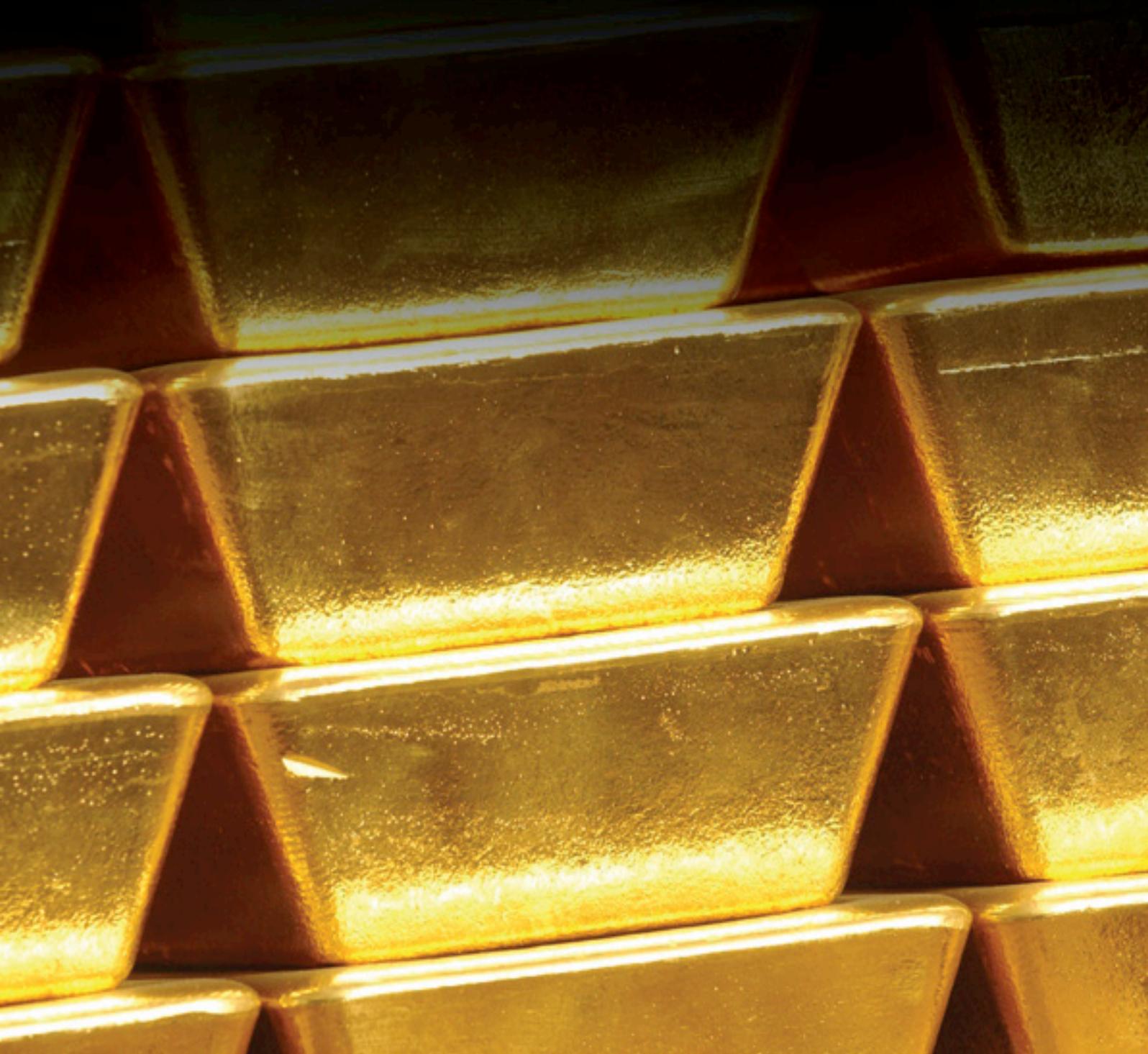
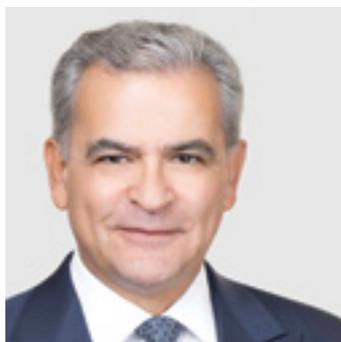


# Gold 2048: The next 30 years for gold





# Foreword



**Aram Shishmanian**  
Chief Executive Officer  
World Gold Council

The World Gold Council was established in 1987 with one overarching aim: to stimulate and sustain demand for gold.

Much has changed in the intervening years. Demand has shifted definitively East, such that China and India are now the two largest consumers of gold. The gold investment market has been transformed by the launch of gold exchange-traded funds. Gold market infrastructure has strengthened, trust in gold has increased and access to gold has broadened.

The World Gold Council has played a key part in each of these developments, working independently and with policymakers, regulators and industry participants to drive understanding and ultimately demand for gold.

Some of the changes that have occurred during the past three decades could not possibly have been foreseen. But some trends were already evident. At this point therefore, we thought it timely to look 30 years ahead and consider ways in which the world and the gold market may develop.

We have sought insights from independent experts and representatives from our members. This compendium reflects their views which chart the direction of travel for the economy, the gold industry and the market. The World Gold Council also sets out its views.

Senior economist George Magnus provides a thought-provoking overview of global economic trends between now and 2048, including observations on emerging markets, developed markets and geopolitics.

Separately, we include individual perspectives on China and India, in recognition of the influential role played by both these economies in today's gold market.

Rick Lacaille, Global CIO of State Street Global Advisors, considers global investment patterns over the next 30 years, encompassing all major asset classes: a compelling read.

## Exploring gold

Looking at the gold industry in detail, leading precious metals consultancy Metals Focus assesses gold mining production trends, as the industry grapples with rising costs and a paucity of major new discoveries. And Michelle Ash, Chief Innovation Officer at Barrick Gold, considers methods and approaches that gold mining companies may adopt, as technology opens up avenues previously considered impossible or impractical.

Environmental, social and governance issues are set to play an increasingly significant role within the gold industry. Brent Bergeron, Executive Vice President of Corporate Affairs and Sustainability at Goldcorp, takes an in-depth look at this field and its impact on the gold market.

We also consider the role that gold will play in industries ranging from energy to healthcare, as technology develops and the use of gold evolves.

And finally, our Chief Market Strategist, John Reade, pulls all these strands together, providing a comprehensive analysis of the outlook for gold over the next 30 years.

We cannot pretend to have all the answers but we have certainly tried to ask the right questions. Looking at the conclusions, certain broad themes stand out.

**First**, economic growth is good for gold. As the middle class expands rapidly in China, India and elsewhere, demand for gold will undoubtedly increase.

**Second**, technology is likely to become an increasingly important sector for gold, as the world becomes more digital and connected.

**Third**, the gold mining industry is going to be challenged to produce as much gold in the next 30 years as it has done during recent years.

**And fourth**, production methods and stakeholder relations will need to evolve if the gold industry is to make a meaningful contribution to society over the next three decades.

Above all, however, we know that gold will continue to be recognised, appreciated and valued in the years ahead. It has been a part of our world for thousands of years. That will not change.

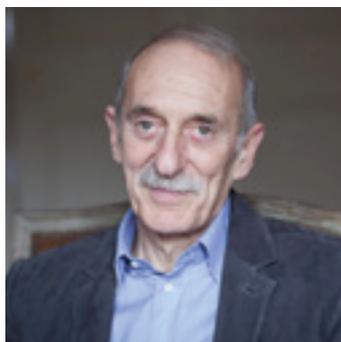


**Aram Shishmanian**

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# Global economic trends: the next 30 years



**George Magnus**  
Economist, author  
and Associate at  
the China Centre,  
Oxford University

**George Magnus** is a senior economic commentator, respected by policymakers and market-makers alike. He assesses where the global economy is heading over the next three decades.

How can we map the global economy between now and the middle of the century?

Looking back 30 years, people did not even predict the fall of the Berlin Wall or much more that was to follow. On the other hand, they knew about the countdown to ageing societies; they were aware of Asia's growth potential; and some even had an inkling about the embryonic information and communications revolution.

Clearly then, a degree of humility is required as we look to the future. Nonetheless, certain trends and patterns should provide useful guidance about the next 30 years.

## Emerging markets and their challenges

Emerging markets have been behind the biggest economic shift in recent times. In terms of purchasing power parity, they lifted their share by nearly 23 percentage points to 58.7% between 1980 and 2017, according to the World Bank. In reality, though, this is essentially about China, which boosted its share by nearly 15 percentage points to stand at 18.3%. India's share was comparable to China's 30 years ago, but it is a more humble 7.2% today. In current US dollar terms, more appropriate when looking at China, GDP shares are rather lower, but the trend is the same. India's share is a somewhat paltry 2.8%, while China's is 14.8%. No other country has come close to the latter's economic achievements.





“Most people expect the rising emerging-market middle class to be the big story of the next quarter century.”

Barring unforeseen shocks, the relative heft of emerging markets in the global economy should increase further, especially while advanced economies languish in the long shadows of the financial crisis. Much of the world's population growth will occur in emerging and developing countries, and most people expect the rising emerging-market middle class to be the big story of the next quarter century. It is true that most new entrants to the middle class will be at the lower end of the scale, not high-rolling members of the Shanghai and Mumbai elites. Nonetheless, a recent report from leading US research group Brookings predicts that, over the next 17 years, 170 million people will enter the middle classes every year from emerging markets, mostly in Asia, especially China and India.

Yet, as a reminder about how forecasts can go astray, we should note that in the last century, Germany did not end up ruling the world, while the Soviet Union and Japan both failed to live up to the high expectations of the time. Will China and India fare any better? Perhaps, but also perhaps not. In fact, since 1945, only about a dozen countries have managed to break out of or avert the so-called middle-income trap, and sustain adequate economic growth for long enough to attain income per head on a par with the 35 advanced economy members of the OECD.

Countries such as Brazil, Argentina and Venezuela have actually regressed. Malaysia and Thailand may now be trapped. India can certainly make a lot of economic progress before it needs to worry, but China is already a high middle-income country. To become a high-income country, it needs to focus hard on the institutional, technological and organisational reforms that sustain high productivity growth. Advances in technology and innovation are not hard to see – China is already a world leader in many advanced technological fields. Institutional and organisational reform may prove more challenging.

## The impact of demographics

Demographic trends will play a significant role. Growth in the working age population is positively associated with economic growth, but a stagnant or weak working age population is linked to weaker savings and investment, lacklustre stock markets and price-earnings ratios, and a greater preference (by older cohorts) for income.

The predicted two billion rise in Africa's working age population will be slightly more than the increase in the rest of the world combined, and Africa's share of working age people will rise from about 13% to over 40% by 2100. This gives Africa the potential for extraordinary and transformational change.

Yet it is not assured, and depends on many factors, including improved reproductive and general health; sustained investment in education and skill formation; strong institutions; and, importantly, enough jobs to absorb large increases in the working age population. Normally this depends on labour-intensive manufacturing: but how can we know how this will evolve in the age of automation and artificial intelligence? Nevertheless, this is certainly a part of the world that will merit close monitoring.

China's age structure, by contrast, is changing faster than anywhere else on Earth. Its working age population is expected to fall from just over one billion people to 794 million by 2050. This alone will lower economic growth by close to 1% per year. The over-60 cohort will rise from about 201 million to over 490 million, or 36.5% of the population. The old age dependency ratio (over 60s as a percentage of working age population) will rise from 13% to 46.7% by 2050. Put another way, while there are 7.7 workers to support each older citizen today, there will be only 2.1 workers by 2050. This would be less than the 2.7 workers in the US, and much lower than the five workers in India.

China has banked its demographic dividend – the phase associated with falling child dependency, an expanding workforce, rising levels of consumption and savings, and low levels of inflation. It did so successfully and in benign global conditions. Now, the country must evolve coping mechanisms to address very different economic and social conditions.

India is altogether different. Its population will overtake China's in a few years. Its fertility rate is falling but it remains almost twice that of China. A third of the population is below the age of 15, and as these children grow up, they will boost India's labour force over the next 30 years by about as much as the entire working age of Western Europe today. By all demographic metrics, India's demographic dividend is just begging to be exploited. Yet, we cannot be certain that India will be as successful as China.

.....

**“India is buffeted by headwinds of its own making, such as complex labour laws and a business environment that favours local provision of goods and services, rather than foreign investment.”**

.....

India's rural sector is still home to 70% of the population but there is a much weaker tendency for people to leave for an urban life than in China. Poverty and relatively low educational attainment mean that far too many people are ill-equipped for productivity-enhancing work. There is a high incidence of poverty among those classified as workers. In any event, without a thriving manufacturing sector and plentiful infrastructure, it is by no means certain that India will be able to generate enough jobs for its teeming working age population.

The country is buffeted by headwinds of its own making, such as complex labour laws, regulations and subsidies that depress employment, and a manufacturing and services technology environment that favours local provision of goods and services, rather than foreign investment. These could all affect India's chances of success and define the challenge it must rise to in the decades ahead.

India undoubtedly has a lot of work to do but there are signs that its government is making progress and putting in place policies that will serve the economy well in the future. In the past few years, it has implemented policies to formalise the grey economy, eliminate 'black money',

improve corporate and financial balance sheets and roll out a nationwide, efficient Goods and Services Tax. These measures have caused short-term problems and economic growth dipped in 2017. In the long run, however, they have the potential to make India more efficient and boost economic growth.



## A 30-year bond bear market

One of the biggest sources of uncertainty is whether ageing societies will prove to be inflationary or deflationary – a distinction with significant implications for real interest rates and the investment climate. Based on current forecasts, these societies include Europe, the US and Japan. There is a consensus view that they will be less dynamic, featuring weaker savings and investments, continued low inflation and persistently low levels of real interest rates. But this might not be right.

The stagnation or fall in the working age population in ageing societies will make skills, and perhaps labour in general, scarce. Scarcity tends to be reflected in higher returns, in this case wages. The era of low inflation and flat Phillips curves (insensitivity of wages to low rates of unemployment) may be ending, therefore, and inflation could rise again. Some of the factors that have held back wages and pricing power may not suppress inflation as much in the future as they have done in the recent past. These include the lingering effects of the financial crisis, anaemic demand and weak investment, globalisation, and lower skilled people replacing higher skilled retirees and those digitised out of jobs.

Age structure is also likely to affect inflation, regardless of the role of monetary policy and inflation expectations. According to IMF researchers, the larger the proportion of children and older citizens in the population, the greater the likelihood of higher inflation.<sup>1</sup> The argument is that different age groups have different consumption and savings patterns, which affect inflation. The young and the old are consumers, not producers, while working age cohorts are the opposite.

<sup>1</sup> Juselius, M. and Takáts, E., *Age and Inflation*, Finance and Development, Vol 53, No:1, IMF, Washington DC, March 2016.

“Policy responses to automation could prove to be financially burdensome and aggravate pressure on interest rates and credit markets.”



To the extent that the demographic dividend era in the West was characterised by low or lower inflation, changes in the age structure can be seen as an important influence on bond markets. The period in which falling child and rising old age dependency just about balanced out was associated with low inflation and falling or low bond yields. There were, of course, many other important factors, including central bank policies, political and policy sensitivities, and booms and busts. Yet, as age structure changes again in the future, we should not be surprised if inflation rises again, pushing bond yields up. It will then be up to central banks to determine whether to accommodate it with a slower rise in interest rates or curb it by pushing policy rates up more firmly, and by implication long rates too. Either way, the falling and low real rates of the past 30 years may be drawing to an end.

## More redistributive Western politics?

The impact of automation and machine intelligence on labour markets and inflation is unknowable and equivocal. There is no question that they will displace more jobs than they create, in line with every technology shift over time. In middle-skill, middle-wage-paying jobs, we can already see those effects. In the end, though, every technology shift has delivered productivity benefits from which either workers or owners of capital have benefited, and jobs have been created as those benefits became entrenched. If this time is different, it is because the main beneficiaries of new technologies are the owners of capital. The current climate already suggests that we should expect politics and policies to become increasingly redistributive to compensate – or face rising social tensions that lead to the same outcome.

In the Western world, there is already a growing chorus of debate about coping mechanisms to deal with the widespread technological unemployment that some fear. These range from training and retraining programmes to the legislation of a universal basic income (UBI), which is already being piloted in a handful of countries, states and cities. It is likely that UBI will always be too little to make a

real difference to those automated out of work and weaken the welfare system for the needy. And if it is enough for these cohorts, it will probably place an excessive burden on the state – especially as age-related spending starts to surge.

Yet it is easy to see why investors need to keep an eye on the policy responses to automation, which could in some cases prove to be financially burdensome and aggravate pressure on interest rates and credit markets. With luck, we can look forward in due course to higher productivity growth, and eventually the creation of new occupations and employment that are impossible to predict today.

## What crises will emerge?

Inevitably, we will face periods of macroeconomic instability and geopolitical crisis. A multilateral world order from which the US is retreating as a benign hegemon, and in which China, Russia, Iran and Turkey want to assert their presence, is a recipe for disorder. Europe has survived its first crisis, but Brexit and unresolved political and banking issues remain to be addressed. Yet the biggest canary in the coal mine is likely to be the way in which Sino-US relations evolve.

