r* gazing: The future path for global interest rates

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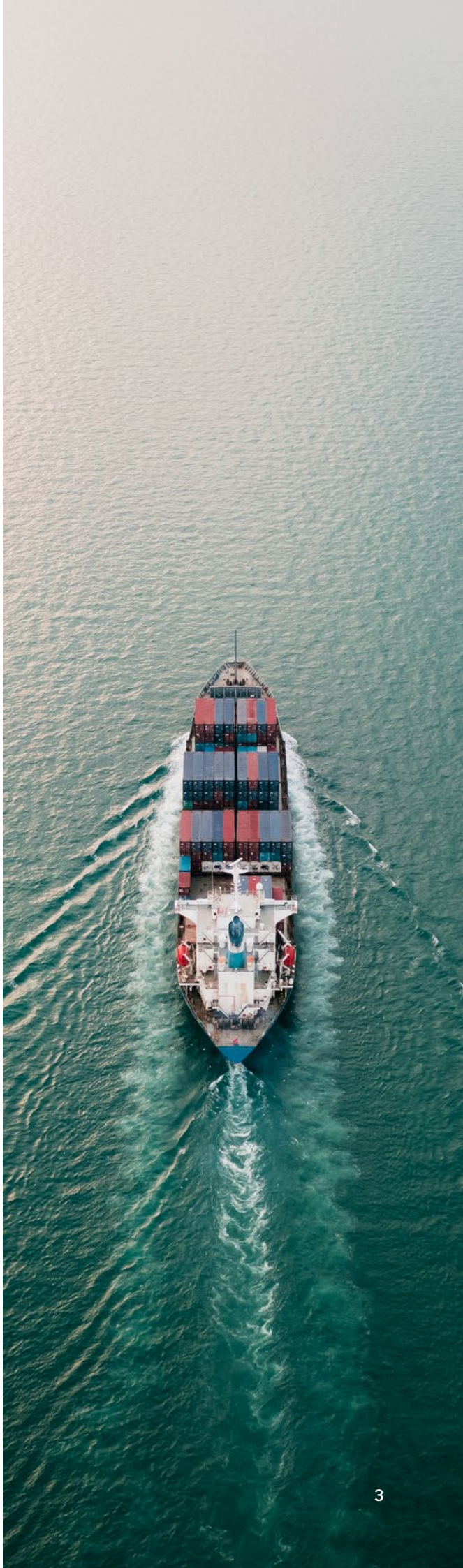
Authors

Robert Gilhooly
Senior Emerging Markets Economist,
abrdn Research Institute

Michael Langham
Emerging Markets Analyst,
abrdn Research Institute

Key Takeaways

- Understanding whether interest rates will remain high or return to their pre-pandemic lows is a first-order question for policy makers and financial markets.
- Interest rates are the price of money, and as such they influence not just the cost of debt, but also the full spectrum of asset prices. Lower rates raise the discounted value of firms' revenues, boosting stock prices, for example.
- Looking beyond the short-term dynamics, where interest rates settle will be determined by the multitude of factors operating on real equilibrium interest rates (r*).
- r* is pinned down by slower moving structural factors that operate over longer horizons.
- Economic growth and the other factors that determine the interplay of savings and investment balances - such as demographics, technology, inequality and government fiscal policy – are therefore key to this assessment.
- Moreover, the global financial system also overlays an international aspect to interest rates, potentially magnifying countries' strengths and weaknesses via debt dynamics and the sustainability of social welfare models.
- This paper brings together these key strands into a unified global framework. In it we show:
  - Why those expecting shifting demographics to keep interest rates elevated will be proved wrong, even in the likes of the Eurozone and Japan.
  - Why growth prospects often matter more than aging populations or inequality.
  - And why we can still expect some convergence between emerging market and developed market yields, despite the fracturing of the co-movement witnessed since the end of 'hyper-globalisation' and the emergence of US-China tensions.



Star gazing is a necessity for investors

Out of control inflation has pushed central bank policy rates sharply higher in the US and Europe. Where policy rates will settle after inflation is tamed is a matter of fierce debate and will be determined by the forces operating on real equilibrium interest rates (r*).

The equilibrium interest rate is a nebulous theoretical concept. It is closely related to economic growth and is also the interest rate that balances an economy's supply of savings with the demand for investment. Both can be influenced by a wide range of factors operating over differing time horizons.

In its simplest definition, r* can be considered as the real interest rate consistent with stable inflationary pressure, meaning r* is both a short-run and a long-run concept.

While it is driven by slower-moving structural factors over longer horizons, the economic cycle and temporary shocks influence the short-term r*, which is crucial for central bank policy setting. This is because r* can in part be seen as defining the level of interest rates at which policy switches from stimulative to restrictive. As we discuss **here**, whether inflation is brought back to target in the US in the medium-term will depend on whether the Federal Reserve has in fact pushed the funds rate above the short-term r*.

Ultimately, growth and the other factors that determine the interplay of savings and investment balances – such as demographics, technology, inequality, and government fiscal policy – will determine r* over the long-term and therefore the level of policy rates and yields within global financial markets.

Demographics play a special role since it operates via two channels that can work in opposite directions: fewer workers on the one hand, reduce the number of savers and put upward pressure on interest rates, but on the other hand, also push down on potential economic growth. This means the total impact of demographics on r* will reflect the net balance of these effects.

Both have major implications on the investment landscape. Weaker potential growth limits corporate earnings and equities, but interest rates on debt don't just determine their own price, but that of a spectrum of other assets too – lower rates raise the value of firms' revenue generation and vice versa. Thus, similar to the impacts on r* itself, in order to judge pressures from demographic change on the investment landscape, it is necessary to consider multiple dynamics.

This note builds on our recently released **Global Growth Perspective**, and considers how demographic pressures intersect with growth prospects to shape long-term r*, both in the past and the future.

Falling bond yields since the 1980s speak to secular drivers

Despite the recent pick-up since the depths of the pandemic, government bond yields have been on a long-run downward trend in developed markets (DMs) since the 1980s. At the time of writing, US 10-year yields are only back around the levels seen on the eve of the Global Financial Crisis (GFC) and are still more than 400bps below their 1990 levels, for example.

Taking this longer vantage, DM yields have also traded in an increasingly narrow range, reflecting not just similar economic structures and obstacles, but also a highly integrated financial system with the US at its core. Nominal yields in emerging markets (EMs) have also drifted lower – helped by some success at lowering inflation – but they have shown a smaller degree of convergence and co-movement.

Sliding government bond yields across the world could imply that common trends are at work. Indeed, adjusting for differing inflation rates, median real yields in EMs and DMs moved in near lockstep between 2003 and 2013 (on both an ex-ante and ex-post basis), falling by roughly 2 percentage points over this 10-year period. And DM real yields have continued to decline over the past 10 years (see Figure 2).

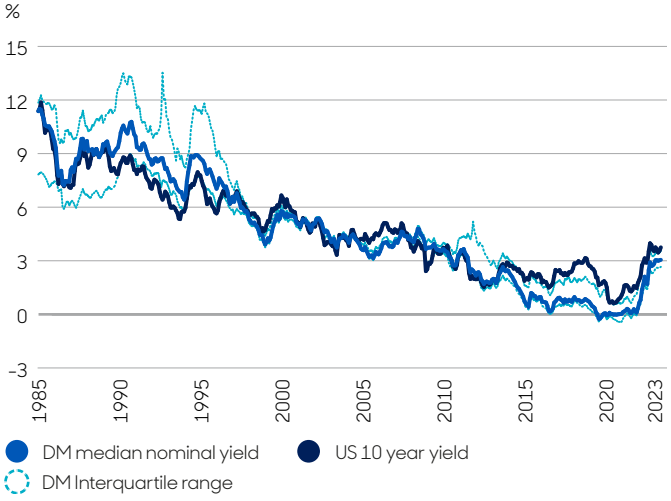
A large body of academic literature, such as Rachel & Smith (2015), points towards an underlying downward trend in equilibrium real interest rates (r*) as the explanation for the fall of real yields in DMs. Many papers conclude that secular trends – including demographics and inequality – explain much of the decline, although there is little agreement on the contribution of the drivers.

