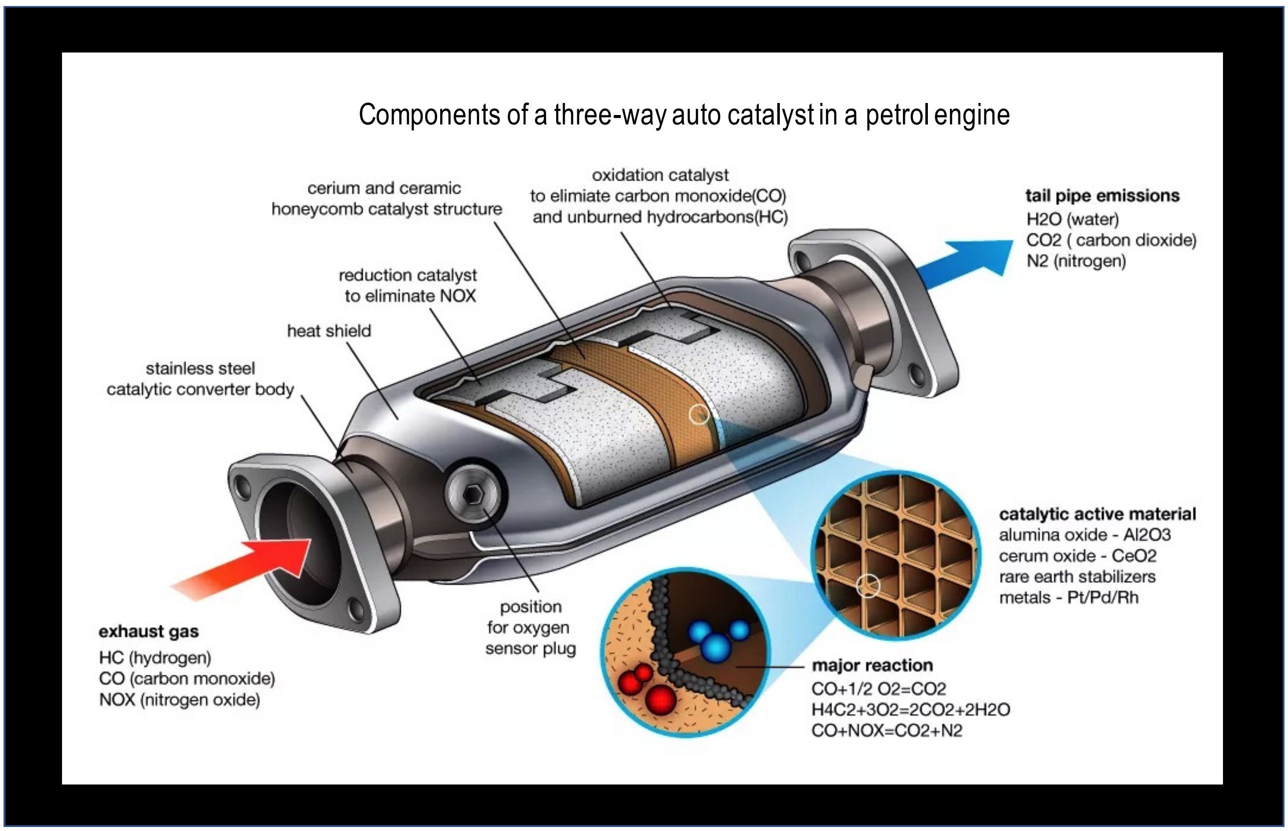
Platinum

Big boost for platinum demand following technology breakthrough and the impact of COVID-19.



Source: Google Sites

March 2020

Dr David Davis PhD. MSc. MBL. CEng. CChem. FIMMM. FSAIMM. FRIC.

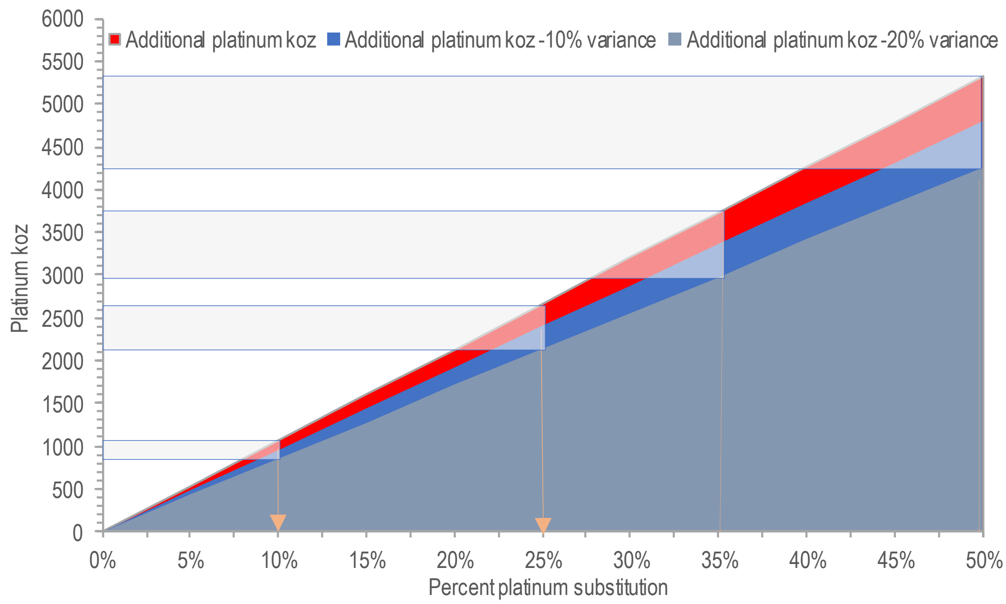
Precious Metals Consultant

In this review, I allude to the implications for the market following the announcement that the auto industry took a step nearer to curbing its dependence on palladium. On 10 March this year, BASF announced it has developed a “tri-metal” auto catalyst converter that enables a partial substitution of lower-priced platinum for higher-priced palladium while still meeting emissions standards has indicated the amount of platinum used in the new catalysts would depend on the vehicle type and sales region.

