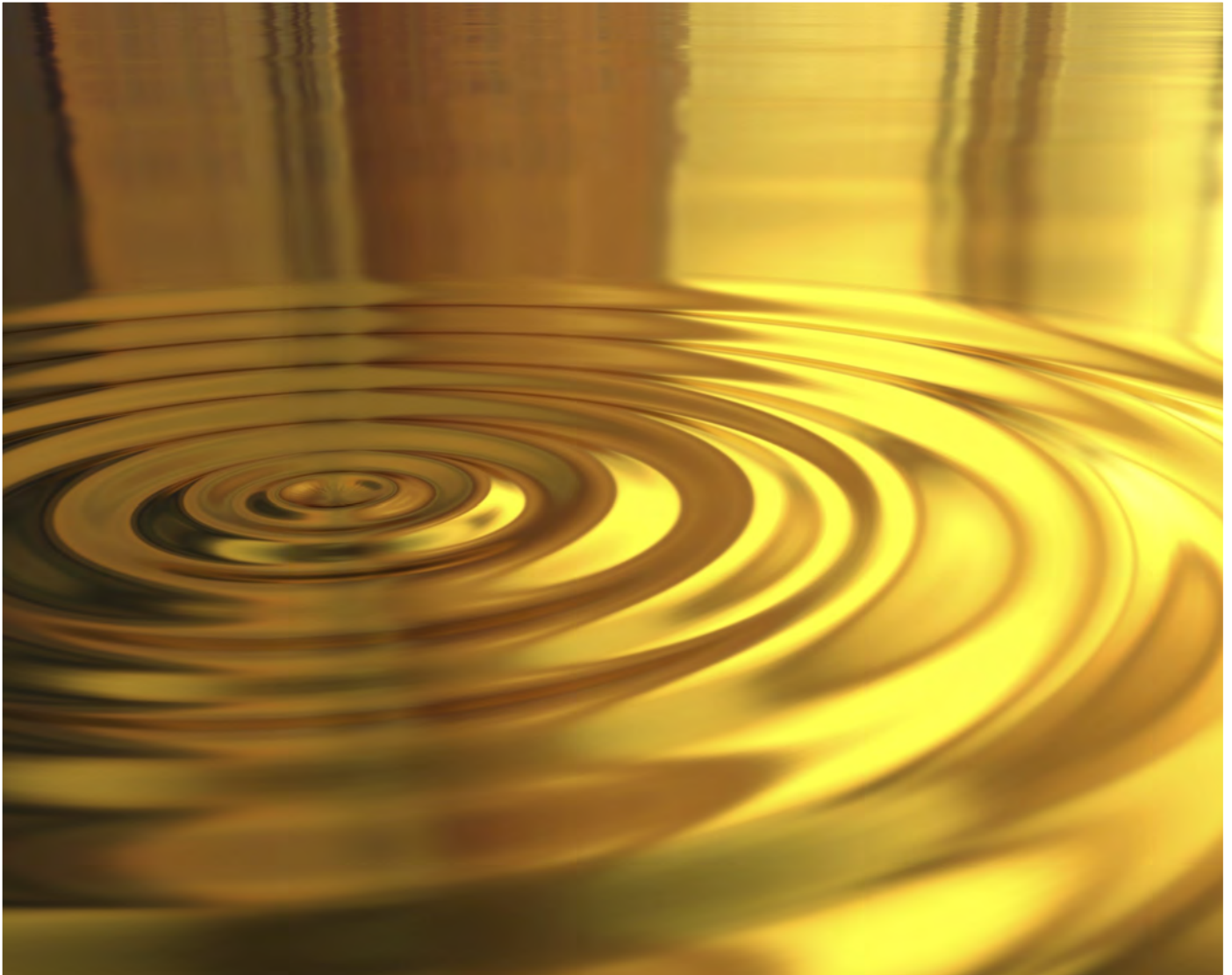# EDISON

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Portents of economic weakness

Gold: Doves in the ascendant

Sector report, August 2019

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EDISON

Portents of economic weakness

Gold: Doves in the ascendant

'Even today, the importance of gold in the international monetary system is reflected in the fact that it is today the only commodity held as reserve by the monetary authorities, and it constitutes the largest component after dollars in the total reserves of the international monetary system.'
Robert A Mundell, Nobel Laureate for Economics, 1999.

Fed's erstwhile asset-reduction plan unsustainable

At the time of our last report on gold in November 2017, 'normalisation' of monetary policy was the mantra of both policy makers and financial markets. After a decade of ultra-loose monetary policy, interest rates were on a tightening cycle and the US Federal Reserve had just begun a plan to reduce its balance sheet by an unprecedented US$1.48tn over five years. Given this background, our historical analogue for gold forecasting was the early 1980s, when Paul Volcker's Fed was similarly embarked on a tightening cycle. After several quarters of moderating economic data, however, in March the Fed performed an abrupt about face, when it announced it would end its asset-reduction programme in September, thereby leaving the total US monetary base 37% higher than our previous expectations. Simultaneously, the markets' erstwhile expectations of interest rate hikes have given way to expectations (and now the reality) of cuts. Add in trade tensions (eg US-China), geopolitical uncertainty (eg in the Persian Gulf) and suddenly the better historical analogue for 2019 appears to be the late 1970s, with at least one more round of monetary easing in prospect before any sense of a return to 'normality'.

Two possible scenarios

Doves favour another round of monetary easing

With the underlying economy at something of a crossroads, gold could follow quite different paths. Supporting the Fed's increasingly 'dovish' outlook, the price of gold is approximately (or even slightly above) where we would expect it to be in the event of another round of accommodative monetary policy. If this continues, then we believe it could appreciate by c US$300/oz vs spot by the end of 2020 and test its erstwhile record of US$1,689/oz (annual average) set in 2012.

Normalisation

However, if the assumption that the economy has just embarked on another round of monetary easing proves wrong and, in fact, a return to a 'hawkish' tightening is in store (as was the case until recently), then we would expect the gold price to fall by c US$300/oz in the next 12–24 months. Rarely has the outlook been so uncertain.

Edison's gold price forecasts for equity valuations

Given the Fed's recent overtures, for the purposes of our equity valuations we have decided to weight our forecasts based on a 75% chance of a dovish outcome and a 25% chance of a hawkish outcome over the next three years and to adopt a flat real gold price of US$1,350/oz thereafter. Among other things, this has the advantage of aligning developers' technical study costs with the approximate gold price environment in which those costs were calculated.

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Gold price executive summary

In common with past methodology, in this report, Edison has updated its gold price forecasts, derived with respect to the gold's historical correlation with the total US monetary base, inflation and currency in circulation. We also value gold on a one- and five-year view, as though it were a currency, with its price determined relative to the US dollar on the basis of predicted inflation and interest rates only, in both real and nominal terms, over one and five years.

What has changed

At the time of our last note on the subject, the Federal Reserve had just instigated its plan to reduce its balance sheet by an unprecedented US$1.48tn (33.0%). This reduction was equivalent to a deflationary drag equivalent to c 7.1% of US GDP (Q418, annualised) over five (but effectively only three) years, from 2018–20 (inclusive). Rather than sell assets outright, the Fed agreed that its goal would be achieved by letting US$6bn a month in maturing Treasuries run off, which would then increase to US$30bn per month, while mortgage-backed securities (MBSs) would run off at a rate of US$4bn per month, rising to US$20bn. Note that this total of US$50bn per month compared with the ultimate level of bond buying during QE3 of US$85bn per month.

As recently as November, indications from new Fed chairman Jerome Powell were that it would be some time before the Fed stopped raising rates and reducing the balance sheet as the asset reduction programme was deemed to be on 'auto-pilot'. As the US yield curve has flattened however (see Exhibit 42), in March of this year, the Fed altered its stance materially, saying it would begin to taper the amount of proceeds that it allowed to roll off in May and end the programme in September. Under the revised plan, the amount for allowable Treasury roll-off reduced to US$15bn per month in May (cf US$30bn previously). Moreover, beyond September, while technically still allowing the proceeds from MBSs to roll off, in reality the Fed's plan was to reinvest these in Treasuries (thereby keeping the size of its balance sheet static, rather than declining). Then, on 31 July, as it announced its first interest rate reduction in a decade, the Fed also announced that it was to end its asset reduction programme two months early, in July, as opposed to September. As a result, our forecast for the evolution of the total US monetary base into the immediate future has altered materially, as shown in the exhibit below:

Exhibit 1: Total US monetary base, actual and forecast vs previous and without quantitative easing and tapering, 1959–2030e (US$bn)
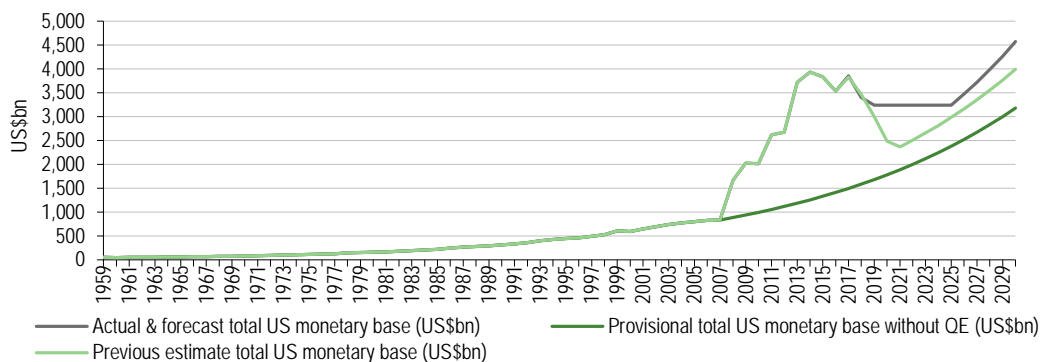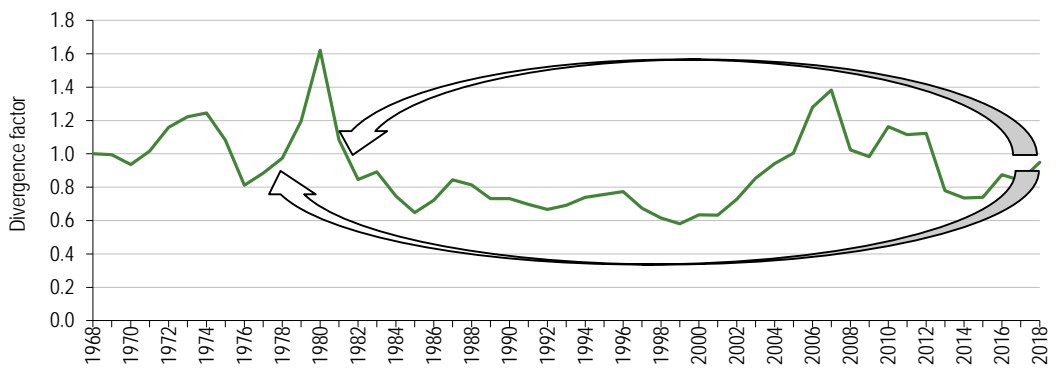

Source: US Federal Reserve, Edison Investment Research

Not only have our forecasts for the total US monetary base changed materially therefore, but also our forecasts for its component parts, namely currency in circulation and reserve bank cash (see Exhibit 30) and our interpretation of the positioning of the US economy within the context of its post-

crisis recovery. Thus, whereas we had previously assumed a policy of normalisation with respect to interest rates and the size of the Fed's balance sheet (in line with official Fed pronouncements), now we are recognising one further round of monetary easing, consistent with the official abandonment of the Fed's asset reduction programme and market expectations of future interest rate cuts, rather than hikes. As a result, where before the obvious analogue for the post-crisis positioning of the US economy (and the level of the gold price thereto) had been the early 1980s, now it appears increasingly likely that the relevant analogue may be the late 1970s and that there is another round of monetary easing in prospect, before any sense of 'normalisation' can be achieved. The consequences of this distinction may be seen in the graph below, which plots the divergence of the actual gold price, relative to the expected one given the level of the total US monetary base at the time, and clearly shows the potential for one more peak in the gold price over the next few years – analogous, in this case, to 1980 – before there is a return to any genuine sense of economic 'normality':

Exhibit 2: Actual gold price vs expected gold price*, 1968–2018 (factor)

Source: Edison Investment Research. Underlying historical data: Federal Reserve, South African Chamber of Mines, Bloomberg, Kitco, dollardaze.org. Note: *Based on correlation between the gold price and the level of the total US monetary base as it would have been perceived at the time.

As a result, we have updated our forecasts for the price of gold, based on its historical correlation with the total US monetary base, currency in circulation and inflation with due regard for the cyclical positioning of the US economy.

Updated forecasts

Edison's current expectations, based on gold's historical relationships with these four economic parameters, are provided in Exhibit 3, below. In this case, two scenarios are shown:

- The first (hawkish scenario) assumes the 'normalisation' of monetary policy and that the post-crisis positioning of US economy within its cycle is analogous to its circumstances in the early 1980s, with a round of monetary tightening in prospect (see Exhibit 2 and Exhibit 19). This is consistent with our approach in November 2017.
- The second (dovish scenario) assumes that the post-crisis positioning of the US economy is analogous to its circumstances in the late 1970s – despite the best efforts of policymakers – and that one more round of monetary easing (and potentially unorthodox monetary policy) is in prospect before 'normalisation' can take place.