It is possible that r* is essentially a global phenomenon, reflecting interconnected financial markets. In the past, commentators have pointed to the co-movement between EM and DM real yields as evidence that this extends beyond the latter, despite emerging economies being much less integrated into the global financial system.

However, while there remains a degree of directional co-movement, the lockstep pattern has fractured since 2013, with a notable wedge opening between DMs and EMs. In the former, real yields have continued to trend down, while in the latter they have been more stable (and this is true whether one looks at ex-ante, ex-post or GDP-weighted measures).

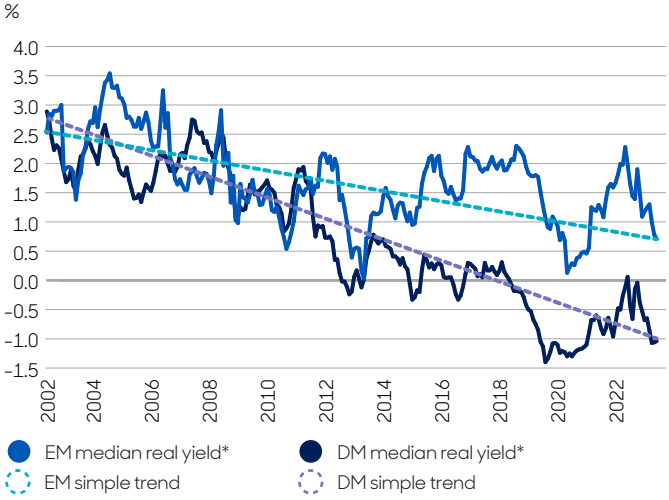
So will real yields converge once again or is divergence set to persist? Perhaps investors' search-for-yield, strong commodity prices and 'hyper-globalisation' contributed to an unsustainable convergence between EMs and DMs that would not normally last given different economic structures and underlying trends. On the other hand, continued financial integration could push real yields back together, particularly if aided by a convergence in r*.

Figure 1: DM yields are still low relative to long-run average



Source: abrdn, Haver (July 2023).

Figure 2: Real yields have been on a long-run drift lower (particularly in DMs), but a wedge between EM and DM has opened up



Source: abrdn, Haver, Refinitiv (July 2023). *ex ante yields approximate expectations using 3yr average of inflation.

Written in the stars: equilibrium real interest rates (r*)

Real 10-year government bond yields are certainly indicative of moves in equilibrium interest rates, but r* is ultimately unobservable.

Most publicly available estimates of r* have focused on the United States and a selection of major DMs. Estimates of r* for a broader group of DMs and EMs are comparatively sparse. Academic studies to date have considered some individual EMs, such as Brazil, Mexico, Russia and South Africa, but there is no comprehensive study utilising consistent methodology.

Before we turn to our approach for estimating r* across the largest economies, it is worth outlining the concept of r* and how theory suggests it links to key drivers such as demographics.

The theoretical r* concept is closely (and positively) related to the growth rate of potential output. Stronger potential growth raises the rate of return on investments, spurring demand for funds to invest in physical assets, while expectations of stronger future income growth can support household consumption by reducing the need to save.

Demographics therefore interact directly and indirectly with r* via the building blocks of potential growth and the impact on savings-investment balances respectively. In the latter case, when a country has a large pool of workers who save more than they consume, total savings rise, and fewer dependents can amplify this effect by raising savings per worker. Investment may be spurred, but, at the whole-economy level, aggregate savings rise, pushing down interest rates. Indeed, this dynamic underpins the notion of a 'demographic dividend' whereby a more favourable population structure helps emerging markets to grow.

Other potential drivers, such as technology and inequality, operate along similar lines. Since high-income households tend to have a lower marginal propensity to consume, wealth inequality tends to increase aggregate savings, bearing down on r*. Automation makes low-income workers vulnerable to displacement, increasing inequality, while the falling relative price of capital is also a potentially powerful force: the price of investment goods has fallen dramatically, reducing firms' relative expenditure on machinery & equipment.

Observing the unobservable

We adapt the work of Holsten, Laubach & Williams (2016) (HLW) to compute r* estimates for 29 major markets, which account for almost 90% of the global economy. The modelling itself is complex and Appendix 1 provides more details on the challenges of applying HLW to such a wide array of countries. But the intuition is that r* is determined by potential growth (Y*) and other factors (Z) and can be defined by the absence of growing inflationary or deflationary pressures.

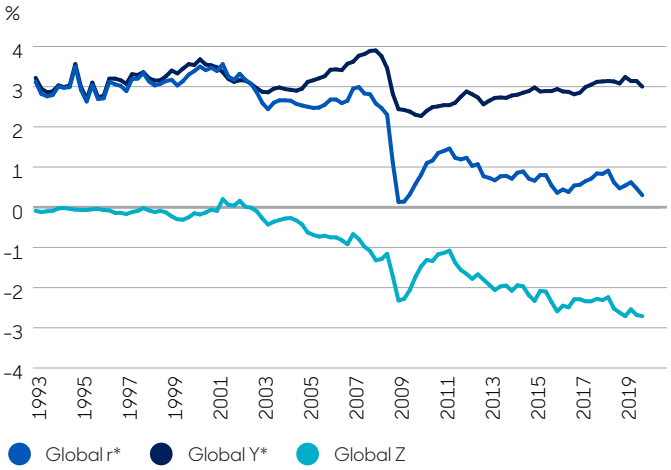
In standard economic theory the equilibrium interest rate is the real interest rate that would prevail when the economy is operating at potential with stable inflation. Therefore, when economic slack turns out to be greater than expected, it implies that the estimate of r* at a given point in time should be lowered slightly. This process continues iteratively through the data until an estimate of r* is constructed for every point in time.

Our estimates for equilibrium real interest rates vary quite widely by country across the global economy. Taking a bird's eye view a few trends are clear:

i. The global average r* (weighted by GDP) has clearly shifted down since the GFC in 2008 (see Figure 3), and it may have been trending down since 2000.

ii. r* and potential growth (Y*) had moved very closely together before the GFC, but r* has subsequently diverged from potential growth, suggesting that other factors (Z) beyond growth have become increasingly important.

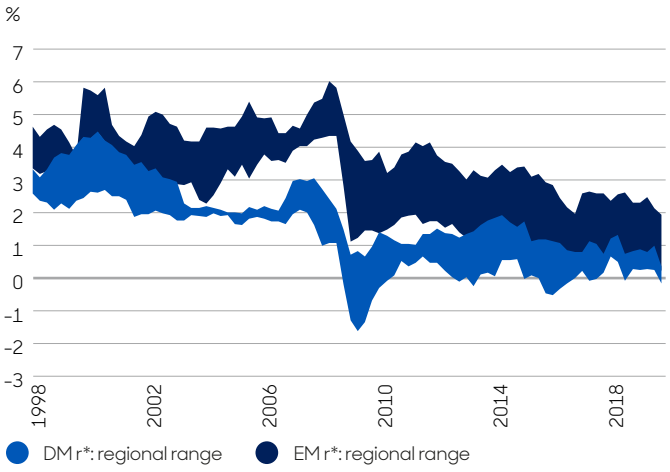
Figure 3: r* has fallen much more than Y*, as 'other factors' (Z) have increasingly weighed



Source: abrdn (July 2023).