In my view, the partial substitution of palladium for platinum in petrol vehicle auto catalyst converters is a “game changer” for platinum autocatalyst demand and price. I believe that this substitution will likely be between 20% and 50%, which will likely fully eliminate the palladium deficit and, in doing so, will increase the demand for platinum significantly.

My calculations imply that at a global substitution rate of 10%, 25%, 35% and 50% of platinum for palladium in petrol auto catalyst converters, the quantum of additional platinum demand is significant and amounts to approximately 1.0moz, 2.7moz, 3.7moz and 5.3moz respectively. My assumptions use 2019 reported figures as well as LMC and JM data, and assume a 1: 1, Pt:Pd exchange rate at the average catalytic converter palladium loading. In this regard, the demand for platinum will increase significantly, as illustrated by Figure 1 below, which, in turn, will likely put upward pressure on the platinum price.

Figure 1: Estimated impact of global substitution of palladium for platinum in petrol auto catalyst converters



Source: Johnson Matthey, Davis analysis and estimates

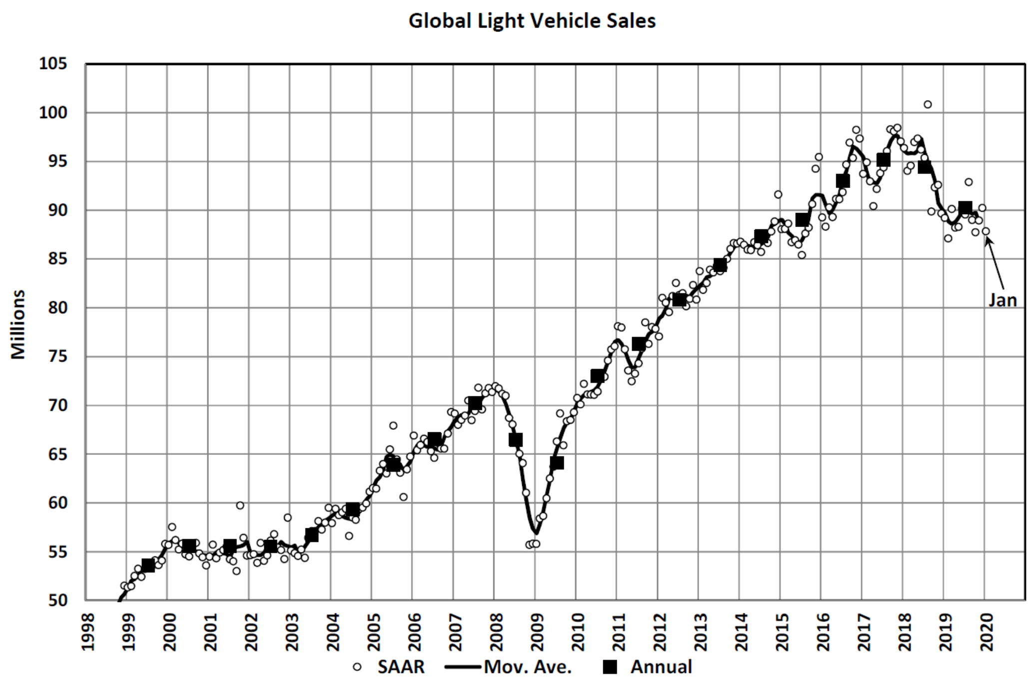
It should be reiterated that my observations relating to platinum and palladium demand are pre the COVID-19 global pandemic. In this regard, significant headwinds as a result of this pandemic lie ahead, in particular its negative influence on automobile manufacturing and the corresponding impact on PGM demand.

The current environment

As indicated above, it is clear significant headwinds as a result of this pandemic lie ahead. There will, however, be a bounce back, in time, from the current prices and demand for PGMs and gold when the corresponding "normalisation" of the financial global environment occurs.

Figure 2 below, illustrates the historic global light vehicle sales from 1999 (LMCA), the impact on sales of the global financial crisis in 2008, the downturn in sales in China together with the emerging impact on sales due to the COVID-19 global pandemic. Analysts are projecting vehicle sales declines of 3% to 9% in 2020, which may even rise to 15% depending on the duration of the outbreak. RBC Capital Markets now envisions U.S. vehicle sales in 2020 to decline 20% y-on-y. I believe that these figures may well be optimistic.

Figure 2: Historic global light vehicle sales from 1999 (LMCA),



Source: LMCA

The factors that put upward pressure on palladium and rhodium are still in place. The landscape surrounding the risk to primary supply from the South African PGM mining industry is changing, in my view, to the downside. The impact of continuous electricity outages will impact supply (stage 4 outages in particular). These outages, in my view, will not abate for at least five years. The reduction in Amplats' production as a consequence of the failure of its ACP reinforces the risk associated with South African mine production's dependency on the primary supply of PGMs. Notwithstanding the potential impact on production of COVID-19, South Africa has announced that the country will be in lockdown for 21 days from 27 March to 16 April in order to try to slow the spread of COVID-19. This action, in my view, is positive for PGM prices.

My comments in this review, equally apply after the COVID-19 global pandemic abates and when the corresponding "normalisation" of the financial global environment occurs. The market balance of PGMs will, however, likely change as a result of a decline in vehicle sales and the global financial environment. Going forward, substitution of palladium for platinum in petrol autocatalyst converters will change the landscape for platinum and palladium.

Why substitution?

History

I indicated in my previous review on palladium that the strong demand for palladium is inextricably linked to the introduction of vehicle regulation and standards for controlling the tailpipe emission of harmful gases (US Clean Air Act of 1970). Vehicle manufacturers introduced catalytic conversion technology to meet these standards by using platinum, palladium and rhodium (PGMs) in various ratios to catalyse (neutralise) harmful gases such as carbon monoxide and the oxides of nitrogen. Vehicle emission standards have been progressively tightened through regulation worldwide since 1970. In response, vehicle manufacturers have had to increase the content (loading and loading ratios) of palladium, platinum and rhodium PGMs) in autocatalysts to meet the stricter limits. It is important to note that the primary metal used in petrol engine autocatalysts is palladium.

