on capital

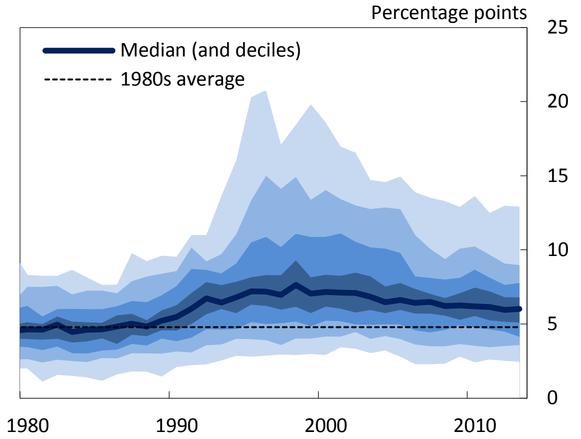
So far our analysis has abstracted from the fact that the interest rate that matters for firms' investment decisions is the rate of return on capital, not the risk free rate. Strictly speaking, when analysing desired investment, the rate of return on capital rather than the risk free rate should appear on the vertical axis of the S-I diagram. This distinction would not be important if the spread between the risk free rate and the return on capital had been constant over time – the desired investment schedule shown in this paper would represent a simple vertical transformation of the 'correct' schedule. However, there is some evidence that the spread has risen over time, which has implications for desired levels of investment. A rise in the spread shifts the desired investment schedule vertically down – because in order to keep desired investment unchanged, the risk free rate must fall by exactly the same amount as the spread has increased, all else equal. However, in general equilibrium all else is not equal, and a lower risk-free rates induce people to save less – suggesting the eventual decline in the risk free rate may be a little smaller than the rise in the spread. Empirically, there is no single measure of the spread between the rate of return on capital and the risk free rate, so we consider a range of measures:

- Bank credit spreads: The difference between bank deposit and lending rates;
- Fixed income spreads: The difference between yields on corporate and government bonds;
- Equity market spreads: Earning yields minus government bond yield.

The IMF construct a weighted measure of the spread across these measures for the world as a whole (**Chart D28**). This shows that ***the rate of return on capital has fallen since the early 1990s, but not by as much as the risk free rate – the spread has increased by around 100bps.*** Market-by-market analysis supports this conclusion.

Bank Credit Spreads: Chart D29 shows the spread between bank lending and deposit rates for over 120 countries.[41] There is a high degree of heterogeneity, with a clear upside skew in the distribution. But the median spread provides a relatively clear steer, increasing substantially between the 1980s and 1990s, and then edging gently downward. Currently the spread is around 120bps above its 1980s average – in the same ballpark as the 100bps calibration based on the IMF analysis above.[42] More detailed analysis for individual countries can be used to cross-check these findings. For example, **Chart D30** shows the spread between interest rates on consumer lending in the US and the federal funds rate. The spread is quite cyclical, with swings of around 4pp quite common. But taking a longer-term view, we see that over the course of the past three decades, the spread has drifted up by a touch over 100bps since the 1980s – again, broadly supportive of the calibration based on the IMF's measure of the global rate of return on capital.[43]

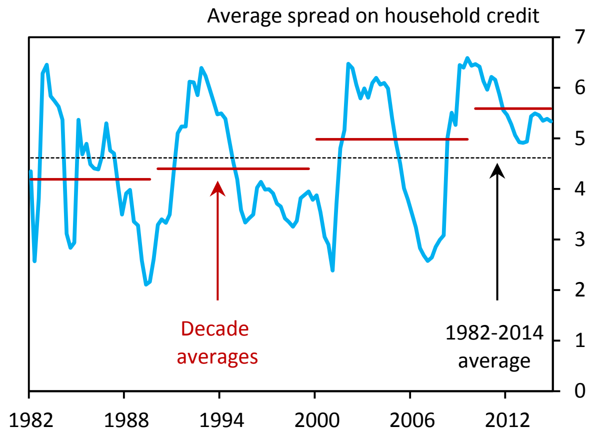
Chart D29: Spread between bank lending and deposit rates



Sources: IMF IFS via World Bank and Authors' calculations

Note: The interest rate spread is the interest rate charged by banks on loans to private sector customers minus the interest rate paid by commercial or similar banks for demand, time, or savings deposits. The swathe covers 80% of the distribution, but excludes some outliers which the spread appears implausibly high (thousands of percentage points).

Chart D30: Spread between the weighted average of consumer borrowing rates and the FFR



Sources: Federal Reserve and Authors' calculations

Note: The series weights together car, personal and credit card loans, plus mortgages, according to their share in borrowing.

Fixed income and Equity Spreads: Turning to market-based measures, **Chart D31** shows the long-run evolution of real yields on three types of asset in the US: government bonds, a mid-risk corporate bond, and a broad equity index.[44] **Chart D32** plots the two associated spread measures – the fixed income spread and the equity spread. Again these measures are quite noisy, but decade averages show that spreads tended to fall during the 1970s and 1980s, reached a record low in the 1990s, but have picked up since by a little over 100bps. Again, this is broadly consistent with the IMF calibration.

Overall, data across a variety of countries and markets supports the conclusion that the spread has increased by around 100bps since the 1980s, which corresponds to a downward shift in the desired investment schedule and a fall in the risk free real rate of around 70bps. Predicting how the spread will evolve going forward is difficult, and is linked to the regulatory landscape among other factors. A detailed analysis is beyond the scope of this paper, but assuming that spreads will stay constant from now on is probably a fair reflection of the regulatory landscape post-crisis. ***We assume no further impact from spreads on global risk free rates in the future.***

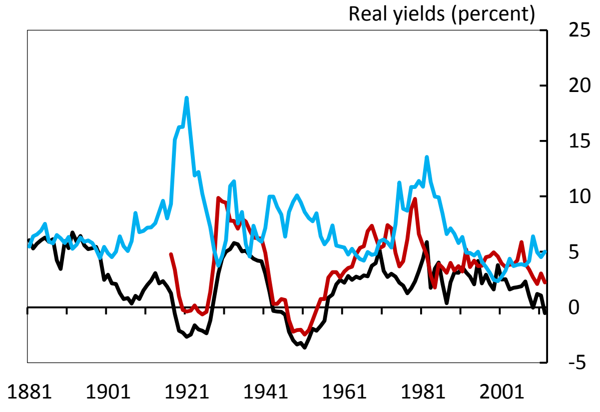
[41] A degree of caution is required in making comparisons across countries as the terms and conditions attached to these lending rates differ.

[42] An important caveat to this analysis is the impact of quantity restrictions, or rationing, on credit spreads: if credit was freely available only to the highest-quality borrowers in the 70s and 80s, it would be natural to see the spread rise in the 1990s as banking expands to include loans extended to riskier borrowers.

[43] One caveat here is that spreads in the banking system are quite short-term, and so caution is needed to infer the implications for the long-term spreads and rates.

[44] Cross-country data over longer sweeps of history are hard to come-by; but the US provides a useful illustration.

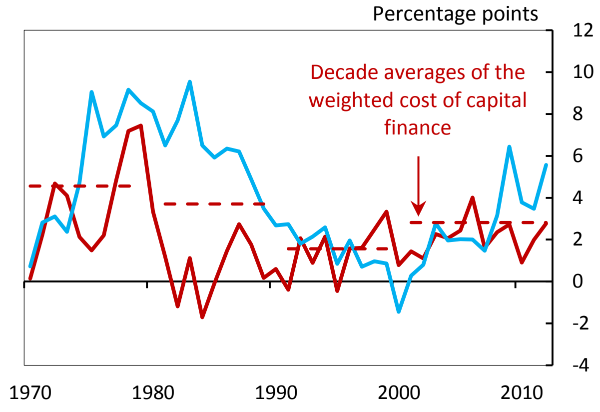
Chart D31: Real yields in the US financial markets



Sources: Robert Schiller, DataStream, FRED and Authors' calculations

Note: Earnings and dividends yields are cyclically adjusted using the Schiller method. Real yields are obtained by subtracting average of the CPI inflation rate over the preceding 10 years from nominal yields. The corpoorate bond is BAA-rated.