Unpacking the r* estimates reveals some similarities to the trends shown in real yields in developed and emerging economies. Specifically, our estimates of r* for DMs show a greater degree of co-movement and a lower dispersion – either when considering the spread of regional averages (as shown in Figure 4), or alternatively if specified in inter-quartile ranges. As Figure 4 shows, there is typically a greater dispersion across our regional estimates for EMs.

Figure 4: r* has fallen across regions, while the gap between EM-DM r* has narrowed



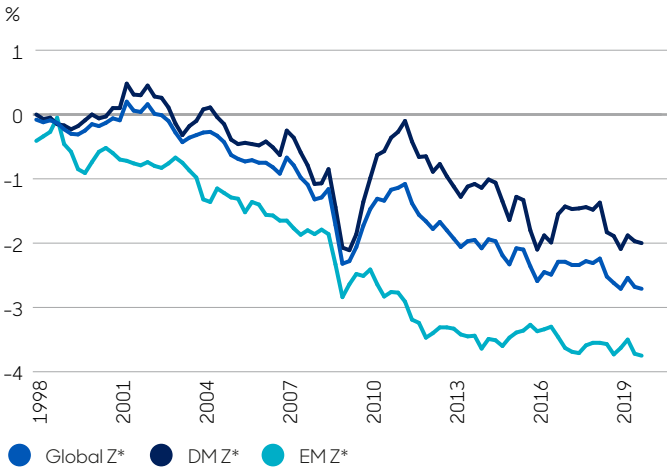
Source: abrdn (July 2023).

The r* story however almost mirrors that of real yields. While there was strong co-movement across DM and EM real yields from 2003 to 2013 and subsequent divergence post-GFC, r* estimates diverged notably before the GFC, but have since converged towards DM norms. The gap between the GDP-weighted EM and DM r* averages was at all-time-high before the GFC and then fell to close to an all-time low by 2017.

As it happens, the larger slowdown in EM potential growth (Y*) and a growing drag from 'other' factors (Z) each account for half of the narrowing in EM and DM r*.

At face value, it is difficult to judge how strong global forces may be in driving convergence. EM regional averages for r* do all move down after the GFC, but the timing is not particularly synchronised. Additionally, there is also a lot of dispersion within EM regions, which indicates that more limited financial links between EMs and DMs may be acting to reduce the contemporaneous influence of global factors.

Figure 5: A larger influence from 'other factors' has dragged down r* in both EMs and DMs



Source: abrdn (July 2023).

That said, 'other factors' (Z) – which we should expect to capture global influences – are weighing more on r* in EMs than in DMs, which would be consistent with r* being dragged down by lower equilibrium rates in advanced economies (see Figure 5). And it is plausible that global factors are important, but that they operate slowly, over a longer time frame. Indeed, 'other factors' drive around 80% of the decline in global r*.

How have demographics, inequality and the global financial system influenced r*?

As noted previously, the Holsten, Laubach & Williams approach calculates r* as a function of potential growth (Y*) and 'other' factors (Z). We can therefore consider the net impact of demographics via both channels, with 'other' capturing drivers which influence savings-investment balances beyond growth, while we can isolate the direct impact of demographics via the number of workers on Y*.

First, our **Global Growth Perspective** already allows us to decompose potential growth into the direct influence of demographics, specifically the contributions from labour and human capital and the other building blocks of growth i.e. the capital stock and total factor productivity (TFP).

The indirect effects of demographics on savings-investment balances – plus the influence of key drivers such as inequality and the global dimensions – can be investigated using an econometric model to consider the drivers of the 'other' (Z) factors.

We follow an approach taken by IMF staff (Arslanalp et al, 2018) who examine how demographics and the degree of financial integration affect 10-year real yields for major economies, but we adjust this to focus on real equilibrium rates, specifically the 'other factors' beyond potential growth, and we consider a wider selection of emerging markets within our panel data set.

Twenty-one emerging markets, eight developed markets (including the 20 Eurozone countries as a single bloc) and data from 1998 onwards form the backbone of our model.

The changing demographic composition is captured by: i) dependency ratios, specified as the number of workers relative to non-workers, rather than the typical academic approach which potentially distorts them by using 'working age' (see **here** for more discussion); and ii) ageing speed (the expected change in the old-age dependency ratio over the next 20 years), which adds a forward-looking dimension, aiming to capture individuals' perceptions of the need to save for retirement.

We use metrics from the World Income Inequality database to consider how changing patterns of income and wealth inequality have influenced r* via the relative pressure on savings. While the capital stock to GDP ratio helps to consider pressure via investment, which is itself a potential warning sign of trouble brewing, particularly when considered in an emerging market context.

Last, but certainly not least, we interact our demographic variables, and the spread between an individual country's r* and the weighted global average of r*, with measures of capital account openness to help capture the influence of global financial markets. For more detail on the modelling approach, please see Appendix 2.

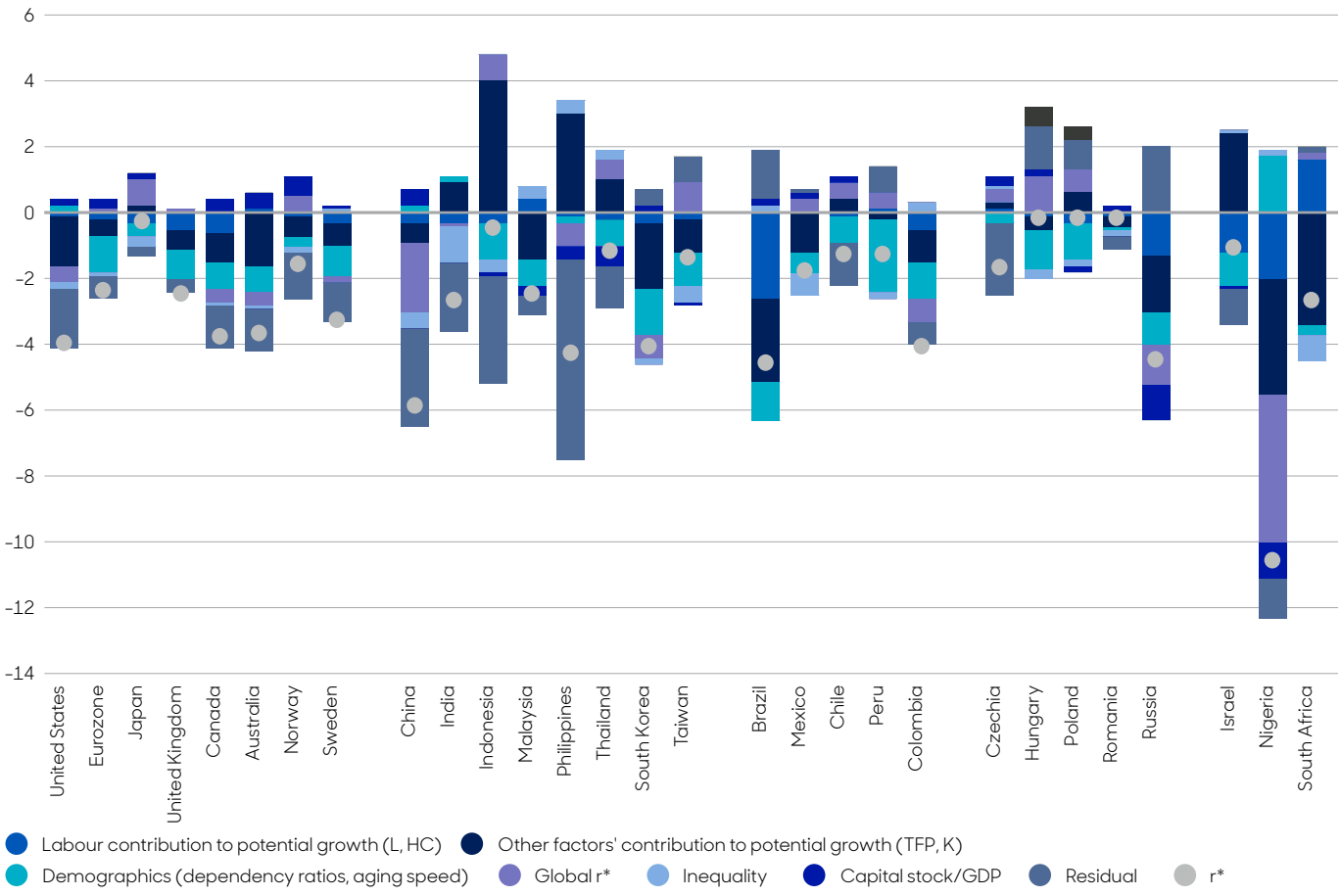
Putting results from both stages together we find that between 1998 and 2019 (see Figure 6):