China's global role is certain to be influenced by both homemade factors and the response of other major nations to its Belt and Road Initiative, a massive infrastructure project designed to boost economic growth – and China's influence – in Asia and beyond.

At home, China will have to endure a major deleveraging sooner or later. Bad or uncommercial debt has to be recognised, written down and paid for eventually, and regulators will need to defuse the volatile and risky funding structure of the liabilities created to issue debt. Whether the government chooses, or is forced, to embrace a proper deleveraging, the economy is likely to face a protracted period of slow growth, which will spill over into commodity markets and supply chains. This 'crisis' is unlikely to look like the 2007–08 variety in the West, but it will almost certainly shape China for a good few years.

President Trump's issues with North Korea are a pointer to the awkward relationship that is developing between the US and China. This spans trade and investment, as well as what the US sees as controversial territorial claims in the South China Sea, and a new assertiveness in Eurasia. It is and will remain the case that the US and China have areas of close interdependence and diplomatic infrastructure to deal with 'issues'.

Yet the shift in US security and diplomatic thinking that now sees China as an adversary and President Xi Jinping's vision for China's footprint in the global system also create risks of tension, to which the world and financial markets will doubtless become more sensitive. Further, one of the areas in which we can already see significant divergence between the US and China is technology, where two related but separate universes are evolving, with Chinese and American tech giants developing in quite different operating environments with different rules.

President Xi Jinping will almost certainly be in office until 2022, and, as his 'Thought' is now embedded in the Communist Party's constitution, his influence will likely remain strong, regardless of what happens afterwards. US politicians including the President, on the other hand, must face their voters regularly. Investors should be alert to the shift in the political climate if the Democrats win the Senate and make gains in the House in 2018, and of course the national and presidential elections in 2020. Democrats' views on trade are traditionally as conservative as the ones currently being championed by the government, but we should expect a softer tone to international relations.

Last but not least, climate change is, like demographics, a relentless challenge that requires protection mechanisms for human beings at risk from drought and flooding, for example. These expose governments to financial risk in the main. For financial markets, though, the main risk of massive losses incurred by insurance companies relates to the non-climate change phenomenon of earthquakes, but also to hurricanes in the US and typhoons in Asia. A major event could become financially systemic, but overall, we might be looking around the wrong corner here. If over time, the effects of climate change lead to stressful levels of flooding, drought and famine, migration flows could prove to be highly disruptive, politically.

## A challenging future

Looking across these trends highlights one overriding theme: uncertainty. China may seize a commanding role on the global stage but it has to manage a number of serious social, economic and political issues over the next few decades. India has demographics on its side but economic growth could be held back by the sheer scale of change that would allow this democracy to maximise its potential. The potential for transformation is even greater in Africa but the journey is also longer and more tortuous. Across the globe, ageing societies and inflation pose a long-term threat, while the impact of artificial intelligence remains unknown and possibly unknowable.

Add in rising geopolitical tensions, climate change and unwanted migration flows and the world could be a volatile place. In such an environment, gold may prove an effective investment for the coming decades. ■



# The outlook for China

China's economic transformation has been one of the most influential global trends of the past 30 years. Looking ahead, further significant change is expected. **Chen Daofu** and **Sun Fei** from the Finance Research Institute of the Development Research Center of the State Council assess the outlook for China.



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After 40 years of reform and liberalisation, China's economy is moving from a period of high-speed growth to one of high-quality development. Over the next 30 years, therefore, China's GDP growth will shift to global average levels, as its economy evolves and matures. According to state-owned research agency the Development Research Center of the State Council, China's economy will grow by an average of 4.8% a year between 2020 and 2035 and its economic scale will double. Over the following 15 years, average annual economic growth is expected to reduce still further, to about 3.4%.

On that basis, China's nominal GDP will reach about US\$63 trillion by 2035, accounting for 26% of the global economy. It will then increase to US\$160 trillion by 2050, accounting for 30% of the global total.

“China's nominal GDP will increase to US\$160 trillion by 2050, accounting for 30% of the global total.”

Taking population growth, inflation and other factors into consideration, China's nominal GDP per capita is expected to reach US\$20,000 by 2025, far exceeding the World Bank's high-income threshold and significantly higher than the global average. Over the next ten years, China's nominal GDP per capita is expected to reach US\$45,000, about 65% higher than the global average. It may even reach US\$120,000 by 2050, twice the global average and equivalent to half of that of the US.



Over that period, the shape of the economy will change substantially. Agriculture, manufacturing and industry will all play a smaller role, while the service sector's contribution to economic growth will increase, surpassing manufacturing between 2020 and 2035. Infrastructure, manufacturing and real estate investment will all grow at a slower pace, and investment demand will play a significantly weaker role in the economy than it has done to date. China will also focus more heavily on innovation and research and development (R&D), so technology is likely to account for around 50% of economic growth by 2030.

Consumption growth rates will also decline but, even so, consumer spending will become a driving force in China and its contribution to economic growth will rise from 50% to more than 70%. Within the consumer space, demand for agricultural and industrial products will decline while demand for services will rise.

Overall, therefore, the Chinese economy will shift to a greater reliance on domestic consumption, the service sector and technology.

The financial services sector will evolve too. As a critical part of China's economy, financial services have experienced rapid development in recent years. Looking ahead, the sector is likely to expand by US\$4.1 trillion between now and 2035, accounting for 6.5% of total GDP. China will continue to improve financial regulation, strengthen transparency and drive a range of financial reforms. Foreign capital will be allowed to participate

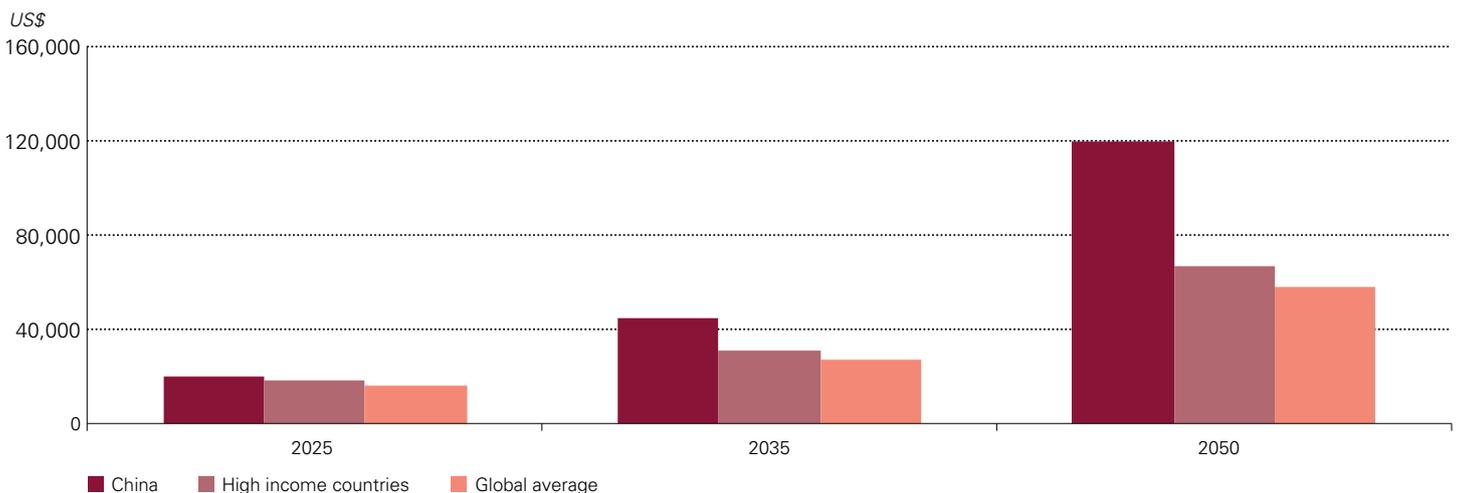
more fully in China's financial sector, there will be freer movement in exchange rates and it will become significantly easier to convert RMB capital. The RMB will also play a greater role in international payments, official reserves and financial transactions, such as RMB-denominated bonds.

.....  
**“ China will also focus more heavily on innovation and research and development, so technology is likely to account for around 50% of economic growth by 2030. ”**  
 .....

Urbanisation will continue at pace. It is expected to reach about 72% by 2035 and 76% by 2050, virtually its peak and equivalent to current average levels in Germany and the rest of the EU.

The proportion of middle-income households will increase considerably. Taking into account such factors as income growth and more equitable distribution of wealth, the proportion of middle-class households is expected to reach 74% by 2020 and will account for a majority of the population by 2035, based on the World Bank's 'absolute standard'.<sup>2</sup> Based on the alternative 'relevant standard',

**Chart 1: China's GDP per capita could be 65% higher than the global average in 2050**



Source: DRC; World Gold Council

<sup>2</sup> The method to calculate middle-income households can be divided into two approaches; the first one is absolute standard, generally represented by "US\$ 10-100 expenditure per capita/family/day" proposed by the World Bank and Asia Development Bank and the other is relative standard, which means defining the middle-income group from the perspective of income distribution; for instance, based on a range of 66%-300% of the international intermediate income levels.

“According to forecasts from the China National Committee on Ageing, the number of senior citizens will increase by 12.6 million people a year from 2022–30, nearly double current rates.”



middle-class households will account for above 60% of the total population by 2035. Over time, therefore, income distribution will shift from the current pyramid-shaped structure to a stable olive-shaped structure and this will become even more pronounced by 2050.

However, China's economic development will face several complex risks over the next three decades.

**First**, there may be unbalanced and insufficient development, as some regions advance faster than others, and cities leave rural areas behind, creating the potential for wide discrepancies among different parts of the population. Debates may also arise around the desire to promote economic growth versus the need to protect the environment, as well as possible cultural conflicts as the economy matures. All of these factors may trigger outbreaks of tension in the years ahead.

**Second**, China may face a lower than expected fertility rate accompanied by accelerated ageing within the population. According to forecasts from the China National Committee on Ageing, the number of senior citizens will increase by 12.6 million people a year from 2022–30, nearly double

current rates. By around 2040, China will enter an ultra-ageing stage. This will affect not only labour supply, but also capital accumulation across the country, as national saving rates diminish.

**Third**, China faces the risk of a slower than hoped for improvement in labour quality, namely the lack of high-quality technicians on the one hand and the need to cope with employment challenges on the other. This issue is particularly acute, given the likely impact of artificial intelligence on job creation across large swathes of the population.

**Fourth**, a persistent lack of social mobility may increase the income gap between the privileged and the rest.

**Fifth**, environmental and resource challenges may pose further risks and international market turbulence may also erupt at some stage in the future.

Overall, however, there are high hopes that China's economy will mature and develop in a measured way, allowing the country to play an increasingly significant role on the economic, social and political world stage. ■

# The great Indian middle class: a force to reckon with



**Dr Rajesh Shukla**  
Managing Director and CEO  
People Research on India's  
Consumer Economy  
(PRICE)

India is the second largest consumer of gold in the world, with a cultural affinity stretching back centuries. It is also undergoing rapid change, a trend that could have profound implications for its economic power, influence in the world and demand for gold. **Dr Rajesh Shukla**, Managing Director and CEO of the People Research on India's Consumer Economy (PRICE), assesses the long-term outlook for India.

India has the potential to become the fastest-growing economy in the world over the next three decades, with average annual growth of between 5% and 6%. Per capita income is set to rise to about US\$38,000 at today's prices, while the population is expected to reach more than 1.7 billion by 2048. This growth will not only make the Indian middle class the biggest group in the country in numerical terms, it will also transform it into a major driver of economic, political and social growth.

By 2048, if political and economic reforms have their desired effect, the income pyramid will gradually develop into a 'fat lady' – with a smallish bottom of the deprived and aspirers, a huge bulge in the middle of the middle class and a big head of the rich.



**India's income pyramid**

Income class	Population (million)		Share of population (%)		Annual growth
	2018	2048 (Est.)	2018	2048 (Est.)	
Deprived	630	40	45%	2%	-8.8%
Aspirers	460	110	33%	6%	-4.7%
Middle class	270	1,250	19%	73%	5.2%
Rich	30	310	2%	18%	8.1%
<b>Total</b>	<b>1,390</b>	<b>1,710</b>	<b>100%</b>	<b>100%</b>	<b>0.7%</b>

Source: Author's calculation using household data of PRICE's ICE 360° surveys (2014 and 2016)

Estimates based on PRICE's ICE 360° pan-India primary surveys suggest that the population of deprived and aspiring people will decrease from almost 1.1 billion today to 150 million in the 2040s. The top income segment – the rich – will soar from 30 million to an estimated 310 million, while the huge bulk of the population will comprise a middle class of nearly 1.25 billion, up from 270 million today.<sup>3</sup>

As middle class numbers rise, so will their heft within the country. Today, the middle class accounts for 19% of the overall population. In three decades' time, that figure is likely to exceed 70%. The middle class will almost certainly account for a lion's share of total income too, while the share accruing to the aspirers and deprived will fall substantially.

Absolute incomes may well be higher among the rich but the numerical strength of the Indian middle class suggests that it will become a driving force within the Indian economy, while its aggregate purchasing power will result in the creation of one of the largest markets in the world. The discretionary spending power of this burgeoning section of society could both spur investment and generate employment, thereby providing a further boost to economic growth.

.....  
**“Not only will the Indian middle class become a driving force within the Indian economy, but its aggregate purchasing power will result in the creation of one of the largest markets in the world.”**  
 .....

India should also benefit from its youthful and fast-growing working age population, a demographic dividend that will provide the country with the largest number of working age people in the world. This could have a material impact on domestic demand and output. However, to maximise the potential of this 30-year demographic sweet spot, certain key changes are needed. These include sustained economic reform; a strengthening of macroeconomic fundamentals and institutions; and, crucially, mass education. If these are delivered effectively, the rapidly growing working age population should make a productive contribution to long-term economic growth. In the absence of a good education, however, young people will remain unemployable and a drag on scarce resources.

Assuming that reforms are initiated and India's middle class expands to a cohort of more than one billion people, the implications are profound. A country's middle class plays a pivotal role in the social and economic fabric because it participates in a wider range of economic activities than any other section of society. The middle classes act as employers and employees, consumers and producers, and agents of political change. This is particularly true in the West, where the middle class plays a crucial and integral role in the functioning of democracy.

Aristotle once said: “The best political community is formed by citizens of the middle class,” and “Those states are likely to be well administered in which the middle class is large.” This age-old wisdom may become increasingly relevant in India because as the middle class expands it may well become more politically engaged, acting as an agent of change and an important stabilising force. Thus, as India grows and becomes more globalised, the middle class may play an important role in shaping Indian society and politics, as well as its economy. ■

<sup>3</sup> The latest PRICE's ICE 360° survey (2016) is among the leading representative samples in India, covering more than 300,000 households across the country. Income classes are defined based on annual household income at 2017-18 prices. Deprived (below Rs.250,000 or below US\$3,800); aspirers (Rs.250,000–Rs.550,000 or US\$3,800–US\$8,500); middle class (Rs.550,000–Rs.2,750,000 or US\$8,500–US\$42,200); and rich (over Rs.2,750,000 or over US\$42,200). Currency exchange rate for 2017: US\$1 = Rs.65.11.

# The investment market in 2048



**Rick Lacaille**  
Executive Vice President  
and Global Chief  
Investment Officer  
State Street Global Advisors

The investment world has altered dramatically in the past 30 years and is expected to continue doing so over the next three decades. **Rick Lacaille**, Global CIO of State Street Global Advisors, assesses the drivers of change and their likely consequences.

To make an educated guess at what the investment climate will look like 30 years hence, it is worth considering how investing and capital markets have changed over the past 30 years – albeit with the usual proviso that past performance is no guarantee of future returns. In this spirit, we analyse the major macroeconomic, demographic, financial, commodity and private market trends over the past three decades and consider how they might develop in future.

Since Black Monday in October 1987, when the Dow Jones suffered its worst ever single-day fall of 23%, the world has changed beyond all recognition. Technology has become integral to daily life, while globalisation has brought both economic growth and political upheaval. Equities and bonds witnessed a golden period in the late 1980s and 1990s, a tech boom and bust in the early 2000s, and a decade of sub-par growth following the global financial crisis (GFC) in 2008–09. The repercussions of the GFC continue to this day, engendering a new paradigm of systemic risk management and macroprudential regulation in developed markets. Meanwhile, a combination of technological innovation, globalisation and ageing populations is creating structural changes in the global economy and financial markets, with implications for growth and inflation that are still under debate among major central bankers and policymakers.



The question is: where do we go from here? To help construct a futuristic view of the investment climate in 2048, we have examined demographics, GDP growth and asset prices over the past 30 years. Our analysis leads us to make the following predictions:

- The population in 2048 will be higher than it is today, but will have different characteristics
- Technology will be more advanced and integral to financial decision-making
- Countries will be more climate-change aware and adaptable
- More people will have access to investments
- Risk management/regulation will be crucial to generating reasonable returns
- Political uncertainty will be regime dependent
- Access to knowledge and information will accelerate globally
- Financial innovation will create new business models and asset classes

## Demographics

An understanding of global population trends is fundamental to understanding how the world might change over the next three decades. Population growth is set to continue, but it will slow down from current levels (**Table 1**). Importantly too, UN projections suggest that, by 2048, roughly nine out of ten people in a world population of almost 9.7 billion will come from poorer countries.