According to Johnson Matthey (JM), three fundamental factors determine the amount of PGMs used in the autocatalyst sector: vehicle production rates, fuel type and standards and emissions legislation.

The key influences on autocatalyst design and the process of catalyst development in the context of PGM use have been summarised from Johnson Matthey's archives and are presented below.

"The first autocatalysts were oxidation catalysts, which convert carbon monoxide (CO) and hydrocarbons (HC) to carbon dioxide (CO_2) and water. These catalysts primarily used a mix of platinum and palladium.

"The focus of regulation then turned to oxides of nitrogen (NO_x) and new US regulations were phased in between 1981 and 1983. Because oxidation catalysts have little effect on NO_x, the new standards resulted in the development and introduction of 'three-way catalysts' which contain various ratios of platinum, palladium and rhodium that simultaneously oxidise CO and HC while reducing NO_x to nitrogen. The most common three-way catalysts fitted to cars in the 1980s contained platinum and rhodium in a 5:1 ratio, rhodium playing an important role in promoting the reduction of NO_x. platinum and palladium.

"Palladium came to the fore from 1989 onwards, as auto makers began using more durable palladium-based three-way catalysts to take advantage of the metal's price discount to platinum. In addition, the sudden spike in the price of rhodium to over USD5,000/oz in 1990 encouraged some manufacturers to utilise palladium-rich catalysts with lower rhodium loadings. Technological advances made by autocatalyst manufacturers enabled auto companies to be more responsive to the changing PGM price differentials.

“The move to greater use of palladium gathered pace with tighter regulations and standards introduced in 1994. These regulations placed further limits on emission levels, particularly HC for which palladium is a highly effective catalyst. The move into palladium was helped by reductions in the sulphur content of fuel in California, Europe and Japan.

Initially, palladium loadings of two or three times that of platinum were required to maintain overall catalyst performance. However, as palladium was typically one-third to one-quarter of the price of platinum (averaging USD88/oz versus USD376/oz in 1991, for example) it was economical at much higher loadings.

The exceptionally rapid rise in auto company demand for palladium throughout the mid and late 1990s, coupled with disruptions to supplies from Russia, spurred the palladium price from around USD200/oz at the start of 1998 to over USD1,000/oz in January 2001. This triggered moves by some auto makers to shift a proportion of their autocatalyst PGM use back in favour of platinum. The subsequent reversal in platinum and palladium prices created the financial incentive for the auto industry to re-examine greater use of palladium once again (2003.)

In order to benefit from changes in PGM prices, auto manufacturers re-examine the PGM loadings or ratios in an autocatalyst system after the vehicle model it is fitted to has entered production. However, catalyst design, testing and certification t by both the auto manufacturer and catalyst supplier typically takes many months. It is complex, time consuming and carries a significant cost to the auto manufacturer.

Auto manufacturers were therefore reluctant to make major changes to PGM loadings after a specific model had entered production. In light of the historical volatility in platinum and palladium prices, some auto companies have investigated the certification of both platinum- and palladium-rich catalyst systems for the same vehicle model. Dual certification would allow an auto manufacturer to have greater control over its PGM costs by switching from a platinum-rich catalyst system to a palladium-rich variant, or vice versa, when metal prices change significantly.

However, the characteristics of the two metals such as reactivity, pollutant conversion efficiency and durability are not identical and a recalibration of engine management systems is normally required. The cost-benefit analysis requires auto companies to take a view on how PGM prices will move over the coming three to four years or more – a tough proposition given their recent unpredictability”.

In 2013, JM reported that palladium was responsible for the majority of palladium demand for light duty gasoline (LDG) vehicles. LDG catalysts accounted for just under 20% of autocatalyst demand for platinum but close to 90% of autocatalyst demand for palladium (see Figure 6).

On the 10 March this year, BASF announced that it has developed a “tri-metal” auto catalyst converter that enables partial substitution of lower-priced platinum for higher-priced palladium while still meeting emission standards. BASF has indicated the amount of platinum used in the new catalysts would depend on the vehicle type and sales region.

The company expects the technology to mainly be implemented in 2023 models, with some applications possible in 2022, after automakers test and certify that each vehicle meets government regulations.

As I indicated in the introduction, in my view, the partial substitution of palladium for platinum in petrol vehicle auto catalyst converters is a “game changer” for platinum autocatalyst demand. Furthermore, substitution will likely lower the demand for palladium, which is in deficit, and increase the demand for platinum. I believe that this substitution will likely be between 20% and 50% and will possibly fully eliminate the palladium deficit and, in doing so, will increase the demand for platinum.

Controversy abounds

Since the BASF announcement, a certain amount of controversy has arisen regarding why the re-adoption of tri-metal catalysts is so protracted. *Mining Weekly,* in a recent interview with CPM Group MD, recalled that trimetallic (three-way) catalysts were the dominant catalysts from the Seventies, through the Eighties and Nineties. So why the delay? This point is reflected in the summary of JM’s historic development of autocatalyst converters outlined above.

