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The Samaritan in your exhaust

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Sometimes we know nothing about everyday things. Particularly when they are hidden from view. But when their mechanics are decoded for us, it imparts a new appreciation for them and arms you with information that'll make you more interesting in conversation. This is especially so when that information is relevant to the most topical investment in the SA market. So, let's get to know the autocatalytic converter tucked away in your exhaust system, and why it matters for those precious metals known as palladium and platinum.

A debt to Mr. Houdry

If you drive a car, run a generator, pilot a forklift, operate mining equipment, steer a bus, wrestle a truck, lead a locomotive, or man a motorcycle, you burn fuel. As fuel combusts to produce the heat that gives your vehicle kinetic energy, some rather nasty gases result:

1. Carbon monoxide (poisonous to pretty much every animal including us)
2. Hydrocarbons (dangerous to our central nervous system)
3. Nitrogen oxides aka NOx gases (causes smog, acid rain, and is a global warming contributor)

Don't sink too low though; there's a Samaritan in your exhaust that saves you from polluting a polluted earth. It's called an autocatalytic converter and it reduces the impact of these harmful emissions as they pass through that pipe under your car. This truly altruistic invention comes to us complements of a Frenchman by the name of Eugene Houdry (1892-1962).

How do they work?

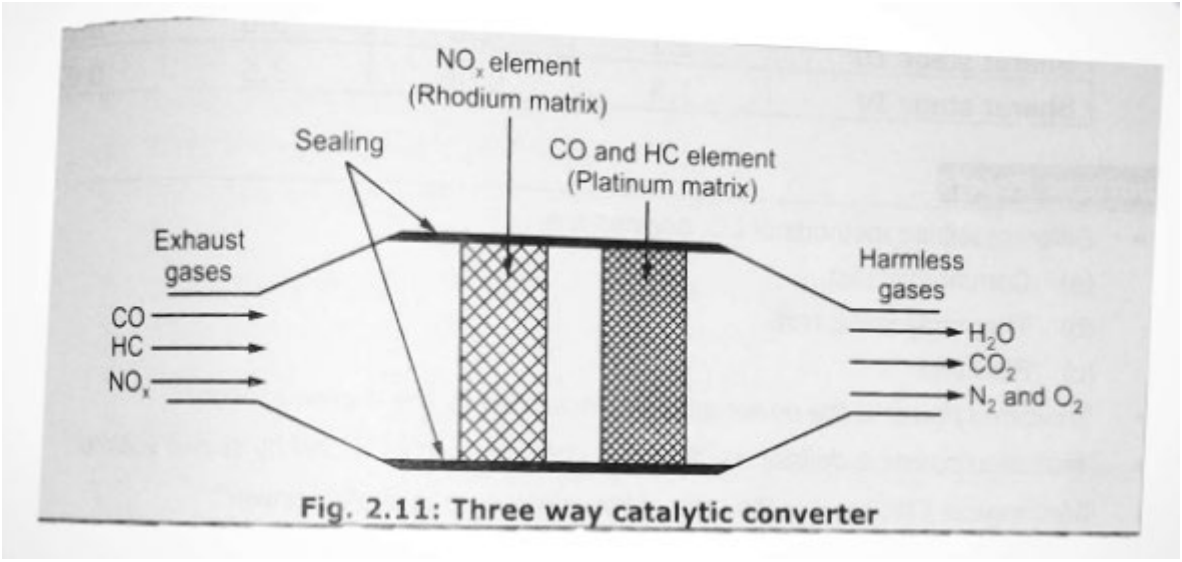


Fig. 2.11: Three way catalytic converter

Source: www.slideshare.net/NayanGaykwad/catalytic-converter

Inside catalytic converters of today is a ceramic honeycomb structure. The small, porous squares that comprise the honeycomb are coated with platinum group metals (PGM's). When the harmful gases flow through the converter, they react chemically with these precious metals, defusing the dangerous air.

There are two types of converters. A **'three-way'** (not that kind) neutralises carbon monoxide and hydrocarbons through *oxidation* (the adding of oxygen) to produce carbon dioxide (what the trees eat) and water vapour. Then, it uses a separate chemical reaction called *reduction* to turn the formidable-sounding NOx gases (nitric oxide and nitrogen dioxide) into harmless nitrogen molecules. Most of today's petrol cars employ three-way converters.

The **'two-way'** format transforms carbon monoxide and hydrocarbons into carbon dioxide, just like the three-way. But it doesn't deal with NOx gases. These inferior converters are used in diesel models where *reduction* doesn't work because of the high oxygen (O_2) content in diesel exhaust fumes.

The effectiveness of any catalytic converter is dependent on multiple, precariously balanced variables. For example, they must reach 400 degrees Celsius before they start to react with, and nullify, dangerous emissions. Indeed, during in the first 2-3 minutes of driving, your exhaust fumes are toxic.

Hybrid vehicles of the future will need some clever engineering – or heavier precious metal loadings – to keep their converters hot, and therefore effective, while switching between combustion and electric drive modes.