- **Demographics – via both the quantity of (quality-adjusted) labour and the composition of the population, shown in dark and light blue bars respectively – have weighed on r* in almost every major economy**. Only South Africa saw demographics push up meaningfully. The US managed a marginal positive contribution due to less favourable trends in its worker dependency ratio; but is more notable for being the only advanced economy not to suffer a meaningful drag from demographics.
- In contrast, **falling worker dependency ratios in most countries have typically combined with falling contributions to potential growth from labour to push down on r***. We find that demographics pushed down on DMs (ex. US) r* by an average of 0.75pp, while this was a strong driver across many EMs as well. In LatAm this effect was on average more than 1.1pp, while much of Eastern Europe and APAC also saw strong downward pressure from this channel. Only Nigeria experienced a significant upward pressure as rapid population growth simultaneously worsened youth dependency and pushed down on ageing speed.
- **The impact of other factors of production (total factor productivity, capital deepening and the relative growth of the capital stock versus GDP) were significant drivers of r* across many countries, but the magnitude and direction vary widely**. Most DMs have seen r* pushed down by the weakness of productivity. But while some EMs, such as South Korea, Brazil, Russia, Nigeria and South Africa, have seen notable drags, in Indonesia, the Philippines and Israel significantly better growth performance supported r*.

- **Inequality has generally been a relatively modest influence on r***. Within DMs, the average is only a 10bp reduction, while the UK and Norway have actually seen marginal upward pressure over the time horizon considered. Indeed, the picture across EMs is mixed. China, India, Mexico and South Africa have seen inequality weigh on r* between 50bp and 75bp, but the impact of inequality on most other EMs has been small and often positive.
- **International financial linkages matter**. Our modelling points to a significant effect from the relative position of a country's r* to that of a GDP-weighted global r*. Moreover, whether global financial markets are allowed to operate unfettered also amplifies this channel. Conversely, those countries with relatively closed capital accounts partially offset this pressure. This channel is consistent with long-run pressure to converge towards global r*, but it operates slowly, implying that global forces do not need to appear particularly synchronised.

Figure 6: Demographics have played an important role, alongside other components of potential growth and the influence of global financial markets in pushing down on r*

% point change in r* (1998-2000 to 2017-2019)



Source: abrdn (July 2023).

How is r* likely to evolve in the future?

As we noted at the start, where policy rates will settle after the recent surge of inflation will in large part be determined by the forces operating on real equilibrium interest rates (r*). Whether r* settles back close to our pre-pandemic estimates or shifts higher will have major implications across a range of asset classes.

We can project the likely course of r* for the major economies by combining our potential growth (Y*) projections with our estimates of the influence of demographics and global forces derived from our panel regressions. This allows us to forecast r* in a globally-consistent manner, and also allows us to consider the likely effects of alternative scenarios, such as the impact of low fertility on demographics, rising inequality, or a 'green/artificial intelligence investment' boom that raises productivity.

Our central case projections assume no change in capital account openness, inequality remaining unchanged, demographics evolving in line with the UN's 2022 central case population projections, and potential growth incorporating 5-10% drags from damage induced by the pandemic as detailed in our **Global Growth Perspective**.

Projections between 2019 and 2030 show (see Figure 7):

- **The net effect of demographics – the balance between a falling labour contribution to potential growth and upward pressure from dependency ratios and ageing speed – is dominated by the negative impact on potential growth.** Demographics are not always even pushing up on r*, and are typically more than offset by the falling contribution of labour to Y*. In DMs only Norway escapes a drag, while the net effect for the Eurozone and Japan is -1.1pp and -1.4pp respectively. The result for Japan is likely to surprise most, reflecting a sizeable drag from labour, but also illustrating that dependency ratios may not conform to expectations when calculated in worker space. Even in EMs, this channel is typically weighing on r*. China and Thailand see some upward pressure, reflecting a more substantial impact from adverse moves in dependency ratios and ageing speeds, while Nigeria benefits from a growing pool of labour.
- **Weaker contributions from capital deepening and total factor productivity weigh notably on r* in APAC and Eastern Europe.** Even assuming an (albeit modest) upward trend in the capital stock to GDP ratio, most countries in APAC and Eastern Europe face considerable downward pressure from the non-labour building blocks of potential growth. Moreover, these pressures are amplified by the impact of global r*, with the exception of Thailand and Poland.
- **Instances of substantial upward pressure on r* reflect pre-pandemic weakness**. Brazil, Nigeria and South Africa stand out as potentially facing substantial upward pressure. In the case of Brazil and South Africa this reflects exceptionally weak pre-pandemic potential growth, while Nigeria at least benefits from stronger population growth. There is of course the risk that the growth recovery we forecast disappoints, but, if it materialises, our modelling implies it could gain a secondary boost from the spread of domestic to global r* that does not fully abate by the end of the decade.