Exhibit 3: Cyclically adjusted Edison forecast gold price range, 2019–30e (US$/oz)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Assuming 'normalisation' (hawkish scenario)												
Currency in circulation	1,177	1,222	1,233	1,253	1,391	1,567	1,712	1,867	1,729	1,683	1,720	1,965
Monetary base correlation	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,361	1,443	1,531	1,626	1,727
Inflation	1,275	1,044	1,181	1,006	887	1,058	1,279	1,247	1,081	1,067	1,017	976
Monetary base correlation & cycle	1,086	1,145	960	831	928	1,085	1,045	997	1,056	1,069	1,083	1,193
Average	**1,206**	**1,174**	**1,165**	**1,094**	**1,123**	**1,248**	**1,330**	**1,368**	**1,327**	**1,338**	**1,361**	**1,466**
Assuming easing * (dovish scenario)												
Cyclically adjusted currency in circulation	1,549	1,857	2,438	3,363	2,375	1,952	2,155	1,947	1,841	2,238	2,737	2,764
Monetary base correlation	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,361	1,443	1,531	1,626	1,727
Cyclically adjusted inflation	1,275	1,933	1,380	1,130	1,278	1,089	960	1,145	1,384	1,350	1,170	1,154
Cyclically adjusted monetary base & cycle	1,535	2,082	1,393	1,086	1,145	960	831	984	1,219	1,246	1,191	1,264
Average	**1,411**	**1,789**	**1,624**	**1,716**	**1,520**	**1,321**	**1,307**	**1,359**	**1,472**	**1,591**	**1,681**	**1,727**
Average (excl currency in circulation)			1,352	1,167	1,236	1,111	1,025	1,163	1,349	1,376	1,329	1,382
Difference (US$/oz)												
Cyclically adjusted currency in circulation	372	634	1,205	2,110	983	386	443	79	113	555	1,017	799
Monetary base correlation	0	0	0	0	0	0	0	0	0	0	0	0
Cyclically adjusted inflation	0	889	199	123	391	30	-320	-103	303	282	153	178
Cyclically adjusted monetary base & cycle	448	937	433	255	217	-125	-214	-13	163	177	108	70
Average	**205**	**615**	**459**	**622**	**398**	**73**	**-23**	**-9**	**145**	**254**	**319**	**262**
Difference (%)												
Cyclically adjusted currency in circulation	31.6	51.9	97.7	168.5	70.7	24.6	25.9	4.2	6.5	33.0	59.1	40.7
Monetary base correlation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyclically adjusted inflation	0.0	85.1	16.8	12.3	44.0	2.9	-25.0	-8.2	28.0	26.5	15.0	18.3
Cyclically adjusted monetary base & cycle	41.3	81.8	45.1	30.7	23.4	-11.5	-20.5	-1.3	15.4	16.6	9.9	5.9
Average	**17.0**	**52.4**	**39.4**	**56.9**	**35.4**	**5.8**	**-1.7**	**-0.7**	**10.9**	**19.0**	**23.5**	**17.9**

Source: Edison Investment Research. Note: *Assuming another period of monetary easing in prospect.

As before, the range of potential gold price outcomes, using all of Edison's forecasting methods, is wide. At the heart of this divergence remains the post-2007 breakdown in the relationship between the total US monetary base, currency in circulation and inflation, for which, as yet, there appears to be no definitive resolution.

Gold price forecasts with respect to equity valuations

Notwithstanding our detailed gold price forecasts (above), for the purposes of our equity valuations, we have decided to weight our forecasts based on a 75% chance of a 'dovish', easing outcome and a 25% chance of a 'hawkish', tightening outcome over the course of the next three years and to adopt a flat real gold price of US$1,350/oz thereafter (summarised below):

Exhibit 4: Edison gold price forecasts, CY20–23 and beyond

Year	2020	2021	2022	2023 and beyond
Nominal gold price forecast (US$/oz)	1,635	1,509	1,560	
Real gold price forecast (US$/oz)	1,572	1,395	1,387	1,350

Source: Edison Investment Research

Note that these new gold price assumptions will be incorporated into our equity valuations upon publication of the first note on each following the publication of this report.

Gold valued as a currency

Alternatively, it is possible to value gold as a currency in terms of expected future interest rates and inflation. Adjusting for such 'real' factors as newly mined supply and estimates of world population growth, Edison's gold price forecasts with respect to future inflation and interest rates, over one year, is as follows:

Exhibit 5: Gold price predicted as currency with respect to the global inflation of 'real' assets as well as US monetary inflation and interest rates (one year)

US$/oz	Future interest rate (%)										
	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
(3%)	1,431	1,417	1,403	1,389	1,376	1,363	1,350	1,337	1,325	1,313	1,301
(2%)	1,446	1,431	1,417	1,404	1,390	1,377	1,364	1,351	1,339	1,326	1,314
(1%)	1,461	1,446	1,432	1,418	1,404	1,391	1,378	1,365	1,352	1,340	1,328
0%	1,475	1,461	1,446	1,432	1,419	1,405	1,392	1,379	1,366	1,353	1,341
1%	1,490	1,475	1,461	1,447	1,433	1,419	1,406	1,393	1,380	1,367	1,355
2%	1,505	1,490	1,475	1,461	1,447	1,433	1,420	1,406	1,393	1,381	1,368
3%	1,520	1,505	1,490	1,475	1,461	1,447	1,434	1,420	1,407	1,394	1,381
4%	1,534	1,519	1,504	1,490	1,475	1,461	1,447	1,434	1,421	1,408	1,395
5%	1,549	1,534	1,519	1,504	1,489	1,475	1,461	1,448	1,434	1,421	1,408
6%	1,564	1,548	1,533	1,518	1,504	1,489	1,475	1,462	1,448	1,435	1,422
7%	1,579	1,563	1,548	1,533	1,518	1,503	1,489	1,475	1,462	1,448	1,435
8%	1,593	1,578	1,562	1,547	1,532	1,517	1,503	1,489	1,475	1,462	1,448
9%	1,608	1,592	1,577	1,561	1,546	1,532	1,517	1,503	1,489	1,475	1,462
10%	1,623	1,607	1,591	1,576	1,560	1,546	1,531	1,517	1,503	1,489	1,475

Source: Edison Investment Research

Note the contrast between the results of our analysis of the gold price as a currency in Exhibit 5, with those of our analysis in Exhibit 3 – the difference between the two arguably representing a measure of the degree of speculative sentiment in the marketplace.

Over five years, our forecasts for the gold price, assuming that gold behaves like a conventional currency during the intervening period of time, are as follows:

Exhibit 6: Gold price predicted as currency with respect to the global inflation of 'real' assets as well as US monetary inflation and interest rates (over five years)

US$/oz	Future interest rate (%)										
	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
(3%)	1,245	1,185	1,128	1,074	1,023	975	930	888	847	809	773
(2%)	1,311	1,247	1,187	1,130	1,077	1,027	979	934	892	852	814
(1%)	1,379	1,312	1,249	1,189	1,133	1,080	1,030	983	938	896	856
0%	1,450	1,379	1,313	1,251	1,192	1,136	1,083	1,034	987	942	900
1%	1,524	1,450	1,380	1,314	1,252	1,194	1,139	1,086	1,037	990	946
2%	1,601	1,523	1,450	1,381	1,316	1,254	1,196	1,141	1,089	1,040	994
3%	1,681	1,599	1,522	1,450	1,381	1,317	1,256	1,198	1,144	1,092	1,044
4%	1,764	1,678	1,598	1,522	1,450	1,382	1,318	1,258	1,200	1,146	1,095
5%	1,850	1,761	1,676	1,596	1,521	1,450	1,383	1,319	1,259	1,203	1,149
6%	1,940	1,846	1,757	1,674	1,595	1,520	1,450	1,383	1,320	1,261	1,205
7%	2,033	1,935	1,842	1,754	1,671	1,593	1,519	1,450	1,384	1,322	1,263
8%	2,130	2,027	1,929	1,838	1,751	1,669	1,592	1,519	1,450	1,385	1,323
9%	2,231	2,122	2,020	1,924	1,833	1,748	1,667	1,590	1,518	1,450	1,385
10%	2,335	2,222	2,115	2,014	1,919	1,829	1,745	1,665	1,589	1,518	1,450

Source: Edison Investment Research

Once again, readers should note the contrast between the results of our analysis of the gold price as if it were a currency in Exhibit 6, with those of our analysis based on the total US monetary base, inflation, US currency in circulation etc of US$1,248–1,321-1,111/oz in 2024 in Exhibit 3, which approximately correspond with one another in the event that real interest rates over the course of the next five years are in the order of 2–6% (green shading) – which appears consistent with historical experience (Exhibit 43), if not completely with current circumstances (Exhibit 42).

Historical forecasting performance

A brief history of Edison's recent gold price forecasts, based on its past correlations with the total US monetary base, inflation and currency in circulation, with due consideration for the assumed position of the US economy within its cycle is provided in , below. Edison's formal forecasts are shown in bold.

Exhibit 7: Edison forecast gold price and ranges, 2017–19e vs actual (US$/oz)

Method of prediction	*PPMC	2017	2018	2019
November 2017 forecasts				
Currency in circulation (basis of formal November 2017 forecast)	**0.895	1,145	**1,082**	**1,315**
Monetary base correlation	***0.909	1,555	1,424	1,256
Inflation	****0.842	1,232	1,010	1,143
Monetary base correlation & cycle		1,272	1,038	907
Average		1,301	1,139	1,155
October 2016 forecasts				
Negative real interest rate scenario		**1,328**	**1,324**	**1,451**
Positive real interest rate scenario		**1,200**	**1,154**	**1,184**
Actual gold price (annual average)		1,258	1,270	*****1,327

Source: Edison Investment Research. Note: *PPMC = Pearson product moment (correlation) coefficient; **since 1959; ***since 1967; ****based on the absolute level of the CPI index since 1959; *****year to date.

A number of features of the actual gold price relative to its predicted level during the periods in question are apparent:

- The average gold price in 2017 was almost exactly mid-way between our forecasts based on both positive and negative real interest rate scenarios – arguably suggesting that the gold market, at least, was taking a 50:50 view of the extent and direction of future interest rate moves in that year.

- During 2018, gold's high was US$1,358/oz, reached on 24 January, which is within US$30/oz of our October 2016 forecast for that year assuming a negative real interest rate scenario – arguably implying that the gold market began 2018 with a 'dovish' outlook on interest rates.

- By contrast, gold's low for 2018 of US$1,174/oz, reached on 16 August, was within US$20/oz of our October 2016 forecast for that year assuming a positive real interest rate scenario – arguably implying that the gold market finished 2018 with a 'hawkish' outlook on interest rates.

- Gold's average price of US$1,270/oz for 2018 was closer to our November 2017 forecast based on its historical correlation with the total US monetary base only than it was with any of the other three methods of calculation – arguably indicating that the gold market, at least, was sceptical about the Fed's ability to pursue 'normalisation' as it was conceived at the time (including its balance sheet reduction programme) to its final conclusion as intended.

- Gold's year to date performance in 2019 is within US$20/oz of both the mid-way point between the positive and negative real interest rate scenario forecasts and also our forecast based on its historical correlation with US currency in circulation.

Gold price

Edison's long-term gold price forecasts draw on gold's historical relationships with 1) inflation, 2) the US monetary base and 3) US currency in circulation. In addition, we have also considered it as if it were a currency (see pages 28–32).

Historical returns – exploding myths

Gold is often thought of as a relatively pedestrian real asset, the returns from which are equally conservative. In fact, while there are periods in which this may be true, over the long term, gold has proved itself an investment to compete with the best. While the Dow Jones Industrials Average increased by 25.8x from 1967 to 2018, for example, the price of gold has increased by 36.3x. Of course, in the normal course of events, gold would not be expected to derive an income for its investor, while the Dow Jones would, in the form of dividends. In annual percentage terms however, the returns from gold over the period are equivalent to 9.6% per year, while those from the Dow Jones are equivalent to 6.6% per year – the three percentage point disparity between the two approximating the average dividend yield over the period for the index. That is a pretty impressive performance for an asset that is often characterised as a portfolio diversifier or insurance policy.

Exhibit 8: Gold price performance vs Dow Jones Industrials Average index performance, 1967–2018
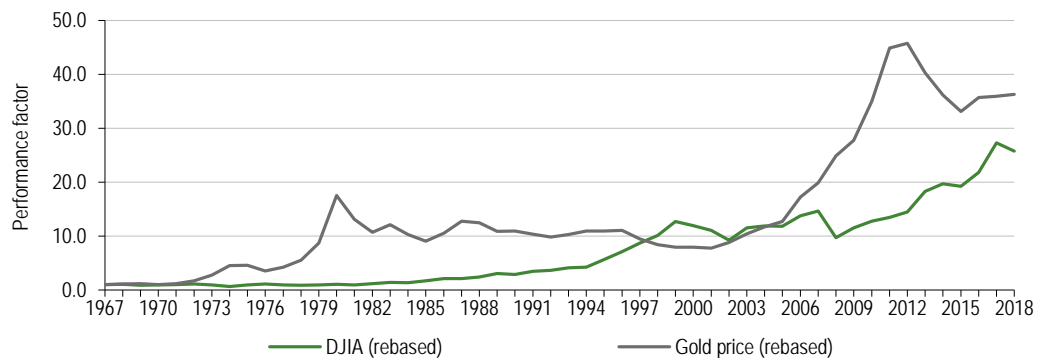
Source: Edison Investment Research, Bloomberg, South African Chamber of Mines, Kitco

In part, the mischaracterisation of gold as an investment may derive from long-term historical experience. A chart of gold's real returns since 1913, on an annual percentage basis, is as follows:
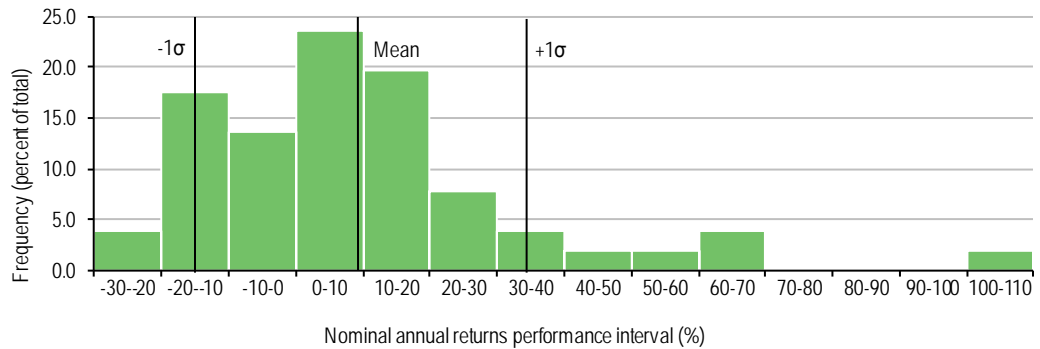
Exhibit 9: Gold real annual percentage returns, 1913–2018 (%)
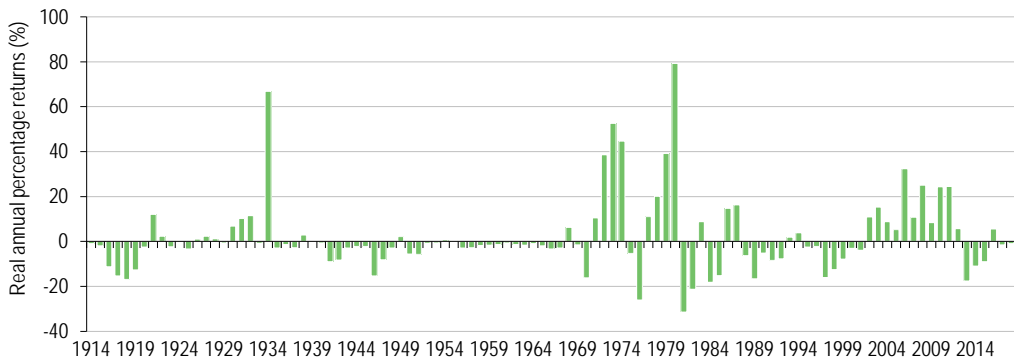
Source: Edison Investment Research; underlying data: South African Chamber of Mines, U.S. Bureau of Labor Statistics, Bloomberg, Kitco

Over the period, the (geometric) average real return for gold has been 2.0% with a standard deviation of ±16.7% (both calculated assuming that the distribution of returns is normal), as depicted in the histogram below:

Exhibit 10: Histogram of gold's real annual percentage returns, 1913–2018

Real annual performance interval (%)

Over this period, the median return is in the interval -10–0%, which corresponds with the long period from 1913–67, during which the nominal gold price moved effectively only once (when it was revalued from US$20.67/oz to US$35.00/oz in January 1934), but was still generally characterised by a small amount of positive inflation, leading to a negative real return. As such, the graph may suggest a log-normal distribution with its characteristic skew to the right. This (relatively predictable) outcome may be the origin of the investing public's belief that the probability of abnormally high positive returns is small and the probability of negative returns is higher than the probability of positive returns.