Reasons for substitution

Three-way autocatalyst

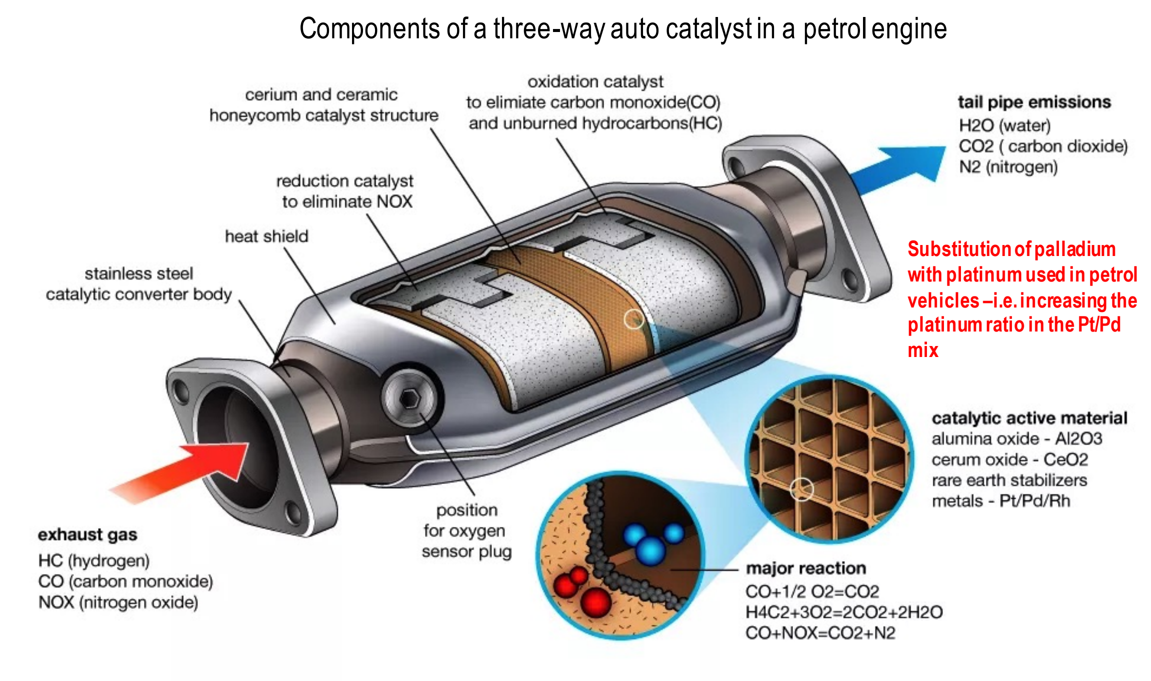
In this conversation, I focus on metal prices and catalytic loadings since these factors relate directly to the reasons for substitution. In this regard, I present a series of graphs that support the conversation.

All of the changes in the converter PGM ratios were mainly driven by platinum and palladium price differentials, emission legislation and improved fuel standards. It is important to recognise that substitution does not only depend on the respective prices of platinum and palladium but also the value of the respective platinum/palladium ratios in a catalytic converter

The reversal in platinum and palladium prices (October 2017) together with the subsequent quantum used in tri-metal (three-way) catalytic converters has created a financial incentive for the auto industry to re-examine greater use of platinum in three-way catalyst systems.

Figure 3 on next page, illustrates the components and structure of a typical tri-metal catalytic converter. Figure 3 also illustrates the major catalytic reactions, which convert carbon monoxide (CO) and hydrocarbons (HC) to carbon dioxide (CO_2) and water, and the reduction of the oxides of nitrogen (NO_x) to nitrogen (N_2).

Figure 3: Components and structure of a typical tri-metal catalytic converter



Source: Google Sites

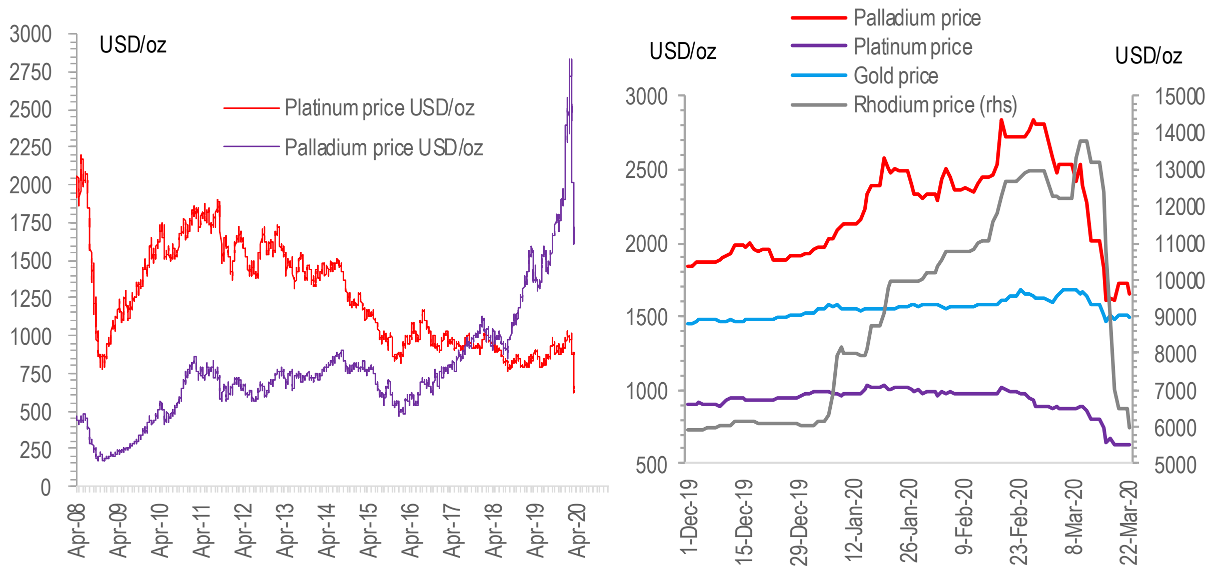
Price and loading ratio trends

Price

Figure 4 illustrates the daily price fluctuation of platinum and palladium from 2008. Figure 4 also illustrates the comparative nature of the market in its response to platinum and palladium prices. For example, between 2015 and 2019 the annual average palladium price skyrocketed increasing by 250% from USD612/oz to USD1,537/oz. January to date, the daily price has accelerated further peaking at highs of around USD2,835/oz at the end of February. The price of all precious metals has since tumbled as a result of a crash in global financial markets and PGM demand due to the impact of the COVID-19 global pandemic.

As indicated in the introduction, the impact of continuous electricity outages will affect supply (stage 4 outages in particular). These outages, in my view, will not abate for at least five years. The reduction in Amplats' production as a consequence of the failure of its ACP reinforces the risk associated with South African mine production's dependency on the primary supply of PGMs. Notwithstanding the potential impact on production of COVID-19, South Africa has announced that the country will be in lockdown for 21 days from 27 March in order to try to stem COVID-19. This action, in my view, is positive for PGM prices.