Life expectancy increases are projected to be greater in developing countries, but the old age dependency ratio – the ratio of the working age population to the number of people aged 65+ – is set to increase across all regions, albeit with smaller rises in developed countries. The UN's base case medium fertility scenario indicates that several advanced countries will see population declines, while others will have negligible growth rates (**Chart 2**). Fertility rates across the world are projected to decline, due to child-rearing costs, while the gender gap is likely to close further, as more women join the global workforce.

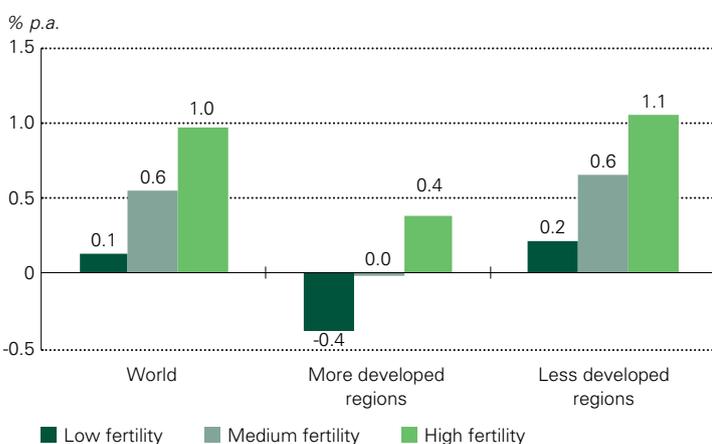
**Table 1: Global demographic indicators: 1988–2048**

	Life expectancy at birth (years)	Fertility rate (children per woman)	Population growth (% p.a.)	Old age dependency ratio (no. of 65+ per 100 of 15–64)
1988	63.7	3.4	1.8	10.0
2018	71.9	2.5	1.1	13.7
2048	76.9	2.2	0.6	24.4

Source: UN Population Division; SSGA Demographics

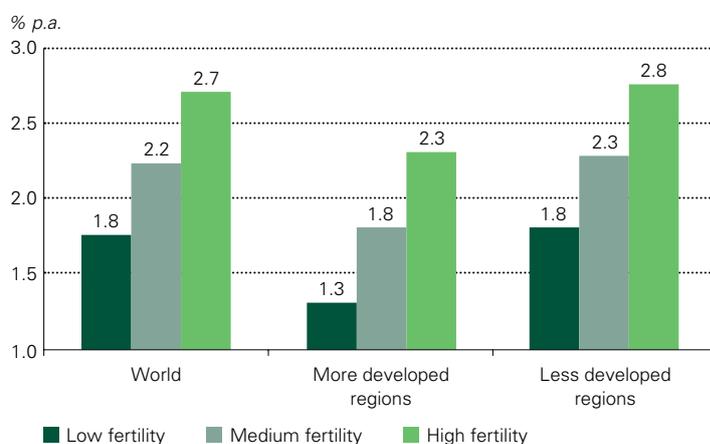
**Chart 2: Population growth and fertility rates (different scenarios)**

**Population growth forecast, 2045–2050**



Source: UN Population Division; SSGA Demographics

**Fertility rate, 2045–2050**



## Macroeconomics

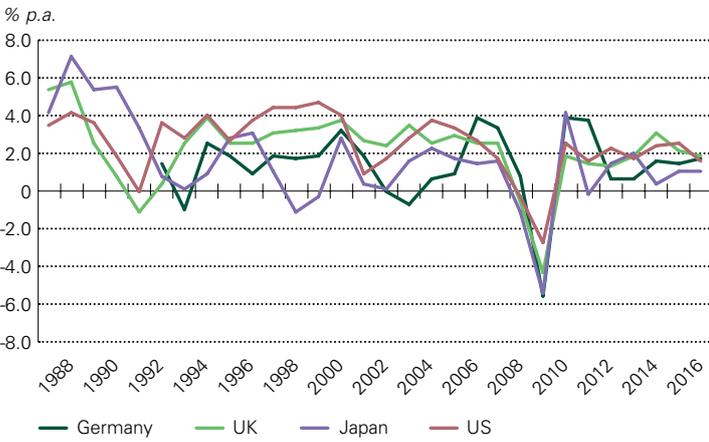
GDP growth can be broken down into growth of three underlying demographic components: working age population, labour productivity and labour utilisation growth (**Chart 3**).

In the 20th century, GDP growth was relatively strong across the four big advanced economies: the US, Germany, Japan and the UK. Since then, most economies have

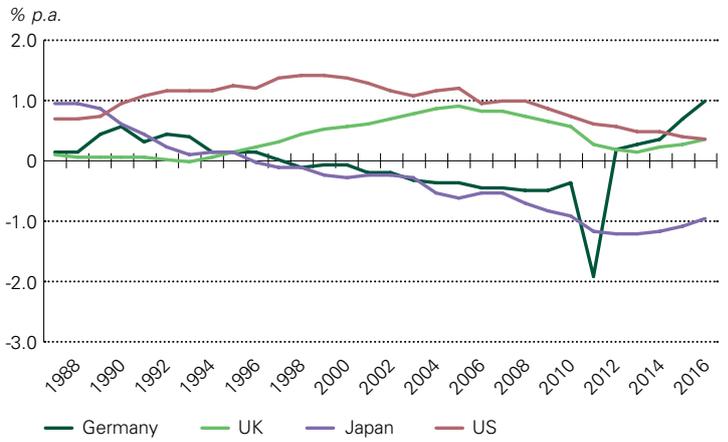
experienced slower growth, primarily due to lower labour productivity growth. To reverse this, countries need to increase the number of women and young workers in the labour force. While GDP growth is still higher in emerging economies, it is not enough to have a faster-growing working age population. Growth in productivity and hours worked are also important components of future GDP growth.

**Chart 3: GDP growth and its demographic components**

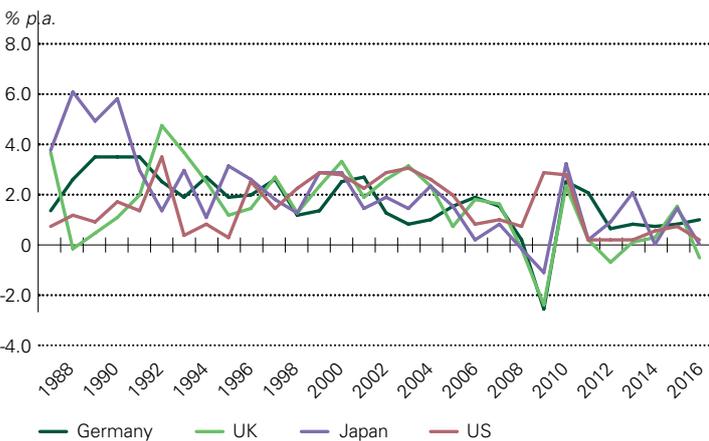
### Real GDP growth



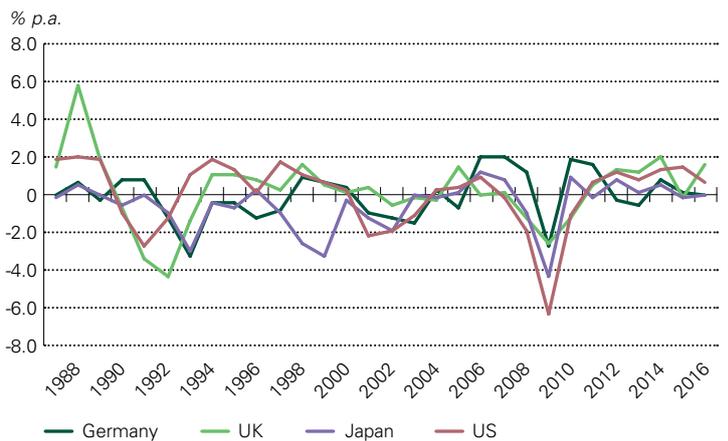
### Working age population growth



### Labour productivity growth



### Labour utilisation growth



Source: OECD; World Bank; SSGA Demographics

GDP per capita – a key measure of prosperity – has been volatile in emerging markets (EMs) versus developed markets (DMs), even though the upward trend in DMs has been tempered by financial crisis aftershocks (**Chart 4**). This EM volatility reflects currency swings, population changes and slower growth figures.

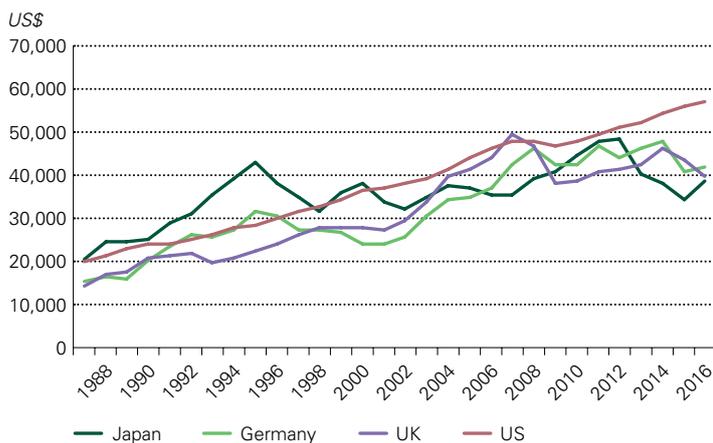
The contribution of demographics to GDP per capita growth is called the demographic dividend. Many EM countries have benefited from this. The EMG6 countries – China, Brazil, India, Mexico, Russia and Turkey – increased their share of global GDP from 6.2% in 1987 to 24.4% in 2016. The share of the G6 countries – the US, the UK, France, Germany, Italy and Japan – has declined from 65% to 45% over the same period. The EM share of global equity markets has also risen.

We believe that future global growth will be driven by EM countries, as more workers become active consumers. GDP per capita should also increase in emerging areas over the coming decades, as education, skills and knowledge improve. This is likely to lead to a shift in economic power from the developed to the developing world.

“ The EMG6 countries – China, Brazil, India, Mexico, Russia and Turkey – increased their share of global GDP from 6.2% in 1987 to 24.4% in 2016. The share of the G6 countries – the US, the UK, France, Germany, Italy and Japan – has declined from 65% to 45% over the same period. ”

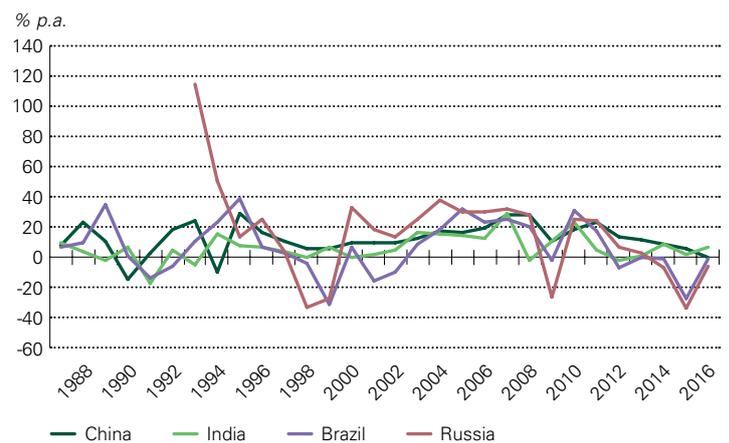
**Chart 4: GDP per capita – developed versus developing countries**

**GDP per capita: advanced countries**



Source: IMF; SSGA Demographics

**Growth in GDP per capita: EM countries**



“Technology will facilitate access to more asset classes and strategies, with execution becoming ever easier and cheaper. In conjunction with increased urbanisation and better education, improvements in technology will also expand the universe of investors.”



## Financial markets

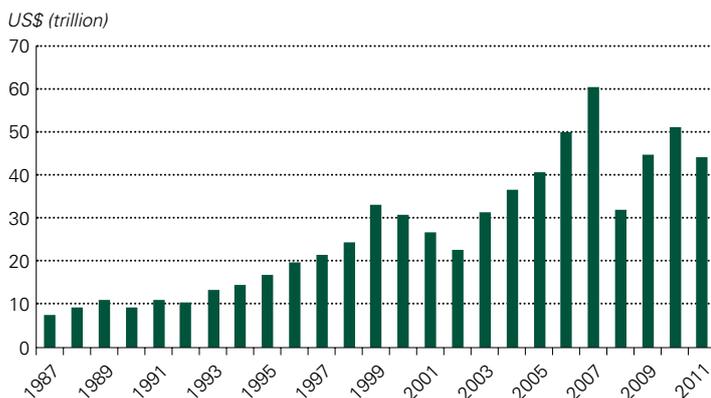
Equity and bond markets have grown significantly over the past 30 years, with bonds unsurprisingly exhibiting a smoother trend than higher-volatility equities (**Chart 5**). We expect the next 30 years to usher in further product innovation, building on the success of vehicles such as exchange-traded funds (ETFs) and becoming a regular part of investing for those seeking diversification, risk management, higher yields or excess returns. Technology will facilitate access to more asset classes and strategies, with execution becoming ever easier and cheaper. In conjunction with increased urbanisation and better

education, improvements in technology will also expand the universe of investors across countries and within them. All these factors should deepen capital markets, especially in Africa, Asia and Latin America, but could present challenges for regulators and national institutions.

Despite a wider set of investment opportunities becoming available, speedier dissemination of information, and an increased ability to process it and form low-cost, systematic portfolios, may reduce some of the diversification benefits. Investor preferences may also become more correlated, leading to greater volatility. A lesson from past crises is not to rely on sophisticated quant models that use common assumptions and fail together.

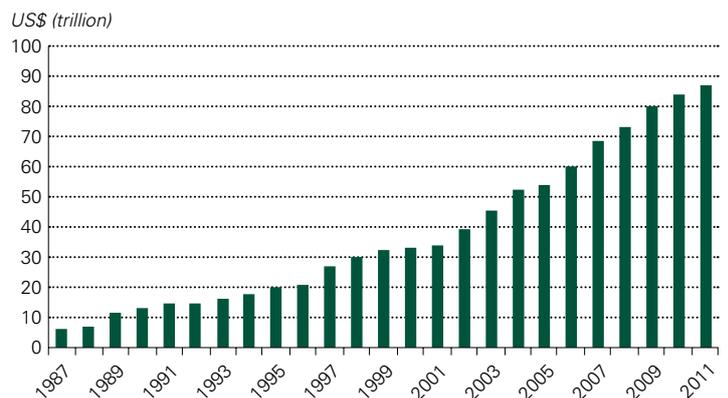
**Chart 5: Equity, bond and ETF market capitalisation over the last three decades**

### Stock market capitalisation



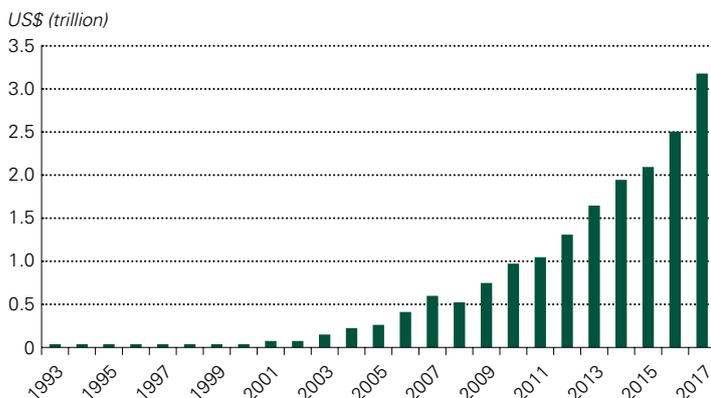
Source: World Bank; SSGA Demographics

### Bond market capitalisation



Source: BIS; SSGA Demographics

### ETF market capitalisation



Source: Bloomberg; SSGA Demographics

### US equity and bond market returns

Cumulative asset returns in the US from 1980 to 2016, without adjusting for inflation, demonstrate that, on average, equities performed best (**Chart 6**). A US\$1 equity investment in 1980 would have grown to US\$51.50 in nominal terms by the end of 2016. Long bonds and treasury bills generated less than equities (in nominal terms), but handsomely beat inflation.<sup>4</sup> Their respective index levels at the end of 2016 were US\$25.40 and US\$5.00, compared to US\$3.10 for inflation. When considering future returns, however, we need to be cautious about extrapolating from an era which includes two golden decades for equity and bond returns. Not only are term premia likely to change as new instruments and strategies emerge, but limits

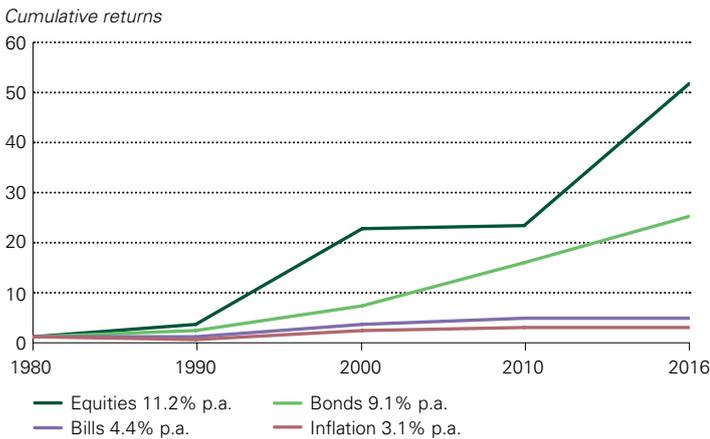
to arbitrage opportunities will prevent institutions from exploiting their size, capital, technology and human capital in the same way forever.