By contrast, a chart of gold's nominal returns from 1967 to 2018, on an annual percentage basis, is as follows:

Exhibit 11: Gold nominal annual percentage returns, 1967–2018 (%)
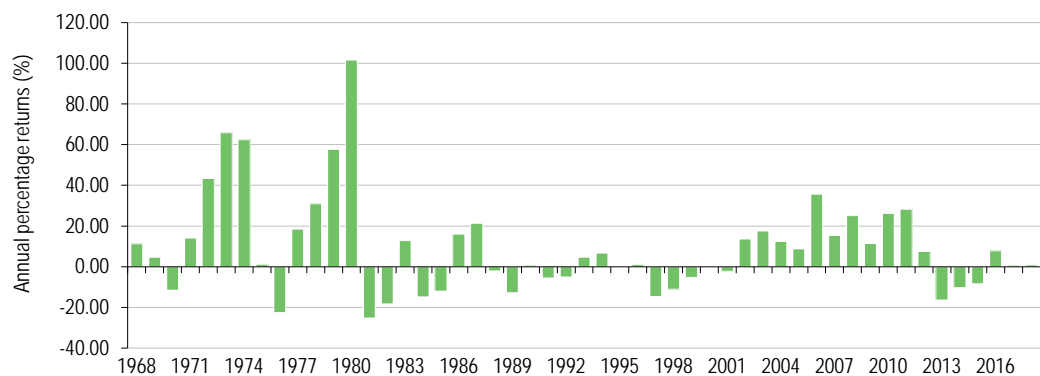
While the chart may bear a superficial relationship that in Exhibit 9, in fact the distribution of returns (albeit nominal rather than real) during the period is entirely different:

Exhibit 12: Histogram of gold's nominal annual percentage returns, 1967–2018

Source: Edison Investment Research; underlying data: South African Chamber of Mines, U.S. Bureau of Labor Statistics, Bloomberg, Kitco

Even allowing for the fact that there was a modest increase in the average inflation rate between the two periods (from an average of 2.3% for the period from 1913–1967 to 4.1% for the period from 1967–2018), it is also apparent that there is a materially increased probability of a positive annual investment return from gold since 1967, a materially increased probability of an outsized positive investment return (eg >40%) and a materially decreased probability of a negative return in the interval -10–0% compared to the chart of real gold price returns. In this case, the (geometric) average nominal return for gold is 9.6% (as observed above) with a (sample) standard deviation of ±24.2% (NB the population standard deviation is ±18.5%). Note that these calculations are again based on the assumption that returns are normally distributed.

Gold's relationship with US inflation

Since 1945, gold can be seen to have undergone at least two completed bull and two completed bear markets:

■ A bear market between 1945 and 1967 (a period that was characterised by inflation and positive real interest rates).

■ A bull market between 1968 and 1980 (a period of financial crisis, negative real interest rates and/or unconventional monetary policy).

■ A bear market from 1980 to 2001 (positive real interest rates).

■ A bull market again from 2001 to 2012 (again characterised by financial crisis, negative real interest rates and unconventional monetary policy).

■ A bear market from 2012 to the present that Edison contends has been characterised by the expectation of a resumption of positive real interest rates – an expectation that is currently being tested seriously by the markets for probably the first time since 2012. Note however that, as of 2018, the price of gold (as measured by its annual average) has been on an upward trend for three years since 2015 – albeit modestly in the case of the last two years:

Exhibit 13: Nominal gold price (1913–2018) and indexed from US$35/oz in January 1934 (US$/oz)
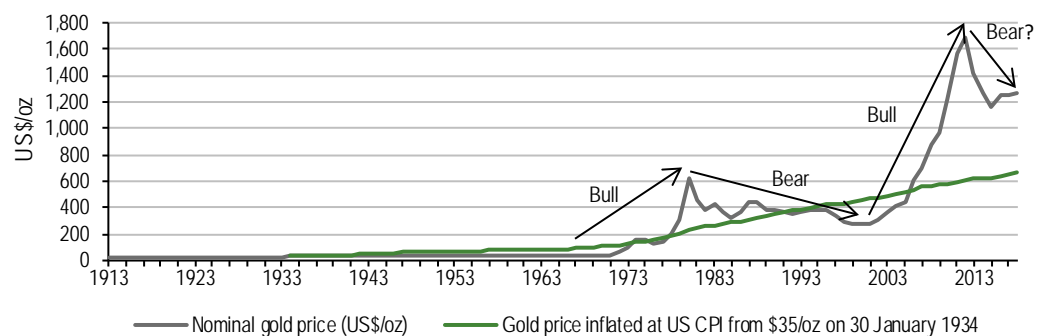
Source: Edison Investment Research, South African Chamber of Mines, Bloomberg, Kitco. Underlying data: US Department of Labor. Note: Prices are annual averages.

Between 1945 and 1971, the gold price was formally linked to the US dollar. Towards the end of this period, however, the US began both to run twin deficits and to expand the money supply. As a result, international creditors (particularly France) began to convert dollar foreign exchange reserves into gold, which put upward pressure on the price of gold and downward pressure on the value of the dollar. After a series of initiatives aimed at preserving the Bretton Woods world order, President Nixon finally abandoned the link in August 1971. The subsequent devaluation of the dollar had the effect, among other things, of importing inflation into the United States, which jumped from a containable 3.4% in 1972 to a virtually unprecedented 8.7% in 1973. The Federal Reserve reacted conventionally by tightening monetary policy, which comprehensively burst the internal US credit bubble and started to suck markets into a debilitating debt-deflation spiral. In 1973–74, the Dow Jones Industrials average lost 45% of its value, while the US economy slowed from 7.2% real GDP growth in 1972 to a 2.1% contraction in 1974. Facing the prospect of a depression, the Fed reacted to the new threat equally conventionally by reducing interest rates to the minimum possible and by expanding the US monetary base. Inevitably, this put downward pressure on the value of the dollar in the foreign exchange markets and imported price rises, leading to a second peak in inflation later in 1979, which was only brought under control after Fed chair Paul Volcker's eventual decision to raise interest rates to defend the dollar at the expense of a further debilitating recession in the early 1980s. Positive interest rates having once again been re-established, international markets returned to something approaching normality, albeit with the dollar (and sterling) at

permanently lower levels compared to the currencies of international creditor nations such as Germany, France and Japan.

As positive real interest rates reasserted themselves in 1980, so currency markets stabilised and gold returned to a bear market phase that lasted until 2001 (analogous to the period of 1945–68). Hence, whereas the German mark appreciated by 66% against the US dollar during the 1970s, in 1999 the DEM/US$ rate was recognisably similar to that in 1980.

As the new millennium dawned, however, (and after a period of relative economic stability) the US once again began to run twin deficits as a result of a combination of the 'war on terror' and the rise of a new economic competitor and international creditor in the form of China, which resulted in:

1. The return of negative real interest rates in 2001.
2. Inflation and a subsequent rise in interest rates in 2007.
3. The bursting of the credit bubble, subsequent banking failures (Bear Stearns, Lehman Brothers, etc) and the beginnings of a debt-deflation spiral in 2007–09.
4. The adoption of unconventional monetary policy in the form of record low nominal interest rates and three rounds of quantitative easing (QE1, QE2 and QE3) from 2008 until 2014.

The two completed bull and bear markets may easily be seen by comparing the actual price of gold relative to the indexed price from US$35/oz in January 1934 (see Exhibit 13) using the US consumer price index (CPI):

Exhibit 14: Nominal gold price relative to indexed gold price,* 1934–2018
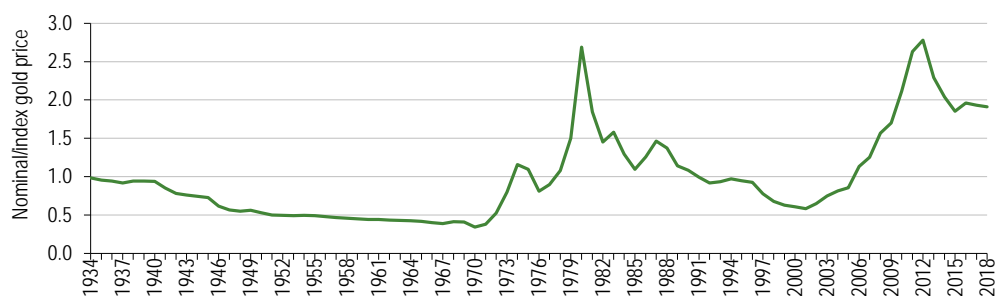
Source: Edison Investment Research. Underlying data: Bloomberg, Kitco, South African Chamber of Mines, US Department of Labor. Note: *See Exhibit 13, above.

Observing Exhibit 14, it is easy for gold bears to conclude that the peak in 2012 was analogous to that in 1980 and that gold has therefore just started another 21-year bear market. In this case, the degree of divergence in 2018 can be seen to be similar to that in 1981. However, it is also notable that this was also true for 2016, suggesting (among other things) that the cycle has, at the very least, been extended as higher prices have been sustained for longer in the 2012–18 period than in the equivalent period in gold's earlier cycle, from 1980–86 (by which time, gold had lost 40% of its peak 1980 value). Using this as a benchmark and projecting the indexed level of gold into the future at the same average historical rate of US CPI inflation between 1972 and 2016 and then applying the same cyclical discount or premium depicted in Exhibit 14, above, generates the following future gold price profile:

Exhibit 15: Gold price, historical and forecast with respect to 1934 price (indexed), 1913–2051
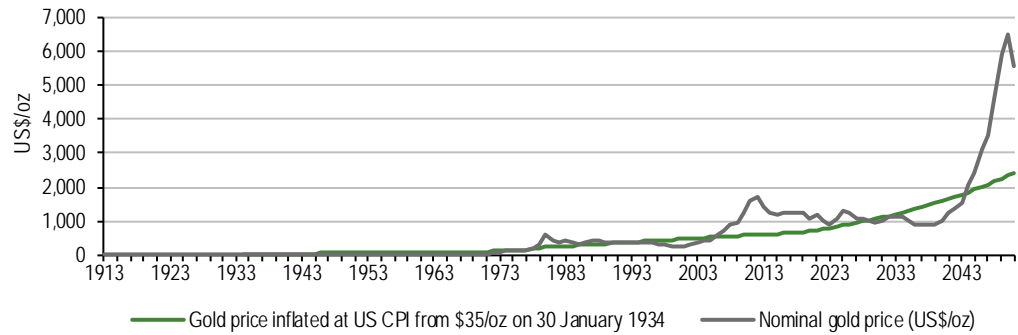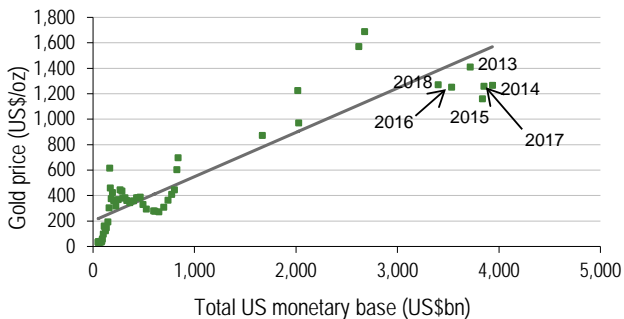

Source: Edison Investment Research and (historical) South African Chamber of Mines, US Department of Labor. Note: Prices are annual averages

On this basis, gold would be expected trade between US$879/oz and US$1,279/oz for the next 20 years before starting another bull run in 2040.
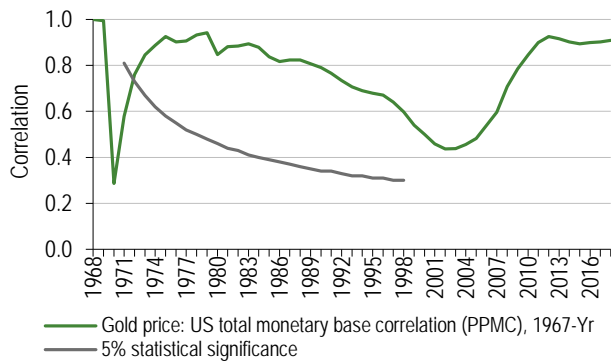
Gold's relationship with the total US monetary base

In addition to its relationship with inflation and consumer prices, however, gold also exhibits a very close, statistically significant relationship with the US total monetary base. Since 1967, the relationship between the two elicits a Pearson product-moment correlation coefficient (PPMC) of 0.909 (vs 0.902 at the time of Edison's note Mining overview: Unlocking the price to NPV discount, published in November 2017), implying that there is less than a 5% chance that the relationship occurred by chance. This may be rationalised as the value of US gold holdings having a very close correlation with the total US monetary base (also with a PPMC of 0.909 since 1967), which reduces to the gold price having a very close correlation with the total US monetary base, given that the gold tonnage held by the Fed as a reserve asset has remained effectively unchanged since 1979 (and, to all intents and purposes, since 1972).

Exhibit 16: Gold price vs US total monetary base, regression analysis, 1959–2018	Exhibit 17: Gold price and US total monetary base correlation, 1968–2018
Source: Edison Investment Research, Federal Reserve, dollardaze.org	Source: Edison Investment Research; underlying data: Federal Reserve, dollardaze.org

Between 2007 and 2014, the Federal Reserve increased the US total monetary base by 4.7 times, or US$3.1tn, from US$0.8tn to US$3.9tn. It declined in 2015 and 2016, but jumped once more in 2017 before falling back to US$3.4tr in 2018 almost exactly in line with Edison's expectations under the influence of its taper programme (see below). This compares to losses in the US economy at the height of the economic crisis of around US$9.0tn. However, US$4.8tn of the US$9.0tn related to retirement assets, savings and pension assets, which are closely related to the stock market. Given that the Dow Jones is now (August 2019) at a level that is comfortably above its pre-crisis level of c 14,000 in September 2007, it is not unreasonable to surmise that these losses have been recouped. At the same time, according to figures from the Federal Housing Finance Agency, nominal US house prices have more than recouped their losses from the crisis (albeit, in real terms, house prices are on a par with immediate pre-crisis levels). As such, the Federal Reserve may be considered to have 'printed' US$2.6tn in new money to cover a nationwide loss from a crisis that no longer exists.

