

## Diesel autocatalyst systems with Selective Catalytic Reduction (SCR) use platinum too

The WPIC Q2'18 *Platinum Quarterly* noted the 12-year low platinum price. Many market commentators suggest the low price is due to the market surplus; however, this is only 4% this year. Uncertainty regarding the platinum demand impact of falling diesel car sales in Europe and platinum use in SCR systems is aggravating the situation. SCR systems on diesel cars are still often mistakenly believed to mean the diesel car does not use platinum in its emissions control system.

Systems to control emissions from internal combustion engines have become extremely complex over the past decade. In addition, the 2015 *Dieseldate* scandal heightened scrutiny of diesel NO<sub>x</sub> emissions, showing that millions of Euro 5 and 6 compliant vehicles (having passed an in-lab test emitting below 180mgNO<sub>x</sub>/km or 80mgNO<sub>x</sub>/km respectively), emit over 500mg/km in on-road testing; some as high as 1,400mg/km.

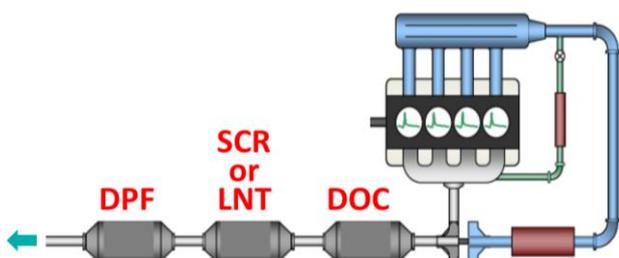
Catalysis by platinum, palladium and rhodium, combined with engine management and exhaust flow/filtering, reduces NO<sub>x</sub> (NO and NO<sub>2</sub>), carbon monoxide (CO), unburnt hydrocarbons (HC) and particulate matter (PM) emissions below legislated levels. However, simplistic categorisations to determine emissions levels or platinum content are no longer possible. Typically, higher metal loadings achieve lower emissions.

Diesel NO<sub>x</sub> emissions are mainly controlled using either Selective Catalytic Reduction (SCR) or Lean NO<sub>x</sub> Trap/ NO<sub>x</sub> Storage Catalyst (LNT/NSC) systems. SCR systems, now used in almost all heavy-duty diesel vehicles have been prolific for over a decade and are now increasingly being used in light duty diesel vehicles. Both LNT and SCR systems need PGMs to catalyse CO, HC and NO<sub>x</sub>: in an LNT system, NO<sub>x</sub> removal uses cycles in the fuel/air ratio while the SCR system injects ammonia (as liquid urea / AdBlue ®) to react with NO<sub>x</sub> which has passed through the diesel oxidation catalyst (DOC). The SCR system may also need an Ammonia Slip Catalyst (ASC), that also contains platinum, to prevent excess ammonia emissions.

For a diesel car to achieve in-lab NO<sub>x</sub> emissions of 80mg/km, an LNT system using 10g of platinum could be replaced with an SCR system using 8g of platinum and less than 0.6 litres of AdBlue per 1000km.

When the in-lab Euro NO<sub>x</sub> level was reduced from 180 mg/km (Euro 5) to 80 mg/km (Euro 6), platinum loadings increased by between 10% and 40%; heavily dependent on system and vehicle performance choices. To reduce on-road emission of NO<sub>x</sub> from over 500mg/km to below 100mg/km, loading increases of platinum in an aftertreatment system are likely to be significant (note that recent diesel vehicles sold show AdBlue dosing at over 1.6 litres per 1000km, compared with the 0.6 litres above).

### *Stylised diesel emissions control configuration schematic*



Source: Oak Ridge National Laboratory, US DoE, DPF: Diesel Particulate Filter, LNT: Lean NO<sub>x</sub> Trap, SCR: Selective Catalytic Reduction, DOC: Diesel Oxidation Catalyst

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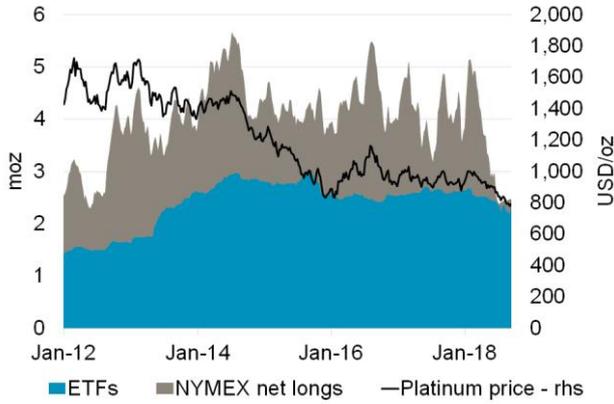
***Diesel autocatalysis using either LNT or SCR technology, to control NO<sub>x</sub> emissions specifically, requires platinum. Platinum loadings will need to be much higher to achieve low on-road NO<sub>x</sub>.***