### Equity premium

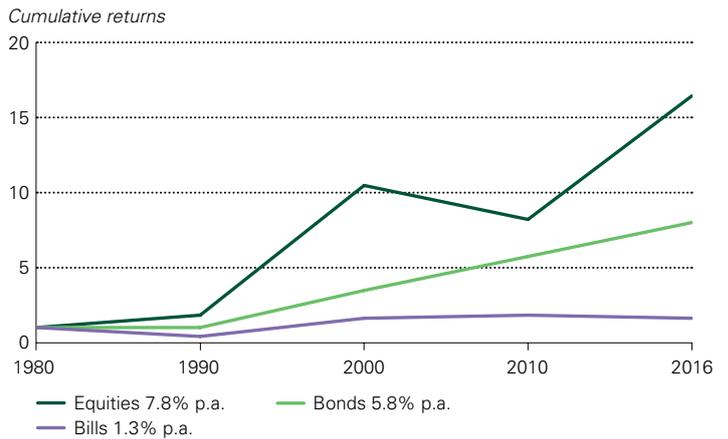
Theory suggests that equities should continue to outperform, subject to market cycles, but returns may be lower. Surveys of practitioners and academics point towards a continued decrease in the equity premium over the next 30 years. The reward for risk-taking will exist but change over time depending on the level of economic uncertainty. The search for yield has led to more investment that might previously have gone to equities flowing into real estate, infrastructure and EMs.

**Chart 6: Equity, bonds, bills and inflation: cumulative returns since 1980**

**US cumulative returns: asset classes in nominal terms**



**US cumulative returns: asset classes in real terms**



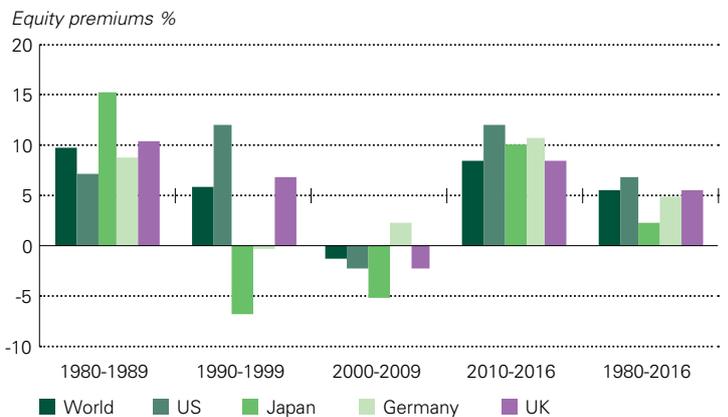
Past performance is not a reliable indicator of future returns.

**Chart 7: Equity premium versus bonds and bills**

**Equity premium vs. bonds**



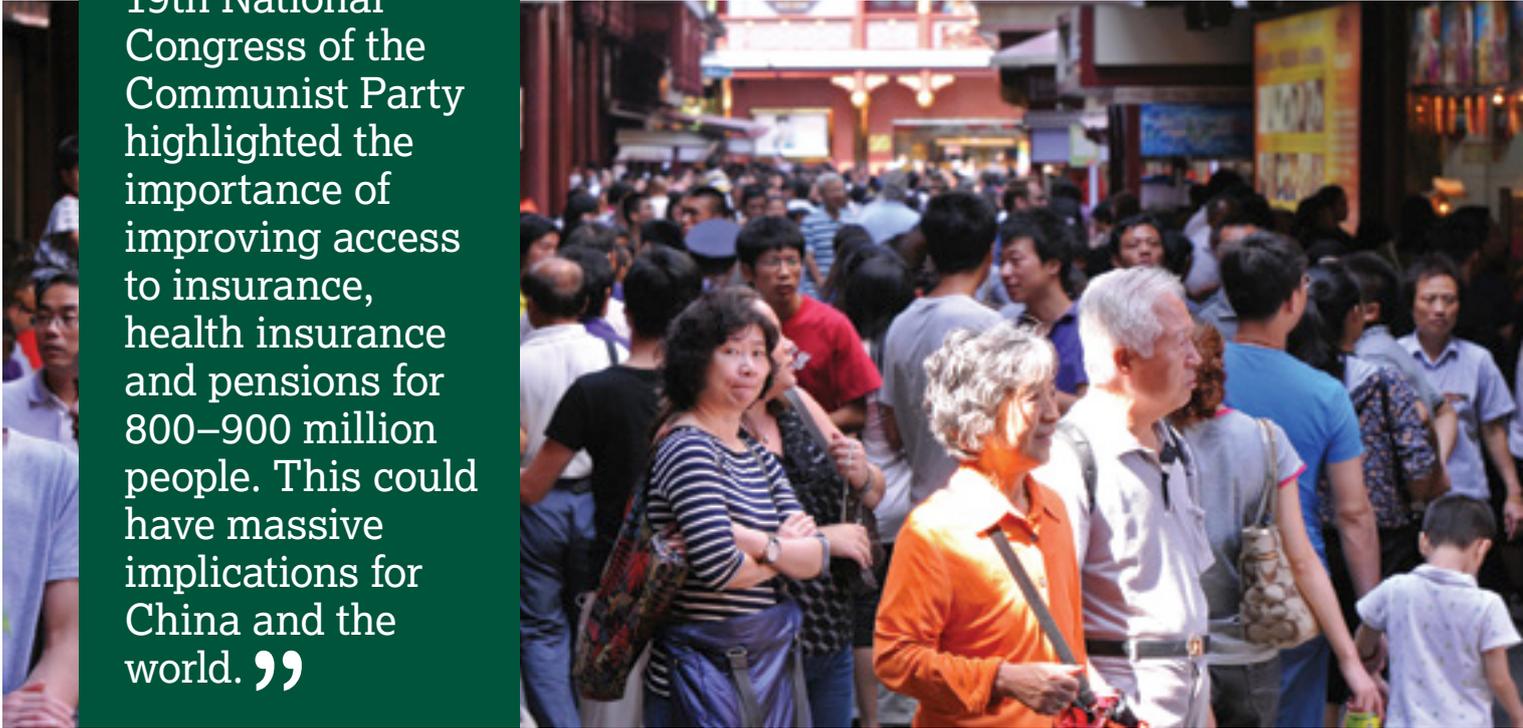
**Equity premium vs. bills**



Source: Credit Suisse Global Investment Returns Yearbook 2017 and Triumph of the Optimists (2001); SSGA Demographics

<sup>4</sup> Credit Suisse Global Investment Returns Yearbook 2017 and Triumph of the Optimists (2001).

“China’s recent 19th National Congress of the Communist Party highlighted the importance of improving access to insurance, health insurance and pensions for 800–900 million people. This could have massive implications for China and the world.”



**Emerging market bonds, corporate and private debt**

EM growth and increasing ownership of local companies by domestic and global investors have led to the development of EM local currency debt. We expect this process to gain momentum as developing countries need deeper, more efficient capital markets, including debt markets, if they are to grow past the middle-income trap that many find themselves in.

China’s recent 19th National Congress of the Communist Party highlighted the importance of improving access to insurance, health insurance and pensions for 800–900 million people. This could have massive implications for China and the world, as Chinese savings affect global capital flows, real estate and financial markets. If the

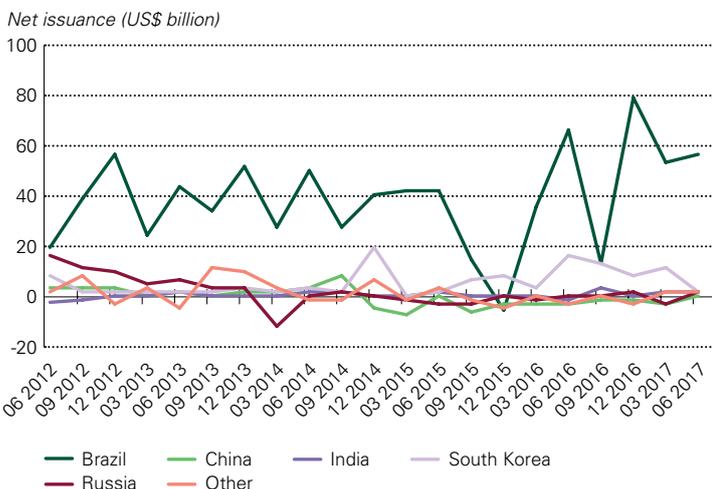
latent potential of the Chinese consumer were to be unlocked, we could see the emergence of a tech-savvy economic power that could become a staple of global investment portfolios.

Indeed, what constitutes an EM or a frontier market may change, with current EMs becoming DMs in some respects but not others. Conversely, some DM economies may face relegation if they fail to deal with growth, technology and public debt challenges.

The need for yield will continue to push investors towards EM debt. More institutions are likely to invest in private debt and structured credit while less liquid debt should become easier to access as more types of securities are traded electronically.

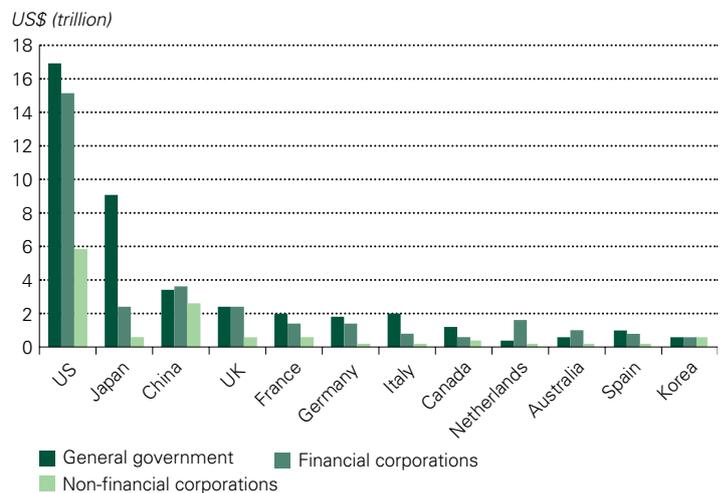
**Chart 8: Debt securities issued by EM borrowers**

**International debt securities issued by borrowers from EM economies**



Source: BIS; SSGA Demographics

**Total debt securities, by residence and sector of issuer**



### Commodities

Platinum apart, commodities have performed well recently, although there has been considerable volatility over the past three decades in silver and oil. Gold is especially popular in India and China, where the average family has more faith in the physical asset as a store of value than financial securities. We expect developments in structured products such as certificates, notes and ETFs to offer greater access to a range of commodities for institutional and retail investors. However, the incentive to switch from physical assets to securities will depend on stability and confidence in financial markets, which in turn will depend on broader political stability. We may also see the emergence of new commodities and stores of value, either as components of new products or as cheaper, more effective and resilient materials.

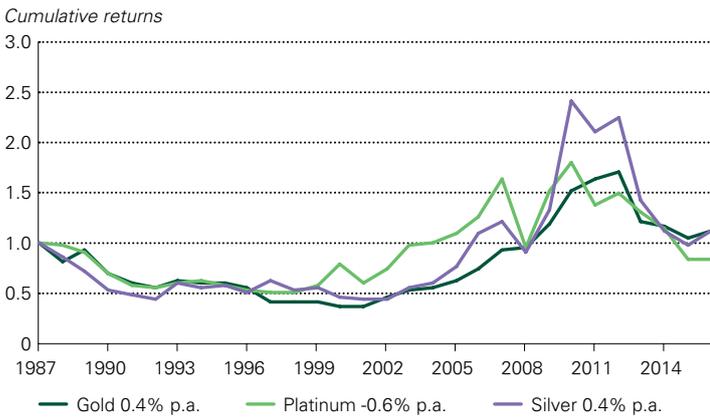
### Derivatives

Derivatives linked to commodities and other assets help investors manage future risk. However, excessive derivatives growth brings its own risks if they are used incorrectly by new participants or misused by existing ones. We anticipate that derivatives will continue to evolve to cover contingent states and facilitate better risk management as the future becomes more uncertain, while also being subject to changes in regulation.

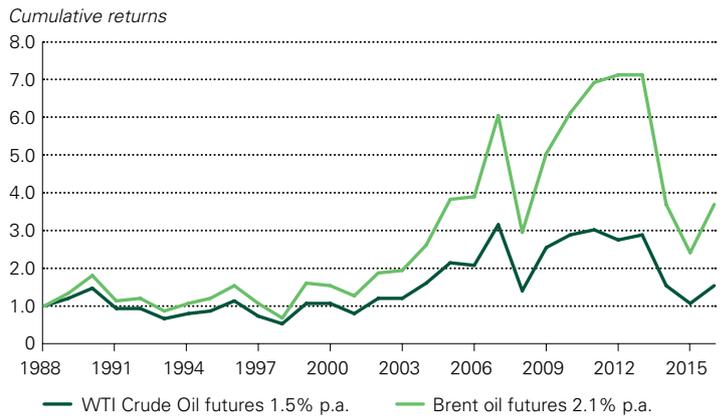
*Derivative investments may involve risks such as potential illiquidity of the markets and additional risk of loss of principal.*

**Chart 9: Gold, silver and platinum**

Precious metals (real cumulative returns)



Oil (real cumulative returns)

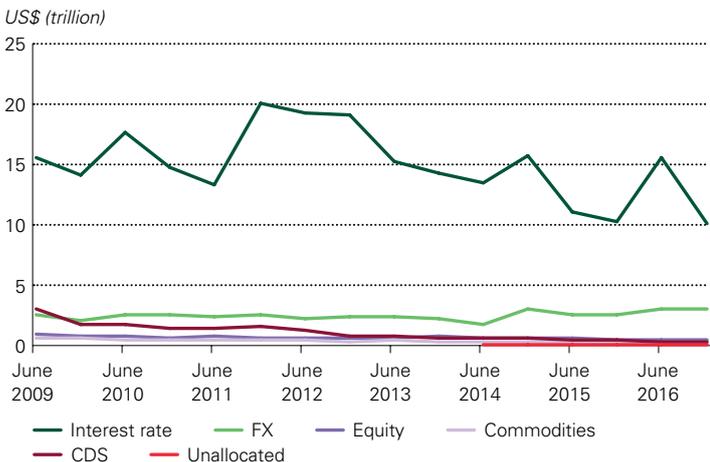


Past performance is not a reliable indicator of future returns. Investing in commodities entails significant risk and is not appropriate for all investors.

Source: Bloomberg; SSGA Demographics

**Chart 10: Gross market value of over-the-counter (OTC) derivatives**

Gross market value of global OTC derivatives markets



OTC commodity derivatives gross market value



Source: BIS; SSGA Demographics

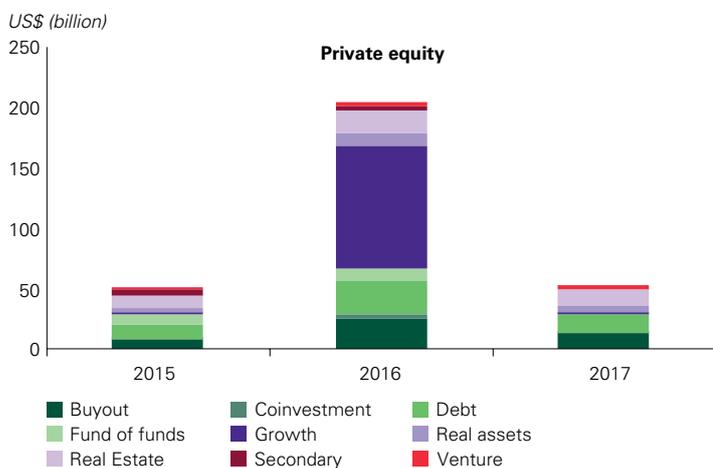
## Alternatives

By 2048, we think ‘alternatives’ – private equity (PE), debt and real estate – will become more mainstream and more regulated. Therefore, we expect that fees and illiquidity premiums will be reduced.

### Private equity

The Standard & Poor’s Listed Private Equity Index shows that from 2004 to 2016, PE annualised real returns were 4%. **Chart 11** shows the amount raised for 250 listed PE funds launched between 2015 and 2017, with a substantial proportion invested in growth, buyout and debt funds.

**Chart 11: PE fund-raising by category, 2015–17**



Source: Bloomberg; SSGA Demographics

Owners of private companies who devote significant time to governance to improve their underlying financial performance should (after fees) generate better returns for owners of PE funds. In a world of lower traditional asset returns, we expect PE to become more prevalent in investor portfolios.

### Hedge funds

Since the mid-1990s, the hedge fund industry has grown rapidly. The HFRX Global Hedge Fund Index indicates an annualised real return of 1.8% to investors from 1999 to 2016. We expect different hedge fund strategy styles to perform differently over future business cycles and strategy selection to become more important.

### Real estate

Research shows that the jump in US house prices since 1997 cannot be explained by population increases or interest rates.<sup>5</sup> Therefore, it is likely to be psychologically driven, with people buying real estate in the belief that prices will keep going up. At the same time, real estate supply and demand factors have evolved, leading to a broader ownership base. The Chinese, for example, are

now the largest foreign owners of US real estate. This trend is likely to continue, with investors from EMs buying real estate in DMs, in addition to owning more financial assets. Real estate investing is also likely to evolve, thanks to technology and new forms of lending.

