

Platinum on a knife-edge

PwC's perspective on trends in the platinum industry



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Introduction



Commodity prices are cyclical and are largely determined by supply and demand. Investment decisions and corresponding life-of-mine price decisions should therefore be taken taking these basic facts into consideration.

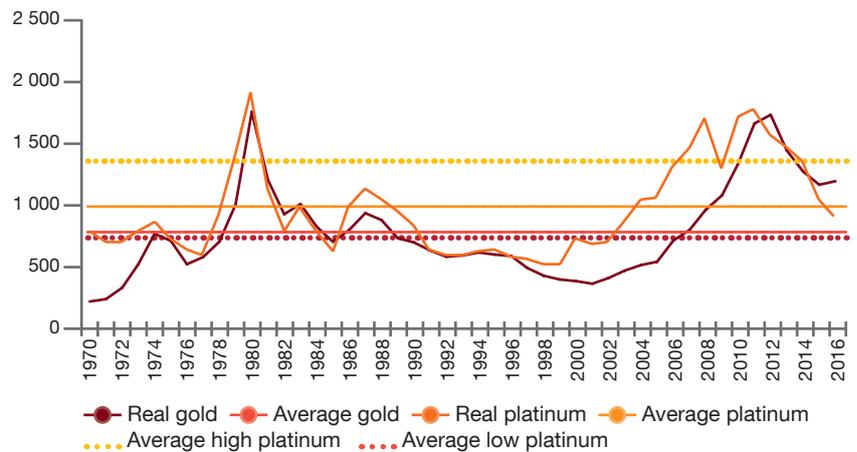
However, as the recent cycle has shown, a number of mining investment decisions, on the up and the down, were taken with reference to much shorter-term price expectations resulting in procyclical behaviour. There is a real challenge to determine a realistic, not overly optimistic or pessimistic price for investment decision purposes.

In our annual SA Mine publication we have, for some time now, maintained that the rand platinum price is unsustainably low and that we'll either see a recovery in prices or the continuance of mine closures. Unfortunately it is currently the latter that's occurring.

Price history

The impossible question for the mining industry and all its stakeholders is when the cycle will turn at the top and the bottom. If one assumes that real prices oscillate around a long-term real position, then the price history of platinum and gold provides an indication of where these prices are in their cycle. The \$934 average platinum price for the first six months of 2016 is below the long-term average real price of \$994. Is it therefore undervalued?

Fig. 1 Real platinum prices (US\$/oz)



Source: World Bank, PwC analysis

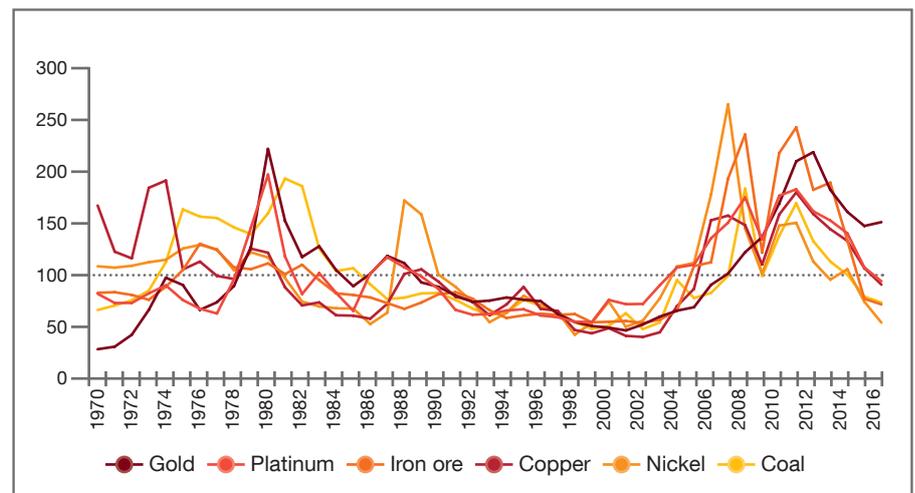
To take it to the extreme, for the period since 1970, during phases when platinum traded below its long-term average, its bottom-of-the-cycle average price was \$259 lower than the overall average. It also stayed below average for 1.4 times more years than it was above.

Applying historic averages between 1970 and 2016 to estimate future prices would suggest that the average real price of platinum would be \$735 over the next 16 years. Following the same unrealistic logic implies an average gold price of \$537 for 16 years once gold drops below its real average of \$786 in 2018. Quite a sobering thought.

The above analysis is obviously simplistic and doesn't take into account all variables. However, one can understand why there are a number of investors sceptical about whether the cycle has turned.

Figure 2 compares the main global commodity prices in real terms indexed against their average real price since 1970 which is set as 100.

Fig. 2 Indexed real prices (US\$)

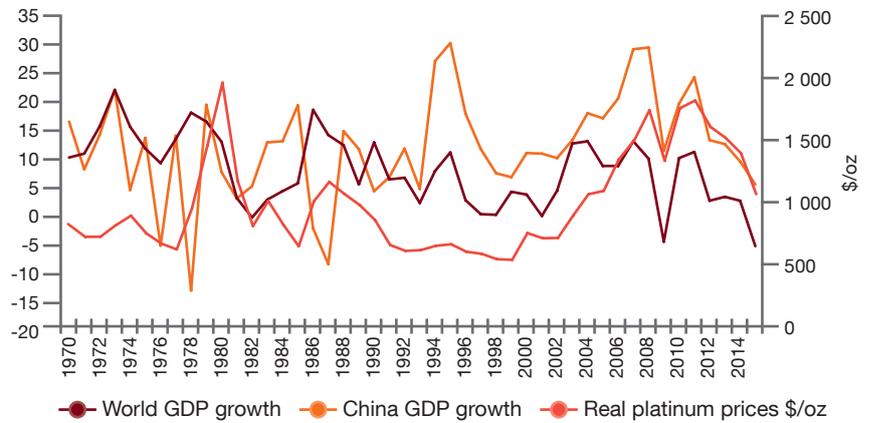


100 = Average real price since 1970
Source: World Bank, PwC analysis

The similarity in the cycle is evident in the graph. It also shows that all these commodities, other than gold, are currently below the long-term real price average, with nickel trading at approximately 50% of its long-term real average.

Figure 3 reflects the correlation between global GDP growth in current dollar terms and the platinum price movements.

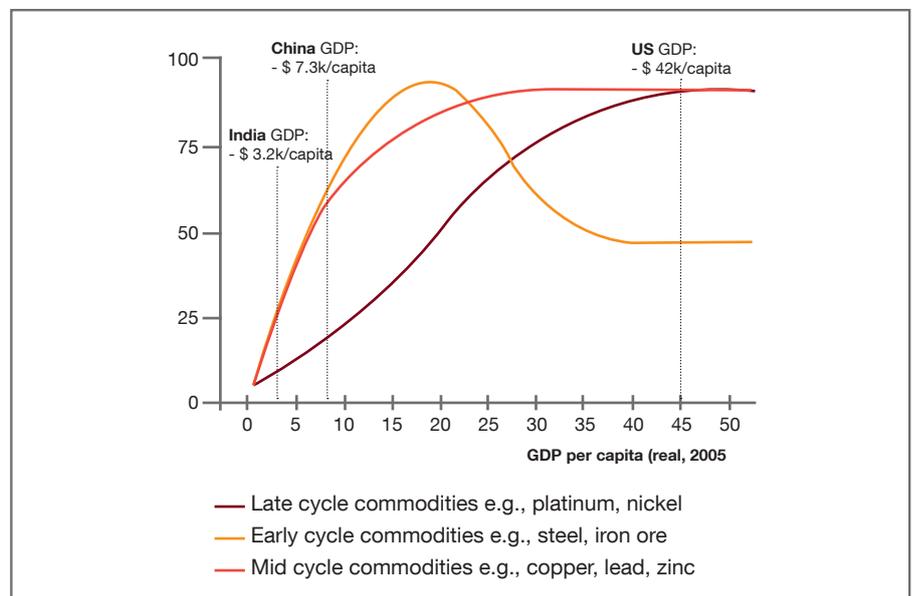
Fig. 3 Real platinum price compared to world and China current USD GDP growth



Source: World Bank, PwC analysis

Platinum demand is largely driven by mature developed economies. As China's growth moves from infrastructure-driven growth to consumer-driven growth, platinum demand should increase.

