

PLATINUM PERSPECTIVES

The palladium price is important for platinum investors

Palladium is a long-standing cost-effective alternative to platinum in gasoline car emissions control with a substitution ratio of 1:1. **Over 90% of mined palladium is produced as a by-product** and consequently its price should be based on the value-in-use of its best available alternative – platinum. Over 80% of palladium demand is automotive and high demand in the growing gasoline car and gasoline hybrid markets caused six consecutive annual palladium deficits. **The increased risk to automakers of insufficient palladium to manufacture cars is the likely driver of substitution by platinum.**

Market view: Palladium's recent strong price performance and upside potential – both argued as better than platinum – are based on palladium's perceived stronger supply/demand fundamentals.

Our view: We believe that the rise in the palladium price from levels around 50% of the platinum price to parity with platinum, while aided by deficits, is due to market recognition of the 1:1 (Pt : Pd) ratio in gasoline autocatalysis. In 2013 Johnson Matthey (JM) published a study confirming the change in substitution from 2(Pd):1(Pt) to 1:1 (table below). Growing automotive palladium demand, sustained deficits and a rising price boosted investor sentiment and positioning. This may be why **palladium's by-product status or substitution ratio were not examined or recognised as the price driver.** Recent ETF liquidation with price strength supports investor recognition of palladium's by-product attributes; almost zero cost of production, no supply response to price – up or down – and under 10% of supply from primary palladium mining.

Palladium and platinum price (\$/oz)



Source: Bloomberg

Market view: Palladium is unlikely to be substituted by platinum in gasoline autocatalysts any time soon.

Our view: Platinum is highly likely to substitute palladium in gasoline cars quite quickly, due to palladium supply concerns and not due to its price relative to platinum. Almost no additional cost is associated with design, 'retooling' or certification. In the 1990s c5Moz of palladium was substituted for platinum at a 2:1 ratio. The 2001 Russian palladium supply disruption saw Ford faced with being unable to produce cars; JM attributed c2Moz of palladium substituted back to platinum in the next 3 years (published retrospectively).

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Palladium is mostly a by-product of nickel and platinum production and has been a cost-effective alternative to platinum in gasoline emissions control for the past decade and a half

Johnson Matthey study test results in 2013 confirming Pt:Pd substitution ratio of 1:1.

Catalyst tested	Catalyst PGM content in g/ft ³			
	Total	Platinum	Palladium	Rhodium
A: Pd, Rh	30	0	25	5
B: Pt, Rh	30	25	0	5
Catalyst emissions in mg/km				
	Hydrocarbon (HC)	Non-methane HC	CO	NO _x
A: Pd, Rh	66	51	245	38
B: Pt, Rh	65	50	228	35

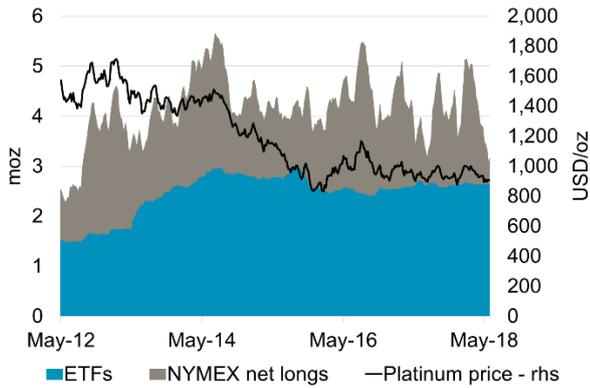
Source: Johnson Matthey: A Study of Platinum Group Metals in Three-way Autocatalysts, Platinum Metals Review, J Cooper & J Beecham, 2013,57,(4), 281-288, ©2013 Johnson Matthey, extracts from table V. <http://dx.doi.org/10.1595/147106713X671457>. Note: JM showed that simple washcoat changes to include platinum, after years of washcoat technology dominated by palladium, were easily achieved during the testwork.

Platinum in six charts – June 2018

We believe there are many reasons supporting consideration of platinum as an investment asset:

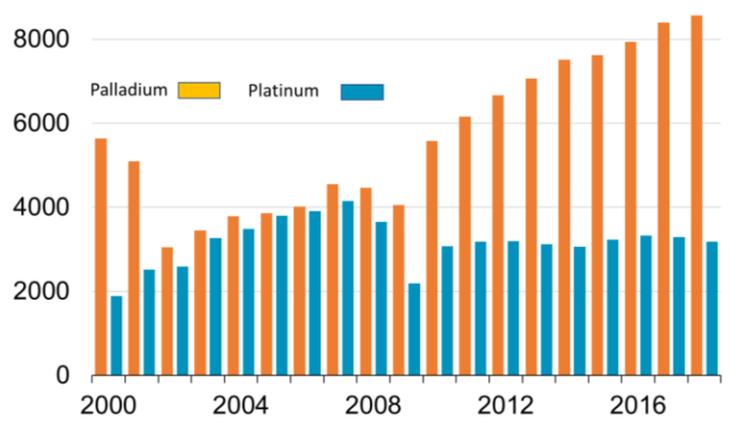
- Supply demand fundamentals are robust and ETF holdings are stable, despite price volatility
- Risks of supply declines are underestimated - cost pressure and falling mining investment continue
- Downside risks to platinum automotive demand are overestimated
- Futures positioning follows sentiment with high correlation to price
- Platinum is undervalued against its past, its production cost, and gold

Figure 1: ETF holdings stable despite price volatility; futures positioning & price correlated



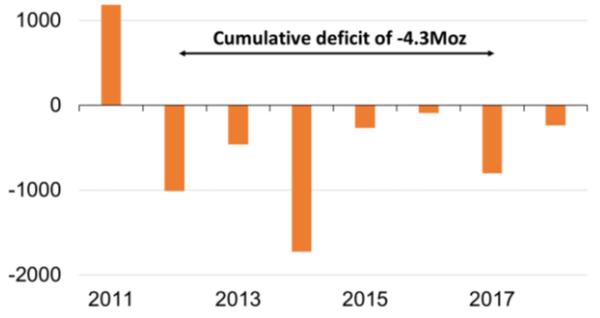
Source: Bloomberg, ETF providers, WPIC Research

Figure 4: Platinum and palladium automotive demand (koz) showing trends in use and substitution



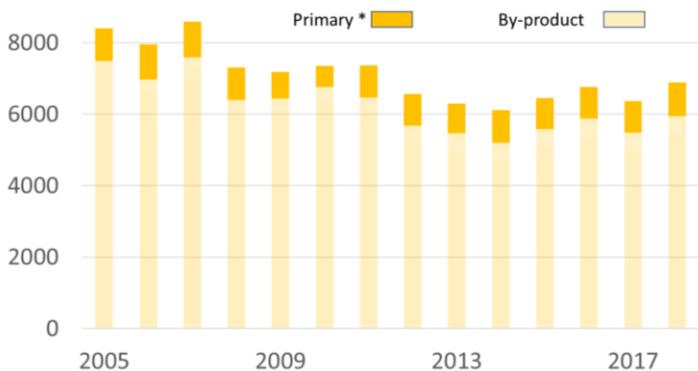
Source: Johnson Matthey

Figure 2: Palladium supply demand balance (koz)



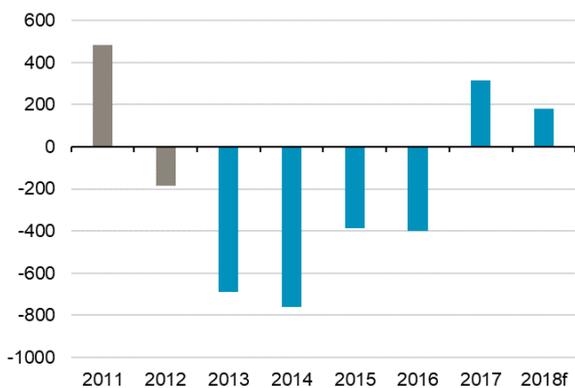
Source: Bloomberg, WPIC research

Figure 5: Palladium supply (koz): By-product production over 90% from Nickel in Russia and from Platinum in Southern Africa.



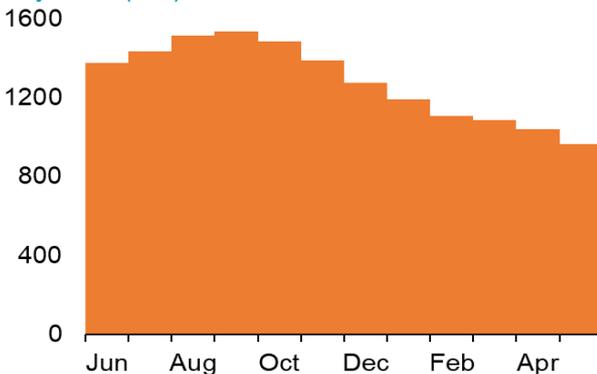
Source: Johnson Matthey * North America containing primary palladium and by-product from other base metals

Figure 3: Platinum supply demand balance (koz)



Source: Johnson Matthey, WPIC Platinum Quarterly Q4 2017, SFA (Oxford)

Figure 6: Palladium ETF holdings, month end, June 2017 to May 2018 (koz) – reduction of -570 koz in 8 months



Source: HSBC, ETF providers, WPIC Research.

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