Chart D32: US capital markets spreads



Sources: Robert Schiller, DataStream, FRED and Authors' calculations

Note: the decade averages assume a 50:50 weight of equity and bond finance.

iv) Desired savings & investment and real interest rates – a summary

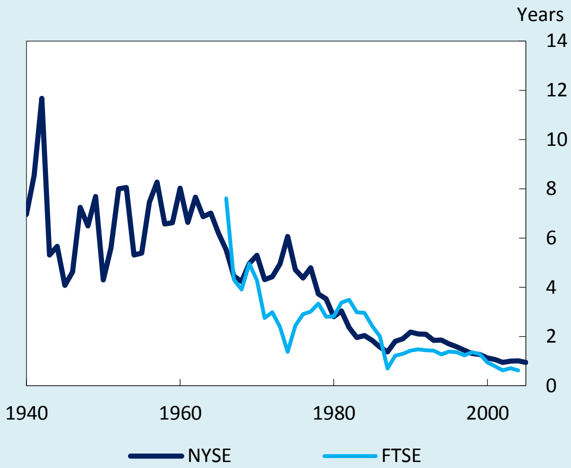
Together, the three investment trends highlighted above account for around 150bps of the fall in real rates seen since the 1980s – a similar order of magnitude to the effect from the three savings trends highlighted earlier. **Section E** brings together these effects along with the growth analysis from **Section C** to summarise the overall impact on global real rates. However, before moving on, it is worth highlighting the wide bands of uncertainty around these estimates. One particular source of uncertainty, highlighted in **Box D2** below, relates to other secular trends that we have either failed to identify or as yet are unable to quantify. Such trends could potentially have a key bearing on the future path of real rates.

BOX D2: What secular trends might we be missing?

The aim of the above analysis has been to bring together the impact of a number of different secular trends on global real rates using a single unifying framework. This has allowed us to compare the relative sizes of each effect and their combined importance in explaining the fall in global real rates. But other trends, which we haven't analysed above may also be important drivers of real rates. Some of these are 'known unknowns' – trends that we are aware of, but have so far been unable to quantify. We elaborate on two of these below – rising short-termism among firms' managers and investors, and a shift in production towards less capital-intensive sectors. Both could have plausibly shifted the desired investment schedule down and exerted further downward pressure on global rates over the past thirty years, but we don't yet know by how much. There is also uncertainty about other trends that economists (including ourselves) haven't yet identified. By definition, it is impossible to know what these other trends may be, but we can speculate that they might be triggered by a significant technological breakthrough or a major political shift. As ever, policymakers need to be alert to these 'unknown unknowns' as they could have a material bearing on the path for global real rates in the future.

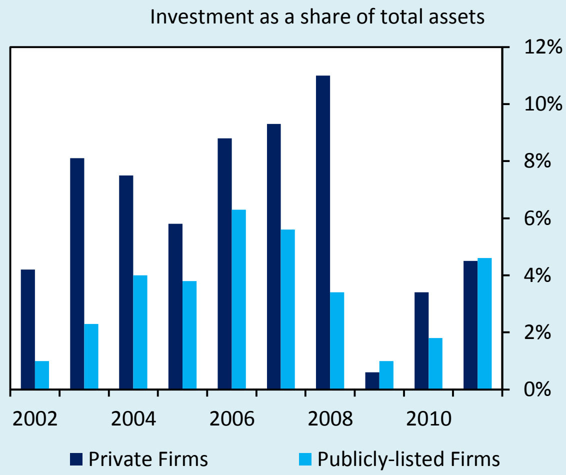
Rising short-termism: By its nature, investment requires forward planning. So a rise in short-termism – defined as heightened discounting of the future – is likely to cause the desired investment schedule to shift inwards. Haldane (2011) and Davies et al (2014) have formalised the notion of short-termism and presented some empirical work suggesting it has been on the rise. Haldane's measure of short-termism increased through the 1990s and remained high in the first half of 2000s. Anecdotally, this effect is supported by the decline in stock holding periods observed in much of the world (**Chart D2.A**). A recent study by Asker et al (2014) finds a strong link between investment and company ownership status (**Chart D2.B**). The authors argue that ownership status proxies for short-termism – intuitively, companies listed on stock exchanges face more short-term pressure (from asset managers and investors), compared to privately-held firms (which are held by a smaller group of individuals and for longer period of time). This would suggest short-termism may be holding investment back.

Chart D2.A: Average holding period for stocks in the US and the UK



Source: NYSE and LSE

Chart D2.B: Average investment level in otherwise identical private and publically listed firms



Source: Asker et al (2014)

Note: The study uses US data to compare investment levels in publicly-listed firms with privately owned firms, controlling for industry characteristics, firm size and other firm-specific characteristics.

Some economists argue that the rise short-termism is a direct consequence of shifting incentives for firms' managers. Smithers (2015) postulates, for example, that the rise of the bonus culture and pay incentives at the managerial level may have led to an excessive focus on short-term results, hurting investment and longer-term growth. Benabou and Tirole (2013) make a related point in a rigorous academic setting.

Some have suggested that increased buybacks is also a symptom of rising short-termism. Taking the United States as an example, we can perform illustrative back-of-the-envelope calculations of the potential size of this effect.[45] Such calculation suggests that the *upper bound* that short-termism could have had on desired investment would be a leftward shift of around 4pp, reducing real rates by around 80bps. However, because the assumptions underlying these calculation are extreme, the actual effect is almost certainly *much* smaller than that. More data and further work is needed to assess the size of this effect more precisely.

Shifting capital intensity of production: An even less explored trend that could be particularly important in the future is the effect of economic activity shifting towards less capital intensive sectors. Since different sectors have different desired capital intensities, aggregate investment rates will shift as the sectoral composition of the economy evolves. There are two aspects to this effect. First, shifts across the traditional sectors of the economy – away from manufacturing and towards services, for example – can change aggregate desired investment. Second, the shift towards software and the digital economy may mean that large swathes of economic activity may require little-to-no capital at all. Some commentators, such as Summers (2013), have highlighted the shifting structure of the economy – toward high-value, low capital intensity firms (such as WhatsApp) as an anecdotal sign of a reduction in the need for capital investment. Again, more research is required to understand the impact of these shifts on desired investment levels and global real rates. However, high-quality data that would enable us to shed light on this issue appears to be limited at the moment.

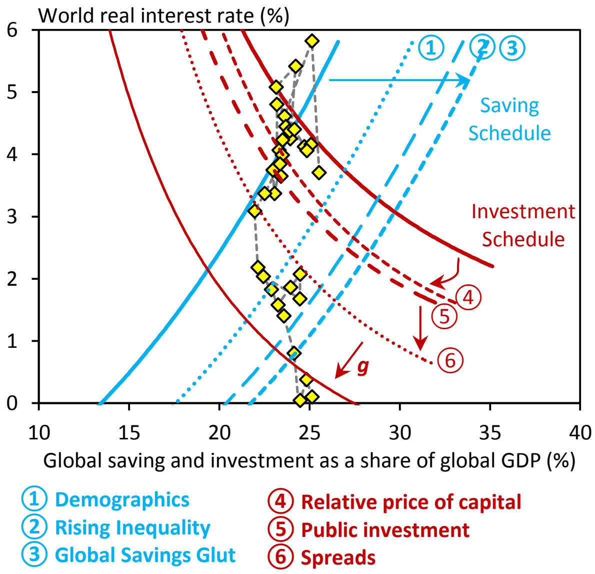
[45] This calculation makes three extreme assumptions, hence we think this is likely the upper bound: (i) The US case is representative for the world as a whole; (ii) all of the trend increase in share buy-backs has been caused by a rise in short-termism; and (iii) absent the rise in short-termism pressures, cash flow would have been spent on investment.