Fig. 4 Commodity intensity (Indexed at 100 for maximum)



Source: Xstrata, reproduced with permission in Mine: The growing disconnect (PwC, 2012)

Basket price

Platinum companies' revenue is not solely determined by the platinum price. While platinum provides more than 50% of revenue, other platinum group metals (PGMs) palladium and rhodium along with the base metal nickel provide meaningful contributions to revenue. Additional by-product revenue is derived from other PGMs, gold and other base metals.

Figure 5 shows real prices for these commodities indexed to their average real price since 1970.

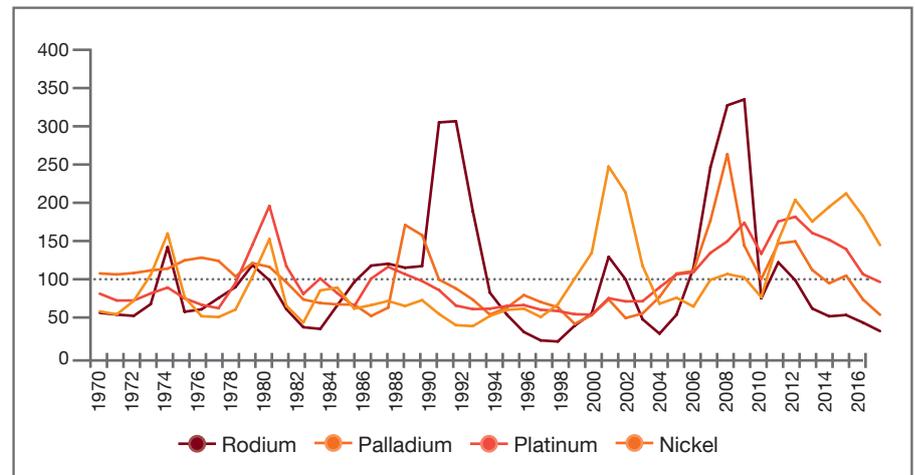
While platinum is trading almost on the long-term real average level, palladium is trading above and nickel and rhodium are trading well below the long-term average.

It is notable that there is seemingly an inverse relationship between the price of nickel and palladium. Whereas primary platinum supply is dominated by South Africa, South Africa produces only approximately 40% of primary palladium supply with Russia producing a similar amount mainly as a by-product to its nickel mining industry.

Figure 6 illustrates an estimated platinum basket price based on current production profiles. This is merely an indication, as the fluctuation in the other prices making up approximately 9% of the current basket value were not taken into account.

The impact of changes in production profile for these producers e.g. moving from the more platinum-rich Merensky Reef to UG2 or the recent increase in mining of the Platreef was also not considered.

Fig. 5 Indexed real prices of main income drivers for SA platinum producers

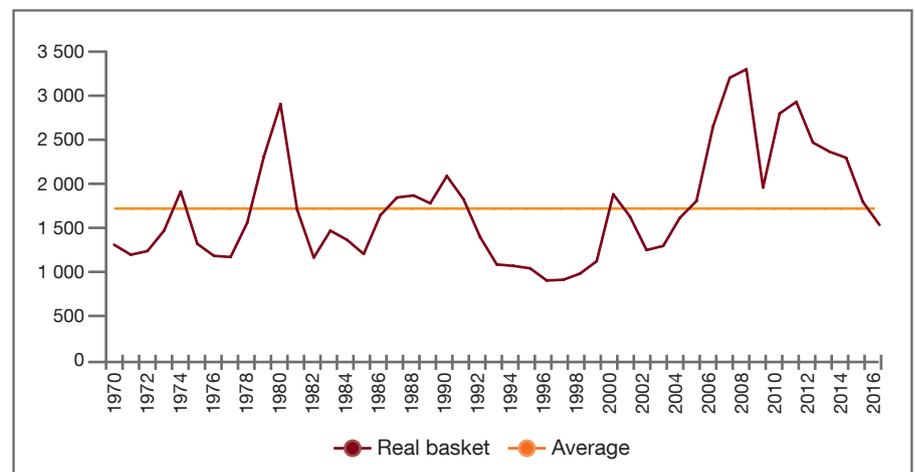


100 = Average real price since 1970
Indexed to long-term average
Sources: World Bank, PwC analysis

Lower nickel prices that lead to lower nickel supply therefore invariably lead to lower palladium production and an increase in palladium prices.

In order to determine a basket price per platinum oz produced, we used production for 2015 from Anglo American Platinum, Impala Platinum, Lonmin and Northam Platinum.

Fig. 6 Real basket price per platinum oz (US\$)

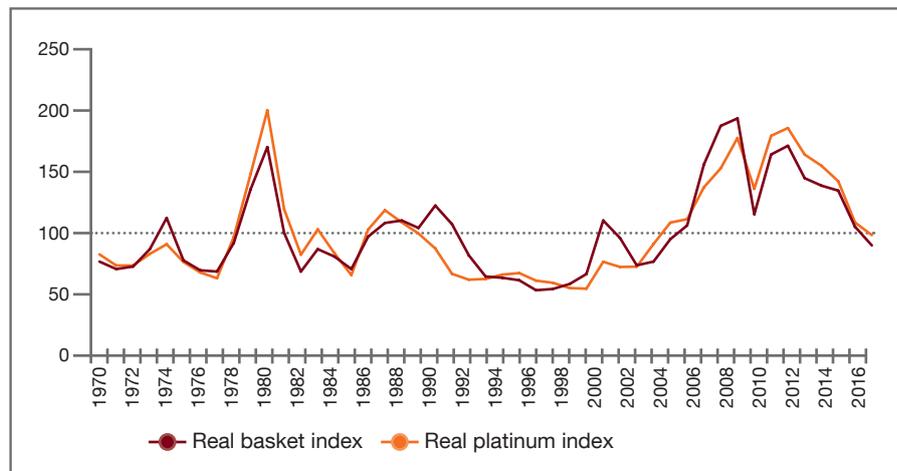


Sources: World Bank, PwC analysis

The average platinum basket price in the first half of 2016 was 11% below the long-term real basket price, compared to the platinum prices that was at 6% below the long-term average price. The difference is explained by high rhodium prices in 1990 and 2007 and high palladium prices in 2000, which helped elevate the basket price.

Although there are minor differences in the basket price and the platinum price as an approximation of the revenue value of platinum companies, the platinum price is probably a good enough indicator of revenue.

Fig. 7 Indexed real platinum basket price compared to real platinum price



100 = Average real price since 1970
Sources: World Bank, PwC analysis



Supply and demand dynamics

Assessing the platinum and platinum basket price in US\$ real terms assumes that only demand will drive price. That is, the global economy measured in dollar terms will dictate at what price it will be willing to pay for platinum and producers will have to fall in with those prices in the long run. Supply cost therefore presumably does not play a role in long-term price dynamics.

When one deals with a global commodity that is 'readily' available from a variety of producer countries, it is fair to assume that in the long run supply is more flexible. Demand will therefore dictate price.