### A changing world

We expect to see a very different investment world by 2048. EM countries will contribute more to GDP growth and asset returns, as PE and hedge funds extend into developing markets. Nearly 80% of the EM population will have access to some kind of investment, facilitating higher growth rates, better allocation of capital and less global and regional inequality.

Geopolitical factors are likely to become important determinants of portfolio outcomes, due to their impact on people and capital flows. Globalisation should continue, alongside demographic changes such as divergences in population growth and greater urbanisation. Newer, larger financial centres in the developing world should spur global growth and investment, but with a greater focus on environmental, social and governance (ESG) factors.

These changes will transform the economic landscape and the opportunity set of asset classes, as well as the risks. Artificial intelligence, big data, cryptocurrencies and machine learning will enhance insights into and applications of modern portfolio construction theory and risk management, as well as increase automated trading in liquid markets.

Alternative asset classes will be more widely used. Distinctions between active and passive investing will be less meaningful, as systematic approaches are combined with fundamental stock-picking to generate excess returns at the right cost. Finally, new institutional partnerships will develop to serve the needs of investors and generate sufficient returns by investing in future industries in a more sustainable and transparent manner. ■

#### Note:

This article may contain certain statements deemed to be forward-looking statements. Please note that any such statements are not guarantees of any future performance and that actual results or developments may differ materially from those projected in the forward-looking statements.

The information provided does not constitute investment advice and it should not be relied on as such.

Equity securities may fluctuate in value in response to the activities of individual companies and general market and economic conditions.

Bonds generally present less short-term risk and volatility than stocks, but contain interest rate risk (as interest rates rise, bond prices usually fall), issuer default risk, issuer credit risk, liquidity risk and inflation risk. These effects are usually pronounced for longer-term securities. Any fixed income security sold or redeemed prior to maturity may be subject to a substantial gain or loss.

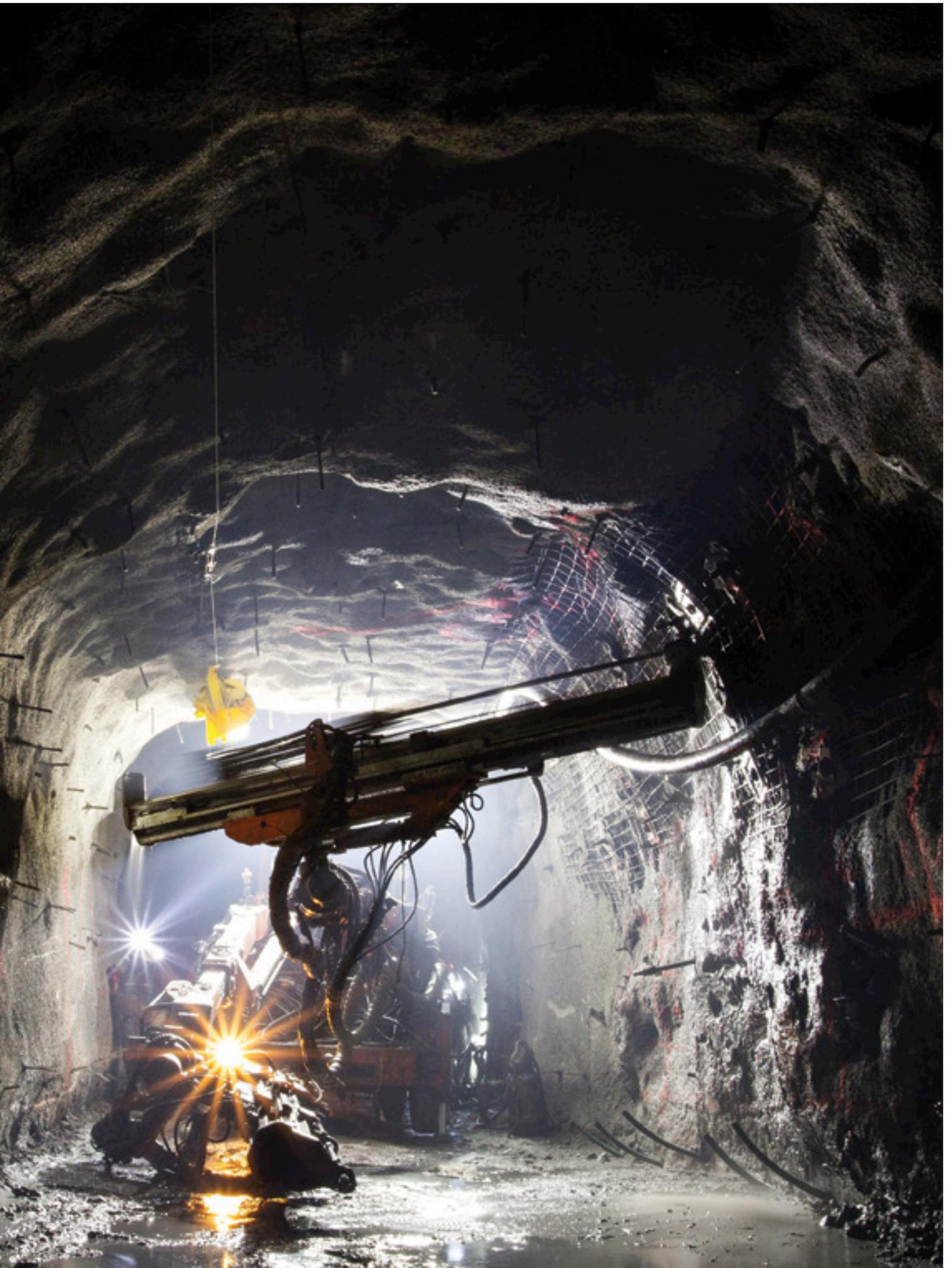
In general, ETFs can be expected to move up or down in value with the value of the applicable index. Although ETFs may be bought and sold on the exchange through any brokerage account, ETFs are not individually redeemable from the Fund. Investors may acquire ETFs and tender them for redemption through the Fund in Creation Unit Aggregations only; please see the prospectus for more details.

Diversification does not ensure a profit or guarantee against loss.

Investing in foreign domiciled securities may involve risk of capital loss from unfavourable fluctuation in currency values, withholding taxes, from differences in generally accepted accounting principles or from economic or political instability in other nations.

Investments in emerging or developing markets may be more volatile and less liquid than investing in developed markets and may involve exposure to economic structures that are generally less diverse and mature and to political systems which have less stability than those of more developed countries.

<sup>5</sup> Robert Shiller, *New York Times*: <http://insights.som.yale.edu/insights/housing-market-still-isnt-rational/>; *A Nation of Gamblers: Real Estate Speculation and American History*, Edward L. Glaeser, NBER Working Paper No. 1882.



# Gold production: a changing world



**Mark Fellows**  
Head of Mine Supply  
Metals Focus

Gold production has doubled in the past 30 years but few believe that trend will continue.

**Mark Fellows**, Head of Mine Supply, Metals Focus, explains why.

## The past 30 years of gold production

Historically, global gold mine production was dominated by South Africa, the US, Australia and Canada. By 1987, these 'big four' accounted for some 60% of all the gold ever mined (GFMS – Gold Survey). However, the past three decades have witnessed significant diversification of supply, and today the big four account for less than 30% of annual production (Metals Focus – Gold Focus 2017).

Geographical diversification has been accompanied by an unprecedented period of growth in gold production. In 2016, annual production hit its seventh consecutive all-time high, and was nearly double the levels of the late-1980s, when the World Gold Council was established. Continued growth from the US, Australia and Canada has been augmented by the rise of China and Russia as major gold producers. In particular, China surpassed South Africa in

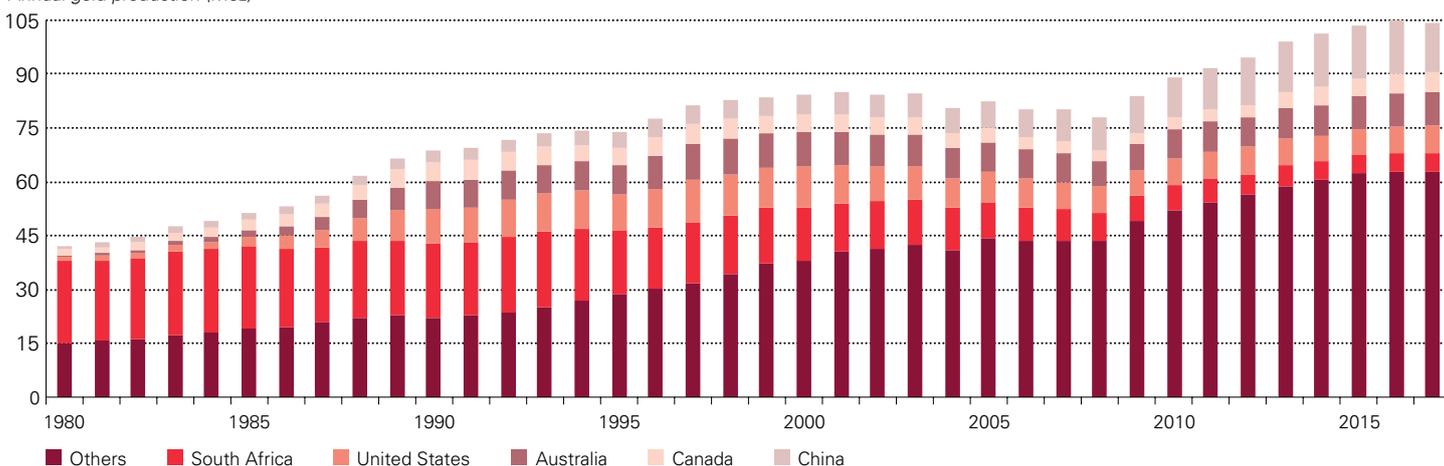
2007 to become the largest gold producer globally, and in 2016 produced 464 tonnes (t), around 60% more than Australia in second place. Meanwhile, Russia ranked third globally, with production of 274t.

As developing nations have opened up to foreign investment, there has also been a significant increase in gold production across Latin America, Africa and south-east Asia. As a result, the amount of gold ever mined has doubled since the mid-1970s, and now stands at around 190,000t (Metals Focus – Gold Focus 2017), equivalent to a solid cube just over 21 metres in height. If current mining rates were to be maintained for the next 30 years, we would add a further 97,000t of gold to current stocks by the end of 2048.

Where will this gold come from, and how much can the mining industry produce, given the extraction that has already taken place? To assess this, a number of factors should be taken into consideration.

**Chart 12: Historic gold mine production**

Annual gold production (Moz)



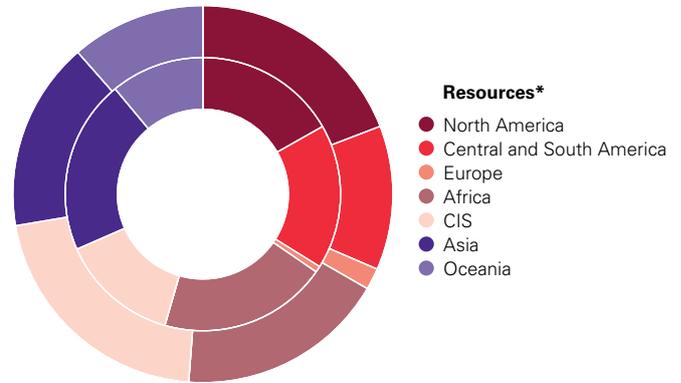
Source: Metals Focus; GFMS

## In-ground reserves of gold

As of end-2016, in-ground gold mineral reserves totalled a little over 55,000t (Metals Focus – Gold Focus 2017). Even including a generous metallurgical recovery factor of 90%, this would only provide the industry with enough ore for 15 years of production at current rates. However, there are an additional 110,000t of gold within known mineral resources, more than enough to carry existing supply rates beyond 2048.

This gold mineralisation cannot be classified as reserves because its recovery is either uneconomic at current prices or it has not received the detailed study required to prove its profitable recovery. At operating mines, which account for around 60% of these total resources, it often makes little financial sense to convert a resource into reserves too far in advance, particularly in underground mines where drilling deep-level deposits from surface or nearer surface levels is often costly. As for the 40% attributed to development projects, companies often prefer to look for better, more prospective targets rather than develop existing marginal resources.

Chart 13: Global gold resources\* versus mine production in 2017



\*Gold resources as of end-2016.  
Source: Metals Focus



“The rate at which gold is being discovered has declined over the past three decades, even though exploration budgets have risen almost continuously since the early-2000s.”

## Cost of construction and the necessary incentive pricing for new supply

Even as production has increased rapidly, so have production costs, rising by just under 10% per annum on average over the past 15 years (GFMS – Gold Survey/ Metals Focus – Gold Focus). At the same time, the costs of resource discovery and mine construction have also risen substantially. So significant capital investment will be required to bring the next generation of gold mines into production. This will have an important impact on future gold production, as some 30% of reserves are associated with assets where a construction decision has yet to be made.

At present, it is estimated that an incentive price of around US\$1,500 per ounce (/oz) is required to maintain global production at current levels. This assumes the following:

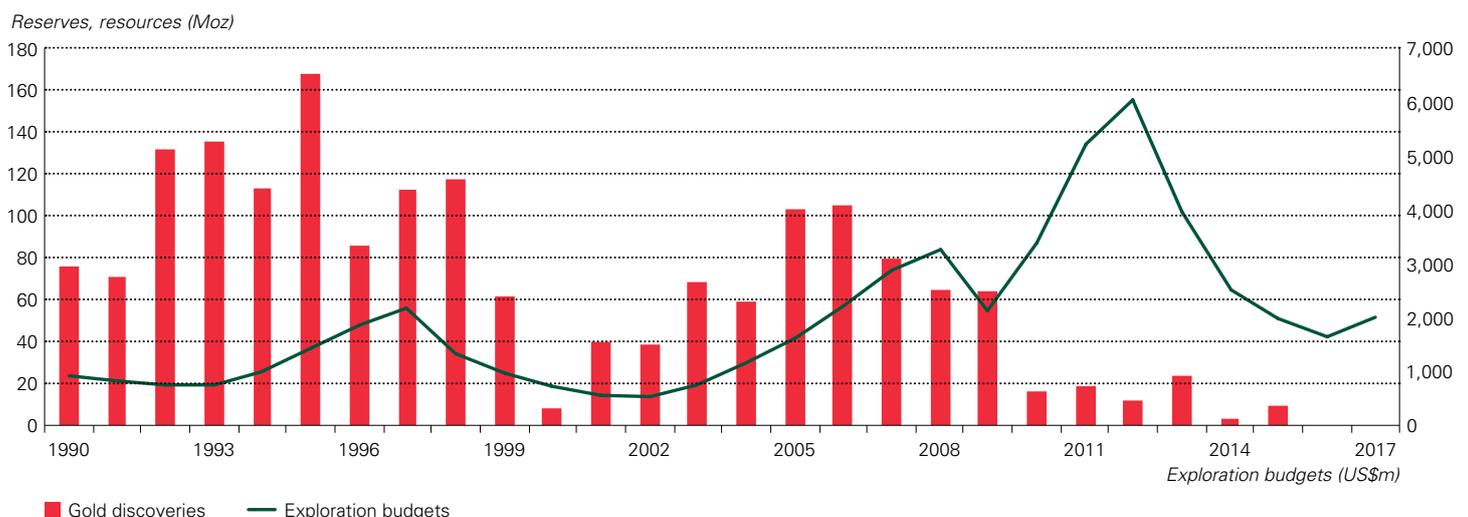
- a US\$75/oz average discovery cost for gold reserves through exploration (MinEx Consulting, 2016)
- an average capital cost (on a per ounce basis) to build a mine of US\$200/oz produced life-of-mine
- the 90th percentile of the gold mining industry's all-in sustaining costs sits at US\$1,150 (Metals Focus – Gold Focus 2017)
- a return on investment of 15%, which could be considered at the lower end of acceptability, especially for less politically secure countries.

## Diminishing returns on exploration and the lack of 'world-class' discoveries

An analysis of historic gold discoveries highlights a number of concerns for a mining industry looking to sustain gold production at or near current levels over the next 30 years. First, after peaking in the 1980s (MinEx Consulting, 2016), the rate at which gold is being discovered has declined over the past three decades, even though exploration budgets have risen almost continuously since the early-2000s.