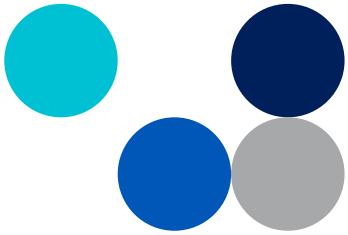
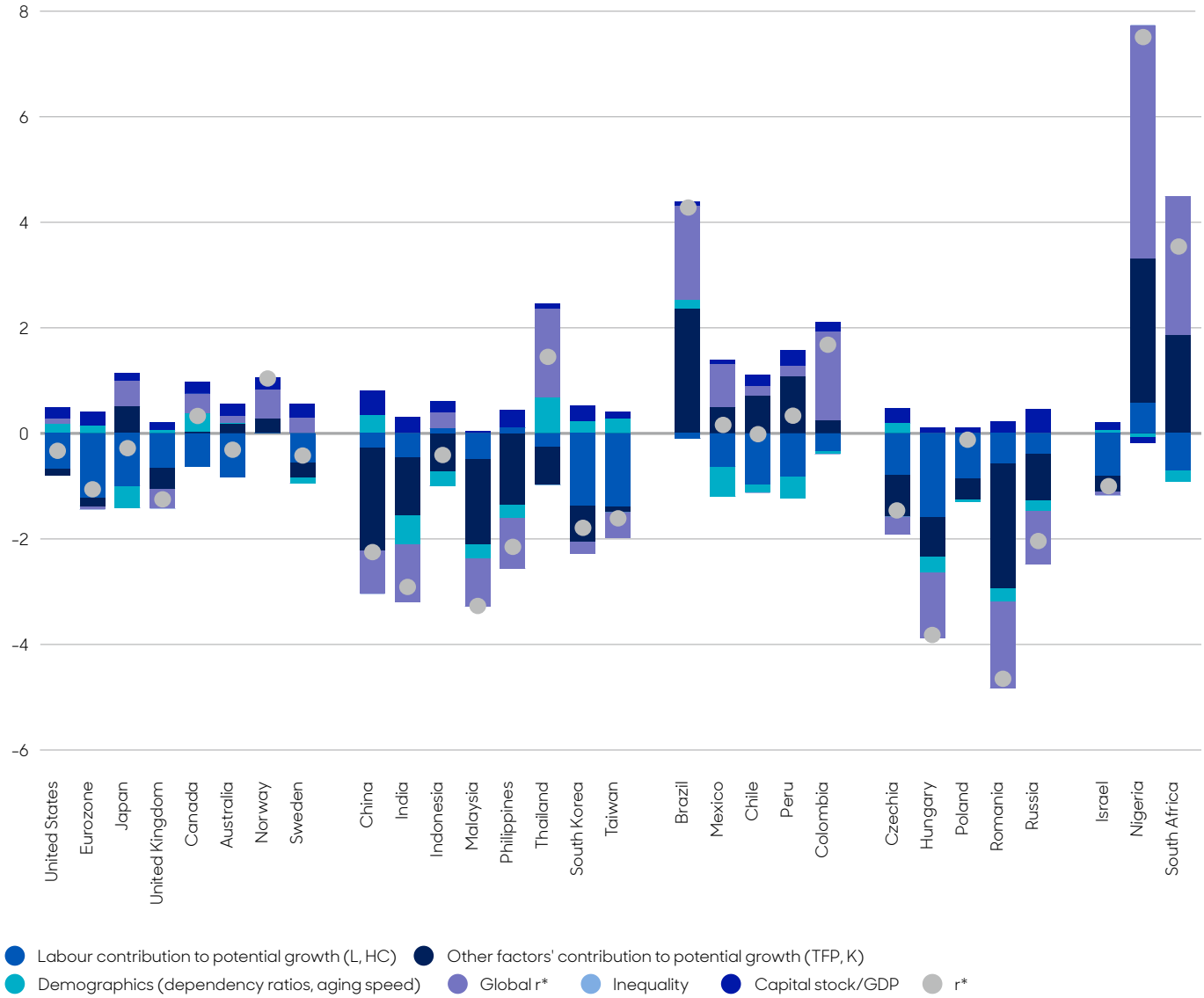


Figure 7: r* is most likely going to continue to fall below pre-pandemic levels as effects from weaker potential growth more than offset some modest upward pressure from demographics

Percentage point change in r* (1998-2000 to 2028-2030)

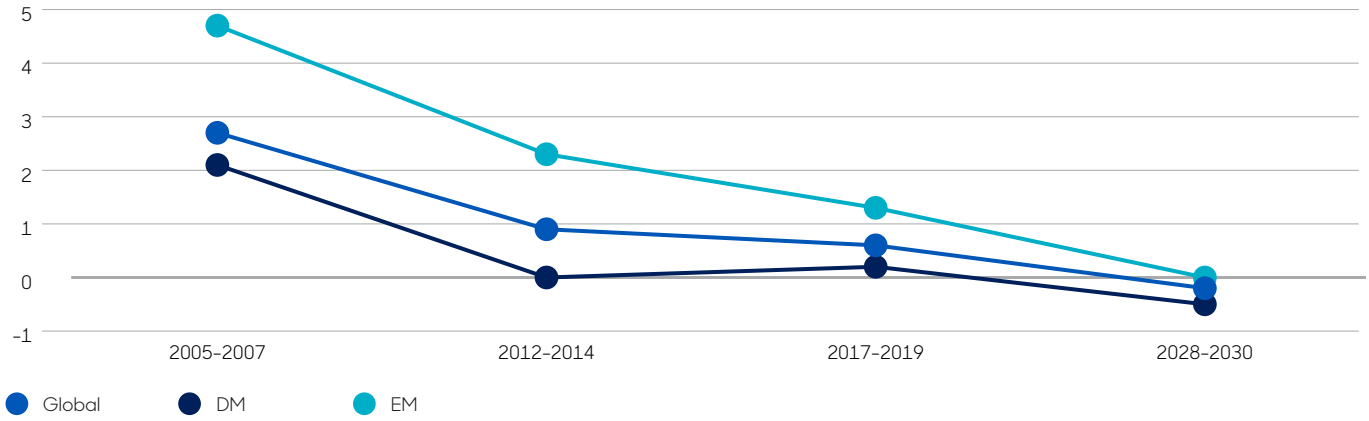


Source: abrdn (July 2023).

- **Finally, downward pressure on r* across the largest economies will help to keep global r* low**, amplifying the global dimension which pulls down on r* on net over long time periods. Overall, we estimate that global r* could fall by 0.9pp, which corresponds to a 0.6pp fall in DMs and a 1.2pp decline in EMs compared to their pre-pandemic averages (see Figure 8).

Figure 8: The downward drift in global r* is set to continue, helped by falls in the largest economies

Real equilibrium interest rates (r*) %



Source: abrdn (July 2023).

Alternative states of the world and the implications for r*

Projecting r* is of course subject to considerable uncertainty, but our modelling framework allows us to consider outcomes that could occur under alternative scenarios.

Seeing how sensitive r* projections are to alternative drivers, such as demographic profiles, helps to give a sense of how much confidence we should place in the central case and what plausible confidence intervals are. If fertility trends are lower than we assume, we would like to know whether that leads to a rise, rather than fall, in global r*, for example.

In this section we consider three plausible alternative states of the world.

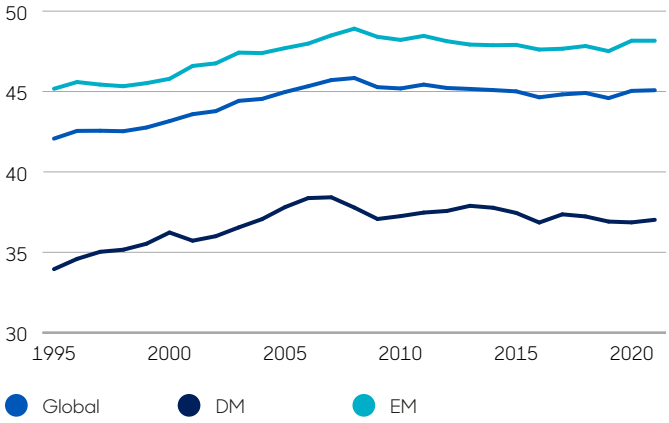
1. Inequality rises again

Inequality trends on a country-by-country basis vary widely and are sensitive to the measures considered. When judged by the share of income or wealth accrued by the top 10% of the population, inequality has risen notably across China, India, Mexico, Russia and the US, but has been broadly stable in Australia, Israel, South Korea, Norway and Sweden, and has actually declined in Colombia, Nigeria, the Philippines and Thailand. In Brazil and Chile, it depends on the data considered, as the share of wealth accrued by the top 10% has risen, but the income of to the top 10% has actually declined.

But on net, after a notable increase in inequality between 1995 and 2010, the last 10 years have shown relatively limited shifts in key measures. The share of pre-tax national income accrued to the top 10% (and similarly wealth held) has shown relatively little change across developed and emerging markets (see Figure 9).