The lag in bringing supply online from investment decision to delivery and reducing supply, once loss making, results in the temporary under and over supply that drives the cycle around the long-term average.

Platinum demand emanates mainly from autocatalysts (40%¹), jewellery (34%¹) and general industrial demand. More recently investment demand has also grown.

Autocatalyst demand, subject to technology improvements, is relatively fixed, and driven by regulatory requirements on new vehicle sales. Recycling of spent autocatalysts provide a meaningful contribution into the autocatalyst demand, but is not sufficient to supply all autocatalyst demand due to higher requirements from regulations and higher vehicle sales. This demand is fairly insensitive to price movements as it makes up a very small percentage of the total vehicle cost.

Jewellery and investment demand are much more price sensitive and often provide the balancing demand figure to fill shortfalls in supply or to take excess supply.

¹ According to World Platinum Investment Council

The purpose of this discussion is not to focus on the demand side. However, the historic demand graph indicates the long-term growth trend that was only temporarily interrupted during the financial crises of 2008 and 2009.

There is no reason to believe that that this growing trend won't continue. New industrial and medical applications as well as general economic growth supports the other demand category.

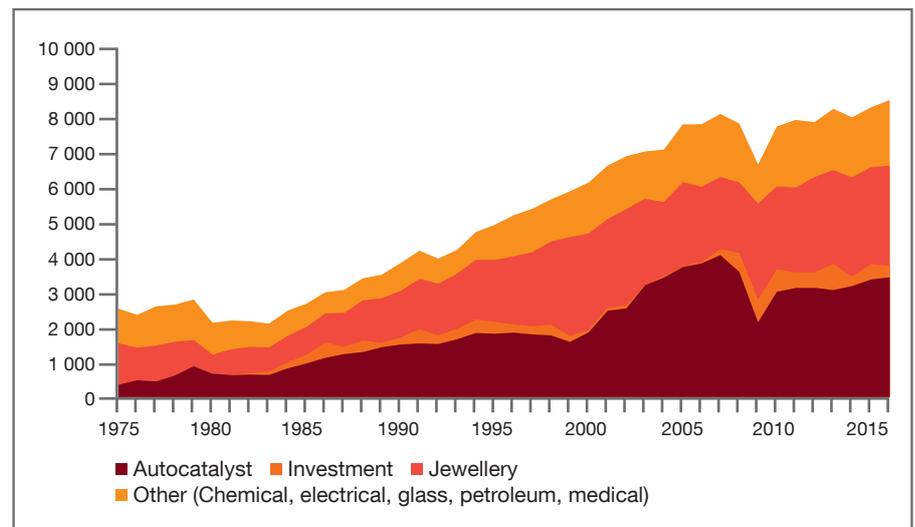
New emission controls and vehicle sales growth supports autocatalytic converter growth despite ongoing efforts to use platinum more efficiently or to substitute platinum with palladium and rhodium.

Current mining supply delivers 1.1oz of palladium for every 1.0oz of platinum mined, while automotive demand is at a ratio of 2.3 to 1. Just 10 years ago this ratio was at 1.3 to 1 indicating significant substitution has taken place. An excessive increase in substitution of palladium for platinum could result in another spike in palladium prices, as was the case in 2000, which will force users back to using more platinum.

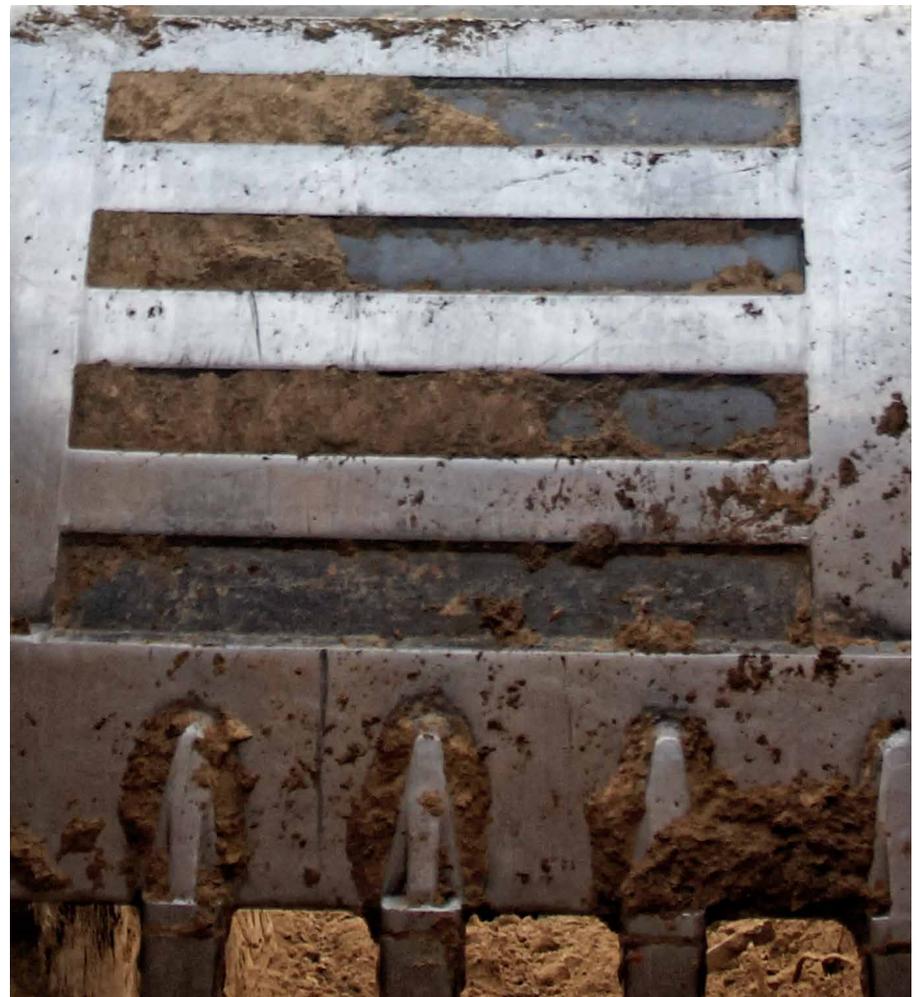
The global drive for emission control will support demand for platinum group metals on the one hand and could reduce it on the other. Whilst hydrogen fuel cell cars make use of platinum group metals, electric cars won't require autocatalysts. New technology will provide an interesting dynamic to the automotive demand for platinum.

South Africa provides more than 70% of primary mined platinum supply and more than 55% of total supply, including recycling. This dominant supply position provides platinum with somewhat unique supply and demand fundamentals.

Fig. 8 Platinum demand ('000 oz)



Source: Johnson Matthey (www.platinum.matthey.com)



In the beginning of 2008 when the global economy reached a peak, the local electricity producer, Eskom, could not meet South Africa's electricity demand. The world took notice as platinum supply is electricity intensive.