Section E: Explaining the fall in real interest rates

When combined, lower expectations for trend growth and shifts in desired savings and investment can account for around 400bps of the 450bps decline in global real rates seen over the past 30 thirty years. Moreover, these secular trends look likely to persist. This suggests that the global neutral rate is likely to remain low and may settle at or slightly below 1% over the medium- to long-term.

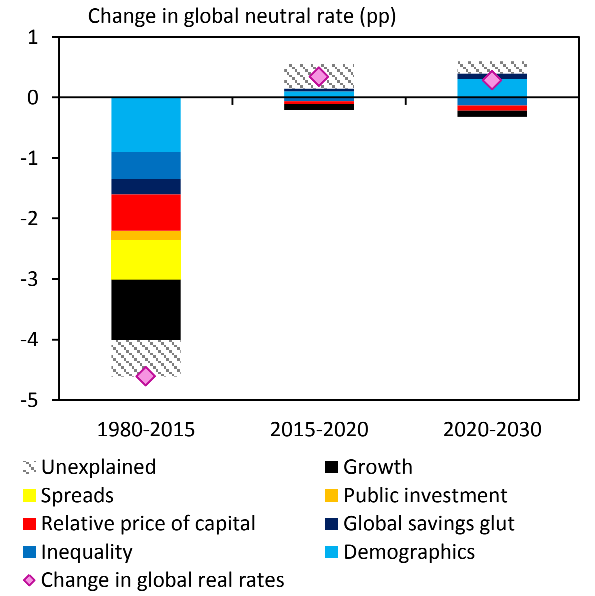
Sections C and D of this paper explored a number of global secular trends that could have had a material impact on the global neutral rate over the past thirty years. **Chart E1** brings together these trends using the savings and investment framework outlined in **Section D**. Our analysis suggests the desired savings schedule has shifted out materially due to demographic forces (90bps of the fall in real rates), higher inequality within countries (45bps) and a preference shift towards higher saving by emerging market governments following the Asian crisis (25bps). In addition, desired investment rates appear to have fallen as a result of the decline in the relative price of capital goods (accounting for 50bps of the fall in real rates), a preference shift away from public investment projects (20bps), and an increase in the spread between the risk free rate and the return on capital (70bps). Together these effects can account for 300bps of the fall in global real rates. We also include an illustrative shift of the desired investment schedule to account for weakening global growth prospects identified in **Section C** (labelled 'g' in the diagram). The shifts are arranged broadly in chronological order – the growth effect is the final shift in the diagram so as to link it to the most recent fall in real rates since the crisis. By contrast, the preference shifts identified in **Section D** above are more closely linked with the longer-term decline in real rates pre-crisis.

Chart E1: Quantifying shifts in desired savings & investment



Source: Authors' calculations.

Chart E2: Secular drivers of global real interest rates



Source: Authors' calculations

This savings-investment framework provides a broad description of the relative sizes of the different forces at play. The confidence interval around such estimates is clearly very wide, but taken at face value, shifts in preferences appear to explain around 300bps of the decline in real rates since the 1980s, on top of the 100bps explained by the deterioration in the outlook for trend growth. In other words, we think we can account for most of the decline in global real rates using evidence independent of the decline itself.

Around 50bps of the fall in real rates remains unaccounted for. This could reflect a number of factors. First, we might be missing certain secular trends from out analysis. As discussed in **Box D1**, rising short-termism and the decline in capital intensity of production could also be pushing down on real rates. Second, some of the trends we have quantified could be having bigger effects than we have estimated. Third, the unexplained component could reflect global headwinds from the financial crisis, such as deleveraging or heightened risk aversion, which are temporarily pushing down on real rates. Fourth, the market measures of real rates we are using, which are derived from government bond yields, may be distorted. As discussed in **Box B1**, post-crisis regulatory changes may have increased demand for safe government assets by financial institutions, while central bank QE has been temporarily boosting the demand for government bonds.

Even more difficult than accounting for the past is predicting what happens from here. **Chart E2** provides a summary of our findings, together with our best judgements about the direction of travel based on the discussions in this paper. The main message is that the trends we have analysed are likely to persist at their current level: we do not predict a big further drag, or a rapid unwind of any of these forces. Some are likely to drag a little further (global growth is set to decline further out, and we assume this will feed into slightly lower rates in anticipation; the relative price of capital is likely to continue to fall, albeit at a slower pace; and inequality may continue to rise); but this will be broadly offset by a rebound in other forces (particularly demographics). What happens to the unexplained component depends on what's driving it. In **Chart E2** we illustrate the effect of assuming it is largely cyclical. Despite this, our predictions still imply the global neutral rate will remain low, perhaps settling at or slightly below 1% in the medium- to long-term.

The policy implications of permanently low real interest rates are extensive and are discussed in detail in **Section F**. But before turning to them, we first offer two thoughts on how the above analysis could be usefully extended in the future. The first extension, is to use a regional perspective to shed light on the fall in global real rates. As discussed in **Box E1**, developed and emerging economies have exhibited different trends in savings and investment over time – future work could usefully explore the reasons for these differences to pinpoint the drivers of global real rates more precisely. The second dimension, outlined in **Box E2**, is to extend the analysis to acknowledge the central role of the monetary and financial sector in the global economy of today, by looking at monetary trends that could have affected the global real rate, such as a structural change in global liquidity. This could complement the analysis of real trends highlighted in this paper.

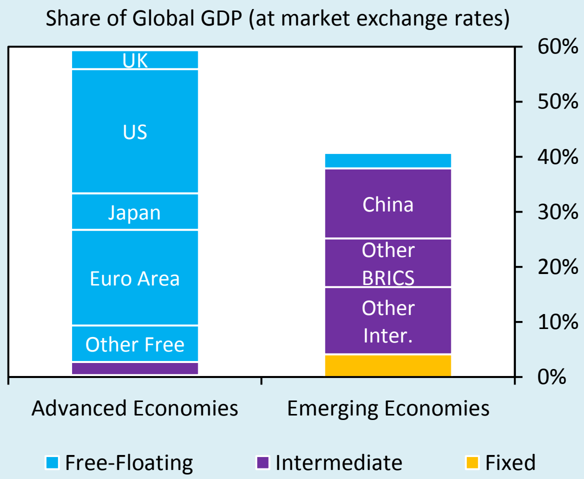
BOX E1: Regional perspective on global real interest rates

The main contribution of this paper is to provide a global perspective on the sustained decline in long-term real interest rates over the past thirty years. In Section A we argued that the common trend in real rates seen across countries is at least suggestive that global forces are at play. Consequently, we think it is logical to analyse real rates at the global level first, in order to gain a good understanding of the external forces shaping country-specific equilibrium real rates. However, this global perspective could usefully be complemented by regional analysis. Here, we offer a few thoughts as to why a regional perspective could help nuance our understanding of the secular drivers of global real interest rates.

In this paper we have implicitly assumed that the world economy can be treated as a single, integrated closed economy. But in reality, different regions of the world are not perfectly integrated with one another. Global factor markets are fragmented, so labour, capital and natural resources do not always flow freely across borders. Restrictions on these factor flows can create distortions in the global economy, which may affect long-term government bonds yields. One way to analyse the impact of these distortions on real rates is at the individual country-level – by first identifying the role that each country has played in driving certain secular trends and their impact on global real rates, then aggregating up the results across countries. However, given the vast number of countries involved and the complexity of the task, a less daunting approach would be to group similar countries together into a few large blocs. One potentially useful categorisation is to focus on differences between advanced economies (which, we tend to think of as being more economically and financially integrated) and emerging markets (which are in the process of integrating themselves into the world economy). Here we use this categorisation to highlight a few potentially important issues that might provide useful avenues for future research.