Figure 9: Inequality varies widely by country, but, when considered in broad aggregates, the trend of increasing inequality stabilised after the Global Financial Crisis

Top 10% share of pre-tax national income, % (simple average)



Source: Global Wealth Inequality on WID, abrdn (August 2023).

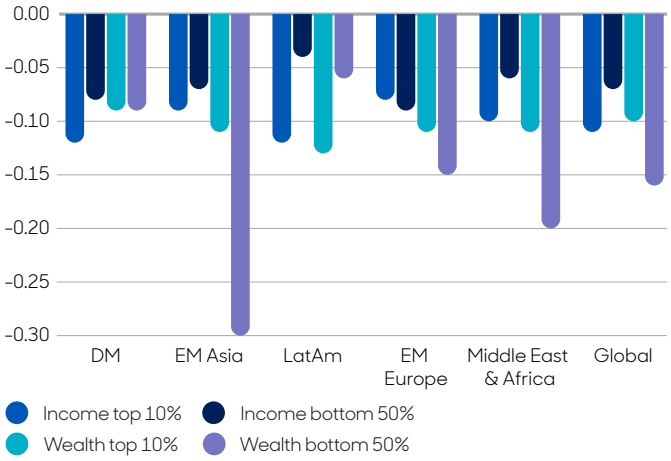
Our central case projections assume inequality is unchanged, but the measure is influenced by a myriad of factors – such as the structure of tax systems, technological change, and the degree of informality in the labour market to name but a few – which makes an assessment on a country-by-country basis particularly challenging.

Moreover, it is possible that inequality has not in fact stabilised and could be set to resume its prior deterioration due to factors which could influence all economies. The adoption of AI could disrupt labour markets, further skewing income towards the wealthiest, who have the highest propensities to save and thus depressing r*, for example.

Our models are relatively insensitive to the measure of inequality considered, but applying similar rises in inequality as seen in DMs and EMs between 1995 and 2010 across four measures (income top 10%, income bottom 50%, wealth top 10%, wealth bottom 50%) gives a range of potential impacts which might occur from now until 2030. In general, we find reducing the share of wealth held by the bottom 50% would have the most significant impact, particularly in APAC and some of EMEA (see Figure 10), but our work also finds that the overall impact of increasing inequality on global r* is small, perhaps only -10 to -15bps.

Figure 10: Rising inequality is only a relatively small driver of r*

Percentage point change in r* (2017-2019 to 2028-2030)



Source: abrdn (July 2023).

2. A green investment boom and adoption of AI boost growth and productivity

With the potential for a surge in green investment compounded by the growing use and development of AI, it is worth exploring what would happen to global growth and r* as a result.

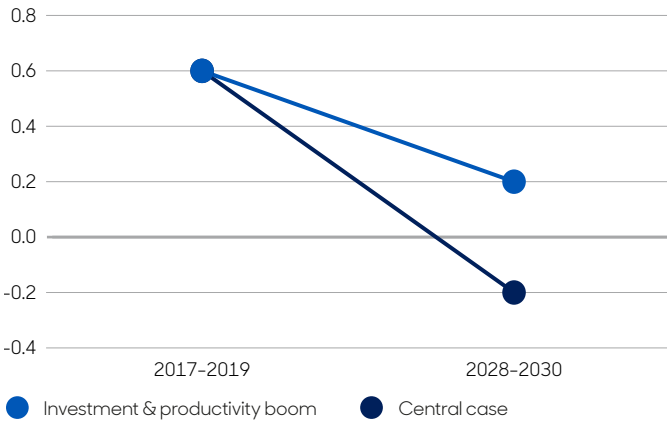
For this scenario, we first increased potential annual growth for DMs and EMs by 0.25pp and 0.5pp respectively to reflect productivity gains from generative AI and the boost to growth from increased investment.

Secondly, and relatedly, we increase the capital stock to GDP ratios relative to the central case to reflect higher investment rates as governments and firms take more aggressive steps to combat the climate crisis and firms seek advantages from generative AI.

This combination pushes global r* up by almost 50bp, keeping it closer to the pre-pandemic average, but still implies that, absent other amplifying factors or structural changes not captured in our framework, r* is unlikely to settle higher than pre-pandemic norms (see Figure 11).

Figure 11: Green investment and AI may not be strong enough to push r* above pre-pandemic norms

%



Source: abrdn (July 2023).

3. Low fertility leads to more rapid ageing and weaker long-run growth

The UN's 2022 population projections revised down expectations for global population growth. The world is now forecast to see the number of people rise by 1.7bn to 9.7bn by 2050, before slowing and peaking at 10.4bn in the 2080s – at a lower level (-0.5bn) and earlier than in the previous projections released in 2019.

While the pandemic may have knocked 1.8 years off life expectancy, fertility rates are the main driver of population projections. In China's case, the population could drop by 655m (-46%) by the end of this century, a massive revision from the previous UN publication in 2019, which projected a fall of 'only' 336m.

But there is still a risk that fertility trends undershoot the central case. For emerging markets, which are the primary driver of global population shifts, a key question is how fertility will evolve alongside economic development. A 2020 study sponsored by the Bill & Melinda Gates Foundation and published in The Lancet provides an alternative take on the outlook. Assuming that total fertility rates decline alongside economic development (aided by improvements in education and access to contraception, for example) the outlook for the global population in 2100 could be radically different, with smaller populations in sub-Saharan Africa and Asia. This would mean that the global population could be 1.6bn smaller by 2100 than the UN's central projection.

The UN's low fertility projections provide an avenue through which to explore the effects on growth and r*.

As we have already noted, the impact of demographic change needs to consider the competing effects from fewer workers depressing potential growth and r* versus ageing populations, which can push up on r* via the indirect effects on desired savings and investment balances. It is also possible that the indirect effects operate differently at different periods of time. For example, in the early phases, fewer children improve dependency ratios, but this then has the opposite effect in later phases as the proportion of elderly rises.