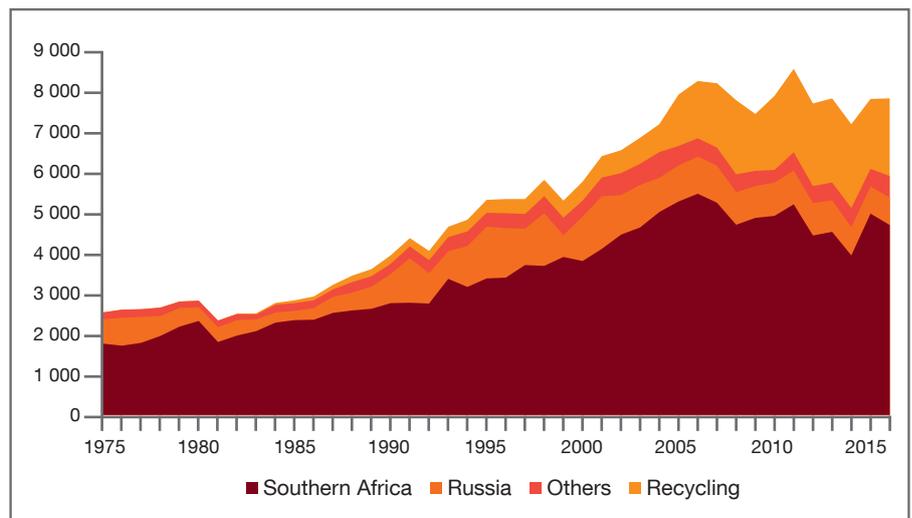
Concerns over the ability of South Africa to supply platinum, coupled with the height of the cycle, resulted in all-time record prices for the metal. The subsequent global economic crises meant a significant fall in prices.

However, it seems consumers made use of the opportunity to increase stock levels to hedge themselves for potential future supply scares that might impact prices in the short term.

At the end of 2012 these excess stock levels were estimated by SFA (Oxford) to be 4.1 million oz, or almost equal to one-year's supply from South Africa. It is these stock levels that have been blamed for low prices, despite the contraction in mining supply and while demand kept growing, albeit at marginal rates.

Consumers' decision to invest in stockholding paid off as the industrial action in the platinum mining sector in South Africa has resulted in a significant decline in supply since 2012, particularly in 2014 when there was a five-month strike in the Rustenburg area.

Fig. 9 Global platinum supply ('000 oz)



Source: Johnson Matthey (www.platinum.matthey.com)

Suppliers also reduced stock holding since 2014 to generate cash in the strained mining environment.

According to the World Platinum Investment Council, excess stockholding had reduced to 2.4 million oz at the end of 2015. In addition, ETF platinum holdings were at 2.5 million oz.

The actual excess stockholding and how long there will be an excess is subject to debate. It will be interesting to see whether consumers believe the current stockholding is sufficient or whether stockholding could reduce further as supply falls short of demand.



Figure 10 provides the annual over or under supply of platinum as tracked by Johnson Matthey and the cumulative position since 1975. The top SA producers provide similar information. Based on their assessments, the cumulative supply shortfall over the last 10 years is even worse than the shortfall calculated by Johnson Matthey. On the other side, other market commentators reflect much lower shortfalls.

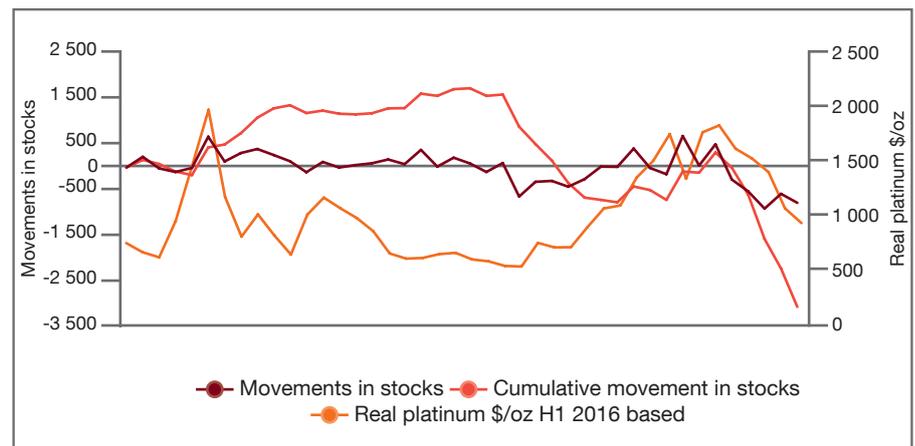
Based on this cumulative position, the excess stockholding is not apparent. The graph displays the historic inverse relation between excess supply and price with an exception in 1980. For example, the shortfall in production from 1999 to 2004 preceded the significant increase in the platinum price from 2003 to 2007. From 2010 there is an apparent anomaly as the production shortfall coincided with a decrease in

SA supply prices

If South African supply dynamics play a larger price-determining role in platinum, then one needs to look at the platinum price in real rand terms. In order to determine real prices we used a South African Consumer Price Index (CPI) adjusted price.

However, based on platinum company reporting it is clear that input costs have grown well above CPI inflation in the last number of years. We therefore weighted the reported unit cost increases of Anglo American Platinum, Impala Platinum, Lonmin and Northam Platinum since 1996 to estimate producer input unit cost inflation, as shown in Figure 11.

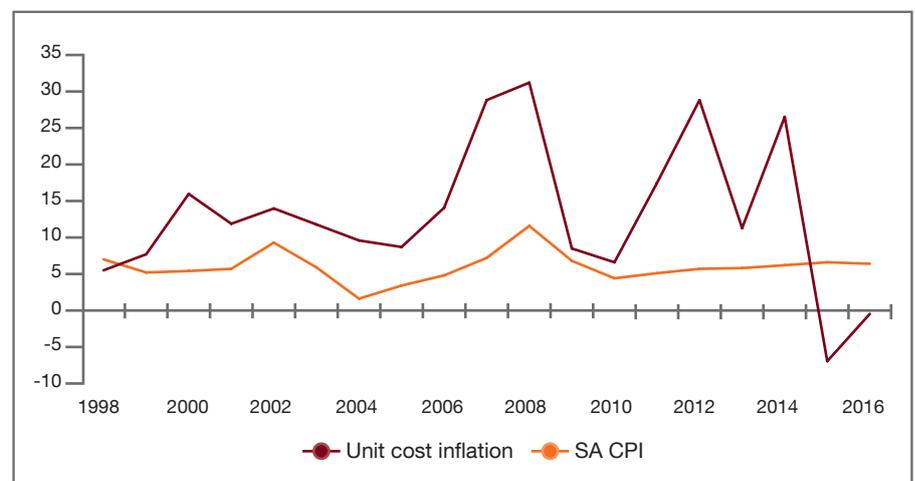
Fig. 10 Global platinum supply ('000 oz)



Source: Johnson Matthey, World Bank, PwC analysis

price. It is hard to see how the shortfall in supply since 2012 won't result in an increase in future prices.

Fig. 11 SA platinum producer unit cost inflation compared to SA CPI



Source: Stats SA, Company annual reports, PwC analysis

These platinum companies have generally experienced above-inflation unit cost increases. In the price boom years leading up to 2008, there was a pervasive produce-at-any-costs attitude across most of the mining sector. South Africa also faced above-inflation wage and electricity increases during this period.

A large portion of the cost base created before 2008 was not removed from the industry once prices had crashed. Although input costs grew at a rate closer to CPI, they did not decrease proportionately.

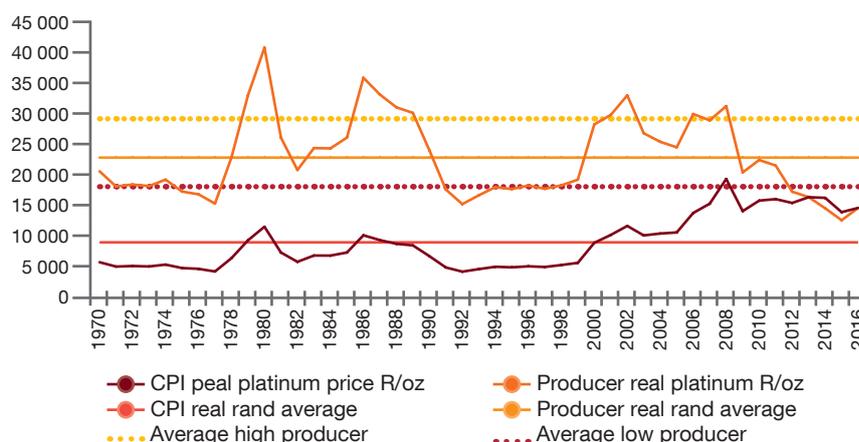
The high unit cost increases from 2012 to 2014 were impacted by severe industrial action in the platinum sector. Although variable costs decrease during strikes, fixed cost remains and lower production volumes therefore result in higher unit cost increases.