Figure 4: Review of the daily platinum and palladium price since 2008

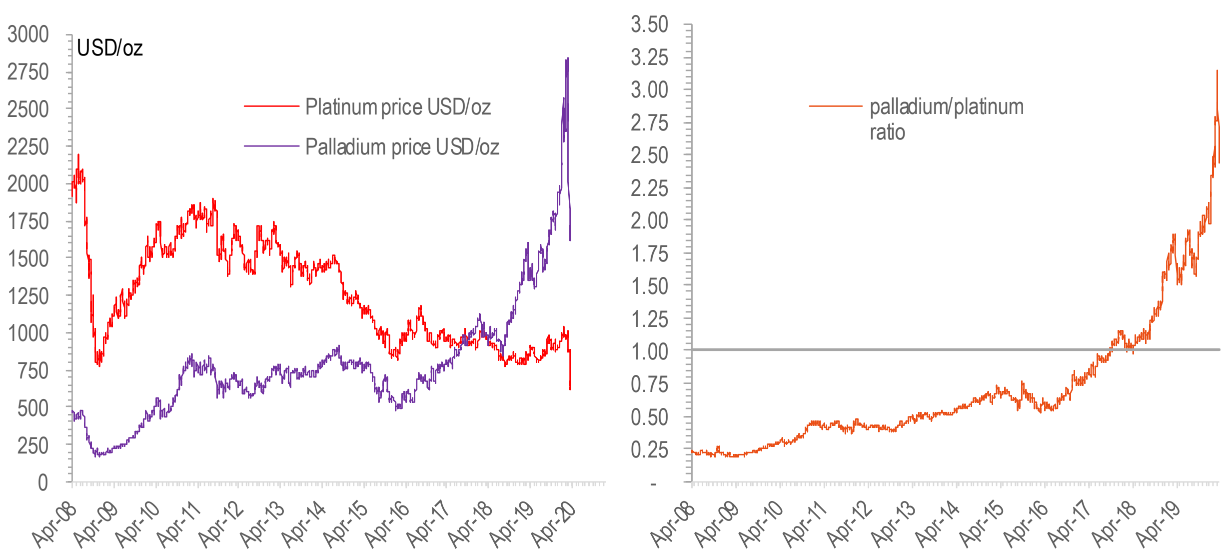


Source: Bloomberg, Davis analysis and estimates

It is interesting to note that the daily palladium/platinum price ratio reached "one" in October 2017; since then the ratio has increased significantly to just over 3.0 at the end of February, implying a palladium price premium over platinum of around c. USD1,915/oz. This ratio and price premium have declined in line with the sharp decline in PGM prices; decreasing to 2.7 and USD1,037 respectively by 3 March. See Figure 5.

I am of the view that this price premium still warrants substitution.

Figure 5: Review of the daily platinum and palladium price and palladium/platinum ratio since 2008



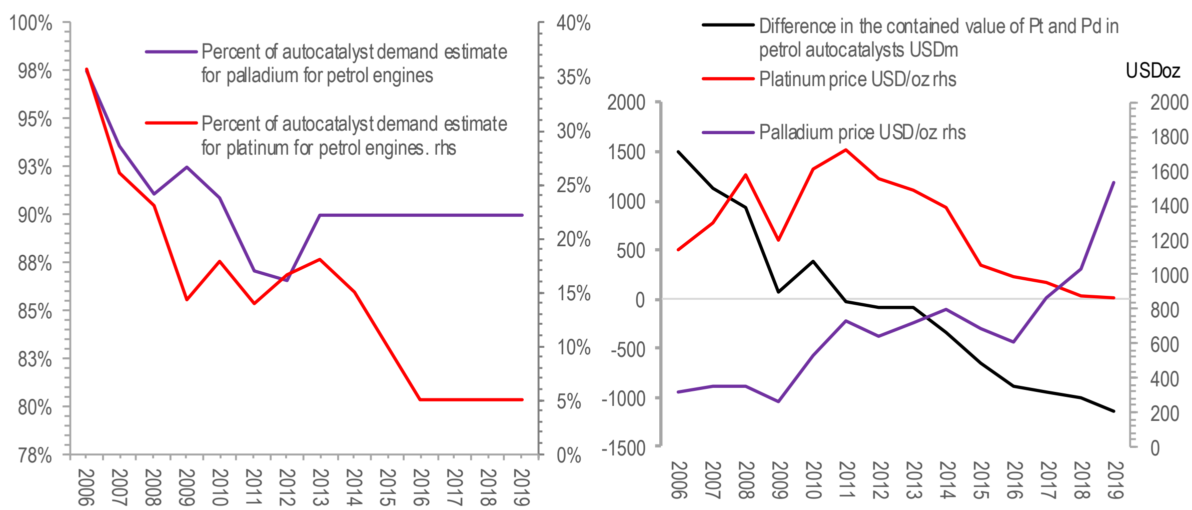
Source: Bloomberg, Davis analysis and estimates

Loading ratio trends

As indicated above, the evolution of auto catalyst converter PGM ratios from the Seventies through the Eighties, Nineties and early Twenties varied significantly, mainly driven by platinum and palladium price differentials, emission legislation, and improved fuel standards.

Figure 6 below, illustrates the estimated change in autocatalyst demand and loading ratio for platinum and palladium respectively, for petrol vehicles between 2006 and 2019. Figure 6 also illustrates the estimated difference between the contained value of platinum and palladium in USD over the same period (value of loading ratios).

Figure 6: Estimated change in autocatalyst demand and loading ratio for platinum and palladium and the difference between the contained value of platinum and palladium in USD



Source: Johnson Matthey, Davis analysis and estimates

It appears that auto manufacturers moved autocatalyst loading ratios towards a palladium-rich catalyst (low price), while at the same time continuously decreasing the platinum content (high price). I am of the view that this response was due to the price differential between the platinum and palladium price. This action was financially successful in reducing the difference in contained value until 2011, following which an opposite swing in the platinum and palladium price began to occur.

The platinum price began a continuous decline from an annual average of USD1,721/oz in 2011 to USD863/oz in 2019, while the palladium price rose exponentially to an annual average of USD1,573/oz in 2019. Figure 6 illustrates the significant and continuous differential value loss sustained by auto manufacturers between 2011 and 2019 due to the palladium-rich catalyst philosophy caught between a continuous and opposite swing in the platinum and palladium price respectively.