Exhibit 18 depicts the gold price and the US total monetary base since 1959, as well as a forecast estimate of the level of the gold price had it been predicted solely on the basis of its relationship with the US total monetary base as it would have been perceived at the time:

Exhibit 18: Gold price, US total monetary base and predicted gold price, 1959–2018
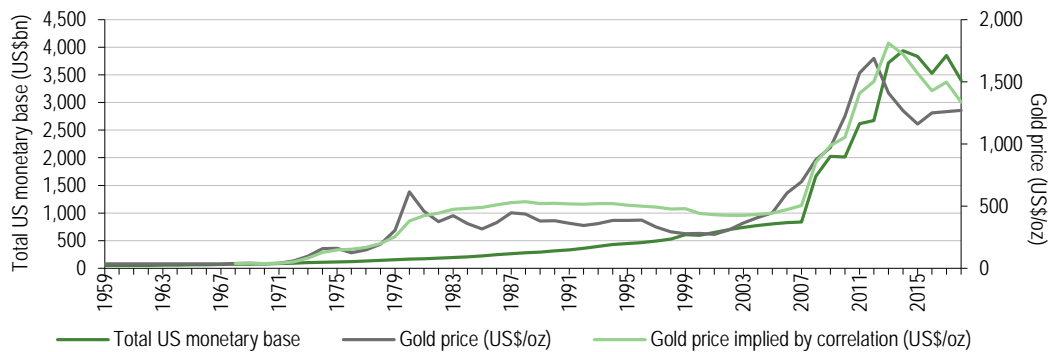
Note that, statistically, the error of estimation of the regression analysis is ±US$183/oz, or 14.4% of 2018's average price of gold of US$1,271/oz. By contrast, in 2018, the actual discount of the price of gold compared to the predicted one was just 5.0%. Exhibit 19 graphs the variation (or divergence) of the actual gold price from the predicted one (as depicted by the grey and light green lines in Exhibit 18, respectively) since 1968.

Exhibit 19: Variation of actual gold price from predicted, 1968–2018
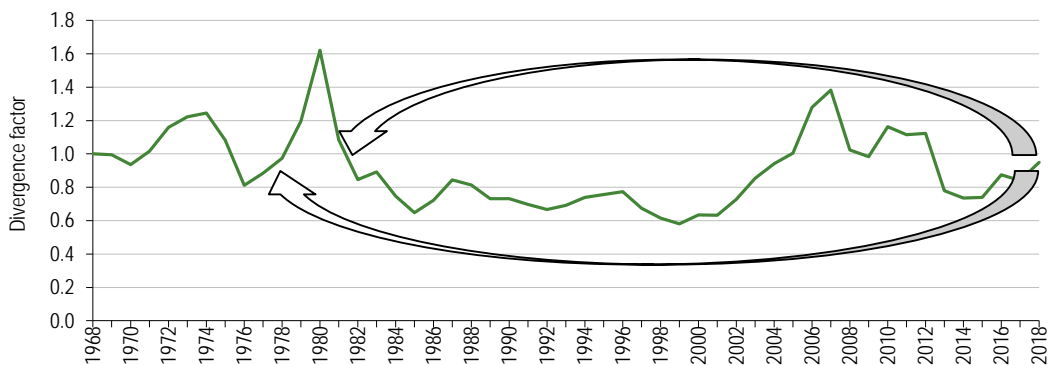
Relative to the total US monetary base, the gold price can be said to have reverted rapidly from the premiums that were typical of bull market conditions in 2005–12 to those that are typical of bear market conditions in 2013–16 (Exhibit 19). In this case, empirically, there are two obvious, potential historical analogues for 2018 – one being the early 1980s and the other being 1978 (see arrows). Note that in the event of 1978 being the most appropriate historical analogue for the current disposition of the US economy, then it would imply, among other things, that the world has yet to achieve any real sense of 'normalisation' in the aftermath of the global financial crisis that started in 2008.

In the meantime, on the basis of the historical correlation between the two:

■ The current gold price (US$1,485/oz at the time of writing) discounts a total US monetary base of US$3,844bn (cf US$3,400bn at end-2018).
■ The end-2018 total US monetary base of US$3,400bn implies a gold price of US$1,337/oz.

Reflecting a monetary paradox

From Edison's two analyses above, it can be concluded that the gold price is expensive with respect to indexed prices (or, stated alternatively, it has more than acquitted itself as a store of

value and a hedge against inflation), but cheap relative to the current level of the monetary base. At first glance this appears to be a paradox, especially since the relationship between prices in general and the total US monetary base has been extremely close in historical terms (eg a Pearson product-moment coefficient of 0.957 between 1959 and 2007):

Exhibit 20: Correlation (PPMC), total monetary base to US CPI index level, 1959–2018	Exhibit 21: Scattergram, total monetary base vs consumer price levels, 1959–2007
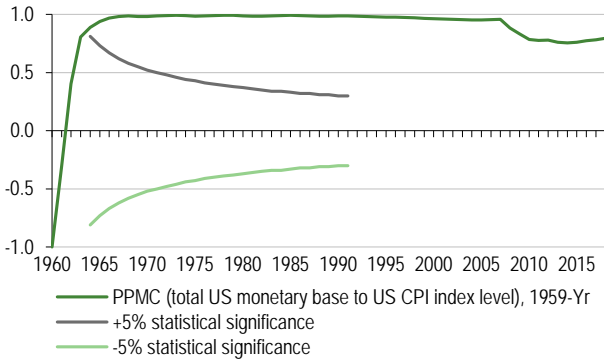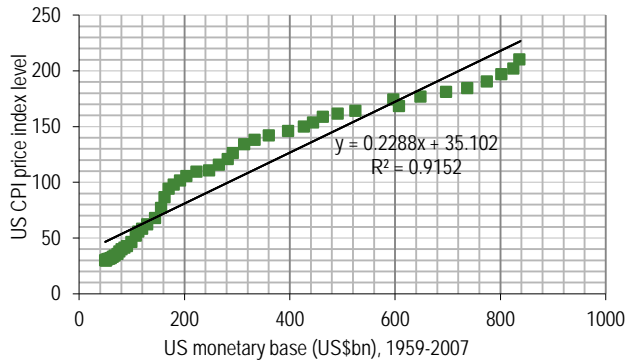
Source: Edison Investment Research, US Department of Labor, Federal Reserve, dollardaze.org

Source: Edison Investment Research, US Department of Labor, Federal Reserve, dollardaze.org

Since 2007 however, the relationship appears to have broken down almost completely, with the US total monetary base recording annual increases of 99%, 21%, 27%, 2%, 2%, 39% 6%, -3%, -8%, 9% and -12% in the decade from 2008–18 while (over the same timeframe) consumer prices have increased by only 19.6% in total (or 1.6% per year, on average):

Exhibit 22: Scattergram, total monetary base vs US CPI level, 1959–2018
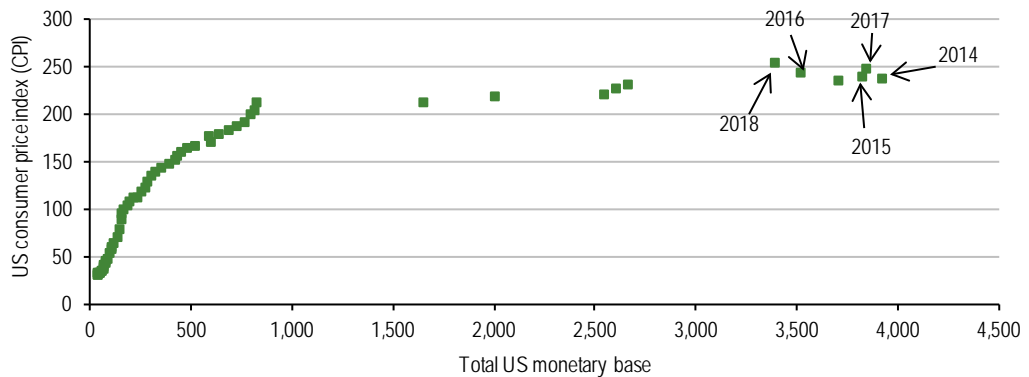
Source: Edison Investment Research, US Department of Labor, Federal Reserve, dollardaze.org

This is all the more striking when the historical relationship between inflation and changes in the monetary base is considered. Traditionally, increases in the total monetary base have been 6.0% per year (geometric mean). Currently, the relationship between the two cannot be said to be statistically significant. However, it was between 1973 and 1992. Moreover, as shown in the exhibit below, there appears to be an increased risk of inflation in the event that the total monetary base increases by more than 4% per year (see below):

Exhibit 23: Scattergram, US CPI inflation vs change in total US monetary base, 1960–2007
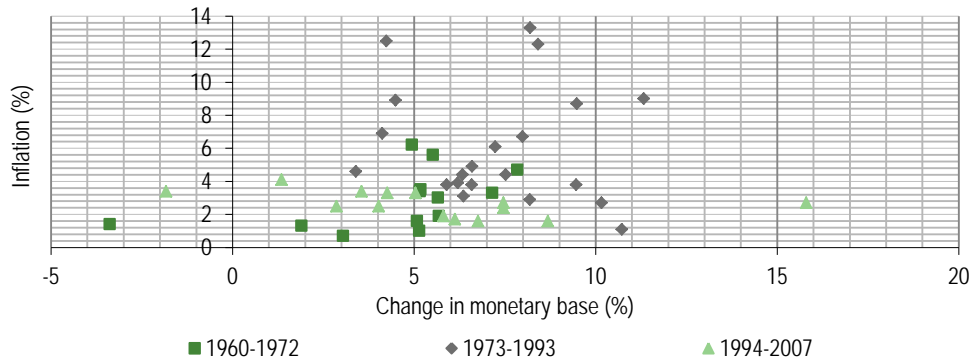
Source: Edison Investment Research, US Department of Labor, Federal Reserve, dollardaze.org

In fact, were the two to maintain the relationship that they had prior to the start of quantitative easing, at the current total US monetary base, the CPI index would be expected to be 813.0, or 3.2x its current level.

Given the historical relationship between the two, the obvious conclusion is that price rises in the general economy have not kept pace with increases in the total monetary base. The gold price has risen by more than general prices in the past 17 years, but not by as much as the increase in narrow money would imply. As a result, it is at a premium to its CPI-indexed level, but a much smaller premium to the level implied by its historical correlation with the total US monetary base.

Currency in circulation vs total monetary base

Probably the simplest explanation for the apparent breakdown in the relationship between the US total monetary base and prices/inflation relates to the level of currency in circulation in the US economy.

The total US monetary base is made up of two components: 1) currency in circulation and 2) total reserve balances maintained by banks and depositary institutions at the Federal Reserve (crudely, currency that could be in circulation).

Traditionally, currency in circulation has made up the majority of the total monetary base. In fact, between 1959 and 2007, it accounted for an average 74% of the total monetary base, with a maximum of 91% (in 2006) and a minimum of 57% (in 1959). During the period since the start of quantitative easing however, this proportion has reduced sharply.

Exhibit 24: US total monetary base, comprising currency in circulation and reserve bank cash, 1959–2018
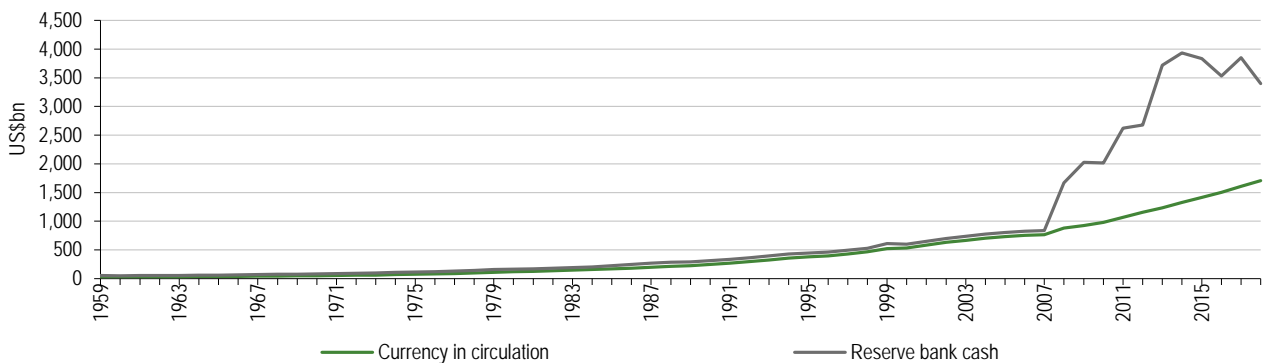
Source: Edison Investment Research, Federal Reserve, dollardaze.org

Arguably, the increase in the total US monetary base since 2007 is what has been required in order to maintain growth in currency in circulation (and probably therefore growth in US GDP as well). Nevertheless, it leaves the proportion of currency in circulation as a percentage of the US total monetary base at just 50.3% as at end-December 2018 – higher than at any other time since 2008, but still well below pre-crisis levels.

Exhibit 25: Currency in circulation as a percentage of the US total monetary base, 1959–2018
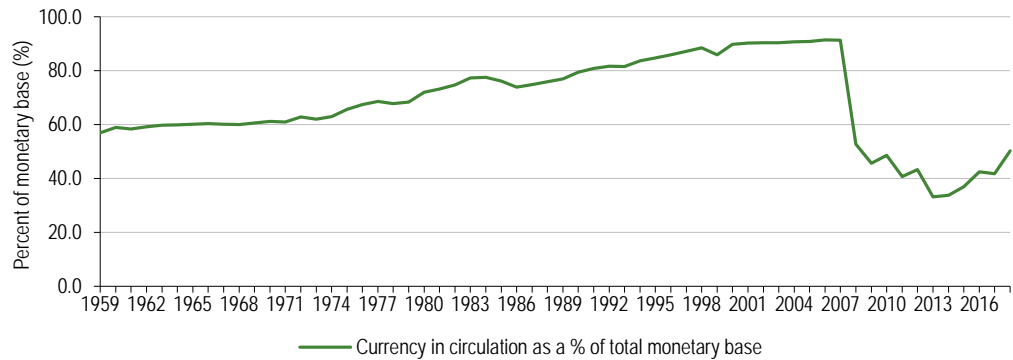
Source: Edison Investment Research, Federal Reserve, dollardaze.org

Gold's relationship with currency in circulation

The correlation between the gold price and currency in circulation (0.878 for the period 1967–2018) is fractionally less positive than between the gold price and the total monetary base (0.909 for 1967–2018). Nevertheless, it is still statistically significant at the 5% level.