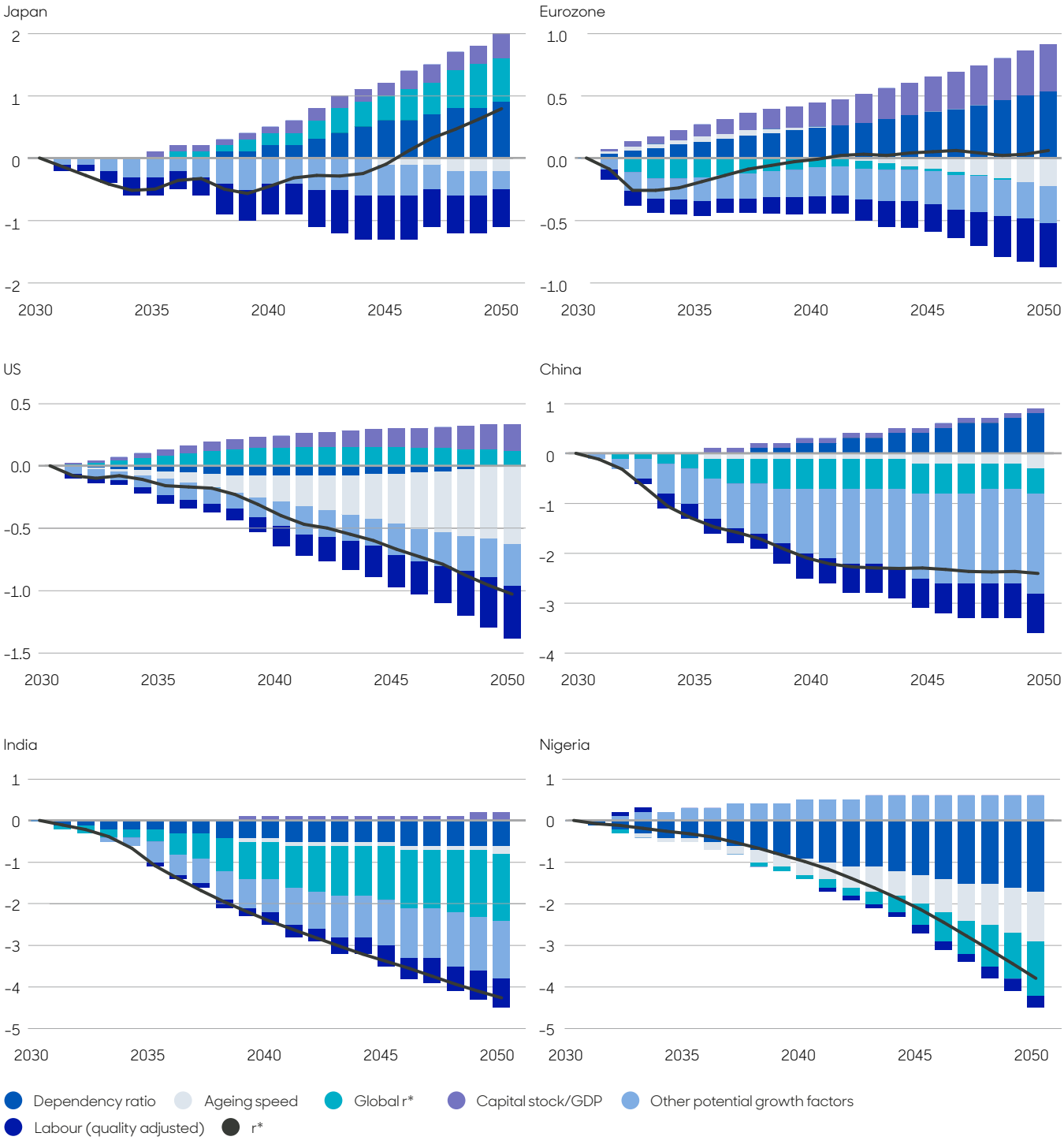
Over the next 15 years past fertility rates have already determined the population structure that will feed through to the workforce; hence, we consider the effects on r* of low fertility from 2030 onwards.

As can be seen (Figure 12, panels 1 and 2), even in the cases of Japan and the Eurozone, a more adverse demographic backdrop actually puts modest downward pressure on r* in the initial phases as effects from fewer workers and other factors of potential growth dominate. It is only much later that the indirect effects are sufficiently strong to start pushing r* higher.

And since the net effects on r* are negative in other major economies (US, China, India) the influence of global r* is largely one of constraining, rather than amplifying r* out to 2050.

Figure 12: Ageing societies are unlikely to push up on r*

Percentage point change in r*



Source: abrdn (July 2023).

Conclusion

In '**Towards the peak: How the rise and fall of populations affects economic growth**' we showed how demographics are set to drive dramatic changes in growth and its composition across the world.

But, as we showed in this paper, this is just one way in which demographics will have a major bearing on the economic and investment landscape. Weaker potential growth limits corporate earnings and equities but structural factors that underpin interest rates determine not just the price of debt, but those of a spectrum of other assets too.

Whether economies are able to age gracefully will depend on a complex combination of their growth trajectories, real interest rates, and policy choices. The interconnected nature of the financial system also overlays a global aspect to interest rates, potentially magnifying strengths and weaknesses via debt dynamics and the sustainability of social welfare models.

Overall, we reject the notion that ageing by itself will drive interest rates higher, compounding the Covid shock.

Indeed, while demographic trends are becoming more adverse as populations age, the impact on real equilibrium rates from higher dependency ratios and faster ageing continue to be offset in many countries by downward pressure from slower growth in working age populations.

Additionally, while we have incorporated damage to growth from the Covid shock, we think that the balance of risks from economic scarring, inequality and technology and the risks from lower fertility give further weight to our estimates, suggesting that r* will rarely face upward pressure.

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Appendix 1: Methodology for calculating r*

Holsten, Laubach & Williams (2016) (HLW) approach this using a State Space model which moves r* with potential growth (y*) and a time-varying unobserved component (z):

$$r^* = y_t^* + z_t$$

The level of potential output (l) follows a random walk with drift, while the growth rate of potential output (y) and that of the other determinants (z) both follow a random walk. Together these form the transition equations:

$$l_t^* = l_{t-1}^* + y_t + \varepsilon_{l*,t}$$

$$y_t = y_{t-1} + \varepsilon_{y*,t}$$

$$z_t = z_{t-1} + \varepsilon_{z,t}$$

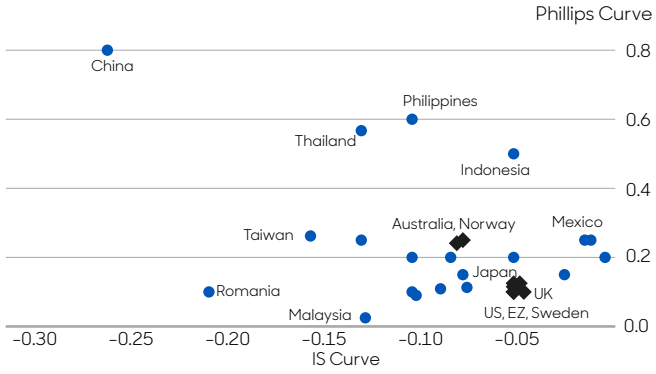
IS and Phillips curves are used to pin down the unobserved variables using the Kalman filter, while constraints are imposed to ensure that the slope of the IS curve is negative and the Phillips curve is positive.

In the original HLW modelling which focuses on the US, Eurozone, UK and Canada the constraints needed for the model to solve (facilitating numerical convergence) are fairly close to 0 i.e. they are more akin to sign restrictions. However, we typically find that setting higher constraints is more productive, particularly in an EM context.

We also deem it more appropriate to use headline inflation (or in some instances the GDP deflator) rather than core as the basis of the policy variable within EMs, since they often lack sufficient institutional credibility to look through transient price level shocks. Since EMs face higher rates of inflation - the variance of Brazilian headline inflation is around 8 times that of core US PCE, for example - this helps justify the scaling up of initial constraints. And separately for China, given the multitude of policy levers and their complex evolution, we map our China Financial Conditions Index into policy rate space, rather than relying on a single variable.

For most economies the constraints and subsequent coefficients are reasonably closely grouped together: the IS curve coefficient is usually between -0.05 to -0.1, while for most the Phillips curve is between 0.1 and 0.25. DMs are generally more tightly grouped (Figure A, black diamonds), while EMs are more dispersed. China stands out with much higher coefficients in both, while some of EM Asia also record relatively high coefficients for the Phillips curve.

Figure A – IS and Phillips curve slopes are more tightly grouped within DMs

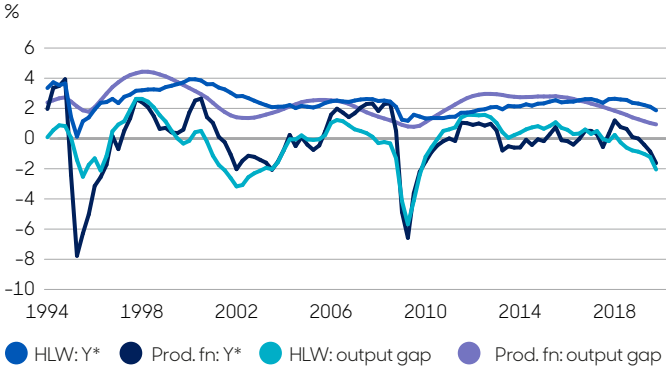


Source: abrdn (July 2023).