The significant and continuous differential of this value loss has finally led to BASF, one of the leading autocatalyst manufacturers, announcing that it has successfully finished developing a tri-metal PGM catalyst (10 March 2020).

Market balance

Palladium

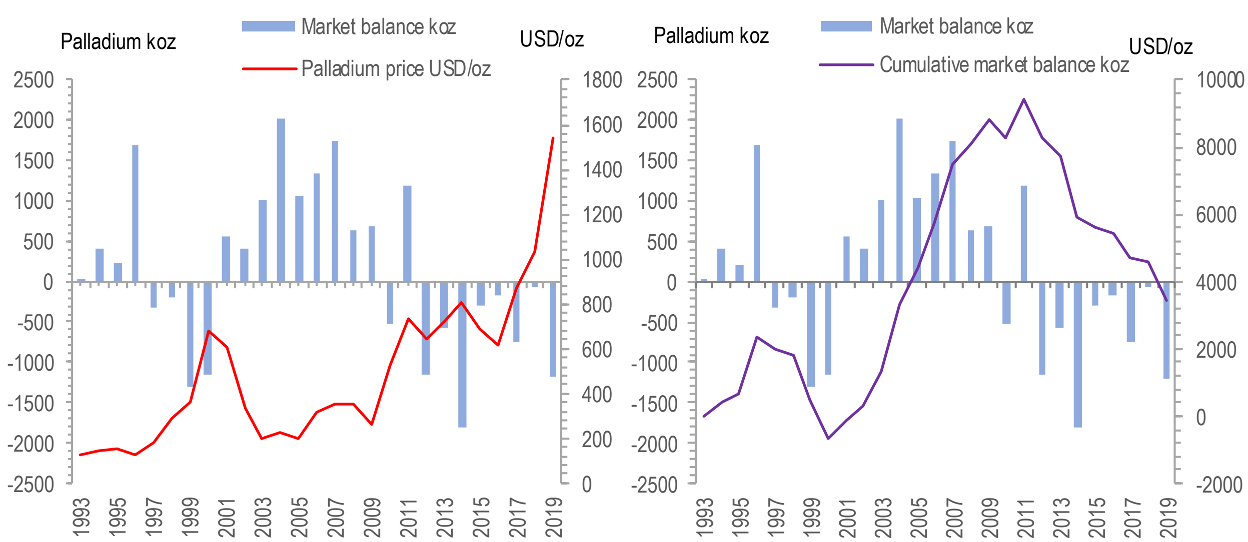
As indicated above, there have been question marks in the market over why the re-adoption of a tri-metal catalyst is so protracted after BASF indicated that implementation of its tri-metal catalyst would likely take two to three years.

I question why the auto manufacturers did not see the train coming?

In my recent review on palladium, I indicated that over the past eight years industry statistics show that palladium exhibited a continuous net deficit in the supply-and-demand balance. I calculated from published data (JM) that the average annual deficit between 2012 and 2019 amounted to c. -755,000oz and in total c. -6.0moz (JM). This continuous deficit represents my interpretation of the train coming over eight years.

Figure 7 illustrates the market balance of palladium and the cumulative market balance between 1993 and 2019. Of note is the relationship between the market deficit and the palladium price.

Figure 7: Palladium market balance, price and cumulative deficit between 1993 and 2019



Source: Johnson Matthey, Davis analysis and estimates

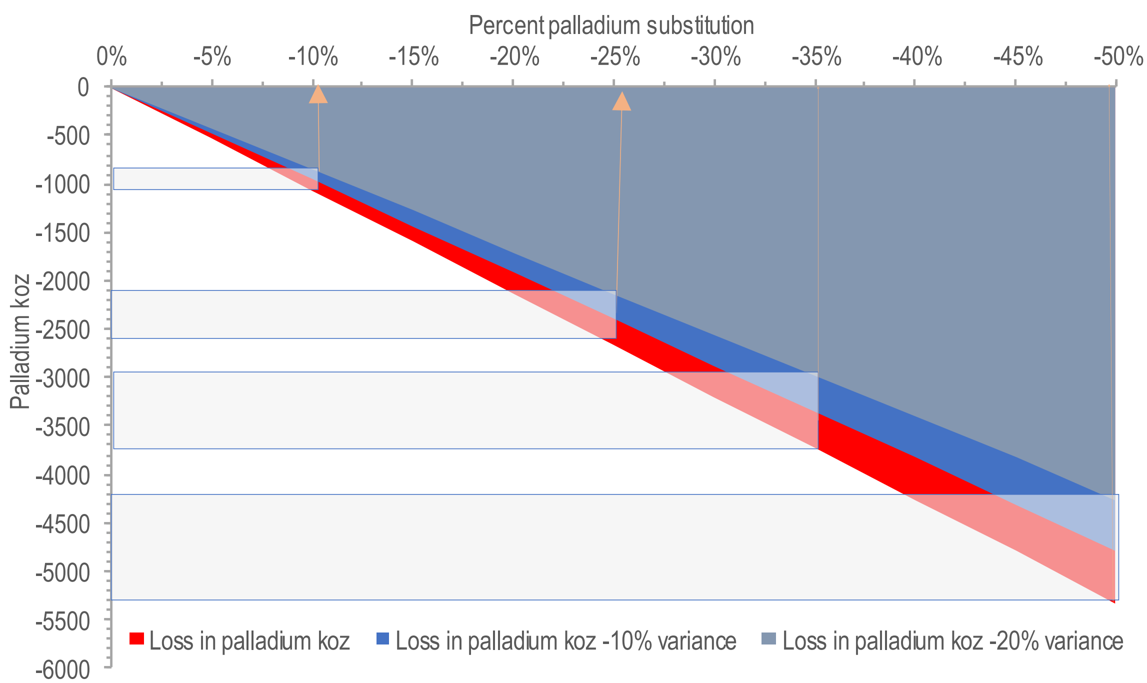
The cumulative market balance deficit reached a neutral position during 2018, which implies the near-term cumulative surplus between 2001 and 2011 has been depleted. In this regard, the depletion of the near-term surplus may be interpreted by some as having an impact on the tightness of palladium in the market.