Managed exchange rates: Exchange rate regimes vary widely across the world. Exchange rates tend to float freely for most advanced economies, whereas over 90% of emerging markets still opt to fix or manage their currencies in some way (Chart E1.A). The presence of these managed exchange regimes can distort the flow of capital across borders and may partly be responsible for some of the secular trends we have identified. For example, the accumulation of foreign currency reserves by EMEs since the late 1990s, and the resulting 'saving glut', may partly be a result of EM governments defending their currency pegs.

Chart E1.A: Exchange rate regimes in 2013



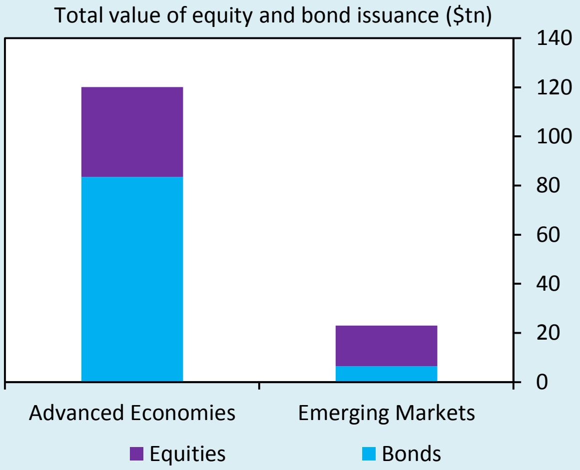
Sources: IMF AREAER 2013 and Oct. 2014 WEO

Notes: Fixed regimes include countries with no separate legal tender, currency boards and conventional pegs. Intermediate regimes include: crawling pegs, bands, and managed floats.

In addition, managed exchange rate regimes can affect the way country-specific shocks are transmitted around the world – potentially increasing the chance that some countries find themselves in a sub-optimal equilibrium. For example, if advanced economies collectively face a large negative shock and find they have insufficient policy space to stimulate the economy (partly because real rates are low) they may face a persistent shortfall of demand. In a world of perfectly flexible exchange rates, advanced economies would likely see their currencies depreciate against those in emerging economies, improving their competitiveness and helping to boost demand via export growth. This stabilisation mechanism could be sufficient to bring advanced economies back to full employment. However, with managed exchange rate regimes, such adjustments are more difficult – meaning that advanced economies could get trapped in a secular stagnation equilibrium – dragging down global trend growth in the process.

Missing markets: Another factor that may distort market measures of the global real interest rate is a lack of depth in some financial markets. The stock of bonds and equity issued by advanced countries dwarfs the stock issued by emerging markets by a ratio of 6:1 (**Chart E1.B**). Yet the distribution of global demand between advanced economies and emerging economies is much more balanced (a ratio of 3:2). This largely reflects the rapid pace of economic growth seen in emerging economies in recent decades. This rapid demand growth in emerging economies seems to have run ahead of financial deepening, which could have created excess demand for the existing stock of safe assets. This effect could be partially responsible for the fall in long-term government bond yields seen globally.

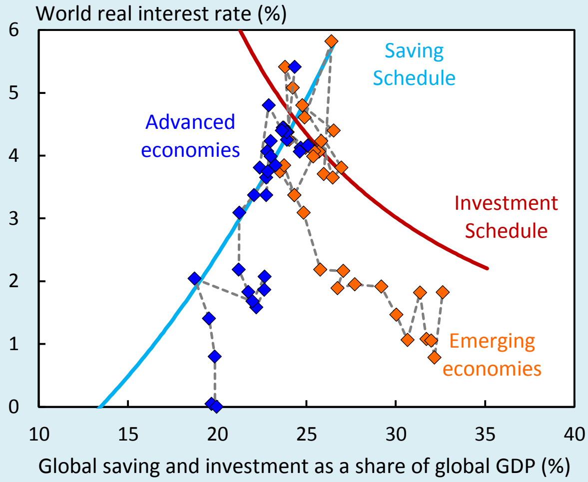
Chart E1.B: Total value of equities and bonds issued in EMEs relative to advanced economies



Sources: BIS & World Bank

Note: Figures are for 2012. Bond market coverage is limited, including 39 countries of which 13 are EMEs. Equity market coverage is better, including 109 countries of which 29 are deemed advanced economies.

Chart E1.C: The S-I diagram with AEs and EMEs



Sources: King and Low (2013), IMF and Authors' Calculations

Note: EME interest rate as in Chart A5 from 2003. Pre-2003 EM rate assumed to follow the global measure from King and Low (2013).

The Savings-Investment framework outlined in **Section D** can also be used to highlight the significance of these regional differences. **Chart E1.C** plots regional data in the S-I diagram for advanced and emerging economies separately. Real interest rates have fallen in both regions, but the two blocs exhibit quite different trends in saving and investment ratios, particularly since the late 1990s. At the global level, saving and investment ratios have remained remarkably stable, but among the country groups they have fallen in advanced economies and risen in emerging markets. This might suggest that a shift in the investment schedule has been more important in driving the moves in real rates in advanced economies, while shifts in the saving schedule may have been more important for EMEs. Such analysis could be usefully extended to identify the role that different regions have played in driving the global secular trends we observe.

The collection of issues highlighted in this Box suggest that regional analysis could usefully add to our understanding of the key drivers of real rates in different parts of the world – helping to nuance our thinking and inform our prediction of the path for the global neutral rate in the future.

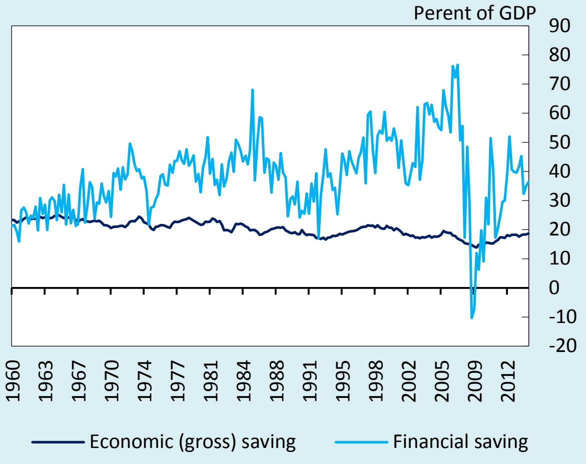
BOX E2: Monetary approaches to analysing global interest rates

The approach taken in this paper is to analyse global real rates using what is effectively a long-run real model of the global economy, where real interest rates move to ensure that real, economic savings (i.e. foregone consumption) equals real economic investment. One criticism of this approach is to question whether trends in economic savings and investment are the only driver of global real rates, or whether monetary trends – the amount of liquidity in the economy – also matters. In this box, we highlight the potential importance of nominal trends as an additional driver of the change in global real rates.

The choice of framework used to analyse the drivers of real interest rates can in part be guided by the timeframe of interest. For example, a monetary model is well suited to short-run analysis over the business cycle. In such a model, the interest rate represents the price of finance and depends on the liquidity preferences of banks and other economic agents (Keynes, 1937). So to understand the determinants of the interest rate over this horizon, agents' liquidity preferences need to be carefully assessed. This was the idea behind the LM curve – an interpretation of the Keynes's General Theory by Hicks and Hansen.