Exhibit 26 depicts the gold price and currency in circulation since 1968, as well as the forecast estimate of the level of the gold price had it been predicted solely on the basis of its relationship with currency in circulation as it would have been perceived at the time:

Exhibit 26: Gold price, currency in circulation and predicted gold price, 1968–2018
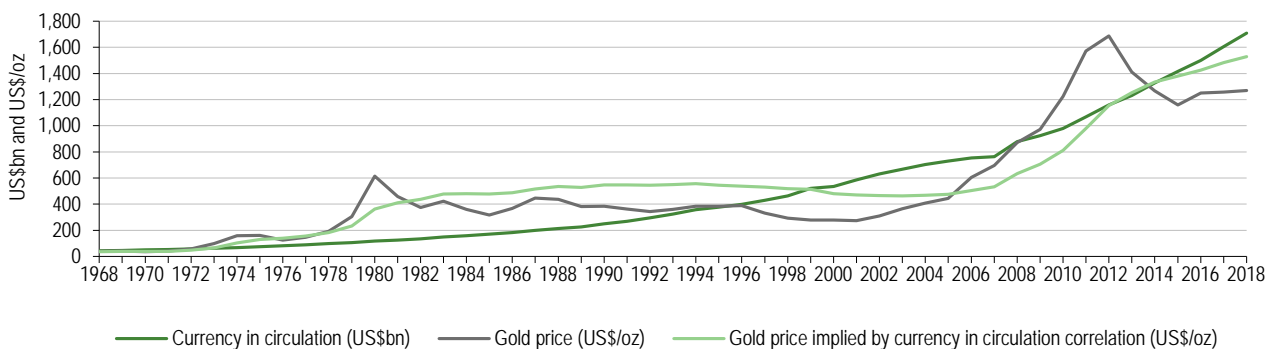
Source: Edison Investment Research and (underlying historical data) Federal Reserve, dollardaze.org

Note that, statistically, the error of estimation of the regression analysis is ±US$196/oz, or 15.4% of 2018's average price of gold of US$1,271/oz, and marginally above the error of estimation derived from the correlation using the total US monetary base of ±US$183/oz. By contrast, in 2018, the discount of the actual price of gold relative to the predicted one was 16.9% (cf 5.0% for the prediction made on the basis of gold's historical total US monetary base correlation).

Exhibit 27 graphs the variation of the actual gold price from the predicted one since 1968:

Exhibit 27: Variation of actual gold price vs that predicted by currency in circulation correlation, 1968–2018
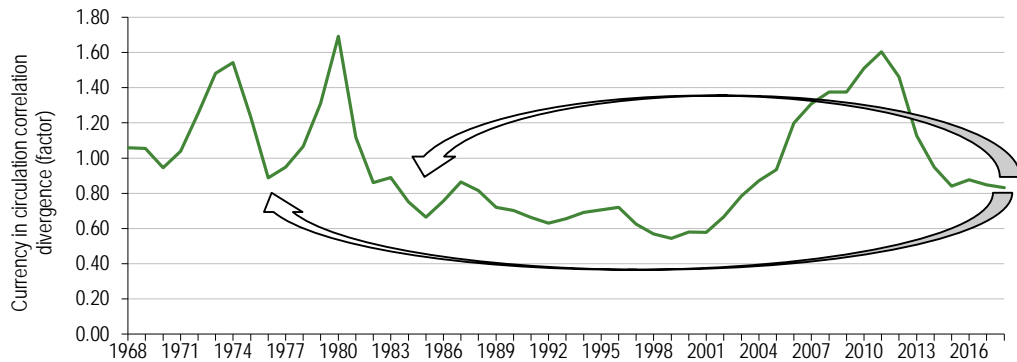
Source: Edison Investment Research; underlying data: Federal Reserve, South African Chamber of Mines, dollardaze.org

Relative to currency in circulation, the gold price can be said to have reverted rapidly from the premiums that were typical of bull market conditions in 2006–12 to those that are typical of bear market conditions in 2014–18. Once again, there are two obvious historical analogues for the level of the gold price in 2018 relative to the positioning of the US economy within its post-crisis cycle – the first is the 1980s and the second is 1976 (see arrows). Either way, investors should note that, as at 2018, at a factor of 0.83x, gold was trading below its long-term average level of 0.96x its predicted level.

On the basis of the historical correlation between the two, we can make the following observations:

- The current gold price (US$1,485/oz at the time of writing) discounts currency in circulation of US$1,657bn (ie 3.0% below end-2018 currency in circulation of US$1,709bn).
- At the current time, end-2018 US currency in circulation of US$1,709bn implies a gold price of US$1,528/oz (note that currency in circulation increased in 2015, 2016 and 2018 in contrast to negative movements in the total monetary base).

Tapering the taper

Background

When Janet Yellen announced the end of its bond buying programme in October 2014, the Federal Reserve's balance sheet had expanded to US$4.5tn (including US$2.5tn of Treasuries and US$1.8tn in mortgage-backed securities, or MBS) and the total US monetary base to US$3.9tn. By reinvesting principal payments and maturing securities, both remained at or about that level until 2018, when tapering began in earnest.

Politics

Hitherto, the Federal Reserve was believed to favour a relatively large balance sheet and therefore a relatively big presence in money markets. Until the election of Donald Trump as US president, the possibility of the Fed actively selling securities in order to reduce its balance sheet was regarded as remote owing to the effect that such a policy could have on market interest rates and, potentially, volatility. Particularly prior to his election in 2016, Mr Trump had been highly critical of the Federal Reserve, while many Republican economists actively criticised quantitative easing. In more recent times however, and since the Federal Reserve first set out its asset reduction plan, President Trump's attitude towards the Federal Reserve appears to have changed markedly to the point at which he has recently called upon it to curtail its policy and to revert to its former policy of reinvesting principal payments and maturing securities in order to maintain its asset base at an approximately constant level. It is within this context that we attempt future changes to both the Fed's balance sheet and its total monetary base.

Economics

In order to soften the potentially deflationary impact of a shrinking balance sheet, at the Federal Reserve meeting in June 2017, committee members agreed that, rather than outright asset sales, they would start by letting US$6bn a month in maturing Treasuries run off, which would then increase to US$30bn pm, while mortgage backed securities would run off at a rate of US$4bn pm, rising to US$20bn. Note that this total of US$50bn per month compares with the ultimate level of bond buying during QE3 of US$85bn per month. Moreover, while the rate of amortisation of mortgage-backed securities was estimated to be c 1% per month (such that the US$20bn maximum cap for MBS allowed for essentially unrestricted roll off), Treasury amortisation was uneven from month to month with the result that the US$30bn maximum monthly cap was likely to force the Fed to continue to purchase Treasury bonds in some months. Nevertheless, under the Federal Open Market Committee's then plan for Treasury roll off, the Federal Reserve's holdings of Treasury securities should have declined at a rate of c 11% per year. Any reduction in demand as a result of its shrinking balance sheet was to be mitigated by lowering the anticipated path of interest rate increases (see Gold considered as a currency on pages 28–32).

On 20 September 2017, the Fed put the process of balance sheet tapering into operation by announcing that its programme would begin in October. In the long term, the Fed said that it planned to keep its balance sheet 'appreciably below that seen in recent years but larger than before the financial crisis'. Once it fell below US$3.0tn, however, there was to be a further discussion as to how big the Fed's balance sheet should be once tapering was over. Under these circumstances, the earliest that the Federal Reserve could reasonably have started to expand its balance sheet once again was mid-2020. At the time, Edison's forecasts for combined Treasury bond and MBS run off per year, over the course of the entire balance sheet reduction programme (as set out in our report, Mining overview: Unlocking the price to NPV discount, published in November 2017), were as follows:

Exhibit 28: Projected reduction of Federal Reserve's assets, by year (as at November 2017)

Year	Reduction (US$bn)	Percentage of total (%)
2017	20	1.4
2018	360	24.3
2019	463	31.3
2020	515	34.8
2021	122	8.2
Total	1,480	100.0

Source: Edison Investment Research

Note that, in the two years since the start of the asset reduction programme (namely 2017 and 2018), the Fed's progress (as reflected in the total US monetary base – ie the liabilities side of its balance sheet) has been almost exactly in line with Edison's prior forecasts:

Exhibit 29: Variation of actual total US monetary base vs Edison prior forecast, years 2017 and 2018

Year	*Edison forecast of total US monetary base (US$bn)	Actual year-end total US monetary base (US$bn)	Variance (actual vs forecast) (US$bn)	Variance (actual vs forecast) %
2017	3,827	3,851	+24	+0.6
2018	3,467	3,400	-66	-1.9

Source: Federal Reserve, Edison Investment Research. Note: *See our report, Mining overview: Unlocking the price to NPV discount, published in November 2017.

As recently as November, indications from the new Fed Chairman Jerome Powell were that it would be some time before the Fed stopped raising rates and reducing the balance sheet as the asset reduction programme was deemed to be on 'auto-pilot'. In March of this year however, it altered its stance materially, saying that it would begin to taper the amount of proceeds that it allows to roll off in May and end the programme in September. Under the revised plan, the amount for allowable Treasury roll-off reduced to US$15bn per month in May (cf US$30bn previously). Moreover, beyond September, while technically still allowing the proceeds from MBSs to roll off, in reality the Fed will now simply reinvest them in Treasuries.

At that point, the Federal Reserve stated that the average level of reserves will probably 'still be somewhat above the level of reserves necessary to efficiently and effectively implement monetary policy. In that case, the Committee currently anticipates that it will likely hold the size of the SOMA portfolio roughly constant for a time. During such a period, persistent gradual increases in currency and other non-reserve liabilities would be accompanied by corresponding gradual declines in reserve balances to a level consistent with efficient and effective implementation of monetary policy. When the Committee judges that reserve balances have declined to this level, the SOMA portfolio will hold no more securities than necessary for efficient and effective policy implementation. Once that point is reached, the Committee will begin increasing its securities holdings to keep pace with trend growth of the Federal Reserve's non-reserve liabilities and maintain an appropriate level of reserves in the system'.

Then, on 31 July, in addition to lowering interest rates for the first time in a decade, the Fed also announced it would bring forward the date of the end the asset reduction programme by two months, from September to July.

Within this context, Edison's forecasts for the total US monetary base for the remainder of the programme are now as follows (and compared with 2007 – the year immediately before the effects of quantitative easing became apparent in the total US monetary base):

Exhibit 30: Revised Edison forecast of currency in circulation, reserve bank cash and total US monetary base, 2019–22e (US$bn)

Year	2007	2019e	2020e	2021e	2022e
Previous					
Currency in circulation	764	1,845	1,978	2,119	2,271
Reserve bank cash	73	1,158	511	247	237
Total US monetary base	836	3,004	2,489	2,367	2,508
Current					
Currency in circulation	764	1,831	1,962	2,102	2,252
Reserve bank cash	73	1,408	1,278	1,138	988
Total US monetary base	836	3,240	3,240	3,240	3,240

Source: Edison Investment Research. Note: Totals may not add up owing to rounding.

The central assumptions behind the forecasts in Exhibit 30 are:

- That currency in circulation continues to grow at its long-term compound annual growth rate, between 1959 and 2018, of 7.1%.
- That changes in the difference between the total US monetary base and currency in circulation are absorbed within total reserve balances maintained by banks and depositary institutions at the Federal Reserve (ie 'reserve bank cash').

On the basis of the above assumptions, it is apparent that the Federal Reserve can execute the first phase of its plan until sometime in 2026, at which point currency in circulation as a percentage of the monetary base will be close to the (peak) levels that it reached in 2006. Thereafter, we assume that the Fed will increase the monetary base at the same rate (7.1%) as the historical rate of growth in currency in circulation in order to maintain a stable relationship between the two and reserve bank cash, as shown in Exhibit 31, below.

Exhibit 31: Currency in circulation as a percentage of the US total monetary base, 1959–2051e
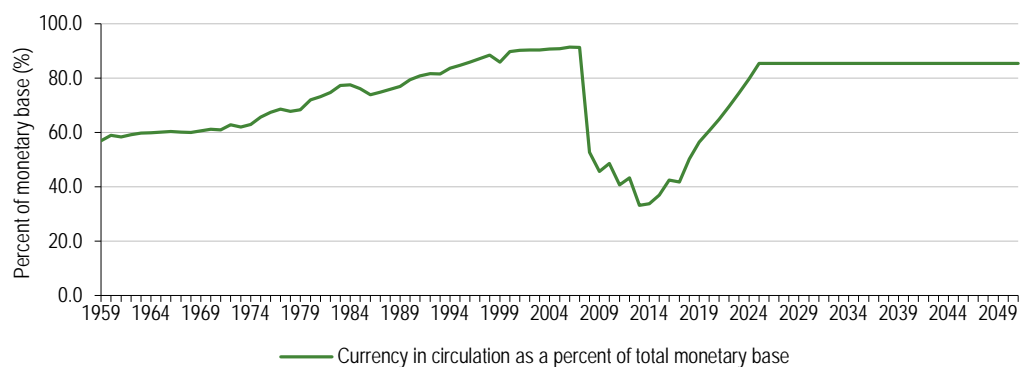
Source: Edison Investment Research, Federal Reserve, dollardaze.org

Note that, according to this analysis, 2026 is the latest date by which the Fed will need to start re-expanding the total monetary base. Moreover, the 7.1% rate of monetary base expansion thereafter will be faster than the historical trend rate of growth of 6.0% between 1959 and 2007.

A quick contra-factual

Historically, the total US monetary base has grown at a fairly consistent 6.0% per year, such that it approximately doubled every decade – a trend that is easily discernible in the following table, with the notable exception of the last fully completed decade, 2000–10:

Exhibit 32: Total US monetary base, by decade, 1960–2010

Year	1960	1970	1980	1990	2000	2010
Total US monetary base (US$bn)	49.8	81.0	163.0	313.6	596.9	2,017.0
Ratio cf prior decade (factor)		1.63	2.01	1.92	1.90	3.38

Source: US Federal Reserve, Edison Investment Research

Readers should note the general pattern whereby 'better' economic decades (eg the 1960s) were accompanied by a lesser increase in the total US monetary base, whereas more troubled ones (eg the 1970s and 2000s) were accompanied by higher increases in the total US monetary base.