I expect the COVID-19 global pandemic will impact the market balance deficit in 2020 significantly as auto sales are expected to decline by at between 10% and 20%. Clearly, the palladium market and global financial markets have been reacting negatively, resulting in a significant fall in PGM prices.

After the COVID-19 global pandemic abates and the corresponding "normalisation" of the financial global environment occurs, I would expect the substitution of palladium for platinum in petrol vehicles to have a significant impact on the continuous market balance deficit.

My calculations imply that at a global substitution rate of 10%, 25%, 35% and 50% of palladium for platinum in petrol auto catalyst converters, the quantum of the loss in palladium demand is significant and amounts to approximately -1.0moz, -2.7moz, -3.7moz and -5.3moz respectively. My assumptions use 2019 reported figures as well as LMC and JM data, and assumes a 1: 1, Pt:Pd exchange rate at the average catalytic converter palladium loading. In this regard, the demand for palladium will decrease significantly, as illustrated by Figure 8 below, which, in turn, will likely have a negative impact on the palladium price.

Figure 8: Estimated impact of global substitution of palladium for platinum in petrol auto catalyst converters



Source: Johnson Matthey, Davis analysis and estimates

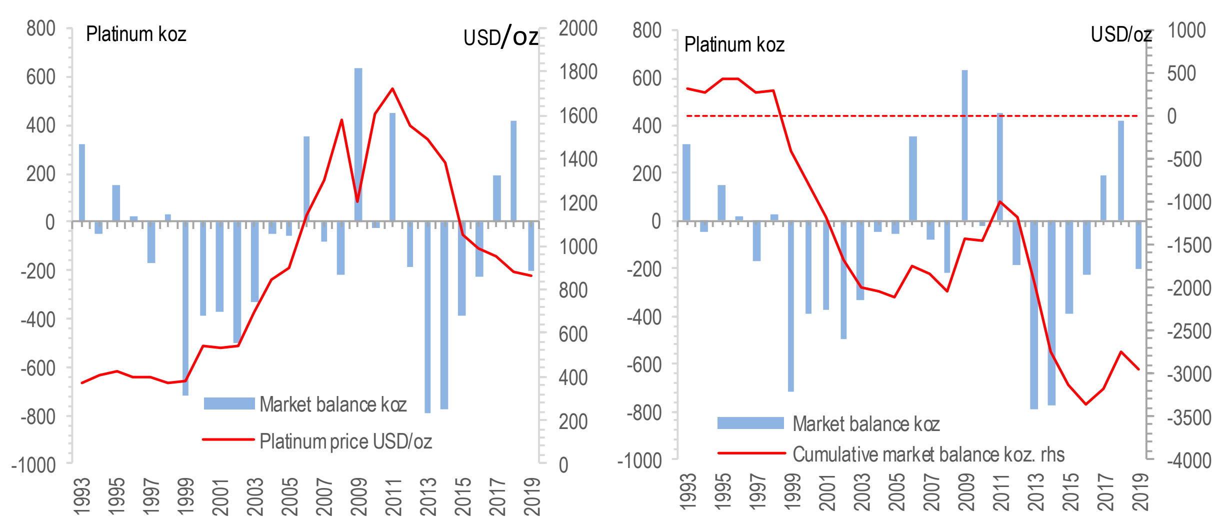
Platinum

The supply-and-demand market balance for platinum between 1993 and 2019 is illustrated by Figure 9 below. Note that this data was drawn from Johnson Matthey archives.

On the macro long-term level platinum exhibited:

- An average annual net market balance deficit of c.110koz and a total deficit of c.1.45moz between 1999 and 2003. Market balance deficits were mainly due to suspended and limited Russian supplies and a strike which reduced South African production. In general, increased platinum demand outweighed supply during this period.
- Between 2004 and 2011, the average annual net market balance was in surplus of c.126koz and a total surplus of c.1.45moz. Difficult economic conditions negatively affected demand for platinum in many sectors during 2009, driving down gross demand, which resulted in a net surplus of over 600koz.
- Between 2012 and 2016, the platinum market balance was in deficit. An average annual net market balance deficit of c.472koz and a total deficit of c.2.31moz was recorded over this period.
- Market deficits were recorded in 2017 and 2018 due mainly to a decline in in vehicle production coupled with a decline in European diesel vehicle output. Furthermore, jewellery consumption declined and remained weak. In 2019, the market balance returned to a record deficit of c.1.13moz, which is attributable to ETF buying. This offset a modest contraction in global industrial and automotive demand and a double-digit drop in the Chinese platinum jewellery market.

Figure 9: Platinum market balance, price and cumulative deficit between 1993 and 2019



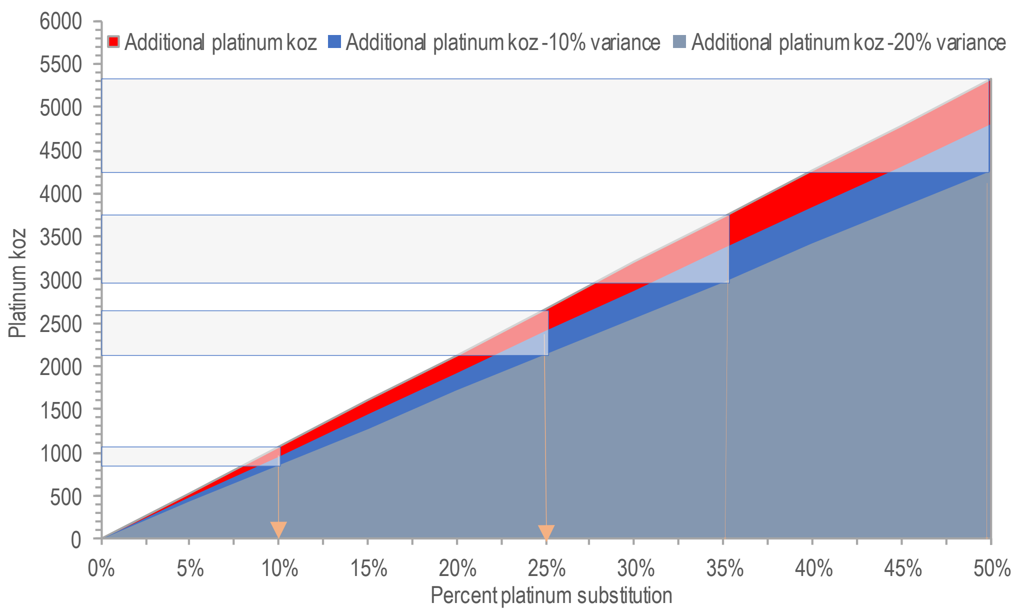
Source: Johnson Matthey, Davis analysis and estimates