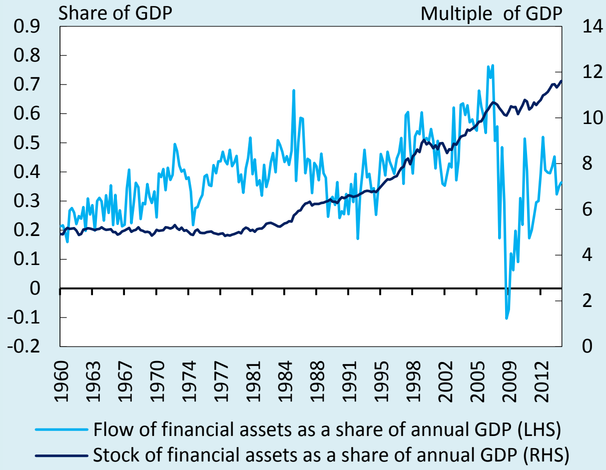
It is also important to note that supply of and demand for liquidity can move independently of agents' preferences for real economic saving and investment. A fast-growing literature highlights that banks do not simply act as intermediaries between savers and investors but also create and destroy liquidity at will, according to financial constraints and risk preferences (see Lindner, 2012, Jakab and Kumhof, 2015) and McLeay et al, 2014)). As a result, there is a stark difference between the trends we see in measures of economic saving in the economy and the amount of finance available at any given time – the provision and demand for financial assets is much more volatile than economic savings (**Chart E2.A**).

Chart E2.A: Economic saving (gross saving) in US national accounts and the flow of financial assets



Source: US Flow of Funds and Authors' Calculations

Chart E2.B: Flow and stock of financial assets in the US, in relation to the annual flow of GDP



Source: US Flow of Funds and Authors' Calculations

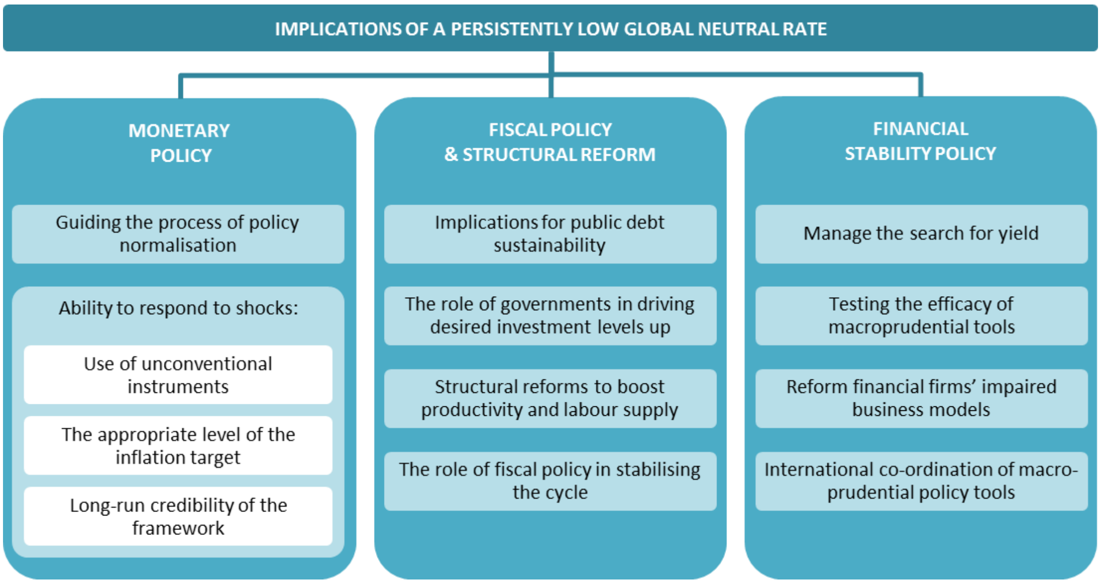
In principle, these monetary factors might be less relevant in determining the *long-run* neutral real rate: to the extent that prices are flexible in the long-run, money is neutral, and only real factors have a lasting effect on long-run real rates. However, even at low frequencies, some nominal trends could in practice be potentially important. The financialisation of the global economy is one such trend. Over the past 30 year or so, we have seen a sustained pick-up in the credit-to GDP ratio and an associated increase in the value of financial assets and liabilities relative to GDP (**Chart E2.B** shows data for the United States, but a similar phenomenon can be observed across the world). We view the monetary approach as an important one. A useful avenue for future work would be to explore the link between this *nominal* trend and the persistent decline in long-term rates globally – to compliment the analysis in this paper on *real* secular trends.

Section F: Policy Implications

The bottom line from our analysis is that powerful global trends have driven the secular decline in the global neutral real rate, and as those trends are likely to persist, the neutral rate is likely to remain low for some time. Taking these findings as given, this section draws out some potential policy implications highlighted in the literature. This section is not meant as a chapter-and-verse on this complex issue and, as with all the content in this paper, it does not represent the views of the Bank of England or its policy committees. Instead, the aim of this section is to underline how widespread the consequences of persistently low real rates could be, so as to stimulate further discussion. The main implication, which cuts across several policy areas, is that with a low global neutral rate appropriate cyclical policy can become more challenging.

The implications of a persistently low global neutral rate are potentially far-reaching, and cut across a range of policy areas. **Figure F1** provides a stylised representation of some of the potential policy implications, which we use to frame our discussion.

Figure F1: A schematic outline of the possible implications of a low global long-term neutral real rate



Implications for monetary policy

One policy challenge currently facing central banks in advanced economies is how to guide market participants and the public through the **process of policy normalisation**. Many central banks have already employed qualitative forward guidance, highlighting that when interest rates are increased, such increases are likely to be limited and gradual – probably more so than in past tightening cycles. To the extent that this guidance has been driven, in part, by a view that equilibrium real rates may remain low for some time, our analysis is supportive of such a view at the global level. Indeed, evidence brought to bear in this paper may aid effective communication and strengthen the credibility of central banks' narrative on this issue.

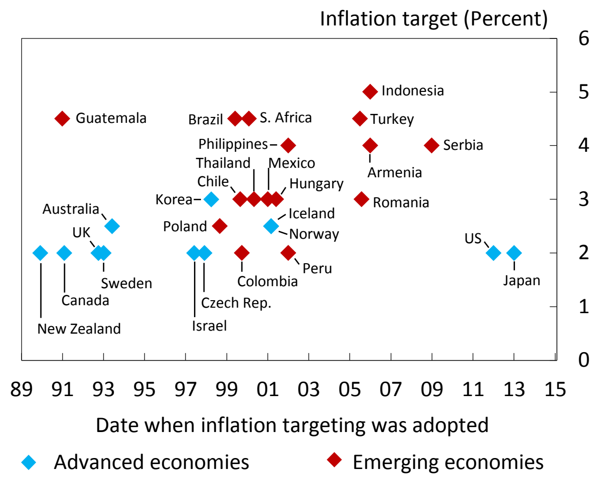
But the implications of a persistently low global neutral rate are likely to go beyond the usual policy horizon. This is chiefly because a low long-term neutral rate may **limit the ability of monetary policy to accommodate adverse shocks,** given the zero lower bound (ZLB) on nominal interest rates (Williams, 2014 provides a helpful discussion). Since nominal interest rates cannot fall much below zero, central banks with an inflation target of around 2% may struggle to lower their real policy interest rate much below -2%. This should not be a problem in good times: in the absence of any large negative shocks, setting real policy rates at around 1% on average across countries is perfectly feasible (as it requires nominal policy rates to be 3%

on average). Moreover, equilibrium real rates (R*s) in individual countries may rise above this global neutral real rate if domestic economic conditions are particularly favourable. But in the face of a large negative shock, policymakers can face a problem. With a low neutral rate, it is more likely that the real policy rate will need to be cut below the critical level of -2% in order to restore equilibrium. In other words, central banks may run out of room to lower interest rates (and hence have to rely on other policy measures). In an economy with a low neutral rate, this problem will tend to occur more frequently. In the limit, if the shock is large enough, economic agents may realise that the central bank's policy space is limited, and if other policy levers cannot be deployed, the expectations of a long-lasting stagnation could ensue. Eggertsson and Mehrotra (2014) formally model this effect, showing that a large-enough shock can lead to an equilibrium where secular stagnation sets in.[46]