The 2015 and 2016 reduction in unit cost is largely as a result of increased production following the strike with a similar fixed cost basis. Cost-saving initiatives in the severely low-price environment also played a roll. In particular the closure of marginal shafts and renegotiation of supply agreements assisted.

Figure 12 illustrates real rand prices for platinum in 2016 (to June) terms since 1970. CPI increases were used up to 1996 in both cases, with producer unit cost increases reflected since 1996 for the producer real platinum price.

The real rand prices using South Africa CPI reflects a long-term real average price of R9 229/oz or, using the recent R14:US\$1 exchange rate, a price of \$659/oz. This average would suggest that platinum is still traded at 60% above the long-term average.

Fig. 12 Real platinum rand price (2016 basis)



Source: PwC analysis

In contrast, producer real price figures suggest that the platinum price is presently trading 35% below the long-term average of R23 056/oz (\$1 646 at R14:US\$). It is also trading below the average of prices at the bottom of the cycle of R18 053 (\$1 289).

Platinum has now been trading below average for 7.5 years. The previous down cycles did not exceed nine years. Based on supplier-based real price averages, platinum is due for a recovery in rand terms. The recovery could happen through a weaker rand exchange rate, a further decrease in unit costs as inefficient mines/shafts are closed or through an improvement in the underlying US\$ price in a stable currency environment.

Production position

The recent commodity cycle, reflected in Figure 2, was largely the result of Chinese infrastructure-driven demand. The stronger-for-longer view resulted in a produce-at-any-cost attitude among bulk commodity producers, notably iron ore, coal and copper.

This resulted in significant new supply, which led to an oversupply of these commodities, coupled with a decrease in demand as China's still substantial growth is transitioning from infrastructure-driven growth to consumer-driven growth.

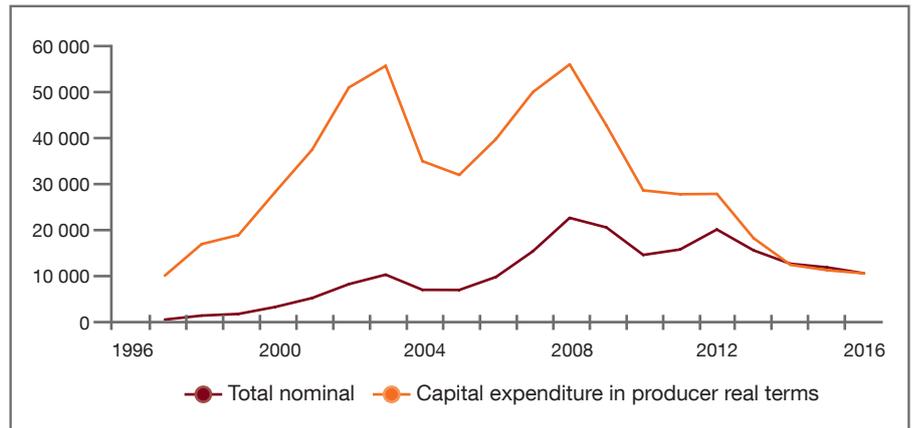
Despite significant investment in platinum mines, supply has not really increased. The capital expenditure histories of Anglo American Platinum, Impala Platinum, Lonmin and Northam Platinum show significant investment. However, levels of investment already started decreasing from 2008 in contrast to capital expenditure by the overall global mining industry, which only started decreasing in 2013 and is still higher than 2007 levels.

Increased capital expenditure from 1997 to 2003 resulted in increased production up to 2006. Although there was further capital expenditure growth from 2006 to 2008, this did not result in increased production. This capital expenditure was really of a sustaining nature, such as replacing end-of-life shafts, and did not result in an increase in mine production.

In fact platinum production for South Africa's four largest platinum producers started decreasing from 2007, as shown in Figure 14. Since almost all platinum mined in Southern Africa is refined by Anglo American Platinum, Impala and Lonmin, (Northam Platinum is the only notable exception), Figure 14 is a fair reflection of total Southern African supply.

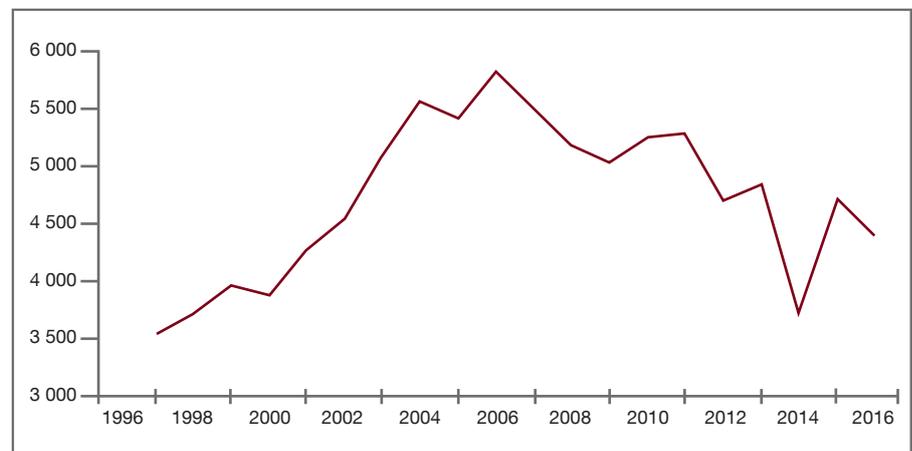
The significant decrease in production since 2012 was mainly as a result of various industrial actions that culminated in a five-months strike in 2014. A number of smaller platinum producers have also been put on care and maintenance since the 2008 crash, which has also negatively impacted the overall supply.

Fig. 13 Platinum capital expenditure by four largest SA producers



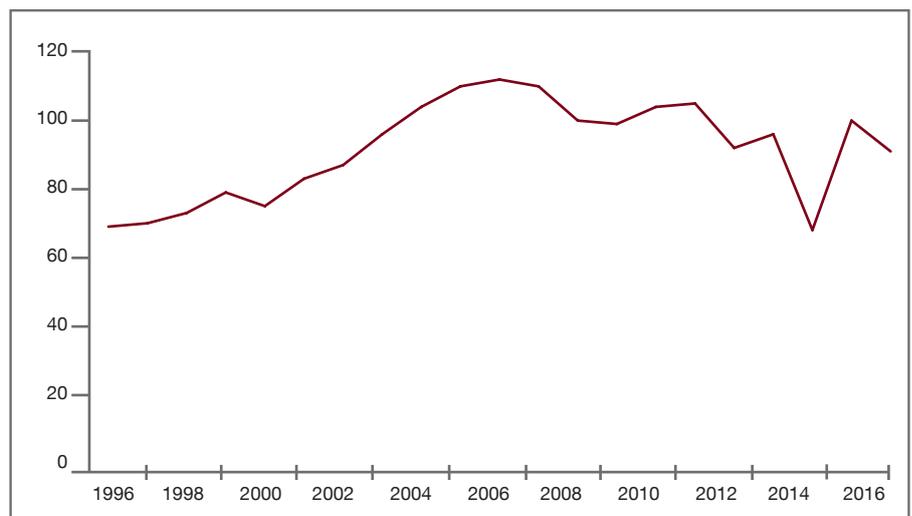
Source: PwC analysis

Fig. 14 Platinum production by the four main SA suppliers ('000 oz)