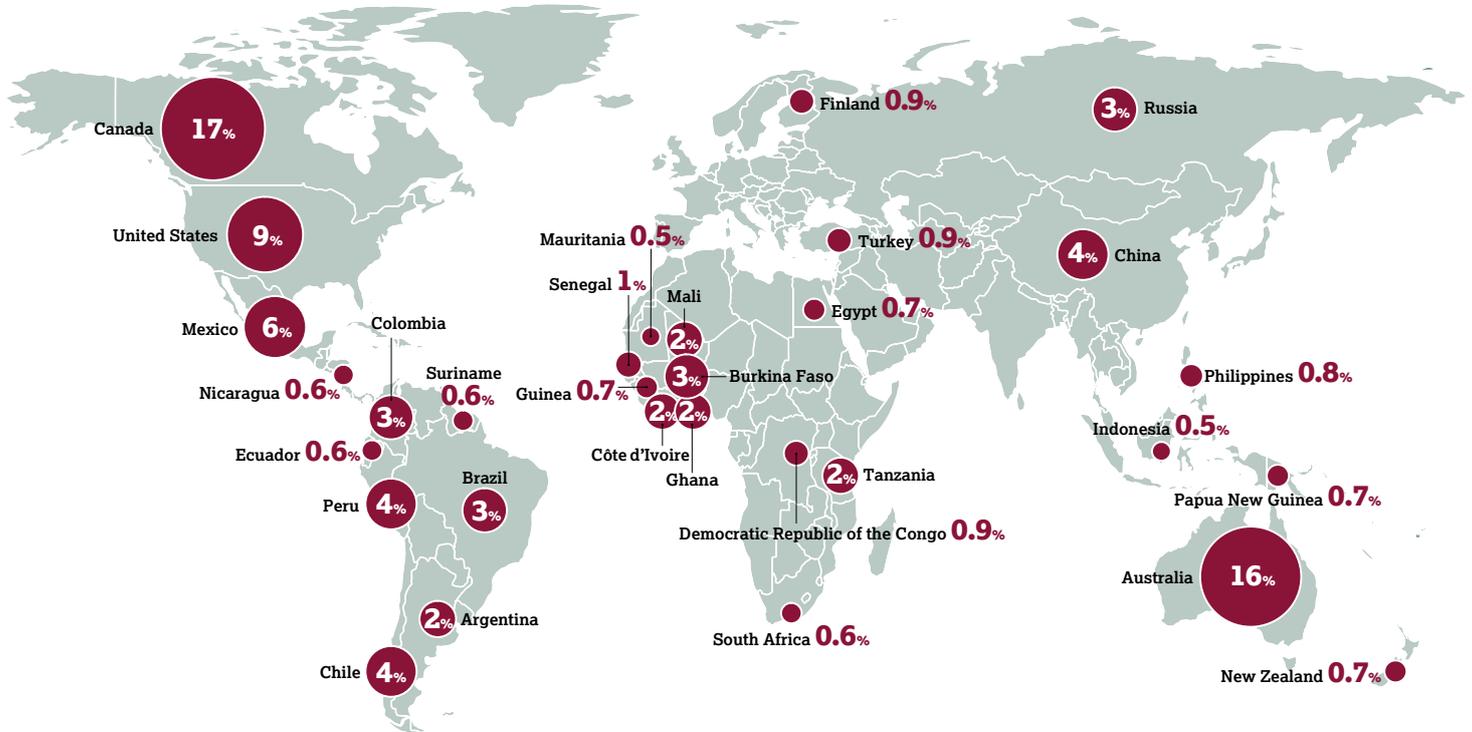
Second, there has been a distinct lack of 'world-class' discoveries (ie those over 5 million ounces (Moz/155t) that can be turned into large, world-class gold mines capable of producing over 250koz/7.8t per annum. A key concern for many of the world's largest mining companies, this is clearly illustrated by the expected capacity of projects in the development pipeline. In contrast to the current population of operating gold mines, the future pipeline is almost devoid of projects capable of producing over 250koz/7.8t per annum. To highlight the potential impact on future gold output, mines producing over this threshold are responsible for around 50% of global production today. This would imply that, as the sector evolves, gold production will be sourced from a greater number of smaller operations, or face a sharp contraction in capacity.

**Chart 14: Gold discoveries versus exploration expenditure**



Source: S&P Global Market Intelligence; World Gold Council

Gold exploration budgets by country in 2017\*



\* Data as of 28 September 2017. From 901 companies budgeting US\$4.05 billion. Source: S&P Global Market Intelligence

Mineral exploration methods have contributed to this trend of diminishing discoveries. Exploration methods often focus on looking for new discoveries along geological trends from existing deposits, rather than staking out new areas. In many instances, these are not virgin tenements so the chance of finding a large new discovery is reduced. Highlighting this trend, exploration budgets continue to concentrate on Australia, Canada and the US, which have absorbed nearly 40% of the global budget since 2005. In comparison, Africa has received just 15% (S&P Global Market Intelligence – Corporate Exploration Strategies), in spite of the continent’s highly prospective geology and large land mass.

Corporate strategies have encouraged this trend too. A number of financial incentives foster exploration in established, gold-producing countries, as well as the political environment, local infrastructure and availability of skilled labour and equipment. Crucially too, any discoveries will ultimately hold a far greater value, due to their simpler and safer path to production. Recent issues between the government and mining companies in Tanzania exemplify the significant headwinds slowing Africa’s potential rise.

The dominance of the established gold-producing nations has been prolonged by two further factors: companies’ increasing focus on near-mine exploration and their ability to find additional mineral deposits near existing mining infrastructure and expertise. The thinking behind this is clear. First, given the significant inflation in construction and operating costs over the past decade, investment to expand or extend a mine’s production life – using existing infrastructure – often offers a far greater return on investment. Second, the time required to bring a project from discovery to production has doubled over the past two decades and currently sits at around 20 years (S&P Global Market Intelligence). As such, brownfield developments generally offer a far easier route to maintaining output than their greenfield counterparts.

However, as returns on exploration continue to diminish, budgets will have to be directed further afield. Arguably, there is an urgent need for this in the US and Australia, where, in spite of significant investment in the last bull cycle, gold production has failed to surpass previous peaks set in the late-1990s and early-2000s respectively. In comparison, Canada is relatively underexploited for gold, with much of its northern region only starting to be more rigorously explored.

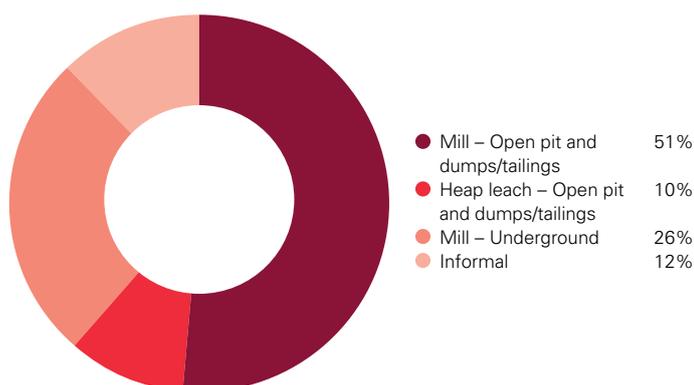
Africa stands to benefit from this change in exploration and development focus. The continent is already a significant gold producer, accounting for a fifth of global mine supply in 2016. However, given its relative size and highly prospective geology (evidenced by the volume and broad distribution of African artisanal gold production), the continent beyond South Africa is relatively underexplored compared with the big four. It is a similar story in countries such as Brazil and other parts of west coast South America, as well as more recent gold-producing nations such as Russia, Kazakhstan and China. Overall, therefore, we are likely to see continued diversification of supply during the coming decades.

## Underground gold mines stage a comeback

Since the early-1970s, the percentage of gold sourced from underground operations has fallen significantly and currently stands at around 25%. Several factors lie behind this trend. First, far less gold is sourced from South Africa and the deep-level mines of the Witwatersrand Basin. Second, low-grade ore can now be processed using new technologies, such as heap leaching, facilitating the development of lower-grade open pit deposits. And third, ever-larger mining and processing equipment have helped to deliver economies of scale. In line with this trend, the average grade of processed ore has fallen markedly, from over 10 grammes (g)/t in the early-1970s (MinEx Consulting, 2016) to around 1.4g/t currently (Metals Focus – Gold Focus 2017).

In future however, the trend towards open pit mining looks set to reverse. The average depth at which new gold deposits are being discovered continues to deepen (MinEx Consulting, 2016), meaning that a higher percentage will be better suited to underground extraction methods. Also, mining will transition underground at an increasing number of brownfield developments so that companies can exploit orebodies at depth. This theme is already common in the more mature gold fields of Western Australia.

Chart 15: Global gold production by mine type in 2016



Source: Metals Focus

Technological improvements, including machine automation, will contribute to this trend as well, reducing labour costs, which often comprise a materially higher share of overall operating costs at underground mines. These developments should help to arrest a four-decade-long trend of declining ore grades, as underground mines generally mine significantly higher grade ore than their open pit counterparts.

“The wave of technological change which we are currently experiencing, facilitated by increased computing power and connectivity, will radically alter the way in which mining is carried out over the next 30 years.”

Other potentially game-changing technologies might include new processing methods for ore which is currently too low grade or refractory (difficult to extract gold from due to mineral composition). It seems certain that the wave of technological change that we are experiencing, facilitated by increased computing power and connectivity, will radically alter the way in which mining is carried out over the next 30 years. These changes are also likely to alter the economics of the industry, allowing lower grade ore to be mined profitably.

## Beyond the traditional locations for mining

Outside traditional land-based mining techniques, a number of companies are looking into the potential for mining elsewhere. While a commercially viable asteroid mining operation looks very unlikely within the next three decades, seafloor mining could be a notable source of supply by 2048. The basic idea is to use existing technologies adapted from the offshore oil and gas industry, combined with rock-cutting and materials-handling technologies used in land-based operations, to extract from high-grade seafloor massive sulphide (SMS) systems and polymetallic nodules (which generally contain copper in addition to significant concentrations of gold and other metals). Although it is still at an early stage, if successful this technology, or technologies that follow from it, could be scalable, as there are estimated to be in the region of 5,000 SMS systems worldwide (Nautilus Minerals, 2017).

“Although the industry can sustain production around current record levels for the next few years, global mine supply looks set to enter a period of secular decline over the longer term.”



Gold mine processing plant.

## The general trend in mine supply is most likely down

The fact that current reserves only cover the next 15 years is not unusual within the history of the gold mining sector, as this window has historically provided ample time for the replacement of mined ounces. However, as with all commodities, gold is a finite resource, even more so when exploration has concentrated on just a handful of countries. As a result, it seems that although the industry can sustain production around current record levels for the next few years, global mine supply looks set to enter a period of secular decline over the longer term.

The rate of this downturn will be dictated by many factors, not least gold prices, technological (cost-saving) advances and the ongoing instability of countries in Africa and the Americas. In addition, the potential development of a new mining or processing method or discovery of a second (or third) Witwatersrand-style deposit could be a step change. The Witwatersrand Basin in South Africa has been responsible for around one-third of the gold ever mined, and it still has significant resources left. There is hype surrounding the discovery of similar mineralisation, although very much in its infancy, within the Pilbara region of Western Australia. This could prove to be a once-in-a-century discovery and so help to dictate the course of gold production over the next three or so decades. ■

### Works cited

- GFMS – Gold Survey.
- Metals Focus – Gold Focus.
- MinEx Consulting. (2016). *Long term trends in gold exploration*.
- Nautilus Minerals. (2017).
- S&P Global Market Intelligence – Corporate Exploration Strategies.

# Gold mining: on the cusp of change



**Michelle Ash**  
Chief Innovation Officer  
Barrick Gold Corporation

Gold mining has evolved considerably over the past 30 years but even greater change may lie ahead. **Michelle Ash**, Chief Innovation Officer at Barrick Gold Corporation, discusses some of the most likely developments.

The mining environment is in the throes of exceptional change. Governments are demanding greater royalties or percentage of ownership; environmental concerns are rising around land, water, waste and dust; and employees are becoming more technologically aware and connected through social media.

All of these pressures will almost certainly drive mining into a number of different places over the next 30 years.

First, I believe that open pit mining will become increasingly unpalatable to local communities and central governments. Even today there is growing antipathy to the use of large amounts of land for mining, especially in developing countries where subsistence farming is practised. Over time, this aversion is likely to become more pronounced, driving mining increasingly underground.

Tailing stands are attracting more criticism too, particularly wet tailing stands. Initially, this is likely to encourage greater adoption of dry tailing. Ultimately, it will almost certainly force mining companies to look at how much waste they move at all.

Pressure around tailing stands will clearly accelerate the shift towards underground mining but it also poses questions about how mines themselves are designed. The rise of automation, artificial intelligence (AI) and better sensing technology will probably lead to smaller tunnels, more compact equipment and the complete removal of people from below ground.



“Open pit mining will become increasingly unpalatable to local communities and central governments.”

Barrick's Cortez mine in northern Nevada, US.

Of course, workers will still be needed at the surface to manage the machines but there should be no need, over time, for miners to work deep underground.

Processing will change too, as the use of cyanide, ammonium nitrate and chemicals more generally becomes increasingly unacceptable. Even though cyanide is safe for use in mining when the proper standards and procedures are applied, such as the International Cyanide Management Code, it continues to be a significant concern for stakeholders who would prefer to eliminate any possible risk.

In fact, it seems likely that the decyanidation of the gold industry will occur quite rapidly. And with that, even processing plants above ground will become less welcome. That is likely to engender more processing at the face and a rise in micro processing. Against this backdrop, I believe that underground explosives will gradually be replaced by continuous and mechanical cutting. Given that mechanical cutting creates smaller chips, grinders could be smaller; compact processing facilities could be installed at the back end, and a much more concentrated form of the product could emerge from the mine.

Even today, mechanical cutting is more prevalent, as it tends to be considerably more accurate and precise than explosive methodology. At present, mechanical devices have limited

success with very hard rock but that is likely to change as technology advances. In the coming decades therefore, mechanical cutting will most likely become the norm, making the concept of processing behind the machine, using small mobile processing plants, increasingly feasible.

Small processing units may also need to be developed to manage situations where it is not economically feasible to mine underground. Given that open pits, waste dumps, tailing stands and big processing plants are likely to come up against increasing criticism, miners will have to create alternative solutions to traditional methods. These may involve extracting ore through drilling holes and putting chemicals or micro processing units down them. I would suggest that this approach may well become workable over the next 30 years.

It seems likely too, that mining companies will turn their attention to marine-based projects. Given that two-thirds of the world's surface is beneath the ocean, and gold is probably distributed fairly uniformly across the globe, it is statistically likely that a considerable amount of gold lies beneath the ocean.

This presents a number of challenges but they can almost certainly be overcome in the next 30 years or so.

“Whether below ground or below sea, automation will become an increasing feature of the gold mining industry, replacing dangerous, repetitive and high computation activities.”



The control room at Hemlo mine.

Of course, in terms of exploration, we will need to develop suitable drill rigs and sensor technology, combined with big data analytics and machine learning, to pinpoint where some of these deposits are. We then have to think about how best to extract them. If we can find a way to start the tunnelling process, dewater it and create an airlock, it would be possible to develop an underground mine in the same way as on land. We could then use small processing facilities close to the face to send up a concentrated slurry form of the mineral.

Technology will have to improve but this scenario is certainly feasible when we look at the future of gold mining.

In fact, there is already an example of marine-based mining in China where the mine is 700m below the seabed, with 200m of water cover.

I believe sub-ocean mining is considerably more practical than alluvial mining, dredging river deltas and such to extract gold. Alluvial gold is invariably close to land and shallow areas so it is more likely to overlap with spots where there are significant fish life, seaweed, fishing and other people-based activities. In other words, alluvial gold mining creates many more environmental issues than appropriately conceived marine mining.

Whether below ground or below sea, automation will become an increasing feature of the gold mining industry, replacing dangerous, repetitive and high computation activities. That will leave the creative, developmental, strategic and tactical work to people, as well as, of course, the management and maintenance of these automated machines or robots.

On another front, energy is an increasing issue for the industry – how to reduce our usage of fossil fuels and increase our usage of renewable or battery-powered energy. Solar energy is already much cheaper than diesel and new solar panels are being developed that can be used for up to 14 hours at a time. As solar technology continues to improve and there are further developments in battery storage, renewable energy should become an increasingly viable option for the gold mining industry.

At the moment, the economics can be difficult, as this type of technology often needs to be up and running for at least 25 years to make commercial sense. This is not an insurmountable problem, but there may have to be government contributions or offtake agreements beyond the mine life to improve the economic appeal of these applications.

Finally, I think there will be significant change in ownership and wealth distribution over the next 30 years.

Today, central governments tend to own 5%–10% of local gold mines and receive royalties from gold mining companies once a mine moves into production. Talks are already under way to increase government ownership in countries such as Mongolia, Guinea and Tanzania and that trend is set to continue.

Barrick Veladero uses solar panels to cover specific installations.



“As solar technology continues to improve and there are further developments around battery storage, renewable energy should become an increasingly viable option.”

More fundamentally, however, discussions are likely to centre on how best to distribute wealth so that local communities are appropriately and sustainably advantaged, when new gold mines are built.

Local communities often feel that they are most disadvantaged and least compensated by the advent of a new gold mine. Technological change may increase this perception, particularly as the number of unskilled and semi-skilled jobs reduces.

Over time, however, gold miners could use technology to create more sustainable change in the communities where they operate, moving the conversation from mine-dependent job creation to broader wealth creation, built around education, commerce and enterprise.

If we consider that there is frequently a 10-year gap from when gold is first discovered in a given area to commercial production, that period could be used to improve connectivity and education as well as generally encourage enterprise.

Overall, I believe that gold mining is likely to experience significant change over the next 30 years, driven by environmental, social and governance needs, as well as major advances in technology. Played out well, these changes have the potential to benefit all stakeholders. ■

# A sustainable pathway for the gold industry



**Brent Bergeron**  
Executive Vice President  
Corporate Affairs and  
Sustainability  
Goldcorp

Environmental, social and governance issues have risen up the corporate agenda over the past 30 years and that trend is likely to accelerate in future. **Brent Bergeron**, Executive Vice President of Corporate Affairs and Sustainability at Goldcorp, considers the steps that gold mining companies will need to take over the next 30 years to be perceived as responsible corporate citizens.