Of course, short-term interest rates are not the only instrument in a central bank's arsenal. With a persistently low global neutral rate, **policymakers may become more reliant on unconventional policy measures** – such as quantitative easing (QE). However, low long-term rates can also affect the potency of these instruments. One of the main channels by which quantitative easing can stimulate aggregate demand is by lowering yields on safe assets and hence encouraging investors to switch their portfolios into other assets. This portfolio rebalancing effect pushes up on asset prices more broadly, raising financial wealth. But if the yield on safe assets is already low, there is less scope for this channel to operate. Sustained active use of central banks' balance sheet can also raise other concerns. For example, in the limit, if the flow of asset purchases is very high, bond market functioning could become impaired – as Kiuchi (2015) argues risks happening in Japan. A growing central bank balance sheet can also raise political economy concerns – either because sustained purchases of public sector debt could expose central banks to allegations of monetary financing, which could threaten credibility and central bank independence, or by exposing the central bank and hence the public sector finances to the risk of credit losses (Bean et al. 2015).

Another consideration is **whether a 2% inflation target remains appropriate**. This debate is not new: it featured prominently in Blanchard et al (2010) and has been discussed more recently by Haldane (2015) along with other potential solutions to the low rates dilemma. Policymakers could risk losing credibility if existing monetary policy tools are found to be insufficient to stabilise the business cycle. Raising the inflation targets is one way to create more policy space. Our analysis suggests that the global neutral real rate is around 450bps lower now than at the time when central banks in advanced economies first began adopting inflation targets – typically of around 2% (**Chart F2**). However changing the inflation target has its own problems. Doing so could risk de-anchoring inflation expectations. In that case, policymakers would then have to tighten policy by more than otherwise would have been the case in order to re-anchor inflation expectations, resulting in lower growth further down the road. In

Chart F2: Inflation targeting across the world



Source: Hammond (2012)

[46] The policy implications of secular stagnation vary in an open economy setting depending on how many countries are affected . If some countries face a persistent shortfall of demand but others do not, then the first group of countries may benefit from weakening their exchange rate – 'borrowing' demand from overseas to counter the demand shortfall. If other countries have sufficient fiscal or monetary policy space to offset the impact of a stronger currency on their economies, then this could lead to an improved policy mix for the global economy as a whole – avoiding the stagnation scenario. However, if all countries face a deficiency of demand and global policy space is limited, then currency moves will have little impact in aggregate – just shifting demand between countries. In such a world, countries may still by incentivised to competitively devalue their exchange rate to improve their own domestic prospects. But the risk of 'currency wars' becomes more likely, leading to greater volatility and sub-optimal economic outcomes. In both cases, international policy co-ordination would be required to avoid unfavourable economic outcomes.

addition, adopting a higher inflation target in today's circumstances may be difficult – with inflation already low it may be hard to stimulate the economy sufficiently to drive inflation up to a higher target.

Implications for fiscal policy and structural reform

Treated in isolation, lower long-term risk free rates should improve **debt sustainability** across countries – allowing governments to borrow more cheaply. However, government bond yields are only one determinant of debt sustainability. Some of the other trends discussed in this paper are important too, and are more likely to reduce debt sustainability. For example, lower trend growth and rising inequality will tend to adversely affect governments' fiscal positions.

In **Section D** we identified weak public investment as one potential driver of the fall in global real rates over the past thirty years. To the extent that government policies themselves have contributed to this decline, they could naturally act as a remedy too. In other words, if a decline in desired investment results in a problematic fall in the natural rate of interest, **governments would be able to drive desired investment levels back up**. This could work directly through increased public investment, and indirectly by raising future growth prospects and encouraging private sector investment. Indeed, Obstfeld (IMF, 2015b) has noted "the case for infrastructure investment seems compelling at a time of very low long-term real interest rates". The difficult question is how to finance such a fiscal expansion – particularly for countries with high levels of public debt and limited fiscal room for manoeuvre. This issue cuts to the heart of the debate on optimal fiscal policy. Some, such as Delong and Summers (2012), have argued that expansionary fiscal policy is likely to be self-financing when rates are low, particularly when the economy is depressed. Others, such as Reinhart and Rogoff (2010), have suggested that countries may risk experiencing a costly rise in risk premia if they engage in expansionary fiscal policy when debt levels are high – due to 'debt intolerance'. This is perhaps more likely to be the case if a country lacks sufficient productive investment opportunities, so the rate of return on public investment is low or even negative.

More broadly, to the extent that weak productivity growth and a decline in the growth rate of the labour force are responsible for some of the secular decline in real interest rates, governments have a key role to play in **implementing structural reforms** that boost productivity (via corporate governance reform and product market regulation) and labour supply (through efforts to increase worker participation). As the IMF (2015b) have noted, "targeted structural reforms help not only to enhance future growth, but to increase the resilience of growth". Without such measures, there is a worrying possibility that weak productivity growth and low real rates could reinforce each other. Long periods of low borrowing costs may lessen the pressure on poorly performing companies, slowing the process of creative destruction.

In terms of cyclical policy, some have argued that an important implication of low rates is that if monetary policy tools become constrained, **fiscal policy may need to play a more active part in business cycle stabilisation** (as noted in DeLong and Summers, 2012 and Eggertsson and Mehrotra, 2014). Coordination between monetary and fiscal authorities may also become more important in those circumstances. But in order to assume such a role, governments will need to ensure they have sufficient fiscal policy space to use in the event of adverse shocks.

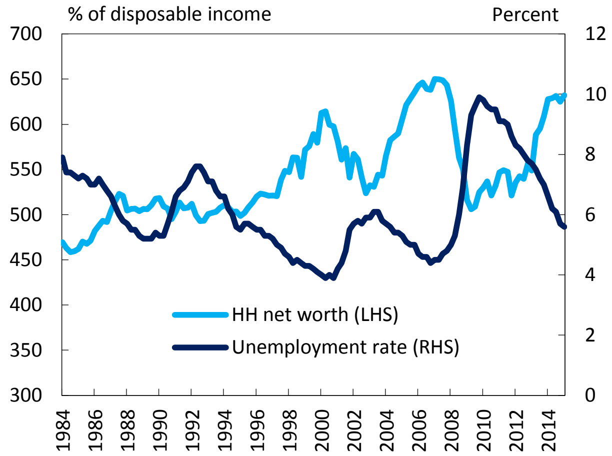
Implications for financial stability policy

One widespread concern for financial stability is that current low levels of short- and long-term interest rates may be fuelling **a search for yield:** excessive risk taking by market participants who reach for higher returns in ever riskier segments of the market. This concern becomes more acute if rates are expected to remain *persistently* low as future expectations of low returns may amplify the incentives created by the current low level of rates. Financial stability policy will need to be vigilant against these risks.

In the face of a search for yield, the first line of defence is typically considered to be **macro-prudential tools**. New instruments – such as counter-cyclical capital buffers – are now being used to address such concerns, but in some cases their **efficacy has yet to be fully tested through the cycle**. Some have argued that if such instruments are found to be too narrowly focused on particular sectors or markets, policymakers may need to resort to broader policy levers, such as interest rates to 'get in all the cracks' (Stein, 2014). In that case, if monetary policymakers need to respond to financial stability risks, they are more likely to underperform on their other objectives – namely maintaining price stability.