In practice there is some sensitivity to the r* estimates produced, depending on the initial constraints chosen. We can however reduce this problem by iterating to ensure consistency with the production function estimates of (y*) and the output gaps which we produced in our Global Growth Perspective - this helps to ensure consistency and rules out implausible r* paths.

Indeed, we have taken comfort from the fact that the estimates produced by these two distinct approaches produce similar results. For almost all countries the HLW estimates of potential growth and those we produced via production functions are very close, particularly after the first couple of years of estimation. And for most countries, the output gaps are also a reasonable match too. For example, in the case of Mexico the output gap opens up by more in 1995 in the production function approach, but the overall pattern produced by both is very similar (Figure B).

Figure B – HLW estimates for y* and the output gap for Mexico are close to the production functions



Source: abrdn (July 2023).

Appendix 2: Modelling the influence of demographics, inequality and the global financial system on r* and assessing the outlook to 2030

The Holsten, Laubach & Williams (HLW) approach models r* as reflecting the influence of potential growth (Y*) one-for-one and also a combination of undefined 'other factors' (z). We have already undertaken work to estimate potential growth drivers using production functions, therefore we seek to understand how demographics, inequality and the global financial system influence the other factors (z) derived during the HLW modelling.

A fixed effects panel data model - following the work of Arslanalp et al (2018) - is our preferred approach. 29 countries and data from 1998 onwards provides the backbone, from which we decompose the influence of demographics, inequality and open economy drivers on 'other factors' (and correspondingly r*).

The explanatory variables pick up a range of demographic and open economy influences via: worker dependency ratios (WD); ageing speed (AS) i.e. the expected 20 year change in the old age dependency ratio; interactions with capital account openness (*CAO), as measured by Chinn-Ito indices; the spread between a country's r* and the GDP-weighted global r* (RSPREAD); income inequality (INEQ), captured by the distribution of income flowing to the top 10% of the population; and the capital stock to GDP ratio (KGDP), which aims to capture periods of particularly rapid investment.

In mathematical notation, the model takes the following form:

$$z_{it} = \beta_0 + \beta_1 WD_{it} + \beta_2 AS_{it} + \beta_3 (WD_{it} * CAO_{it}) + \beta_4 (AS_{it} * CAO_{it}) + \beta_5 KGDP_{it} + \beta_6 INEQ_{it} + \beta_7 RSPREAD_{it-1} + \beta_8 (RSPREAD_{it-1} * CAO_{it-1}) + \varepsilon_{it}$$

Arslanalp et al (2018) do not use the standard definitions for dependency ratios, instead focusing on those aged 30-64 as the most relevant for influencing savings balances and stocks of assets – this is aligned to the life-cycle hypothesis in which these age groups have the highest savings rates and correspondingly drive the largest increases in asset holdings. See Vlieghe (2021) for a discussion on the importance of considering the stock of assets of the whole population, not just the savings patterns of the elderly.

As we discussed in **here**, we prefer worker-based dependency ratios which should more accurately capture the relative weights of earners vs non-earners in the economy. Moreover, as we have shown worker dependency ratios often paint a less alarmist picture of demographic change since there has been a tendency for workers to start and finish their working lives later.

For some countries in particular the projected paths for dependency looks markedly different: if we instead look at dependency ratios in terms of workers rather than those of working age, we actually find that these are set to improve in India, Indonesia and Malaysia, not worsen.

Theoretically, higher dependency ratios should push up on r*, while faster ageing speeds should push it down. Fewer prime-age workers relative to dependents reduces savings. On the other hand, a rapidly ageing society may lead to higher saving rates – this may be more pertinent in an emerging market context, where life expectancy has risen sharply and has potential to rise further than developed markets. Moreover, social security may lag behind these shifts, reflecting political and institutional inertia. Ageing speed is therefore a forward-looking variable which captures individuals' expectations and their perceptions of the need to self-insure.

Income or wealth inequality should be unambiguously negative for r* and may be an important driver of the downward drift in 'other factors'. Since high income households tend to have a lower marginal propensity to consume, higher levels of inequality tends to increase aggregate savings, bearing down on r*.

The capital stock to GDP ratio acts as a control variable to improve the model fit and capture relative strength of investment. This variable may be useful in an EM context because investment is often more cyclical, and including this variable helps to capture longer lasting drivers, such as commodity booms.

Global factors are potentially very important. If domestic financial markets are deep and highly integrated to global markets, real interest rates and real equilibrium rates could be largely a global phenomenon. Put simply, the impact of demographics or inequality could be offset by capital flows, causing r* to converge towards the global r*.

We investigate the global dimension of r* via two routes. First, we consider the impact of the relative position of a country's r* versus the GDP-weighted global r* (RSPREAD). If global dimensions are important then we should expect to find that global r* 'pulls' domestic r* towards it. Secondly, the global impact is likely to be amplified in open economies and mitigated in closed economies. The Chinn-Ito index ranks countries' openness with negative scores being assigned to the most closed economies and positive scores to the most open, this means we can capture structural differences via the interaction term (*CO).

Table 1 shows our preferred model set-up. As can be seen, the coefficients broadly align with the theoretical priors: rising working dependency pushes up on r* via Z; ageing speed reduces it; strong investment relative to GDP raises r*; we find a statistically significant effect from inequality with the expected sign, but in contrast to some of the academic literature the overall effect is relatively modest compared to other drivers (as we discuss in the main text); finally, there is a strong effect from the lagged spread to global r* - a positive coefficient less than 1 creates a 'half life' effect that pulls domestic r* towards the global r*, while the interaction with capital account openness amplifies and mitigates the global influence, depending on whether a country's capital account is relatively open or closed.

This model set-up allows us to forecast r* in a globally-consistent manner, lending a flavour of general equilibrium. First, we can forecast Y* using our production function estimates, giving us our first component of future r*. Secondly, we can draw out several components influencing 'other factors' (Z) using a combination of capital stock and the worker profile within the production functions. Finally, the use of a lagged spread and GDP weights in 2015 real $ GDP, allow us to consider both how global r* is influencing domestic r* and the evolution of global r* itself.

Attempting to attribute the role of demographics and other key drivers to an unobservable variable of course introduces a large degree of uncertainty about the precision of the estimates and the inference one can take from the model. Before settling on this approach we considered many different model set ups.
Using random effects gives similar estimates to those presented here. More detail on robustness and alternative model specifications will be provided in a forthcoming working paper.

Table 1 – Fixed Effects panel regression: demographics, inequality, financial openness and r*

Dependent variable:	**Z**
C	-5.07***
	(0.79)
Worker dependency ratio	0.47***
	(0.78)
Ageing speed	-0.01**
	(0.003)
Worker dependency ratio*Capital openness	0.003**
	(0.001)
Ageing speed*Capital openness	-0.003*
	(0.001)
Income inequality	-6.35***
	(1.72)
Capital stock/GDP ratio	0.61***
	(0.19)
Spread r* to global r* (-1)	0.51***
	(0.06)
Spread r* to global r* (-1)*Capital openness	-0.08**
	(0.19)
Observations:	598
Number of countries:	29
R-squared:	0.59
Standard errors in parentheses	
*** significant at 1%	
** significant at 5%	
*significant at 10%	

Source: abrdn Research Institute (August 2023).

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