Source: PwC analysis, company annual reports

Fig. 15 Indexed South African PGM production



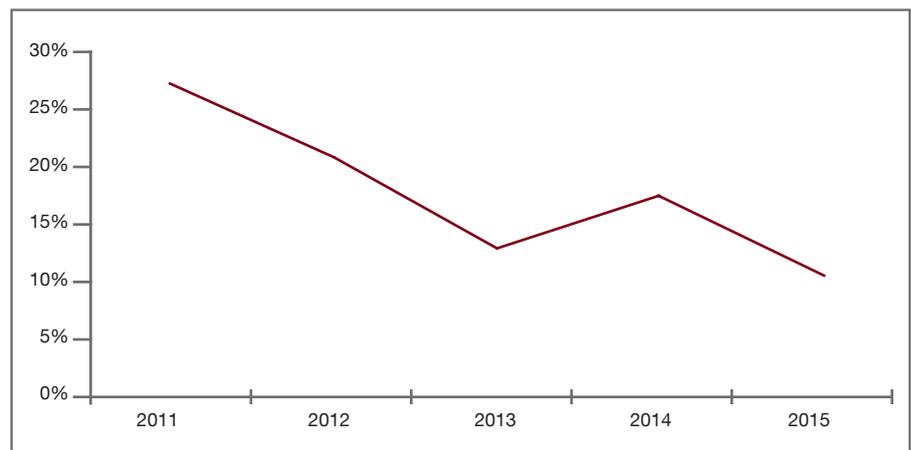
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Source: Stats SA

Since 2014, platinum mines have experienced relatively low levels of industrial action. However, SA mines have not been able to bring production back up to the pre-2012 levels. In fact, they are struggling to maintain production at 2012 levels.

As a result of low prices and the increased cost base, platinum companies have been struggling with low margins. The earnings before interest, tax, depreciation, amortisation (EBITDA) and impairment for platinum miners, as calculated in PwC's SA mine publication, reflect a declining trend over the last five years.

Fig. 16 EBITDA margin



Source: PwC analysis



Low margins have meant that platinum companies have often not been able to fund existing development commitments from cash generated from operations.

Cash that could otherwise have been used for new developments was used for survival during the prolonged industrial actions in 2012 to 2014, resulting in weaker balance sheets.

A number of junior companies had no option but to put projects on care and maintenance or to dispose of their projects. Even the major producers have been forced to reconsider marginal mines, which has resulted in closures or early retirements of shafts.

Weak balance sheets post the 2014 strike have also necessitated the disposal of non-core assets, restructuring of balance sheets and halting or delaying of new development projects.

The table below summarises recent mines put on care and maintenance, early retirement or developments stopped or delayed.

The inability of the industry to generate sufficient cash places a significant constraint on its ability to develop new mines in order to maintain existing demand, let alone supply into new demand, once demand for platinum starts growing.

Table 1: Mines recently put on care and maintenance or developments delayed

| Mine | Year put on care and maintenance | Production before being put on care and maintenance (Platinum ['000 oz])** | Prospects |
|--|---|--|---|
| Smokey Hills | 2012 and 2016 | | |
| Everest (Aquarius Platinum) | 2012 | 50 | Now part of Booyssendal South development, as discussed in Table 2 |
| Crocodile Bridge (Eastern Platinum) | 2013 | 50 | |
| Anglo American Platinum consolidation of Rustenburg mining operations (Khuseleka and Khomanani shafts) | 2013 | | |
| Anglo American Platinum consolidation of Union mine and closure of declines. | 2013 | 50-100 reduction | |
| Elands platinum (Glencore Xstrata) | 2015 | <50 | |
| Impala's 12 shaft mechanised section | 2015 | | |
| Mine | Year development delayed | Stage of development | Planned steady state production (Platinum ['000 oz])** |
| Blue Ridge (Aquarius Platinum) | 2011 | In ramp up and redevelopment | 75 |
| Thembelani 1 and Siphumelele 1 UG2 projects (Anglo American Platinum) | 2012 | Feasibility stage in 2011 | |
| Twickenham (Anglo American Platinum) | 2013 | Trial mining considering redevelopment options. | 180 |
| K4 Lonmin | 2012 | Was in early stage ramp up. | |
| Leeuwkop/Afplats (Impala) | 2014 | Early stage development | 145 |
| Impala 17 shaft | 2015 | Before hard stop in development in December 2015, it still had seven years of development and ramp up. Redevelopment is likely to increase the time. | 180 |

** Not all projects disclose estimated platinum production. Some of the production numbers were derived from PGM or 4e production forecasts and should therefore only be seen as an indication of size and not an absolute value.

Source: Company annual reports

Figure 17 provides an estimated production profile for the next 25 years based on company annual reports, technical reports and estimated production profiles.

The existing producing shafts include mines already well progressed in their ramp-up, such as Impala's 16 and 20 shafts and their return to service 14 shaft, Booyesendal North's Merensky expansion, Bokoni's refocused expansion, as well as a number of minor planned improvements to production.

Despite these increases, the existing shafts will barely maintain production at current levels up to 2021. At current price levels, it is questionable whether that will in fact be maintained. The possibility of any significant industrial action or mine failure or significant safety shutdown is also not included. The graph therefore provides a best-case production profile for existing mines based on current plans.

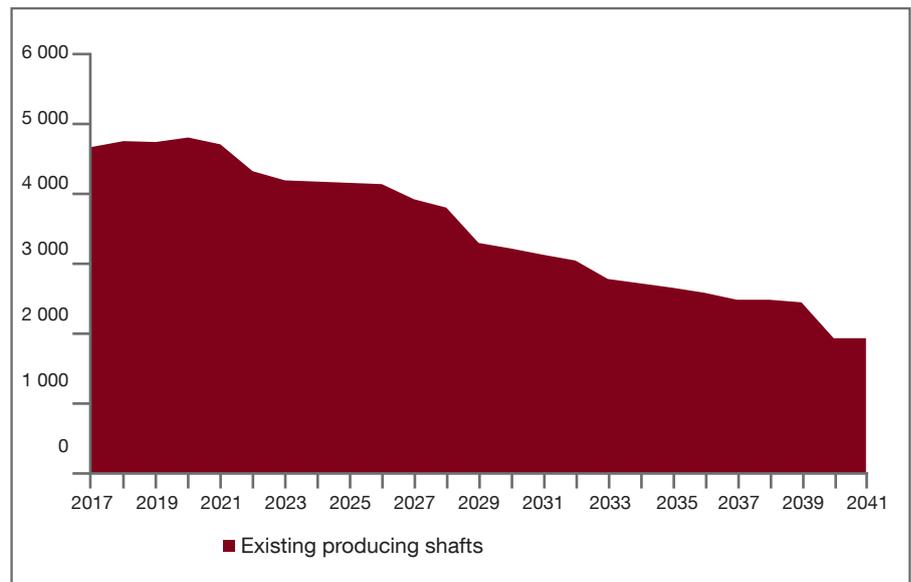
The significant decline expected in 2022 will be the result of various mines reaching closure. These include: Kroondal, Mototolo, shaft 4B at Lonmin and reduction at Zimplats. The ongoing decrease thereafter is based on expected mine closures for mined-out shafts.

This projection corresponds with the comments raised by a number of mining executives around the platinum supply cliff approaching in five years' time and the increase in long-term prices post 2020 in consensus price forecasts.