Against a backdrop of heightened risks, policymakers may also face an increasingly stark trade-off between maintaining growth on the one hand, and safeguarding stability on the other. For example, Summers (2014a) argues that over the past 15 years it is difficult to identify any period when the US grew at a satisfactory rate without financial conditions being unsustainable – the US only enjoyed full employment at the height of the dot-com bubble and recent US housing bubble (**Chart F3**). Prudential policy could have been tightened to safeguard stability in the run up to the crisis, but Summers notes that "to an important extent, macroprudential policies, if they work, undo the stimulus that comes from easier money". This highlights a broader point about the mix of policy. In the past, in the face of tighter prudential policy, monetary policy could have been loosened to maintain growth. But in the future, if monetary policy is more constrained, then this mix of tighter prudential policy and looser monetary policy may not be available – so changes in prudential policy could have more significant impacts on growth.

Chart F3: US households net worth and the unemployment rate



Sources: US Flow of Funds, BLS, BEA and Authors' Calculations.

Note: Fluctuations in household net worth will be largely driven by the value of assets owned by households – particularly real estate and equity, which rose in value during the dotcom equity price bubble and more recent housing bubble.

The low rate environment may also present a particular **challenge to financial firms' business models**. For example, when the yield curve is flat, the spread between short-term and long-term interest rates is low, making it more difficult to earn returns from maturity transformation (borrowing funds short-term and lending long-term). Persistently low rates can thus squeeze commercial banks' net interest margins, undermining their profitability. Life insurance companies may also face challenges, particularly if they have offered products with a guaranteed rate of return, as it will become increasingly difficult to meet such obligations if risk free rates are permanently low. Indeed, several euro area countries are currently facing such challenges (as highlighted in IMF, 2015a).

Finally, if low real rates encourage excessive risk taking in financial markets, macroprudential policy is likely to become an increasingly important tool to help safeguard global financial stability. But the high degree of financial interconnectedness between countries means that domestic macroprudential policies may be insufficient to deal with such risks on their own. For example, policy measures implemented in one country to reduce domestic lending and contain a domestic credit boom, risk being undermined if the same policy measures do not apply to foreign capital flows, which could substitute for domestic flows. In order to avoid such policy leakages and address the risks associated with international capital flows, macroprudential policy measures implemented in one jurisdiction ideally need to be reciprocated by regulatory authorities in other jurisdictions. This suggests a **growing role for macroprudential policy co-ordination** in the years ahead.

REFERENCES

Ali Abbas S M, Blattner L, De Broeck M, El-Ganainy A and Hu M (2014) 'Sovereign debt composition in advanced economies: a historical perspective', *IMF Working Paper WP/14/162*

Asker J, Farre-Mensa J and Ljungqvist A (2014) 'Corporate investment and stock market listing: a puzzle?', *Review of Financial Studies, no.2 (February 2015): 342-390*

Baker D, Delong J D, and Krugman P R (2005) 'Asset returns and economic growth', *Brookings Papers on Economics Activity, 1:2005 – Pages 289-330*

Bean C, Broda C, Ito T and Kroszner R (2015) 'Low for long? Causes and consequences of persistently low interest rates', *Geneva Reports on the World Economy, CEPR Press*

Benabou R and Tirole J (2013) 'Bonus culture: competitive pay, screening, and multitasking', *NBER Working Paper No. 18936*

Bernanke B S (2005) 'The global saving glut and the U.S. current account deficit', *Federal Reserve Board, Sandridge Lecture*

Bernanke B S (2015) 'Why are interest rates so low, part 3: the global saving glut?', *Brookings Blog*

Bernanke B S (2015) 'Why are interest rates so low?', *Brookings Blog*

Bertola G, Foellmi R and Zweimuller J (2006) 'Income distribution in macroeconomic models', *Princeton University Press*

Blanchard O, Dell-Ariccia G and Mauro P (2010) 'Rethinking macroeconomic policy', *IMF Staff Position Note SPN/10/03*

Broadbent B (2014) 'Monetary policy, asset prices and distribution', *Speech given at the Society of Business Economists Annual Conference, Bank of England*

Brown E C (1989) 'Alvin H. Hansen's contributions to business cycle analysis', *Massachusetts Institute of Technology, Working Paper 515*

Bryne D M, Oliner S D and Sichel D E (2013) 'Is the information technology revolution over?', *Finance and Economics Discussion Series, Federal Reserve Board*

Brynjolfsson E and McAfee A (2014) 'The Second Machine Age: work, progress and prosperity in times of brilliant technologies', *W.W. Norton & Company*

Buiter W, Rahbari E and Seydl J (2015) 'Preventing secular stagnation from becoming the new normal: why the time of one-armed economic policy is gone', *Citigroup Research*

Burgess S, Fernandez-Corugedo E, Groth C, Harrison R, Monti F, Theodoridis K and Waldron M (2013) 'The Bank of England's forecasting platform: COMPASS, MAPS, EASE and the suite of models', *Bank of England Working Paper No. 471*

Caballero R J and Farhi E (2013) 'A model of the safe asset mechanism (SAM): safety traps and economic policy', *NBER Working Paper No. 18737*

Carroll C D (2000) 'Why do the rich save so much?', *published in 'Does Atlas Shrug? The economic consequences of taxing the rich' Harvard University Press*

Cingano F (2014) 'Trends in income inequality and its impact on economic growth', *OECD Social, Employment and Migration Working Papers, No. 163*

Congressional Budget Office (2014) 'The long-term budget outlook', *Congress of the United States Congressional Budget Office*

Crossley T and O'Dea C (2010) 'The wealth and saving of UK families on the eve of the crisis', *Institute for Fiscal Studies*

Cynamon B Z and Fazzari S M (2014) 'Inequality, the Great Recession, and slow recovery', *Cambridge Journal of Economics*

Davies R, Haldane A G, Nielsen M and Pezzini S (2014) 'Measuring the costs of short-termism', *Journal of Financial Stability, Volume 12, Pages 16-25*

DeFina R H (1984) 'The link between savings and interest rates: a key element in the tax policy debate', *Business Review, Federal Reserve Bank of Philadelphia*

DeLong J B and Summers L H (2012) 'Fiscal policy in a depressed economy', *Brookings Papers on Economic Activity, Spring 2012*

Durlauf S N, Johnson P A and Temple J R W (2005) 'Growth Econometrics', *Chapter 8, Handbook of Economic Growth, Volume 1, Part A, Pages 555-677*

Dynan K E, Skinner J and Zeldes S P (2004) 'Do the Rich save more?, *Journal of Political Economy, Vol. 112, No. 2*

Eggertsson G B and Mehrotra N R (2014) 'A model of secular stagnation', *NBER Working Paper No. 20574*

Eichengreen B (2015) 'Secular stagnation: the long view', *NBER Working Paper 20836*

Ellis C and Price S (2003) 'UK business investment: long-run elasticities and short-run dynamics', *Bank of England Working Paper No. 196*

Federal Reserve Board (2015) 'FRB/US – a macroeconomic model of the United States', *Board of Governors of the Federal Reserve System*

Fernald G J and Jones C I (2014) 'The future of US economic growth', *NBER Working Paper No. 19830*

Frey C B and Osborne M A (2013) 'The future of employment: how susceptible are jobs to computerisation', *Oxford University - Machines and Employment Workshop*

Gilchrist S and Zakrajsek E (2007) 'Investment and the cost of capital: new evidence from the corporate bond market', *NBER Working Paper No. 13174*

Goldin C and Katz L F (2007) 'The race between education and technology: the evolution of US educational wage differentials, 1890 to 2005', *NBER Working Paper No. 12984*

Goodhart C A E and Erfurth P (2014) 'Demography and economics: look past the past', *VoxEU 4 November 2014*