Exhibit 33 analyses how the total US monetary base might have been expected to evolve had it continued to expand at average historical rates beyond 2008 compared to how it has actually evolved (and our expectations of how it will continue to evolve based on Exhibit 30 followed by long-term, trend rates of growth to derive our 2030 forecast) in the light of both quantitative easing and subsequent tapering:

Exhibit 33: Total US monetary base, by decade, 1960–2030e

Year	1960	1970	1980	1990	2000	2010	2020e	2030e
Actual & forecast total US monetary base (US$bn)*	49.8	81.0	163.0	313.6	596.9	2,017.0	3,239.9	4,572.8
Ratio cf prior decade (factor)		1.63	2.01	1.92	1.90	3.38	1.61	1.41
Actual & trend rate total US monetary base (US$bn)**	49.8	81.0	163.0	313.6	596.9	995.6	1,779.5	3,180.5
Ratio cf prior decade (factor)		1.63	2.01	1.92	1.90	1.67	1.79	1.79

Source: US Federal Reserve, Edison Investment Research. Note: *With tapering. **Assuming neither quantitative easing nor tapering and the total US monetary base continuing to expand at historical trend rates.

Of note is the fact that, were it not for the global financial crisis, the 2000s, as a decade, was on course to be a relatively 'benign' economic decade, more akin to the 1960s than the 1970s. It also demonstrates how the process of quantitative easing, followed by tapering, will, according to anticipated trends, leave the total US monetary base some 82.1% higher than it would otherwise have been expected to be under 'normal' circumstances in 2020 and 43.8% higher than it would otherwise have been expected to be in 2030 (ie US$4,572.8bn vs US$3,180.5bn in 2030 – see Exhibit 33, above) – and widening thereafter:

Exhibit 34: Total US monetary base, actual and forecast vs without quantitative easing and tapering, 1959–2030e (US$bn)
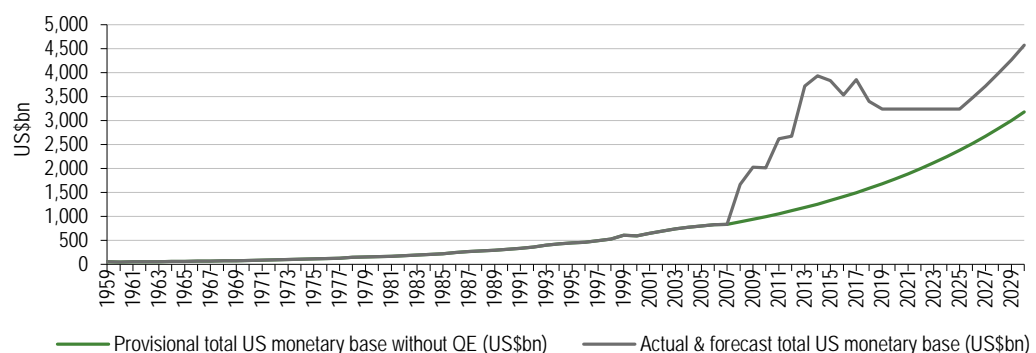
Source: US Federal Reserve, Edison Investment Research

Gold price forecasts

For the purposes of our forecasts, future changes in the Federal Reserve's assets are assumed to be reflected also in changes in the total US monetary base. As stated previously, empirically, there are two obvious, potential historical analogues for 2018 – one being the early 1980s (the hawkish scenario) and the other the late 1970s (the dovish scenario).

The hawkish scenario

For the purposes of continuity with our approach in November 2017 only, we have chosen to consider the hawkish scenario first. In this case, if the same gold price cycle relative to the total US monetary base repeats itself in 2018–49 (and beyond) as in 1982–2012 (ie assuming that the US economy is in a tightening cycle and that the 'normalisation' of monetary policy is in prospect), then the gold price may be expected to evolve as shown in Exhibit 35, assuming the same discounts and premiums in future years as in the corresponding years of the past cycle (see Exhibit 19).

Exhibit 35: Historical and forecast gold price (forecast made with respect to US total monetary base)
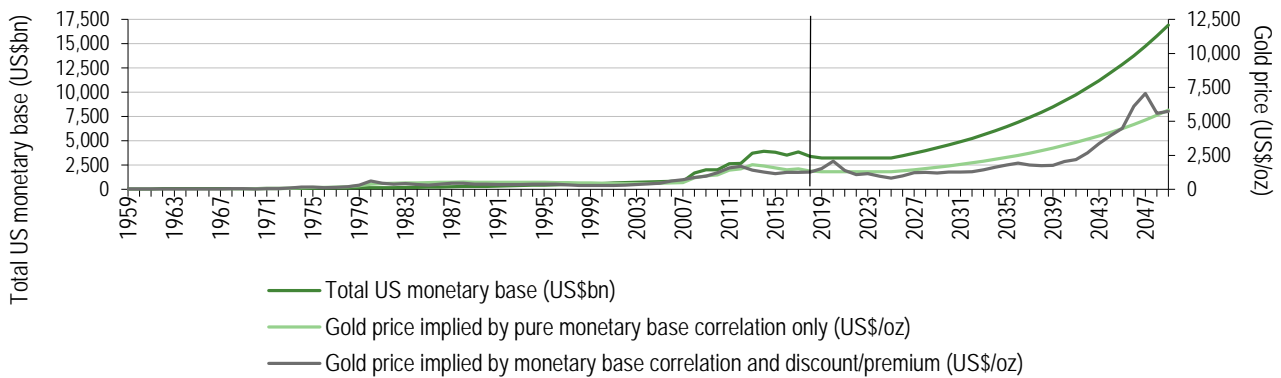
Total US monetary base (US$bn)

Gold price implied by pure monetary base correlation only (US$/oz)

Gold price implied by monetary base correlation and discount/premium (US$/oz)

Source: Edison Investment Research; underlying historical data: Federal Reserve, South African Chamber of Mines, dollardaze.org

According to this analysis, the effect of the Federal Reserve successfully executing its asset reduction plan taper, as set out above, and this being reflected in the monetary base would be to reduce the gold price to US$831/oz in 2022, before recovering to something close to current levels, in nominal terms, a decade later, in 2033.

These may be compared to our forecasts based on gold's historical relationship with US inflation (see Exhibit 15) and a similar analysis based on its relationship with currency in circulation (and cycle), as follows:

Exhibit 36: Historical and forecast gold price (forecast made with respect to 1. US total monetary base, 2. inflation, 3. currency in circulation), 1959–2049e
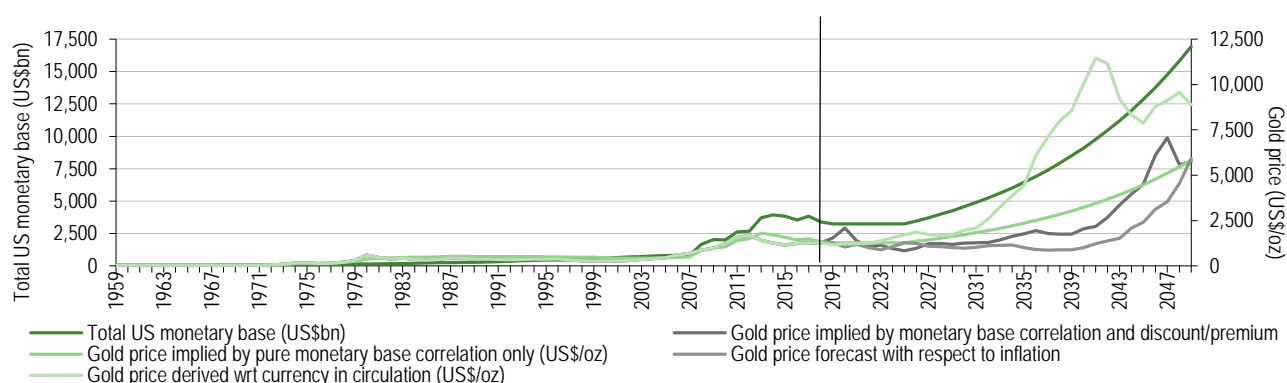
Source: Edison Investment Research; underlying historical data: Federal Reserve, South African Chamber of Mines, dollardaze.org

Note that Exhibit 36 is identical to Exhibit 35 except that it includes two additional lines to reflect our forecasts based on gold's historical relationships with US inflation and currency in circulation. In tabular form, a summary of Edison's gold price forecasts from 2019–30 is as follows:

Exhibit 37: Edison forecast gold price range, 2019–30e (US$/oz)

Forecasting basis	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
July 2019 (hawkish scenario)												
Currency in circulation and cycle	1,177	1,222	1,233	1,253	1,391	1,567	1,712	1,867	1,729	1,683	1,720	1,965
Monetary base correlation only	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,361	1,443	1,531	1,626	1,727
Inflation	1,275	1,044	1,181	1,006	887	1,058	1,279	1,247	1,081	1,067	1,017	976
Monetary base correlation & cycle	1,086	1,145	960	831	928	1,085	1,045	997	1,056	1,069	1,083	1,193
Average	1,206	1,174	1,165	1,094	1,123	1,248	1,330	1,368	1,327	1,338	1,361	1,466
November 2017												
Currency in circulation and cycle	1,315	1,606	1,622	1,532	1,593	1,610	1,637	1,821	2,053	2,245	2,451	2,271
Monetary base correlation only	1,256	1,069	1,025	1,076	1,131	1,188	1,249	1,314	1,383	1,456	1,533	1,615
Inflation	1,143	975	860	1,027	1,243	1,213	1,053	1,040	992	953	1,012	1,094
Monetary base correlation & cycle	907	730	661	712	796	854	918	835	797	776	896	933
Average	1,155	1,095	1,042	1,087	1,191	1,216	1,214	1,253	1,306	1,358	1,473	1,478
Change (US$/oz)												
Currency in circulation and cycle	-138	-384	-389	-279	-202	-43	75	46	-324	-562	-731	-306
Monetary base correlation only	28	215	259	208	153	96	35	47	60	75	93	112
Inflation	132	69	321	-21	-356	-155	226	207	89	114	5	-118
Monetary base correlation & cycle	179	415	299	119	132	231	127	162	259	293	187	260
Average	50	79	123	7	-68	32	116	116	21	-20	-112	-13
Change (%)												
Currency in circulation and cycle	-10.5	-23.9	-24.0	-18.2	-12.7	-2.7	4.6	2.5	-15.8	-25.0	-29.8	-13.5
Monetary base correlation only	2.2	20.1	25.3	19.4	13.5	8.1	2.8	3.6	4.4	5.2	6.1	6.9
Inflation	11.6	7.1	37.3	-2.0	-28.6	-12.8	21.5	19.9	9.0	12.0	0.5	-10.8
Monetary base correlation & cycle	19.8	56.9	45.2	16.7	16.6	27.0	13.9	19.4	32.5	37.8	20.9	27.9
Average	4.4	7.2	11.8	0.6	-5.7	2.7	9.5	9.2	1.6	-1.5	-7.6	-0.9

Source: Edison Investment Research

While there is some variation for individual years, on average our gold price forecasts for the period 2019–30, inclusive, have increased by US$28/oz, or 2.6%, relative to those made in November 2017.

The same data may be depicted graphically, as follows:

Exhibit 38: Gold price forecast made with respect to 1. US total monetary base, 2. inflation, 3. US currency in circulation and 4. unadjusted US total monetary base correlation only, 2019–30e
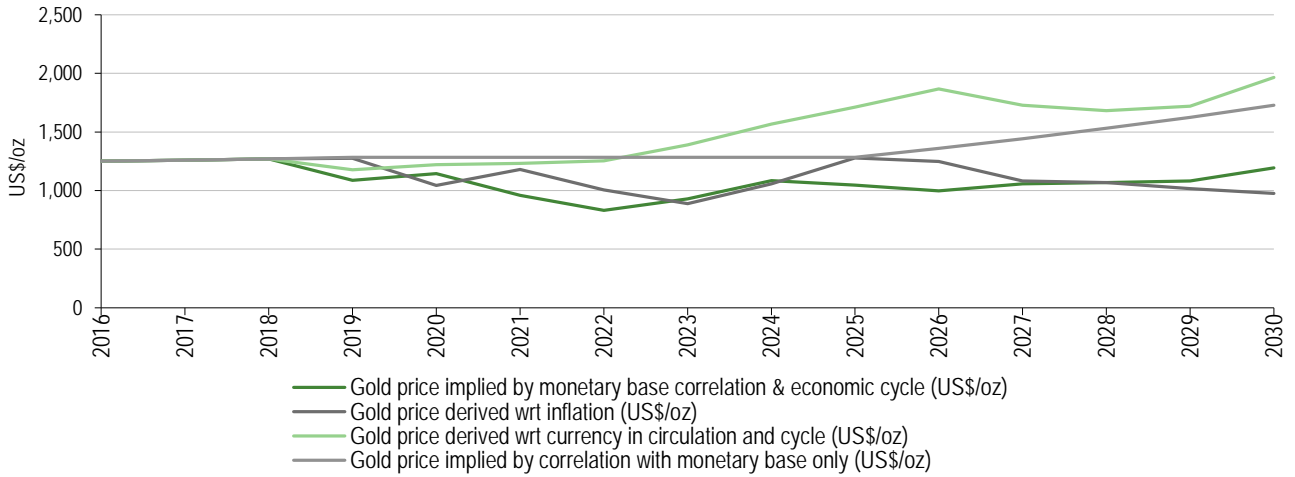
Source: Edison Investment Research; underlying historical data: Federal Reserve, South African Chamber of Mines, dollardaze.org

Of note is the fact that our gold price forecasts based on currency in circulation represent the top of the range of forecasts (with the single exception of 2019), while those based on inflation and the total US monetary base and cycle are at the bottom of the range.