# Platinum in six charts – September 2018

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

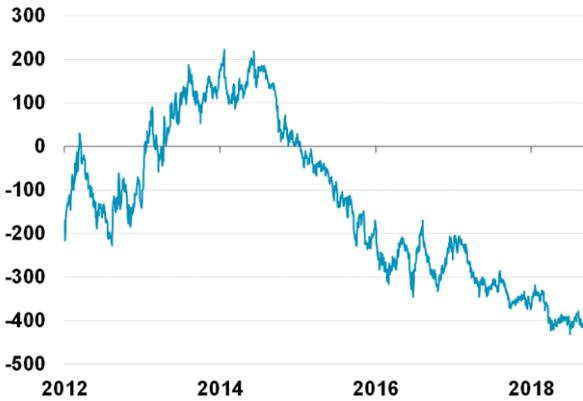
- Supply demand fundamentals are robust and ETF holdings are stable, despite price volatility
- Risks of supply declines are underestimated - cost pressure and falling mining investment continue
- Downside risks to platinum automotive demand are overestimated
- Futures positioning follows sentiment with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

Figure 1: ETF holdings stable despite price volatility; correlation between futures positioning and price



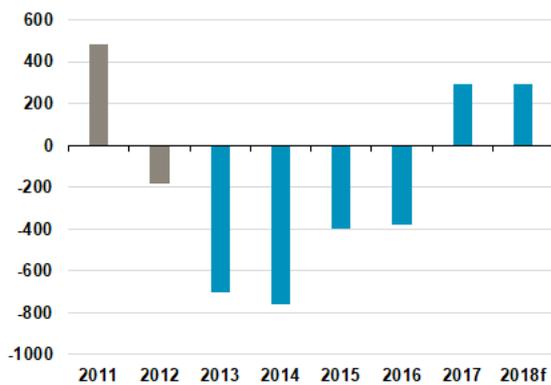
Source: Bloomberg, ETF providers, WPIC Research

Figure 2: Platinum discount to gold at an all-time high of c\$400/oz



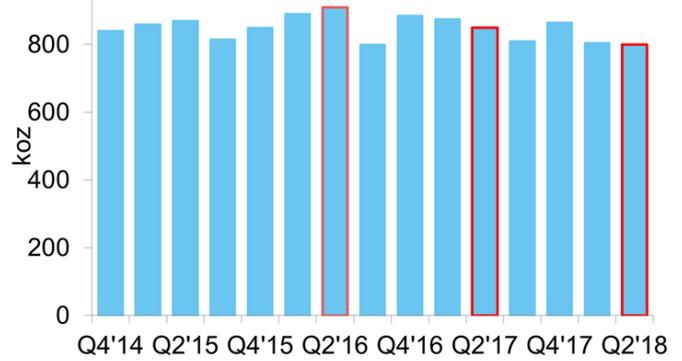
Source: Bloomberg, WPIC research

Figure 3: Platinum supply/demand balance (koz)



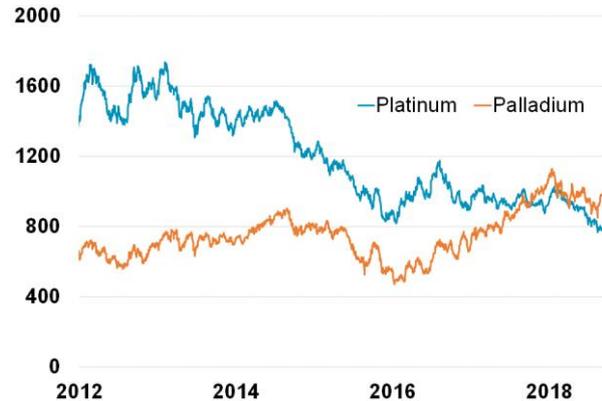
Source: Johnson Matthey, WPIC Platinum Quarterly Q2 2018, SFA (Oxford)

Figure 4: Automotive demand being impacted by falling European diesel car sales (koz)



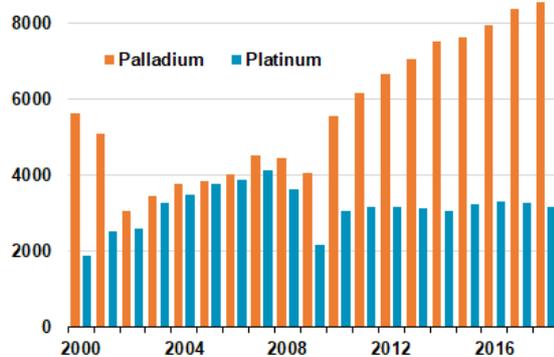
Source: WPIC Platinum Quarterly Q2 2018, SFA (Oxford)

Figure 5: Pt:Pd substitution ratio in gasoline cars of 1:1 drove price parity (90% of mined Pd is by-product) (\$/oz)



Source: Bloomberg

Figure 6: Platinum and palladium autocatalyst demand (koz) showing trends in use and substitution



Source: Johnson Matthey

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