Goldcorp was incorporated in 1994. Since then we have grown substantially through acquisition. Along the way, we have inherited a number of legacy sites, which are now in various stages of reclamation. The process is extensive, costly and in many cases involves input from Goldcorp in perpetuity. Of course, we are not alone in this. Many gold mining companies face the same issues, which affect not just our bottom line but also the perception of our industry.

This is significant when we look to the future because the decisions that we make today will have a direct impact on the way our industry operates, the income we generate and the reputation we enjoy in 30 years' time.

So, how should we behave today to ensure that our industry is profitable, effective and well regarded tomorrow?

First, we need to be able to shape the way policies, standards and regulations develop. In the past, we tended to take a reactive role, only becoming involved in the conversation once proposals have been put forward.

But, if we want to ensure that the policies of the future are at least revenue neutral and take into account long-term risk mitigation practices, we have to be part of ongoing discussions that affect our industry. We must be clear with governments and regulators about what we want to achieve, the benchmarks and targets that we set for ourselves, the benefits that we can reap from rapidly advancing technological innovations and how we will be held accountable to evolving societal expectations.

That does not mean attempting to dilute every policy that we encounter. On the contrary, some companies are already moving faster than governments expect in reducing water and energy consumption and minimising their carbon footprint. Nonetheless, we are often seen as adversaries, rather than partners.

**That needs to change.**



Goldcorp Peñasquito mine.

“Goldcorp’s Borden mine in Ontario will be the first fully electric underground mine.”



Borden electric mining vehicle.

## Shifting mindset

It is no longer good enough for companies in our industry to see themselves as simply mining businesses that produce gold and generate returns for their investors – that kind of outlook certainly will not cut it in 2048. Instead, we need to step back and consider how we will work in partnership with governments and all our stakeholders to deliver both social and financial benefits to society. I believe that an emphasis on partnership will become increasingly important over the next 30 years.

“Our projects are so large and our investments so significant that we tend to stick with what we know rather than consider how we can make new technology and new ideas work for us.”

We also need to move from the traditional ways of doing business. Our projects are so large, our capital investments so significant that we tend to stick with what we know, rather than considering how we can make new technology and new ideas work for us.

Looking ahead, we need to collaborate with new and different partners, bringing the best new developments to the mining process and rapidly commercialising them through our technical process. This does not just mean adding more data processing power or using robotics to increase automation. It is about considering how we can fundamentally change mining processes to positively impact our water and energy usage and ecological footprint both during *and* after production.

Major operational shifts are already under way in our industry. Goldcorp’s Borden mine in Ontario, for example, will be the first fully electric underground mine, benefiting not only the environment but also our workers, by eliminating the use of diesel-powered equipment from our fleet.

Over the next three decades, this may become commonplace or even mandatory. And once companies begin to introduce electrical equipment and alternative energy sources to their operations, that should ultimately allow them to reduce costs over the life of the mine, so the switch becomes a value driver.

## Environmental, social, financial

That can create a virtuous circle. The financial benefits of environmental and social innovation encourage further innovation, prompting new ideas and leading to more environmental and social benefits that also drive financial value.

Making bold moves that benefit the environment, employees and communities has broader implications – society tends to see you as progressive and a force for good. And governments see you as a business they want to collaborate with and support.

Borden exemplifies this as a blueprint for the future, and hopefully a time when we can be seen as innovators and pioneers, rather than old-school traditionalists.

Those stuck in old ways of thinking will be left behind. Once governments and society see that there are better ways of operating mines that supply the materials necessary for modern society, more responsible operations will become the benchmark against which all other operations will be compared. If they are found lacking, they are likely to face resistance, if not from governments themselves, then from other stakeholders.

Energy is clearly a big issue for our industry but so is water usage. Over the next 30 years, there will be a growing need to move to 'zero water'. That does not mean eliminating water completely from the mining process but it does mean reducing overall usage, not needing to source extra water from surrounding communities, and reusing all our water.

There are lots of ideas around this concept already. Our EcoTails technology incorporates some of them and, importantly I believe, it shows that our industry can be in the vanguard of progress.

## True costs

It also suggests that wet tailings have no future in our industry, certainly not three decades hence. As we know, filtered tailings already exist but the process involves significant investment at the beginning of a project. Conversely, our industry is financially incentivised to focus on wet tailings because companies discount the cost of reclamation in 30 years' time down to zero today from an accounting perspective.

We are actively trying to address this right now by attributing a cost and/or a value on water usage. But we are also looking at the financial implications of closure and reclamation differently so we can understand the true long-term impact of the decisions and the investments that we make today.

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“ We need to start making decisions based upon costs incurred across the entire mine life – not just during construction and production but also reclamation and maintenance. ”  
.....

This is where mining companies need to change. We need to start making decisions based upon costs incurred across the entire mine life – not just during construction and production but also the costs of reclamation and maintenance well beyond closure. And let's remember, in many cases, we are paying in perpetuity for the monitoring and maintenance of infrastructure left behind after mine closure – that is neither economically nor socially viable when we look 30 years ahead.

Community relations are also encouraging us to take a longer-term perspective than ever before. In Northern Canada, for example, discussions with the First Nation indigenous communities stretch way out in the future about what will be left behind on their traditional territories once the mine has closed. That is clearly the right perspective. We are digging a huge hole in their ground and they want to know what the positive counterbalance will be for them. Of course, there are economic benefits but we need to show that we are serious about sustainability: that we care about the land and that it will be returned to them in the right way.

I hope we will see increased collaboration with local communities in the future. Working together is key so that both sides recognise their responsibilities and respect each other's concerns.

## Supply evolution

Looking more broadly at our industry, we also need to develop stronger partnerships in our supply chain. Most of our suppliers make minor improvements to the same type of equipment that they have always built and continue to sell it to our industry.



“Traditionalists will be left behind. Once governments see that there are better ways of operating a mine, those ways will become the benchmark against which all other operations will be compared.”

Water testing at Balmer Lake, part of Goldcorp's Red Lake gold mine.

That will have to evolve. We need to create a different vision for how we want our mines to operate and the type of equipment that will be necessary. In some cases, the requisite technology may not have been developed; or it may have been developed but not adapted for use in our industry. So we need to partner with our suppliers to ensure that equipment is both cutting edge and fit for purpose in a world where priorities are changing fast.

As an industry, we can be much more proactive. We can demonstrate that we are aware of what society wants and expects from us and we can demonstrate new processes, new projects and innovative ideas.

The cost of failing to evolve could be great – ensuing regulations may increase the cost of doing business without actually reducing mining's overall footprint. Mining may become uneconomic at certain properties, which would be unfortunate because, when it's done well, mining can be an important driver of local wealth and prosperity.

Even today, mining has been banned in certain jurisdictions, reflecting great mistrust and disappointment in the way our industry has conducted itself in the past and, to a certain extent, continues to act today.

So clearly there are real opportunities here. We need to show that we are progressive, we can do things the right way and that, in so doing, we can create positive impacts for all stakeholders. Above all, we need to show that we are prepared to do more than just talk about change. Instead, we need to move the needle in terms of our actions.

That means a typical mine will be quite different in 2048: fully electrically powered, largely consuming renewable energy and using much less water and discharging none. The use of wet tailings will almost certainly be eliminated. We will need to conform to tougher environmental regulations, developed by mining companies in collaboration with governments and stakeholders. And we will have an even longer-term outlook than exists today. Stakeholder benefits will be mapped out before, during and after a mine is operational, so that expectations are clear. And even the first feasibility study will include environmental and rehabilitation plans that stretch across the mine life and beyond.

If we get it right, our industry will have a very different reputation and place in the world in 2048. Looking ahead, there really is no alternative. ■

# Gold 2048: technology on the rise



**Dr Trevor Keel**  
Consultant  
World Gold Council

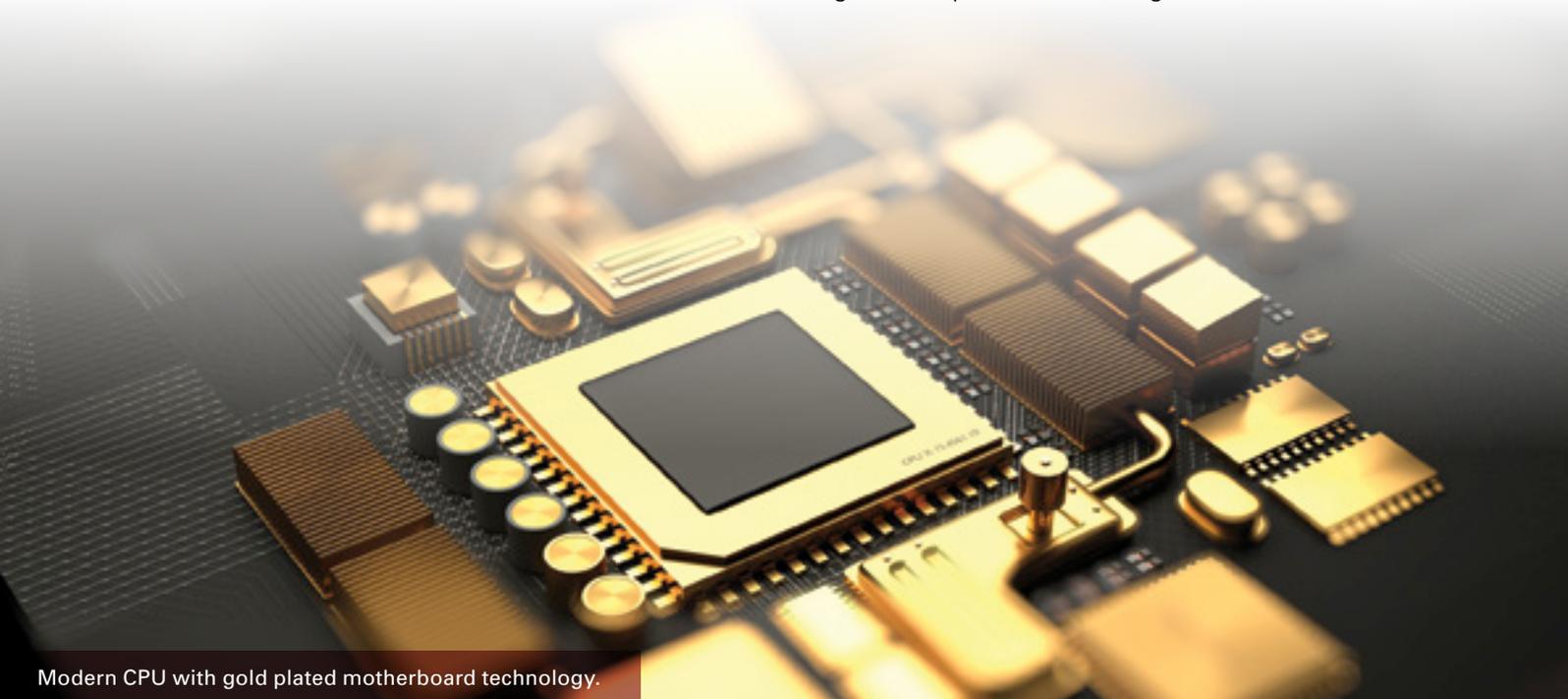
Technology already makes an enormous contribution to industries around the world and its relevance is likely only to increase. As a key component in this industry, gold almost certainly likely play an essential role over the next three decades, as World Gold Council consultant **Dr Trevor Keel** explains.

Successfully predicting the evolution of new technologies is notoriously challenging. Scientific breakthroughs, societal need, politics and simple serendipity all combine to shape our future, and none is easy to determine or predict with any certainty.

Of these four categories, societal need probably provides most clues about the evolution of technology over the next three decades. According to the United Nations, the world's population is projected to be close to 10 billion people in the years leading up to 2050.<sup>6</sup> This unprecedented level of growth represents over two billion additional people to feed, transport, clothe and keep warm and healthy.

It is an enormous challenge, probably the single biggest issue we face as a society. If we consider water availability alone, the World Health Organization (WHO) reports that in 2017, three out of ten people worldwide (over two billion individuals) lacked access to safe, accessible water at home.<sup>7</sup> Adding rapid population growth, growing water scarcity and ongoing climate change to this equation makes for sobering reading.

However, the challenges will undoubtedly be matched by the opportunities. According to US research group Brookings, the coming decades will see unprecedented growth of middle-class populations, particularly across Asia.<sup>8</sup> This will drive demand for improved technologies and healthcare provision, while simultaneously producing an ever-larger pool of well-educated scientists and engineers capable of delivering such innovations.



Modern CPU with gold plated motherboard technology.

6 <https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html>

7 <http://www.who.int/mediacentre/news/releases/2017/water-sanitation-hygiene/en/>

8 [https://www.brookings.edu/wp-content/uploads/2017/02/global\\_20170228\\_global-middle-class.pdf](https://www.brookings.edu/wp-content/uploads/2017/02/global_20170228_global-middle-class.pdf)

Throughout history, humankind has evolved to face and defeat obstacles through scientific progress. Over the past three decades, gold has played a critical, yet rarely discussed, role in the evolution of technology: here we consider its impact in the future.

## Why gold?

In recent times, gold has become an increasingly important industrial metal. Malleable, highly conductive and corrosion resistant, it has assumed a critical role in the electronics industry, as a key component of thin conductive wires and coatings. Practically every item of electronic equipment contains a small quantity of gold, including the most recently released smartphone technology. Gold nanoparticles (tiny particles of gold many thousands of times smaller than the width of a human hair) are also widely used in the healthcare and clean technology sectors, thanks to their unique properties and cost-effectiveness. We believe gold will continue to be at the heart of research and development (R&D) programmes around the world and help to tackle many of the challenges we face in 2048.

## Satisfying a technology-hungry world

In 2018, technology already touches practically every aspect of our lives. In 2048, it is likely to be even more pervasive – and there will be a much larger pool of people with the education, infrastructure and financial means to access and use the latest technologies. This represents an enormous opportunity for innovators the world over, as huge, wealthy markets await the best ideas. A single thread will run through all these technical advances: access to improved electronics.

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“Gold remains the material of choice for a variety of applications across the technology space. That is expected to continue and evolve over the coming decades.”

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It will require better and more diverse functionalities, which will, in turn, demand innovative sensors and chips. Gold remains the material of choice for a variety of applications across the technology space. That is expected to continue and evolve over the coming decades.

Of course, we cannot know for sure how technology will develop between now and 2048. But we do know that demand is likely to be enormous. Here are a few key sectors that may be of particular significance.

### Electric and autonomous vehicles

Providing safe, comfortable and environmentally friendly transportation to a growing population represents a huge challenge for policymakers. Existing infrastructure is already operating at or near-capacity in many countries and incumbent modes of transport are often highly polluting and inefficient. New answers are desperately required.



Hybrid and electric vehicles (HEVs) are slated to be part of the solution, as traditional gasoline and diesel vehicles are increasingly banned from the road.<sup>9</sup> This represents an enormous opportunity for gold. HEVs require considerably more high-end electronic components than traditional combustion engines, and gold already plays a role in the sector. Looking ahead, that contribution is likely only to expand, reflecting not just a significant increase in the use of HEVs but also persistent growth in in-car entertainment and general connectivity demands.

Longer term, we may see the rise of autonomous (or self-driving) vehicles, known as AVs. Currently undergoing tests around the world, AVs are expected to make roads safer and more efficient by removing the largest variable from the equation – the human driver. As with HEVs, AVs will require considerable electronics infrastructure, both internally and externally. Gold is likely to play a significant role here, as the systems controlling these vehicles demand high-end, safety-critical components.

<sup>9</sup> <https://www.ft.com/content/d3bcc6f2-95f0-11e7-a652-cde3f882dd7b>



“Gold nanoparticles hold considerable promise, both for improving the efficiency of solar cells and as catalysts in hydrogen fuel cells.”

### The Internet of Things (IoT)

At the highest level, the IoT can be described as the interconnection via the internet of computing devices embedded in everyday objects, enabling them to send and receive data. In recent years, the IoT has begun to be used in relatively simple, connected devices such as refrigerators and thermostats. However, it is envisaged that by 2048, everything will be connected, from devices in homes to those in offices and vehicles. These ‘smart’ devices will communicate over the internet via the cloud, generating data that should make the world safer, more productive and healthier.

More connectivity and more devices will drive demand for semiconductor chips. The impact for gold will most likely be positive.

#### A flexible revolution

Scientific breakthroughs in the world of electronics often come thick and fast, with companies ranging from two-person start-ups to blue-chip Goliaths collectively ploughing billions of dollars into research and development (R&D) to identify the next big thing. One technology expected to be commonplace in 30 years’ time is flexible electronics, whereby electronic devices are mounted on flexible material. Currently in its infancy, flexible electronics will prove revolutionary, we believe, permitting the development of devices such as wearable solar cells, sensors and flexible displays. The well-respected journal *Science* suggests that gold may play a central role in this burgeoning sector, as researchers work on the development of thin films of gold, which have extraordinary flexibility and resistance.<sup>10</sup>

### Clean and green

We expect that over the coming years energy provision will be a global priority, particularly how to generate sufficient energy for the world’s needs without further polluting the planet and accelerating climate change. The sheer number of variables makes this an incredibly complicated space to model, but one thing is certain: expanding populations and a predicted doubling of GDP per capita will drive demand for energy across the globe.