The dovish scenario

In contrast to the above forecasts however (and as noted in Exhibit 19), should the late 1970s be considered the appropriate analogue for the current level of the gold price with respect to the post-crisis positioning of the US economy within its cycle, then our gold price forecasts based on this (cyclically adjusted) scenario are as follows:

Exhibit 39: Cyclically adjusted Edison forecast gold price range, 2019–30e (US$/oz)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Dovish scenario												
Cyclically adjusted currency in circulation	1,549	1,857	2,438	3,363	2,375	1,952	2,155	1,947	1,841	2,238	2,737	2,764
Monetary base correlation	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,361	1,443	1,531	1,626	1,727
Cyclically adjusted inflation	1,275	1,933	1,380	1,130	1,278	1,089	960	1,145	1,384	1,350	1,170	1,154
Cyclically adjusted monetary base & cycle	1,535	2,082	1,393	1,086	1,145	960	831	984	1,219	1,246	1,191	1,264
Average	1,411	1,789	1,624	1,716	1,520	1,321	1,307	1,359	1,472	1,591	1,681	1,727
Average (excl currency in circulation)			1,352	1,167	1,236	1,111	1,025	1,163	1,349	1,376	1,329	1,382
Hawkish scenario*												
Currency in circulation	1,177	1,222	1,233	1,253	1,391	1,567	1,712	1,867	1,729	1,683	1,720	1,965
Monetary base correlation	1,284	1,284	1,284	1,284	1,284	1,284	1,284	1,361	1,443	1,531	1,626	1,727
Inflation	1,275	1,044	1,181	1,006	887	1,058	1,279	1,247	1,081	1,067	1,017	976
Monetary base correlation & cycle	1,086	1,145	960	831	928	1,085	1,045	997	1,056	1,069	1,083	1,193
Average	1,206	1,174	1,165	1,094	1,123	1,248	1,330	1,368	1,327	1,338	1,361	1,466
Difference (US$/oz)												
Cyclically adjusted currency in circulation	372	634	1,205	2,110	983	386	443	79	113	555	1,017	799
Monetary base correlation	0	0	0	0	0	0	0	0	0	0	0	0
Cyclically adjusted inflation	0	889	199	123	391	30	-320	-103	303	282	153	178
Cyclically adjusted monetary base & cycle	448	937	433	255	217	-125	-214	-13	163	177	108	70
Average	205	615	459	622	398	73	-23	-9	145	254	319	262
Difference (%)												
Cyclically adjusted currency in circulation	31.6	51.9	97.7	168.5	70.7	24.6	25.9	4.2	6.5	33.0	59.1	40.7
Monetary base correlation	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cyclically adjusted inflation	0.0	85.1	16.8	12.3	44.0	2.9	-25.0	-8.2	28.0	26.5	15.0	18.3
Cyclically adjusted monetary base & cycle	41.3	81.8	45.1	30.7	23.4	-11.5	-20.5	-1.3	15.4	16.6	9.9	5.9
Average	17.0	52.4	39.4	56.9	35.4	5.8	-1.7	-0.7	10.9	19.0	23.5	17.9

Source: Edison Investent Research. Note: *Assumes imminent 'normalisation' of monetary conditions consistent with our last report on the subject, Mining overview: Unlocking the price to NPV discount, published in November 2017.

Comparing the two, in the case of the dovish scenario, the gold price forecast is, on average, US$277/oz (23.0%) higher than the equivalent forecast based on the hawkish scenario and brings it much more closely into line with the forecast based on inflation, in particular:

Exhibit 40: Gold price forecast made with respect to cyclically adjusted US total monetary base; inflation; US currency in circulation; and 4nadjusted US monetary base correlation only, 2019–30e
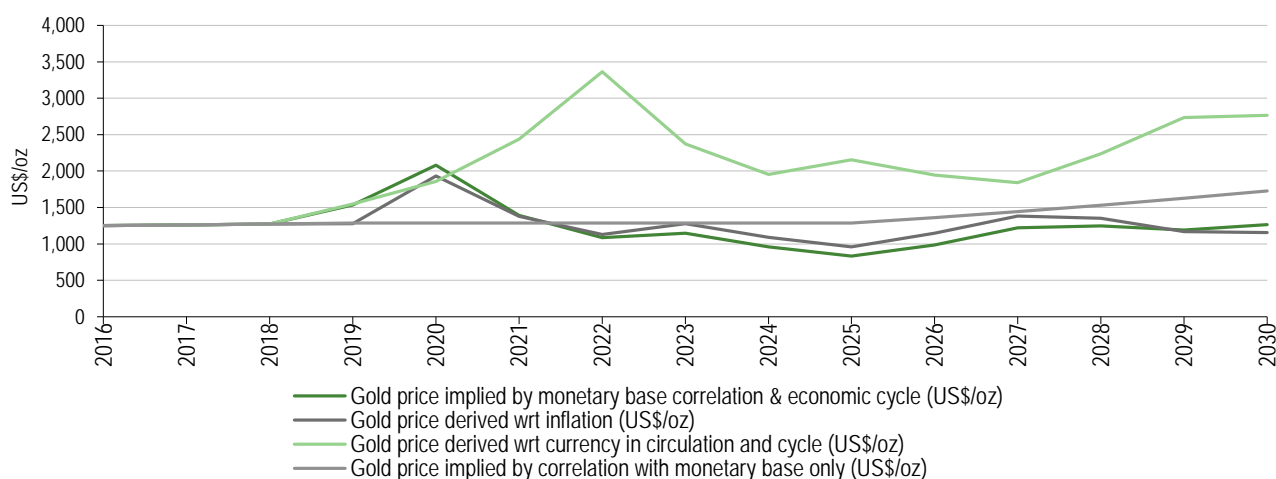
Source: Edison Investment Research; underlying historical data: Federal Reserve, South African Chamber of Mines, dollardaze.org

Note that the reason for the peak of our forecast based on currency in circulation (and cycle) being out of phase with those based on inflation and the monetary base (and cycle) is because the apparent historical analogue for 2018 in the former case is 1976 (see Exhibit 27), whereas for the others it is 1978 (see Exhibit 19) – hence the two-year lag.

Reversion to the norm

Note that, where, in November 2017, our forecasts were based on gold's correlation with currency in circulation only (to reflect the fact that we believed the Fed's asset reduction plan to be unsustainable), in this note – and in the light of the Fed's tapering announcement in March – we have reverted to basing our forecasts on an average of all four different analyses.

Gold considered as a currency

Implicitly, the analysis above, which relates the price of gold to inflation and money supply, recognises certain characteristics of gold that render it amenable to analysis as a currency – which, of course, it was, historically, and remains so for many millions of consumers and investors without access to a credible fiat currency alternative and who wish to own it simultaneously as a store of value and also as a medium of exchange. In this case, the future gold price can be explicitly valued relative to the US dollar on the basis of the two entities' respective inflation and interest rates. Initially, the interest rate associated with gold will be assumed to be zero, as the metal is assumed to be bought and held, in physical form, by investors (NB it could, alternatively, be considered to be the gold lease rate). Similarly, the inflation rate associated with gold is assumed to be zero, as it is assumed to be purchased by investors precisely on account of its 'real' qualities. This being the case, from a spot price of US$1,485/oz at the time of writing, the future price of gold in one year's time may be expressed in US dollars, relative to expected future US inflation and US interest rates, according to the following table:

Exhibit 41: Gold price predicted as a currency with respect to US dollar inflation and interest rate environment over one year

US$/oz	Future interest rate (%)										
	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
(3%)	1,440	1,426	1,412	1,398	1,385	1,372	1,359	1,346	1,334	1,322	1,310
(2%)	1,455	1,441	1,427	1,413	1,399	1,386	1,373	1,360	1,348	1,335	1,323
(1%)	1,470	1,456	1,441	1,427	1,414	1,400	1,387	1,374	1,361	1,349	1,337
0%	1,485	1,470	1,456	1,442	1,428	1,414	1,401	1,388	1,375	1,362	1,350
1%	1,500	1,485	1,470	1,456	1,442	1,428	1,415	1,402	1,389	1,376	1,364
2%	1,515	1,500	1,485	1,471	1,456	1,443	1,429	1,416	1,403	1,390	1,377
3%	1,530	1,514	1,500	1,485	1,471	1,457	1,443	1,429	1,416	1,403	1,391
4%	1,544	1,529	1,514	1,499	1,485	1,471	1,457	1,443	1,430	1,417	1,404
5%	1,559	1,544	1,529	1,514	1,499	1,485	1,471	1,457	1,444	1,431	1,418
6%	1,574	1,559	1,543	1,528	1,514	1,499	1,485	1,471	1,458	1,444	1,431
7%	1,589	1,573	1,558	1,543	1,528	1,513	1,499	1,485	1,471	1,458	1,445
8%	1,604	1,588	1,572	1,557	1,542	1,527	1,513	1,499	1,485	1,471	1,458
9%	1,619	1,603	1,587	1,572	1,556	1,542	1,527	1,513	1,499	1,485	1,472
10%	1,634	1,617	1,601	1,586	1,571	1,556	1,541	1,527	1,513	1,499	1,485

Future inflation rate (%)

Source: Edison Investment Research

Investors should note the diagonal line of equivalence (highlighted in grey), at which future interest rates and inflation are the same, such that real interest rates are zero, with the result that there is no expected change in the gold price.

Flattening of the yield curve…

Within this context, it should be noted that one-year market US interest rates, as calculated from the US Treasury bond with the appropriate maturity, are 1.77% (vs 1.519% in September 2017 and 0.629% in October 2016) and that historical US inflation to June 2019 is 1.6% (vs 2.2% in September 2017 and 1.1% in August 2016), as measured by the CPI for All Urban Consumers (CPI-U), or 2.1% (vs 1.7% and 2.3%), as measured by the core CPI for All Urban Consumers less food and energy (ie real interest rates over the course of the next one year are close to zero, depending on the inflation rate chosen), as depicted in the graph below:

Exhibit 42: US yield curve (%), October 2016, November 2017 and August 2019 and inflation rate (%)
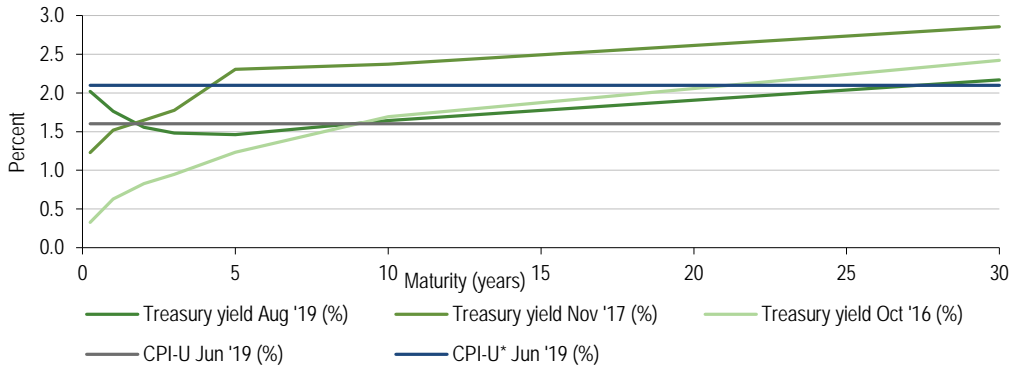
Source: Bloomberg, U.S. Bureau of Labor Statistics. Note: *Core rate (less food and energy).

After a material steepening between October 2016 and November 2017, it is notable that yields have since fallen back and the only yield increases since then have occurred at the short (less than one year) end of the spectrum (at a time when inflation – either underlying or headline – has been fairly static around the 2% level), leading to a substantial flattening of the curve as at August 2019 to the point of inversion.

…leading to reversal of previous orthodoxy of 'normalisation'

In conjunction with other factors, this has led inexorably to a reversal of the previous orthodoxy, which anticipated a continued tightening of monetary conditions, to one that now anticipates one, if not three, relatively near-term cuts in interest rates. Within this context, it can also be seen that real interest rates remain low within the historical context since at least 1961, as shown below:

Exhibit 43: US real interest rates, 1961–2017
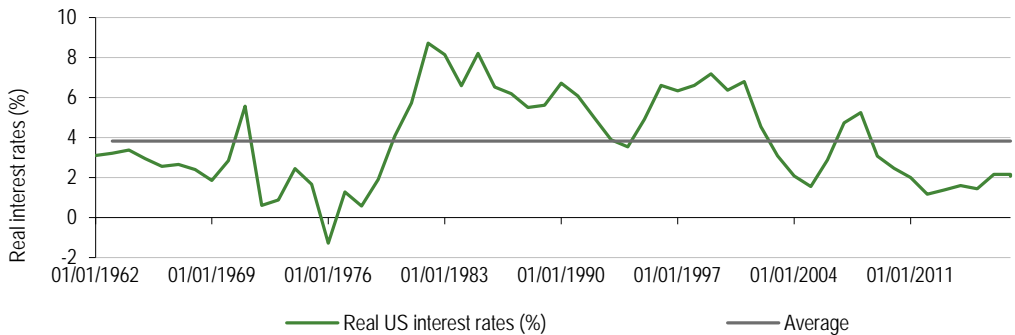
Source: Bloomberg, World Bank

Over five years, time compounds the effect of both US dollar inflation and interest rates on the forecast price of gold, when considered as a currency, as follows:

Exhibit 44: Gold price predicted as a currency with respect to US dollar inflation and interest rate environment over five years

US$/oz	Future interest rate (%)										
	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
(3%)	1,275	1,213	1,155	1,100	1,048	999	953	909	868	829	792
(2%)	1,342	1,277	1,216	1,158	1,103	1,052	1,003	957	914	872	833
(1%)	1,412	1,344	1,279	1,218	1,161	1,107	1,055	1,007	961	918	877
0%	1,485	1,413	1,345	1,281	1,221	1,164	1,110	1,059	1,011	965	922
1%	1,561	1,485	1,414	1,346	1,283	1,223	1,166	1,113	1,062	1,014	969
2%	1,640	1,560	1,485	1,414	1,348	1,285	1,225	1,169	1,116	1,066	1,018
3%	1,722	1,638	1,559	1,485	1,415	1,349	1,286	1,227	1,172	1,119	1,069
4%	1,807	1,719	1,636	1,559	1,485	1,416	1,350	1,288	1,230	1,174	1,122
5%	1,895	1,803	1,717	1,635	1,558	1,485	1,416	1,351	1,290	1,232	1,177
6%	1,987	1,891	1,800	1,714	1,633	1,557	1,485	1,417	1,352	1,292	1,234
7%	2,083	1,982	1,886	1,797	1,712	1,632	1,556	1,485	1,418	1,354	1,293
8%	2,182	2,076	1,976	1,882	1,793	1,710	1,630	1,556	1,485	1,418	1,355
9%	2,285	2,174	2,069	1,971	1,878	1,790	1,707	1,629	1,555	1,485	1,419
10%	2,392	2,276	2,166	2,063	1,966	1,874	1,787	1,705	1,628	1,554	1,485

(Left axis label: Future inflation rate (%))

Source: Edison Investment Research

The green shading approximates Edison's gold price forecast for the equivalent year via its previously elucidated methods in Exhibit 39. In this case, it can be seen that Edison's forecasts (both 'hawkish' and 'dovish') derived via gold's historical correlation with the total US monetary base, inflation, currency in circulation etc are consistent with real interest rates of 2–6% over the course of the next five years (see Exhibit 43 and Exhibit 42).

A refinement on the above analysis is to consider newly mined gold as representing a form of inflation – analogous to monetary inflation as a result of increases in the money supply. All other things being equal, this would be expected to result in a gradual decline in the price of gold with time. However, it should properly be considered within the context of a rising global population, which utilises gold and therefore accords it its value.