Having a significantly declining production profile based on existing mines is not uncommon. There is an expectation that future developments will be able to deliver into the shortfall in order to sustain production and where appropriate grow production.

Figure 18 adds current in-development projects to the production profile. This figure reflects a fairly stable production

Fig. 17 Southern Africa platinum production profile (Existing mines)



Source: PwC analysis, company annual reports, reserve statements and investor information

environment for the next 10 years, which even includes an effective annual growth of 3% over the next five years before supply starts declining. However, if demand, net of recycling, continues to grow at the average 2.2% for the last five years, then this Southern African supply growth will barely offset future demand growth.

The development mines used indicative ramp-up production for projects in early stage ramp-up such as Royal Bafokeng Platinum's Styldrift 1, PGM's Maseve mine and Wesizwe's Bakabung mine. It also includes earlier stage committed developments such as Northam's Booyesendal South, Ivanhoe Mines' Flatreef and Zimplats portal 6 (still subject to board approval).

These new developments, if they adhere to their stated development and ramp-up periods, will provide an increase in supply up to 2021, after which supply will decline to the 5moz mark again. Even at the highest forecast point of 5.5moz in 2021, supply along with stable other global supply, will still be below the average demand net of recycling for the last three years as estimated by Johnson Matthey.

Platinum mining companies are facing a number of development challenges at present:

- The depth of new shafts is significantly greater than was the case for previous generation shafts. This increases the cost of development, the time to develop and the cost to operate.
- The absolute essential focus on safety has also increased the cost base.
- Lower grade as a result of a move from the Merensky to Platreef and UG2 reefs. UG2 and Platreef generally have a lower 4E grade and lower platinum content as a percentage of total 4E ounces.
- Based on reserves disclosed by the top 4 producers, a mine would on average have to mine 1.25 tonnes UG2 reef for every 1 ton Merensky reef to deliver the same number of platinum ounces to the plant. UG2 concentrator recoveries are generally also lower than Merensky recoveries further increasing cost per platinum ounce.

This implies that 1 ton of UG2 ore needs to be mined to deliver an equivalent number of platinum ounces to the concentrator. To add further cost, the recovery in UG2 processing is generally also worse than Merensky ore.

- Negative view of the global investment community on mining investments, in general, as reflected by the severe decrease in market capitalisation of mining companies and weakened credit ratings, has raised concerns over the ability to source funds for future development.

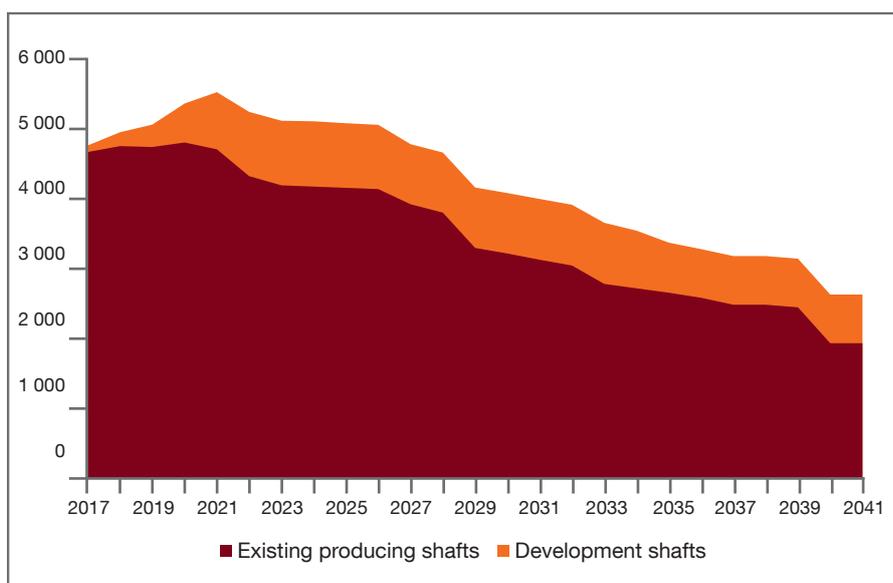
Taking into account the general challenges faced by the industry, ongoing liquidity concerns and the ability to fund expansions Figure 18 reflects a fairly optimistic supply position for both the existing supplies and new developments. Recent threats of industrial action could also create additional pressure on supply.

A summary of recent new developments indicates the substantial cost and time required to add fairly limited ounces to the overall production profile. Table 2 includes only some significant replacement projects. There are also a number of ongoing sustaining capital investments required to maintain production at current levels. The impact of potential underdevelopment in this regard is likely to only play out in a couple of years' time when the lack of flexibility will become apparent. Table 2 indicates the significant shortfall in production and delayed steady-state production experienced by recent major mine developments.

If supply shortfalls continue, then prices will eventually have to go up to incentivise new production. Where will this supply come from?

The most likely source of new supply in the short to medium term is from existing mines where unprofitable supply was previously cut back. Bringing back that supply won't require significant time or capital

Fig. 18 Southern Africa platinum production profile



Source: PwC analysis, company annual reports, reserve statements and investor information

investment, but companies would have to feel comfortable that the price increase is sustainable to invest in human resources and equipment to mine areas previously suspended.

The bulk of these areas were mined on a labour-intensive conventional basis. The lack of true retrenchments required to reduce the platinum workforce over the last two years is reflective of the aging workforce and the unwillingness of the new generation to do conventional mining underground.

According to company disclosures, natural attrition, early retirements and voluntary separation packages accounted for the biggest portion of employee reductions. It is questionable whether platinum mining companies will be able to attract a trained workforce to increase production in the short term. Training and skilling-up of resources will have to be factored into the investment decision to go back to old working areas.

Existing shafts might have their lives extended with appropriate investment if prices justify it. This will result in a smoother decrease in production from 2022 than currently estimated.

Sibanye Gold's purchase of Anglo American Platinum's Rustenburg assets, which is still subject to regulatory approvals, could provide an interesting dynamic in the ability of these Rustenburg shafts to extend lives and increase production mainly on the back of the UG2 resource.

Medium-term supply increases could come from mines put on care and maintenance or developments delayed.

As indicated in Table 1, the mines on care and maintenance did not have significant production. They would probably require a significant premium to existing prices to be brought back into operation. It is also questionable whether the independent smaller companies would have the financial backing to invest in a return-to-service-mine without a substantial increase in price to incentivise new investors.

Table 2: New shaft developments

| Project | Original board approval | Original estimated time to develop | Original estimated cost* | Stage of development | Current annual production | Steady state achieved | Original expected annual steady-state production (Platinum ['000 oz])** |
|--|---|--|--|--|---------------------------|-----------------------------|--|
| Modikwa (Anglo American Platinum and ARM) | 2000 | 2005 planned | R1.85billion | In production | 105 | 135 in 2006 | 162 |
| Marikana (Anglo American Platinum and Aquarius Platinum) | 2005 | Limited added to the pool and share assets. | | Care and maintenance from 2012 with reserves now mined from Kroondal | N/A | 55 in 2010 | 145 |
| Twickenham (Anglo American Platinum) | 2001 Decision to slow down development in 2003. Updated development approval 2008 and slowed again in 2013. | 8 years to 2009 planned | R3.2 billion (2003) 2008:R5.9 billion | Care and maintenance from 2016 | N/A | N/A | 2001: 160 2008: 180 |
| Unki | 2003 | 5 years to 2008 planned | R0.63billion | In production | 66 | 2012 | 58 |
| Kroondal | 2003 | 3 years to 2006 | R0.75billion | In production | 263 | 213 in 2008 | 280 (130 increase on existing 150) |
| Mototolo (Anglo American Platinum) | 2004 | 3 years to 2007 | R0.675billion | In production | 114 | 95 in 2007 | 132 |
| Pandora JV (Lonmin and Anglo American Platinum) | 2000-2003 Decision to revise development plan for Lonmin in 2004 | 10 years to 2012 | R3.1 billion | Development delayed | Included in Lonmin total | N/A | 230 |
| Saffy (Lonmin) | Revised development plan 2004 | 5 years from 2004 to be done by 2009. A 5-year reduction from the original plan. | | In production | Included in Lonmin total | N/A | |
| K4 (Lonmin) | Revised development plan 2004 | 7 years from 2011, a 6-year reduction from the original plan. | | Care and maintenance from 2012. Development delayed. | N/A | N/A | |
| Hossy (Lonmin) | Revised development plan 2004 | 2008 | | Orderly closure planned for 2017 | Included in Lonmin total | N/A | |
| Lonmin total | Revised development plan in 2004 including above. | 2011 | >R6 billion | In production | 760 | Sales peaked in 2006 at 953 | 1150 in 2011 |