The cumulative platinum market balance remained in a declining deficit from 1999 to 2019, which may be interpreted by some as the market is having to drawdown its stocks and/or from above-ground stocks.

I have indicated above that I expect the COVID-19 global pandemic will have a significant impact on the market balance in 2020 as vehicle sales are expected decline by at between 10% and 20%.

The following discussion was initially presented in the introduction of this review, however, for completeness of my conversation on loading trends I have repeated my view and illustration in Figure 10.

Figure 10: Estimated impact of global substitution of palladium for platinum in petrol auto catalyst converters



Source: Johnson Matthey, Davis analysis and estimates

My calculations imply that at a global substitution rate of 10%, 25%, 35% and 50% of platinum for palladium in petrol auto catalyst converters, the quantum of additional platinum demand is significant and amounts to approximately 1.0moz, 2.7moz, 3.7moz and 5.3moz respectively, given my assumptions described above. In this regard, the demand for platinum will increase significantly, as illustrated by Figure 10, which, in turn, will likely put upward pressure on the platinum price.

Summary

Throughout this discussion, I have alluded to a number of factors that support the case for the substitution of platinum for palladium in petrol vehicle three-way autocatalysts.

Substitution of platinum for palladium and vice versa is, however, not new to auto manufacturers. All of the changes made over time in the converter PGM ratios were mainly driven by platinum and palladium differentials, emission legislation and improved fuel standards. It is important to recognise that substitution does not only depend on the respective prices of platinum and palladium but also on the value of the respective platinum and palladium ratios in a catalytic converter.

I believe that this substitution will likely be between 20% and 50%, which will possibly fully eliminate the palladium deficit and, in doing so, will increase the demand for platinum significantly. My calculations imply that at a global substitution rate of 10%, 25%, 35% and 50% of platinum for palladium in petrol autocatalyst converters, the quantum of additional platinum demand is significant and amounts to approximately 1.0moz, 2.7moz, 3.7moz and 5.3moz respectively. Similarly, a negative quantum will apply with respect to the decline in demand for palladium, which, in turn, will likely have a negative impact on the palladium price.

In my view, the partial substitution of palladium for platinum in petrol vehicle autocatalyst converters is a "game changer" for platinum autocatalyst demand and price.

About Dr David Davis PhD. MSc. MBL. CEng. CChem. FIMMM. FSAIMM. FRIC.

David has been associated with the South African mining industry and mining investment industry for the past 43 years (mainly PGM, gold and uranium). At present, David is working as an independent precious metal consultant. David's PhD involved: "Studies in the catalytic reduction and decomposition of nitric oxide 1976".

Important Notice

General Disclosures, Disclaimers and Warnings

This Report (“the report”) in respect of the global Rhodium Industry is directed at and is being issued on a strictly private and confidential basis to, and only to, Professional Clients and Eligible Counterparties (“Relevant Persons”) as defined under the Investment Research Regulatory Rules and is not directed at Retail Clients. This report must not be acted on or relied on by persons who are not Relevant Persons. Any investment or investment activity to which this Report relates is available only to Relevant Persons and will be engaged in only with Relevant Persons.

The Report does not constitute or form part of any invitation or offer for sale or subscription or any solicitation for any offer to buy or subscribe for any securities in any Company discussed nor shall it or any part of it form the basis of or be relied upon in connection with any contract or commitment whatsoever.

The opinions, estimates (and where included) projections, forecasts and expectations in this report are entirely those of Dr David Davis as at the time of the publication of this report, and are given as part of his normal research activity, and should not be relied upon as having been authorised or approved by any other person, and are subject to change without notice. There can be no assurance that future results or events will be consistent with such opinions, estimates (where included) projections, forecasts and expectations. No reliance may be placed for any purpose whatsoever on the information or opinions contained in this Report or on its completeness and no liability whatsoever is accepted for any loss howsoever arising from any use of this Report or its contents or otherwise in connection therewith. Accordingly, neither Dr David Davis nor any person connected to him, nor any of his respective Consultants make any representations or warranty in respect of the contents of the Report. Prospective investors are encouraged to obtain separate and independent verification of information and opinions contained in the Report as part of their own due diligence. The value of securities and the income from them may fluctuate. It should be remembered that past performance is not necessarily a guide to future performance.

Dr David Davis has produced this report independently of the companies that may be named in this report except for verification of factual elements. Any opinions, forecasts, projections, or estimates or other forward-looking information or any expectations in this Report constitute the independent judgement or view of Dr David Davis who has produced this report (independent of any company discussed or mentioned in the Report or any member of its group).

The Report is being supplied to you for your own information and may not be reproduced, further distributed to any other person or published, in whole or in part, for any purpose whatsoever, including (but not limited to) the press and the media. The distribution of the Report in certain jurisdictions may be restricted by law and therefore any person into whose possession it comes should inform themselves about and observe any such restriction.

The Report has been prepared with all reasonable care and is not knowingly misleading in whole or in part. The information herein is obtained from sources that Dr David Davis considers to be reliable but its accuracy and completeness cannot be guaranteed.

Dr David Davis Certification

Dr David Davis attests that the views expressed in this report accurately reflect his personal views about BASF and Anglo Platinum. Dr David Davis does not hold any interest or trading positions in any of the Companies mentioned in the report.