In the last 32 years, the annual supply of newly mined gold has doubled, from 1,637t per year in 1986 to 3,295t in 2018 – equivalent to growth of 2.2% per year (although it is notable that this appears to occur in distinct waves, arguably lagging a prior price rise) – such that above ground stocks are now in the order of 193,500 tonnes:

Exhibit 45: World mine supply of gold, 1986–2020e (tonnes)
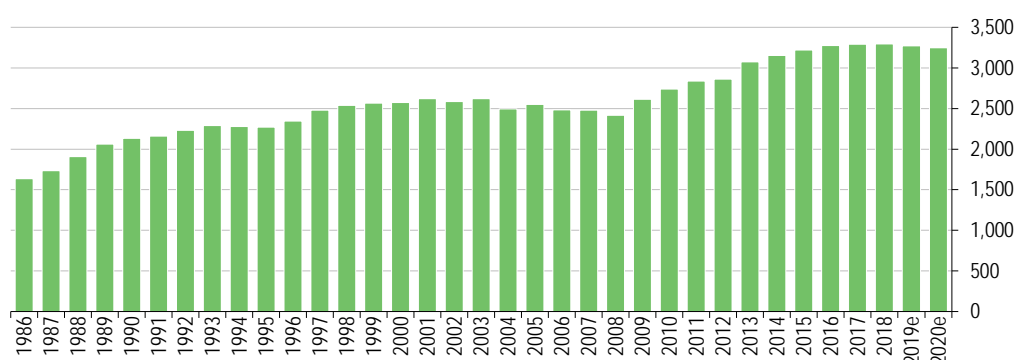
Source: South African Chamber of Mines, Metals Focus

Thus, since the gold price last peaked in 2012, there has been a reduction in investment in the sector, combined with an effort to run existing mines at, or near, full capacity to maximise economies of scale and to minimise the effect of fixed costs on overall unit costs of production. In the absence of a discernible stimulus (usually in the form of the gold price itself), it therefore seems unlikely that new mines will do any more than fill the shortfall resulting from the natural decay in output from existing operations. All other things being equal, having reached 3,295t in 2018, future output is therefore now expected to decline by 1.4%, to 3,249t in 2020 (source: Metal Focus).

Relative to initial above ground stocks of 193,500t, this equates to an initial gold inflation rate (ie acting to deflate the real value gold) of 1.7%.

At the same time, global population growth is expected to continue its declining trend, albeit it is expected to keep growing. The world population has experienced continuous growth since around the year 1350, with the highest population growth rates (ie global population growth rates above 1.8% per year) recorded between 1955 and 1975 and peaking to 2.06% between 1965 and 1970. The growth rate has since declined to 1.18% between 2010 and 2015 and is projected to decline further in the immediate future. In 2019, it is expected to grow at 1.0276% (source: United States Census Bureau), followed by, 1.0043% in 2020, 0.9793% in 2021, 0.9557 in 2022 and 0.9331% in 2023.

Adjusting for these 'real' factors, the future price of gold in one year's time may be expressed in US dollars (again relative to expected future US inflation and US interest rates), according to the following table:

Exhibit 46: Gold price predicted as currency with respect to the global inflation of 'real' assets as well as US monetary inflation and interest rates (one year)

US$/oz	Future interest rate (%)										
	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
(3%)	1,431	1,417	1,403	1,389	1,376	1,363	1,350	1,337	1,325	1,313	1,301
(2%)	1,446	1,431	1,417	1,404	1,390	1,377	1,364	1,351	1,339	1,326	1,314
(1%)	1,461	1,446	1,432	1,418	1,404	1,391	1,378	1,365	1,352	1,340	1,328
0%	1,475	1,461	1,446	1,432	1,419	1,405	1,392	1,379	1,366	1,353	1,341
1%	1,490	1,475	1,461	1,447	1,433	1,419	1,406	1,393	1,380	1,367	1,355
2%	1,505	1,490	1,475	1,461	1,447	1,433	1,420	1,406	1,393	1,381	1,368
3%	1,520	1,505	1,490	1,475	1,461	1,447	1,434	1,420	1,407	1,394	1,381
4%	1,534	1,519	1,504	1,490	1,475	1,461	1,447	1,434	1,421	1,408	1,395
5%	1,549	1,534	1,519	1,504	1,489	1,475	1,461	1,448	1,434	1,421	1,408
6%	1,564	1,548	1,533	1,518	1,504	1,489	1,475	1,462	1,448	1,435	1,422
7%	1,579	1,563	1,548	1,533	1,518	1,503	1,489	1,475	1,462	1,448	1,435
8%	1,593	1,578	1,562	1,547	1,532	1,517	1,503	1,489	1,475	1,462	1,448
9%	1,608	1,592	1,577	1,561	1,546	1,532	1,517	1,503	1,489	1,475	1,462
10%	1,623	1,607	1,591	1,576	1,560	1,546	1,531	1,517	1,503	1,489	1,475

Source: Edison Investment Research

Over five years, it is as follows:

Exhibit 47: Gold price predicted as currency with respect to the global inflation of 'real' assets as well as US monetary inflation and interest rates (over five years)

US$/oz	Future interest rate (%)										
	0.0%	1.0%	2.0%	3.0%	4.0%	5.0%	6.0%	7.0%	8.0%	9.0%	10.0%
(3%)	1,245	1,185	1,128	1,074	1,023	975	930	888	847	809	773
(2%)	1,311	1,247	1,187	1,130	1,077	1,027	979	934	892	852	814
(1%)	1,379	1,312	1,249	1,189	1,133	1,080	1,030	983	938	896	856
0%	1,450	1,379	1,313	1,251	1,192	1,136	1,083	1,034	987	942	900
1%	1,524	1,450	1,380	1,314	1,252	1,194	1,139	1,086	1,037	990	946
2%	1,601	1,523	1,450	1,381	1,316	1,254	1,196	1,141	1,089	1,040	994
3%	1,681	1,599	1,522	1,450	1,381	1,317	1,256	1,198	1,144	1,092	1,044
4%	1,764	1,678	1,598	1,522	1,450	1,382	1,318	1,258	1,200	1,146	1,095
5%	1,850	1,761	1,676	1,596	1,521	1,450	1,383	1,319	1,259	1,203	1,149
6%	1,940	1,846	1,757	1,674	1,595	1,520	1,450	1,383	1,320	1,261	1,205
7%	2,033	1,935	1,842	1,754	1,671	1,593	1,519	1,450	1,384	1,322	1,263
8%	2,130	2,027	1,929	1,838	1,751	1,669	1,592	1,519	1,450	1,385	1,323
9%	2,231	2,122	2,020	1,924	1,833	1,748	1,667	1,590	1,518	1,450	1,385
10%	2,335	2,222	2,115	2,014	1,919	1,829	1,745	1,665	1,589	1,518	1,450

Source: Edison Investment Research

Once again, the green shading approximates Edison's gold price forecast for the equivalent year via its previously elucidated methods in Exhibit 39 (see above). In this case, it can once again be seen that Edison's forecasts (both 'hawkish' and 'dovish') derived via its other methods are consistent with a real interest rate of 2–6% over the next five years, which appears consistent

relative to historical precedent (see Exhibit 43), if not relative to the current environment (Exhibit 42).

Edison gold price forecasts and gold equity valuations

The present report on the gold price is the ninth in a series that began in April 2009. During that period, the inter-relation between the gold price and the resulting company valuations generated in our equity research has varied. Between April 2009 and November 2012, we based our equity valuations on the gold price forecast for a limited number of years, followed by a flat gold price in real terms (usually calculated as the average of our forecast gold prices for the subsequent years). As the number of methods by which we derived the gold price forecasts multiplied however, so our approach changed and, between November 2013 and November 2017, our equity valuations were derived solely from our long-term gold price forecasts (ie excluding any flat real gold price from a particular date). While we continued to use several methodologies for forecasting the gold price in November 2017, our formal forecasts in that year were based specifically on the correlation over time between the gold price and US currency in circulation until 2030, followed by a flat real price thereafter. The decision to use currency in circulation as the basis of our forecasts was made specifically within the context of the Federal Reserve's then official asset reduction programme and reflected, among other things, the fact that the behaviour of the gold market strongly suggested that it did not believe that the Fed's policy of 'normalisation' could be executed to its stated conclusion. As noted previously, the decision to adopt this methodology ultimately proved to be 'bearish' in FY18, but has been proven to be accurate in CY19 to date and, arguably, for CY20 as well, given the increasing sentiment towards future easing in the marketplace. Historically, however, it was the size of a country's total monetary base (including reserve bank cash) that was related to its reserves of gold and not simply the currency in circulation component. Moreover, the steady growth of currency in circulation over time is arguably not an ideal base by which to capture the volatility that is exhibited by the gold price.

Change in approach

Now that the Fed's asset reduction programme has been curtailed and its monetary stance has once again reverted to one of easing, rather than tightening, we believe that it is therefore appropriate to revert to using gold price forecasts based on all four highlighted methodologies, rather than just the one. In contrast to previous years however – and given that we believe that a return to 'normalisation' is not impossible – we have decided to weight our forecasts and also to adopt a flat real gold price after three years. This approach also reflects the fact that we believe that there is less clarity now regarding US economic growth in the medium term and hence the Fed's long-term monetary policy stance.

A graph of our average gold price forecasts, assuming both 'normalisation' on the one hand (the hawkish scenario) and one further round of monetary easing on the other (the dovish scenario), is as follows:

Exhibit 48: Edison gold price forecasts assuming 'normalisation' (hawkish scenario) and easing of current monetary conditions (dovish scenario)
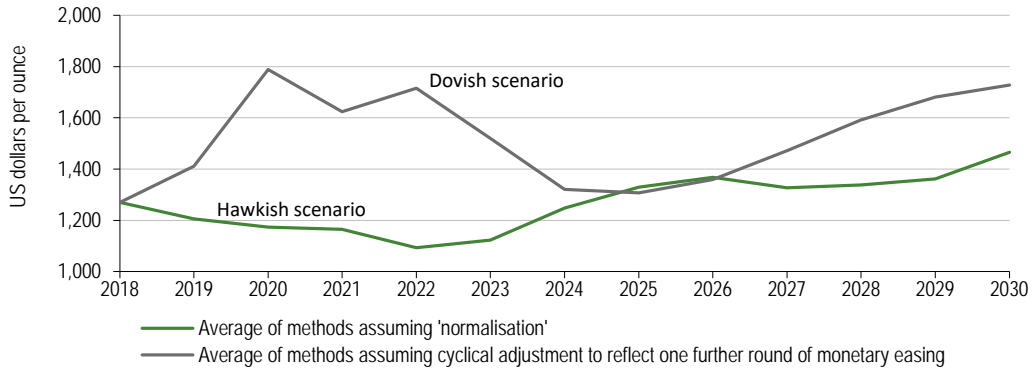
Source: Edison Investment Research

In this case however, for the purposes of our equity valuations, we have decided to weight our forecasts based on a 75% chance of a 'dovish', easing outcome and a 25% chance of a 'hawkish', tightening outcome over the next three years and to adopt a flat real gold price of US$1,350/oz thereafter. Note that, as in all previous years, the assumption for the current year will be that gold remains at its existing spot price level for the remainder of the year. As such, our forecasts, for the purposes of our equity valuations, are as follows:

Exhibit 49: Edison gold price forecasts, CY20–23 and beyond

Year	2020	2021	2022	2023 and beyond
Nominal gold price forecast (US$/oz)	1,635	1,509	1,560	
Real gold price forecast (US$/oz)	1,572	1,395	1,387	1,350

Source: Edison Investment Research

The level of the long-term flat real gold price of US$1,350/oz may be justified in three ways. Firstly, US$1,350/oz of all-in sustaining costs equates to approximately the 99th percentile of global gold production (based on Metals Focus's Primary Gold Mine Production Cost curve for 2017) – or approximately the top of what might be regarded as the credible cost curve. Secondly, an analysis of 70 technical studies on gold projects (drawn from the same population as those analysed in our related note, *Gold stars and black holes*, published in January 2019) conducted in US dollar terms showed that the average price of gold used was US$1,269/oz, with a median price of US$1,250/oz, within a range US$1,000/oz to US$1,500/oz, as depicted in the histogram below. For the purposes of our equity valuations, US$1,350/oz may be regarded as US$1,250/oz inflated in real terms at approximately 2% per year (see page 9) for four years (ie 2019 to 2023).

Exhibit 50: Gold project technical study gold price histogram (US$/oz)
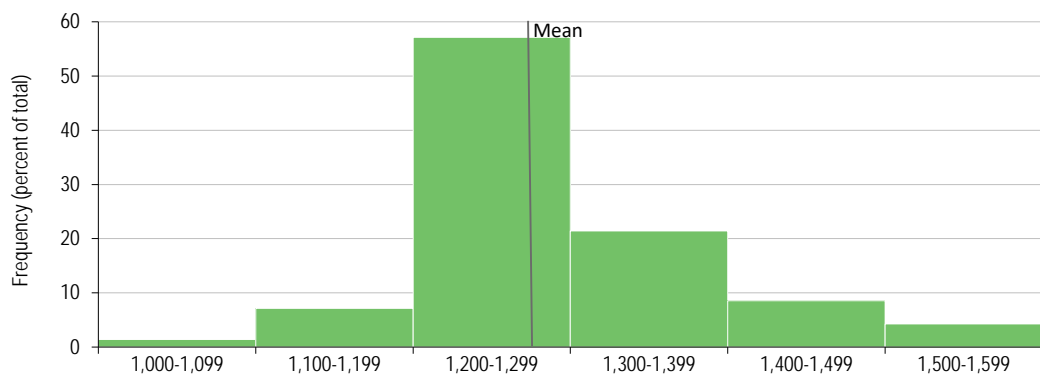
Source: Edison Investment Research

Thirdly, an analysis of Edison's notional gold mining company, NonSuch Gold (see *Gold stars and black holes*, published in January 2019) suggests that a project that is in all other respects average will not be sanctioned for development by the market if its all-in sustaining costs (AISC) are above US$930/oz and the long-term price of gold is US$1,350/oz (and at which, incidentally, the conventionally calculated IRR of the project would be 21.5%). On the one hand, this figure of US$930/oz equates, approximately, to the 57th percentile of the existing gold cost curve (based on Metals Focus's Primary Gold Mine Production Cost curve for 2017) and suggests that average projects that have AISCs that are not in the bottom two cost quartiles (or the very bottom of the third cost quartile) will struggle to attract funding. On the other hand, inasmuch as the real price of gold is below US$1,350/oz, even these projects will struggle to attract funding.

Note that our gold price forecasts for the purposes of our equity valuations may be compared with our previous forecasts in Exhibit 37 and will be incorporated into our equity valuations upon publication of the first note on each following the publication of this report.

The adoption of a flat real gold price assumption in CY23 and beyond has a number of advantages, including the fact that, from that point, the assumed gold price should be close to that used in developers' most recent feasibility studies, which should therefore largely negate the effect on costs of a gold price assumption that may otherwise differ materially from that upon which the related costs were originally estimated (NB see our report, *Gold – US$2070 by 2020*, published in November 2013, for a discussion of the relationship between gold prices, unit revenues, unit costs and average grades).

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