It is clear that renewables will need to play a much more prominent role in 2048 than today. Recent research has even suggested that many major countries could be completely fossil fuel-free by 2050.<sup>11</sup> This will require new solutions to improve electricity generation, which may completely alter the way that energy is stored and delivered. It is possible that highly efficient, localised solutions will make the grid redundant, removing the need for costly and complicated infrastructure.

Metals have traditionally played a key role in the form of catalysts and nanoparticles designed specifically to convert input energy to electricity. Indeed, gold nanoparticles hold considerable promise, both for improving the efficiency of solar cells and as catalysts in hydrogen fuel cells. Any electronic control systems most likely will also require gold as a core component.

10 Mahenderkar et al., *Science*, 2017. DOI: 10.1126/science.aam5830

11 Jacobson et al., *Joule*, 2017. DOI: 10.1016/j.joule.2017.07.005

## Diagnosing and treating disease

The provision of healthcare in 2048 will probably be very different from today. As populations grow, healthcare is likely to focus increasingly on prevention to reduce the pressure on traditional medical services. New technologies will play a key role in this trend.

Sensors, for example, will be designed to diagnose potential issues early, pre-empting the need for costly interventions. Researchers are already developing so-called ‘electronic second skins’ to monitor basic patient outputs such as body temperature and muscle activity. Gold is a critical component of these sensors, providing the requisite flexibility and biocompatibility for devices that are attached directly to the body. We believe that, in time, technology will evolve to broaden diagnostic capability and these devices may be worn permanently, as an early-warning tool for a range of diseases.

Even now, gold plays a central role in healthcare. Gold nanoparticle-based diagnostic test kits (commonly known as rapid diagnostic tests, or RDTs) have been at the forefront of the fight against many common diseases for decades. According to the WHO, over 300 million gold-containing tests were used in 2016 in the diagnosis of malaria, primarily in Africa and Asia.<sup>12</sup> Several non-governmental organisations and funding bodies have set the goal of eliminating malaria by 2040–50,<sup>13</sup> and improved gold-containing diagnostics will help them to achieve this goal. Researchers around the world are working to improve RDTs and develop smart-reader devices that allow more accurate diagnoses, alongside better data collation and management.

“Gold compounds are showing promise as a new class of antibiotic in early-phase clinical studies. It is conceivable that gold-containing drugs will form part of our defence against infection in 2048.”



One step malaria testing kit.

Across the globe, the rise of antimicrobial resistance (AMR) represents one of the most significant threats to healthcare provision in the coming years. AMR occurs when microorganisms (such as bacteria, fungi, viruses and parasites) change following exposure to antimicrobial drugs. Microorganisms that develop AMR are sometimes referred to as ‘superbugs’. In such instances, medicines can become ineffective and infections persist in the body, damaging patients and increasing the risk of widespread contamination.

The combination of AMR and rising populations could be devastating for future generations, and work is urgently under way to find alternative antibiotics. Gold compounds are showing promise as a new class of antibiotic in early-phase clinical studies.<sup>14</sup> If this type of compound is effective in broader trials, it is conceivable that gold-containing drugs will form part of our defence against infection in 2048.

## Looking ahead

Gold is a unique metal, cherished by individuals and communities the world over. Unknown to many, it is also a critical industrial material, powering the devices and diagnostics we take for granted daily.

Over the next 30 years, gold’s role is likely only to increase. Society faces many challenges and we will need to innovate to provide the planet’s projected 10 billion people with a fair and decent standard of living. Much of this innovation will stem from technological advances: cleaner, more efficient energy provision and vehicles; better diagnostics and therapeutics; and improved connectivity. We believe gold has a part to play in all of these advances, and probably many others yet to be determined. ■

<sup>12</sup> <http://www.who.int/malaria/publications/world-malaria-report-2017/en/>

<sup>13</sup> [https://www.pmi.gov/docs/default-source/default-document-library/pmi-reports/pmi\\_strategy\\_2015-2020.pdf](https://www.pmi.gov/docs/default-source/default-document-library/pmi-reports/pmi_strategy_2015-2020.pdf)

<sup>14</sup> <http://auspherix.com/scientists-present-positive-progress-in-the-development-of-a-new-class-of-broad-spectrum-organogold-antibiotics/>

# Gold in 30 years



**John Reade**  
Head of Research and  
Chief Market Strategist

The gold market has been transformed in the past 30 years. Production and demand have soared and the axis of the market has shifted definitively East. Looking ahead to 2048, what can we expect from gold? World Gold Council chief strategist **John Reade** assesses possible outcomes.

It is almost a truism to say that predicting the future is a thankless task. And the gold market has undergone so many changes over the past three decades that forecasting where it will go next may be considered virtually impossible.

That said, a number of recent market developments were in sight even in the 1980s and, looking ahead, it may be easier to forecast longer-term trends, as they suffer less from short-term cyclicality. Of course, it is almost impossible to forecast the out-of-the-box changes but we've done our best.

#### **Our report highlights some common themes:**

We don't account for a major geopolitical event such as a world war but we do expect regional conflicts to continue.

Population growth will continue, albeit at a slower pace, and the global economy will grow too, although there will be a greater contribution from emerging markets than currently developed economies.

China and India will become the world's largest economies but both countries will face challenges. China needs to overcome the potential roadblock of the middle-income trap. India needs to continue restructuring its economy and reducing bureaucracy to achieve its potential.

Africa has the greatest potential to deliver transformational change, provided it grasps the opportunity presented by its youthful population.

On a global level, climate change is also expected to become an increasingly important issue for companies, governments and individuals so efforts to curb greenhouse gas emissions will grow.



## Jewellery demand

For centuries, gold has been valued as a financial instrument and an object of beauty. Those twin roles persist to this day but their nature has changed rapidly in recent decades and is likely to continue evolving over the coming years.

Back when the World Gold Council was founded, jewellery was a crucial aspect of gold demand, centred definitively in the West. Today, there are considerably more ways to access gold than there were 30 years ago and jewellery demand has shifted East.

Looking ahead, we do not expect a substantial recovery in developed-market jewellery demand, as historic buyers of large amounts of jewellery are ageing. Young, developed-market consumers appear to favour experiences over material possessions and jewellery has struggled as a result of this trend. But developed markets have faced these challenges for some time, and US jewellery demand has actually grown in recent years, suggesting this trend does eventually mature. Looking ahead, we expect jewellery demand will persist in developed markets. The excitement, however, will focus on emerging markets, as developing countries' economies – and in many cases their populations – grow.

Today, China and India are the largest jewellery-buying nations but they may experience pressures on jewellery demand too, as they develop and age. We believe, however, that rising incomes, a shift to a more consumption-oriented economy in China and the demographics of India should offset these trends.

In the near term, it may be that Indian gold demand will increase substantially – if the government is successful in its ambition to dramatically increase rural income. But this is likely to moderate in the longer term. There is considerable potential for recycling some of the approximately 25,000-tonne stock of gold already in India and that may reduce the need for the country to import ever-growing quantities of gold.

The Indian jewellery trade will also become much more organised, with consolidated jewellery manufacturers selling a range of modern and traditional hallmarked pieces to increasingly urbanised and sophisticated consumers. Gold jewellery's role as a store of wealth will remain, but investment products will become much more prevalent, with jewellery increasingly used for cultural and matrimonial purposes.

In China, traditional 24-carat gold jewellery will become much less common; 18k, 22k and modern 24k jewellery will predominate, and investment in gold via pure but crude jewellery will have ceased, as low mark-up investment bars and savings plans become ubiquitous. There will still be a 24-carat market, however, as China develops its innovative new design and manufacturing techniques, producing intricate pieces that look solid but are much lighter.

Other emerging markets will become important too. Economic growth in countries such as Vietnam, Indonesia and Cambodia is likely to drive gold demand in south-east Asia, while demand in Africa may increase, if its expected rapid economic development materialises.

One theme that is common to both developed and developing markets, we believe, will be a greater emphasis on responsible sourcing of gold. Twin factors are driving this phenomenon. First, we see a concerted effort to eliminate irresponsibly mined gold that has used child or coerced labour, or unsafe environmental or unjust social practices. Second, gold's potential role in money laundering, smuggling or tax evasion is being addressed by governments and the formal gold ecosystem. Both these factors will see greater efforts by refineries, jewellery fabricators and vault holders to ensure that the gold they deal with and store has the best reputation.



Long Feng Shan store in Shanghai, looking at 24 carat gold.

## Investment demand

The changes seen in the gold investment market over the past 30 years highlight the challenges associated with forecasting the outlook for this sector. Back in the 1980s and 90s, investment in gold was limited to coins, physical bars and – for the larger buyer – the over-the-counter (OTC) market. The development of physically backed exchange traded funds (ETFs) has revolutionised the investment market, greatly reducing transaction costs for smaller purchases and allowing institutional investors easier and more compliant access to gold. Now, the growth of digital platform and/or fintech-enabled gold trading may be about to deliver another round of radical change.

While investment demand is related to income growth, (**Chart 16a**) other factors are also at work. In the 1990s and early 2000s, gold fell from favour as an investment asset and demand was dominated by non-investment applications. The shifts that took place after 2008–09 are instructive, as investment demand increased substantially, at the expense of more price-elastic jewellery demand (**Chart 16b**).

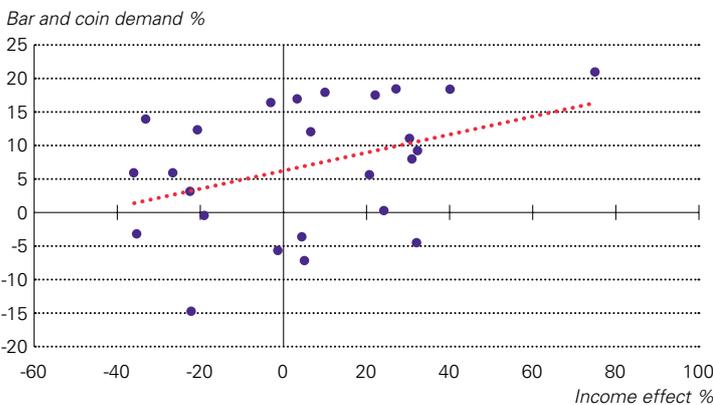
“Anticipation of – and reaction to – economic downturns and financial crises are likely to buoy investment demand for many years to come.”

If we return to the non-inflationary, constant expansion (NICE) times of the 1990s and early 2000s, investment demand may revert to a marginal component of the gold market. Yet NICE was a term coined by Mervyn King, then Governor of the Bank of England, during the same era that Gordon Brown, then UK Chancellor of the Exchequer, claimed his prudence would prevent a return to boom and bust economics. Admittedly, Brown was talking only about the UK economy but even so his assertion proved misguided, even hubristic. Now, it seems almost impossible to envisage a NICE 30 years, uninterrupted by boom and bust. Instead, anticipation of – and reaction to – economic downturns and financial crises are likely to buoy investment demand for many years to come.

Other factors are expected to bolster the investment market too, including the elevated valuations of many asset markets, large debt levels in many economies and unresolved structural problems dating from the 2008–09 global financial crisis. There are two further potential drivers of financial crises that we expect to play a role in investment demand for gold over the next 30 years. First, the US will inevitably lose its position as the largest economy to China, although superior demographics may lead India to threaten China’s status near the end of this period. This may well incur volatility within currency and asset markets and the associated uncertainty should favour gold. Similarly, we believe that climate change will play an increasing role in the global economy, with the potential for large-scale weather-related insurance losses a potential driver of volatility.

Overall, therefore, we believe interest in gold as an investment asset class is likely to increase over the next 30 years, although clearly this will ebb and flow, in line with perceptions of stability and economic growth prospects.

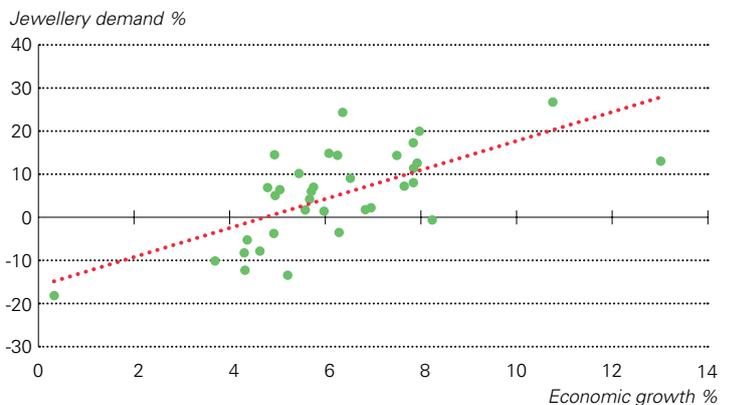
**Chart 16a: Year-on-year change in bar and coin demand as a function of previous year’s demand versus EM GDP growth\***



\*Based on data between 1992 and 2016.

Source: GFMS, Thomson Reuters; Metals Focus; World Gold Council

**Chart 16b: Year-on-year change in jewellery demand as a function of previous year’s demand versus EM GDP growth\***





“ Discoveries have been scant; permitting timelines are long; capital costs have ballooned; ESG requirements are becoming more challenging; operating costs have risen; and political risk has increased. ”

## The rise of technology

Gold will almost certainly play a significant role in technology over the next 30 years. Rising wealth, connectivity and the use of electronics in ever-expanding applications will require increasing amounts of gold. The perennial trends of thrifting, substitution and recycling will be a drag on growth rates but they are highly unlikely to quash demand completely.

Medical usage of gold in nanoscopic quantities in medicines and health devices is an interesting area of demand but it is unlikely to move the needle substantially. Dental use will probably decline to near-zero, although this has largely occurred already.

## Production and supply

The gold mining industry will almost certainly be around in 30 years' time; indeed, some of the mines in production now will probably still be in operation then. But the challenges that the industry faces – and the associated costs of meeting these challenges – look set to grow.

Gold mine supply will struggle to expand, according to precious metals consultancy Metals Focus. Discoveries have been scant; permitting timelines are long and becoming more extended; capital costs for the next generation of large, low-grade open cast mines have ballooned, perhaps beyond readily fundable levels; environmental, social and governance (ESG) requirements are becoming more challenging; operating costs have risen; and political risk has increased in many prospective regions.

We expect new mine supply to decline over the next 30 years, hit by rising costs. Metals Focus estimates that, even today, new gold mines need a price of about US\$1,500/oz, and with costs having increased at a compound annual rate of 10% over the past 15 years, additional ESG costs are likely to mean that even higher gold prices will be required in the future.

Of course, there is always the potential for a major discovery along the lines of the Witwatersrand or Nevada gold deposits but the industry has been looking exhaustively for such deposits with very limited success.

## Trading venues and access to the market

Two, perhaps three, major factors are likely to dominate the evolution of gold trading and market access over the next three decades.

First, regulatory changes are afoot in both developed and developing markets. The regulatory response to the global financial crisis is encouraging a migration of activity from the OTC market to more transparent trading venues, including exchanges. Even where OTC trading persists, reporting and central clearing will become more widespread. In developing markets too, regulators are pushing for a formalisation of gold trading towards exchanges, such as in India, and the development of a joined-up gold ecosystem, such as in Russia.

Second, mobile applications that allow individuals to buy, sell, invest and gift gold are developing rapidly in India and China and we expect these applications to become increasingly popular over the coming decades. In China, digital wallets are fast displacing cash in urban areas, and gold is represented on the most important platforms, such as WeChat. In India, gold savings are of particular interest, as most Indian households have a future requirement to give gold as a wedding gift. The ability to buy and accumulate gold via a mobile electronic platform and take delivery at a jewellery store when needed has tremendous potential in India.

These sorts of applications may spur interest in other developing markets too and they may even spread in the developed world, although 'physical' investment seems to dominate these markets today. Yes, ETFs have been increasingly used to facilitate gold investment, but as the German and US markets demonstrate, physical ownership of bars and coins remains an intrinsic part of gold's attraction to many people.

The third possible way that gold investment could change dramatically is through adoption as a crypto asset. There have already been some developments in this area, such as RMG, a blockchain initiative from the UK Royal Mint; InfiniGold, from The Perth Mint; Digital Gold, from TradeWind; and Responsible Gold, from Emergent Technology Holdings. None of these has really taken off so far but we suspect there will be repeated attempts to join gold and blockchain for transaction and investment purposes. If one (or more) is successful, it could be as big a change to the gold markets as the development of ETFs, but with the added advantage of appealing to younger generations too.

## Gold: an enduring asset

This report considers how the world – and gold – will develop over the next 30 years. We know that there will be many developments that we have not even considered and our overall optimism for continued economic development and an absence of any major geopolitical conflict may prove overly positive, in light of the challenges the world faces. But assuming we are largely correct, we believe that the gold industry should be alive and well at the end of this period. Gold supply is likely to be somewhat smaller, while jewellery and technology demand will probably have grown in a richer, more middle-class, connected world. Investment demand will see peaks and troughs, but there is enough potential economic risk to keep investors attracted to the merits of gold, following a 5,000-year-old tradition. ■

“ Mobile applications that allow individuals to buy, sell, invest and gift gold are developing rapidly in India and China and we expect these applications to become increasingly popular over the coming decades. ”



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