Gordon R J (1990) 'The measurement of durable goods prices', *University of Chicago Press and National Bureau of Economic Research*

Gordon R J (2012) 'Is US economic growth over? Faltering innovation confronts the six headwinds', *NBER Working Paper No. 18315*

Gordon R J (2014a) ‘The demise of US economic growth: restatement, rebuttal and reflections’, *NBER Working Paper No. 19895*

Gordon R J (2014b) ‘A new method of estimating potential real GDP growth: implications for the labor market and the debt/GDP ratio’, *NBER Working Paper No. 20423*

Gordon R J (2014c) ‘US economic growth is over: the short run meets the long run’, *Brookings - Think Tank 20: Growth, convergence and income distribution: the road from the Brisbane G-20 summit*

Groth C (2011) ‘Lecture notes in Macroeconomics’, *Department for Economics, University of Copenhagen*

Guiso L, Kashyap A K, Panetta F and Terlizzese D (2002) ‘How interest sensitive is investment? Very (when the data are well measured)’, *European Central Bank Conference Paper*

Haldane A G (2011) ‘The short long’, *Speech given at the 29th Société Universitaire Européene de Recherches Financières Colloquium, Bank of England*

Haldane A G (2015) ‘How low can you go?’, *Speech at the Portadown Chamber of Commerce, Bank of England*

Hamilton J D, Harris E S, Hatzius J and West K D (2015) ‘The equilibrium real funds rate: past, present and future’, *Paper written for the US Monetary Policy Forum, New York City, 27 February 2015*

Hammond G (2012) ‘State of the art of inflation targeting – 2012’, *Centre for Central Banking Studies Handbook No. 29, Bank of England*

Hansen A (1934) “Capital Goods and Purchasing Power’, *Proceedings of the Academy of Political Science Vol. 16, No. 1*

Hansen A (1938) ‘Economic Progress and Declining Population Growth’, *Presidential address delivered at the 51st annual meeting of the American Economic Association, 28 December 1938*

Havranek T, Horvath R, Irsova Z and Rusnak M (2015) ‘Cross-country heterogeneity in inter-temporal substitution’, *Journal of International Economics, Vol. 96, No. 1, Pages 100-118*

IMF (2014a) ‘Perspectives on global real interest rates’, *Chapter 3 IMF World Economic Outlook April 2014*

IMF (2014b) ‘Is it time for an infrastructure push? The macroeconomic effects of public investment’, *Chapter 3 IMF World Economic Outlook October 2014*

IMF (2015a) ‘Navigating Monetary Policy Challenges and Managing Risks’, *Chapter 1 IMF Global Financial Stability Report April 2015, Pages 22-25*

IMF (2015b) ‘World Economic Outlook – Adjusting to lower commodity prices’, *IMF World Economic Outlook October 2015*

Jakub and Kumhof (2015) ‘Banks are not intermediaries of loanable funds – and why this matters’, *Bank of England Working Paper No. 529*

Jorgenson D W and Vu K M (2010) ‘Potential growth of the world economy’, *Journal of Policy Modeling, Vol. 32, No. 5, Pages 615-631*

Joyce M, Tong M and Woods R (2011) ‘The United Kingdom’s quantitative easing policy: design, operation and impact’, *Bank of England Quarterly Bulletin 2011 Q3*

Kaldor N (1955) ‘Alternative theories of distribution’, *The Review of Economic Studies, Vol. 23, No. 2*

Kaldor N (1966) 'Marginal productivity and the macro-economic theories of distribution : comment on Samuelson and Modigliani', *The Review of Economic Studies, Vol. 33, No. 4*

Keynes J M (1937) 'The ex-ante theory of the rate of interest', *The Economic Journal, Vol. 47, No. 188*

King M and Low D (2014) 'Measuring the world real interest rate', *NBER Working Paper No. 19887*

Kiuchi T (2015) 'Revisiting QQE', *Speech at the Capital Markets Research Institute, Bank of Japan*

Koo R C (2011) 'The World in balance sheet recession: causes, cure and politics', *Real-world economics review, No. 58*

Kumhof M, Ranciere R and Winant P (2015) 'Inequality, leverage and crises', *American Economic Review Vol. 105, No. 3*

Kurzweil R (2005) 'The singularity is near: when humans transcend biology', *Published by the Penguin Group*

Kuznets S (1960) 'Population change and aggregate output', *Chapter in NBER book Demographic and Economic Change in Developed Countries, 1960*

Laubach T and Williams J C (2003) 'Measuring the natural rate of interest', *The Review of Economics and Statistics Vol. 85, No. 4, Pages 1063-1070*

Lee R and Mason A (2011) 'Population aging and the generational economy – a global perspective', *Published by Edward Elgar*

Lindner F (2012) 'Saving does not finance investment: accounting as an indispensable guide to economic theory', *IMK Macroeconomic Policy Institute Working Paper*

McLeay M, Radia A and Thomas R (2014) 'Money in the modern economy: an introduction' *Bank of England Quarterly Bulletin 2014 Q1*

Mendes R R (2014) 'The neutral rate of interest in Canada', *Bank of Canada Discussion Paper 2014-5*

Milanovich B (2012) 'Global income inequality by the numbers: in history and now', *Policy Research Working Paper 6259*

Mishkin F S (1984) 'Are real interest rates equal across countries? An empirical investigation of international parity conditions', The Journal of Finance, Vol. 39, No. 5

Ostry J D, Berg A and Tsangarides C G (2014) 'Redistribution, inequality and growth', *IMF Staff Discussion Note 14/02*

Pasinetti L L (1962) 'Rate of profit and income distribution in relation to the rate of economic growth', *The Review of Economic Studies, Vol. 29, No. 4*

Piketty T (2012) 'Models of growth and capital accumulation – is balanced growth possible', *Economics of Inequality Course Notes, Paris School of Economics*

Piketty T (2014) 'Capital in the 21st Century', *Harvard University Press*

Piketty T and Saez E (2014) 'Inequality in the long run', *Sciencemag.org Vol. 344, No. 6186*

Reinhart C M and Rogoff K S (2010) 'Growth in a time of debt', *NBER Working Paper No. 15639*

Saez E and Zucman G (2014) 'Wealth inequality in the United States since 1913: evidence from capitalized income tax data', *NBER Working Paper No. 20625*

Smithers A (2015) 'Racing way? Correcting the damage done to wage growth by perverse management incentives', *The Resolution Foundation*

Speller W, Thwaites G and Wright M (2011) 'The future of international capital flows', *Bank of England Financial Stability Paper No. 12*

Stein J C (2014) 'Overheating in credit markets: origins, measurement, and policy responses', *Speech, Federal Reserve Bank of St. Louis*

Summers L H (2013) 'Economic possibilities for our children', *NBER Reporter, Martin Feldstein Lecture, 2013 No. 4*

Summers L H (2014a) 'US economic prospects: secular stagnation, hysteresis and the zero lower bound', *Business Economics Vol. 49, No. 2*

Summers L H (2014b) 'Bold reform is the only answer to secular stagnation', *Financial Times 7 September 2014*

Thwaites G (2015) 'Why are real interest rates so low? Secular stagnation and the relative price of investment goods', *Centre for Macroeconomics Discussion Paper*

Tuelings C and Baldwin R (2014) 'Secular Stagnation: facts, causes and cures', *A VoxEU.org Book published by CEPR Press*

Williams J C (2014) 'Monetary Policy at the zero lower bound: putting theory into practice', *Hutchins Centre on Fiscal and Monetary Policy, Brookings*

United Nations (2013) 'National Transfer Accounts Manual: measuring and analysing the generational economy', *Population Division, Department of Economic and Social Affairs, United Nations*

Zingales L (2012) 'The college graduate as collateral', *New York Times Opinion Page, 13 June 2012*