* Note that capital costs are not comparable as they are often disclosed in current cost terms with different base years impacting on the total value. Some numbers are also disclosed in nominal terms. In addition, some projects were acquired with previous development done, which reduced the remaining costs required to develop as indicated here.

** Not all projects disclose estimated platinum production. Some of the production numbers were derived from PGM or 4E production forecasts and should therefore only be seen as an indication of size and not an absolute value.

Source: Company annual reports, websites and investor presentations

| Project | Original board approval | Original estimated time to develop | Original estimated cost* | Stage of development | Current annual production | Steady state achieved | Original expected annual steady-state production (Platinum ['000 oz])** |
|---|-------------------------|---|-------------------------------|--|---------------------------|---|--|
| Mogalakwena North (previously PPRust), expansion project (Anglo American Platinum) | 2006 | 4 years to 2010 | R4 billion for expansion | In production | 2015: 400 | 2015 | 200 original +230 expansion = 430 |
| Everest (See Booyesendal South) (Aquarius) | | | | Put on care and maintenance in 2012 Sold to Northam. (See Booyesendal South) | N/A | 2011 | 100 |
| Booyesendal North UG2 | 2009 | 7 years to 2016 | R3.9 billion | In production | 93 | 2016 | 93 |
| Booyesendal North Merensky | 2016 | Short term | R0.3 billion | In development | N/A | N/A | 15 |
| Booyesendal South | 2016 | 6 years to 2022 | R4.2 billion | In development | N/A | N/A | 116 |
| Impala 16 shaft and 20 shaft (replacement shafts for the lease area) | 2004 | 8 and 5 years to commence ramp up production in 2012 and 2009 | R6.6 billion | Ramping up | Part of Impala production | 16 shaft in production in 2013 and 20 shaft in production in 2015 | 355 |
| Impala 17 shaft (replacement shafts for the lease area) | 2008 | 10 years to full production 2018 | R8.9 billion | Care and maintenance from 2015 | N/A | N/A | 180 |
| Leeuwkop (Impala) | 2013 | 8 years to first production in 2021. Ramp up to 2026 | R1.3 billion for phase 1 only | Delayed capital investment from 2014 | N/A | N/A | 145 |
| Marula (Impala) | 2002 | 3 years to 2005 | R1.4 billion | In production | 78 | 70 in 2008 | 103 |
| Styldrift 1 (Royal Bafokeng Platinum) | 2008 | 9 years to 2017 | R11.8 billion | Ramping up to be in production in 2020 | N/A | N/A | 123 |
| Bakabung Mine (Wesizwe Platinum) | 2008 | 5 years to start production in 2013. Ramp up to 2017 | R5.6 billion | In development | N/A | N/A | 250 |
| Maseve (PGM) | 2008 | 3 years to commence production in 2011. Ramp up to 2013 | R5 billion | First concentrate produced in 2016. In ramp up to production in 2020 | N/A | N/A | 140 |
| Sedibelo (Platmin) | 2007 | 2 years to production in 2009. Ramp up to 2011 | R1.7 billion | In production | 88 | Reached current production levels in 2013 | 175 |
| Flatreef (Ivanhoe Mines) | 2014 | 6 years to steady state in 2020/21 | R12 billion | In development | N/A | N/A | 175 |

Developments delayed or put on care and maintenance would be the first to be reactivated. Even if development were to recommence immediately, they wouldn't be able to fully offset the expected decrease in production from shaft closures in the next 10 years.

New open-pit mining operations, which generally provide more flexibility in medium-term supply, could assist in providing the necessary supply once required. Shallower resources in Zimbabwe could also assist in bringing production on stream quicker than the deep-level shafts in South Africa if the ownership uncertainty is addressed.

In the long term there are still a number of good platinum resources to be mined in South Africa and Zimbabwe. Once prices increase, a number of them will be brought to feasibility stage or into development.

As can be seen in table 2, such developments will require significant capital and time investment. Technology is likely to play a key role in their success, both on the supply side and the demand side. The key for miners is to ensure that only those assets that can be mined in a sustainable and profitable basis are developed in order to avoid excess supply, which will again fuel the commodity cycle.

Processing capacity

We will comment more extensively on metal processing capacity in a follow-up document.

There is currently excess concentrating capacity in the industry as a whole. However, infrastructure cost to take ore to the excess concentrating capacity could be costly in the form of infrastructure (conveyor, rail, transport equipment) or in running costs when trucked using existing infrastructure.

The location and dynamics of individual projects will determine whether making use of existing infrastructure or building new concentrating capacity is most feasible. The time to build additional concentrating capacity is generally less than the time to develop a mine and is not seen as constraint to growth at this stage.

Given the reduction in Southern African mining supply since 2012, there is sufficient smelting and refining capacity subject to electricity supply and environmental regulatory compliance. However, the higher nickel and copper content in the Platreef and Zimbabwe ore could provide interesting base metal refining dynamic in the future.

Alternatives to Southern African mining supply

Outside Southern Africa, Russia is the main supplier of platinum with Norilsk Nickel the world's fourth-largest producer with production of approximately 650koz per year.

Platinum constitutes 8% of Norilsk Nickel's revenue and is merely a by-product. Although Norilsk Nickel has a number of projects in development, these projects are of a sustaining nature and should not create significant additional supply in the short term.

If mining companies cannot meet demand, the question is whether alternative supply is available. Recycling has grown to over two million platinum oz per year with a substantial portion now also coming from jewellery.

Stricter emission control regulations could increase the content of PGMs in catalytic converters, which would create a bigger incentive to recycle. Countering the impact of stricter regulations is technological

advancements that improves the effectiveness (ability to capture more emissions for less platinum) of PGMs and therefore requires lower PGM content for the same emission control.

In a low-price environment, the value of recycled material might be less than the cost to collect, decant and process it. If prices increase recycling is incentivised.

Although catalytic converters now require more PGMs to comply with new regulations, the increased substitution of platinum by palladium will also impact the number of platinum ounces available for recycling.

Conclusion

We are optimistic that platinum prices should recover in the medium term from their current unsustainable low rand price levels.

The lack of investment in platinum mines as a result of the low-price environment post 2008 and severe industrial action from 2012 to 2014, will continue to put pressure on the existing supply deficit.

It is debatable how long above-ground stocks can supply into this shortfall. While recycling will continue to assist in reducing the supply shortfall, it won't be able to supply into any real demand growth.

The ability of platinum mining companies to increase production once prices rise in a disciplined way and without significantly impacting their unit cost, will determine the fate of South Africa's platinum industry in the next 10 years. Doing this in a sustainable way and maintaining their social licence to operate in a challenging socio-economic environment is likely to be the biggest requirement for long-term success.

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