The PGM players

To facilitate the *oxidation* and *reduction* chemical reactions, the honeycomb structure must be coated with specific precious metals. Palladium or platinum (substitutable) are used in the *oxidation* process, which takes place in both three and two-way converters. The use of rhodium is reserved for the three-way converter where *reduction* is used. Rhodium is best equipped – 7 times more so than palladium – to deal with NOx gases and is considered irreplaceable by those who build catalytic converters.

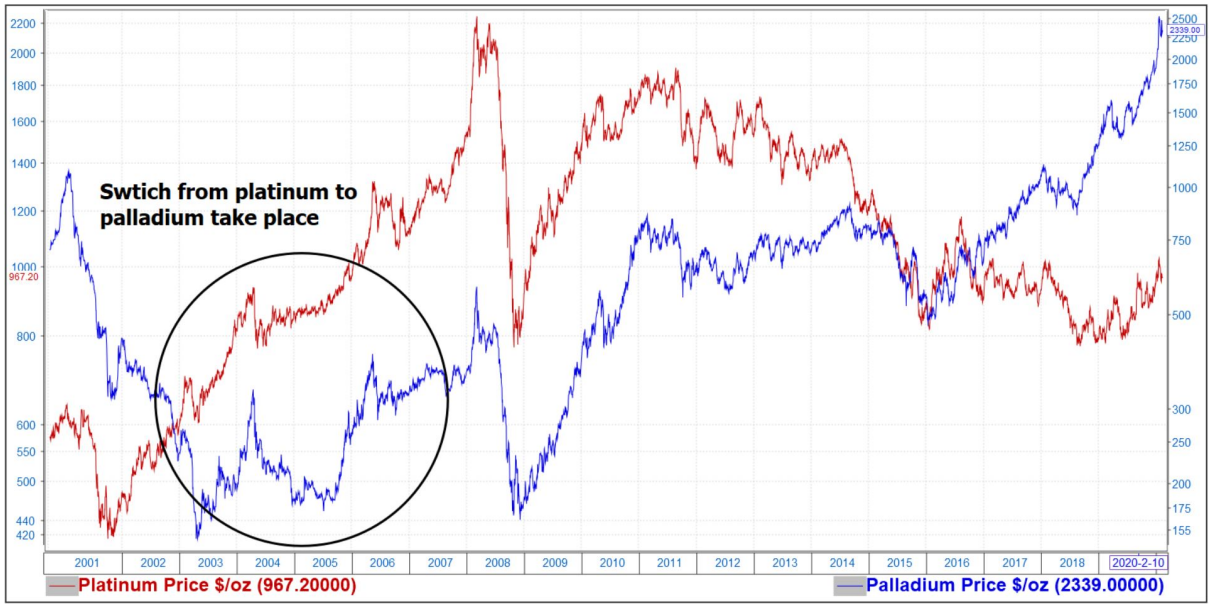
While rhodium is a fascinatingly volatile metal as far as its price goes, up from $600/oz in 2016, to $10,000 today, it makes up a relatively small amount of PGM production. In a good year, about 30,000 tonnes will be produced versus approximately 200,000 each of palladium and platinum. This means the market for rhodium is thin and dangerous to trade. Platinum and palladium, however, are very much investable assets.

So, we turn to the following questions; why has palladium been so strong; can platinum catch up; and what are the prospects for the PGM basket as a whole?

Why the palladium price power?

Roughly 80% of all palladium supply is usurped by the auto industry. That number sits at about 50% for platinum, industrial applications and jewellery making up the balance. Palladium's prodigious price progression is unquestionably a result of it being the preferred catalyst for use in converters. Has it always had this pleasure?

No. Platinum was the favoured catalyst in the 2000's, but eventually the price of palladium became too attractive on a relative basis and car manufacturers began to retool their production lines to use cheaper palladium instead. Fast forward and we now have the opposite dynamic at play with palladium at $2,400/oz versus platinum at $1,000/oz.



Source: INet, Obsidian Capital, February 2020

If car manufacturers were to switch back to platinum, the cost of precious metal per converter would moderate from between $200-$500 to between $70-$200, depending on the size of the vehicle. Sounds like easy money. Given that platinum and palladium are good substitutes for each other, why aren't they chopping and changing? Well, there are a few reasons.

Retooling

Replacing palladium with platinum is not like swapping a black and white ink cartridge for a colourful one. When the initial switch was made from platinum to palladium in the 2000's, it required a large investment of time and capital from the manufacturers. They would need to do the same again.

In addition, palladium has better thermal stability than platinum under typical petrol exhaust temperatures, so technological improvements would also need to be made (to utilise platinum) in order to cope with the hotter temperatures expelled from modern day engines. Side note, sintering, an onomatopoeic delight, is where heat causes the palladium/platinum particles to clump together inside the honeycomb, reducing surface area and undermining the efficiency of the catalyst; platinum is more susceptible to sintering than palladium.

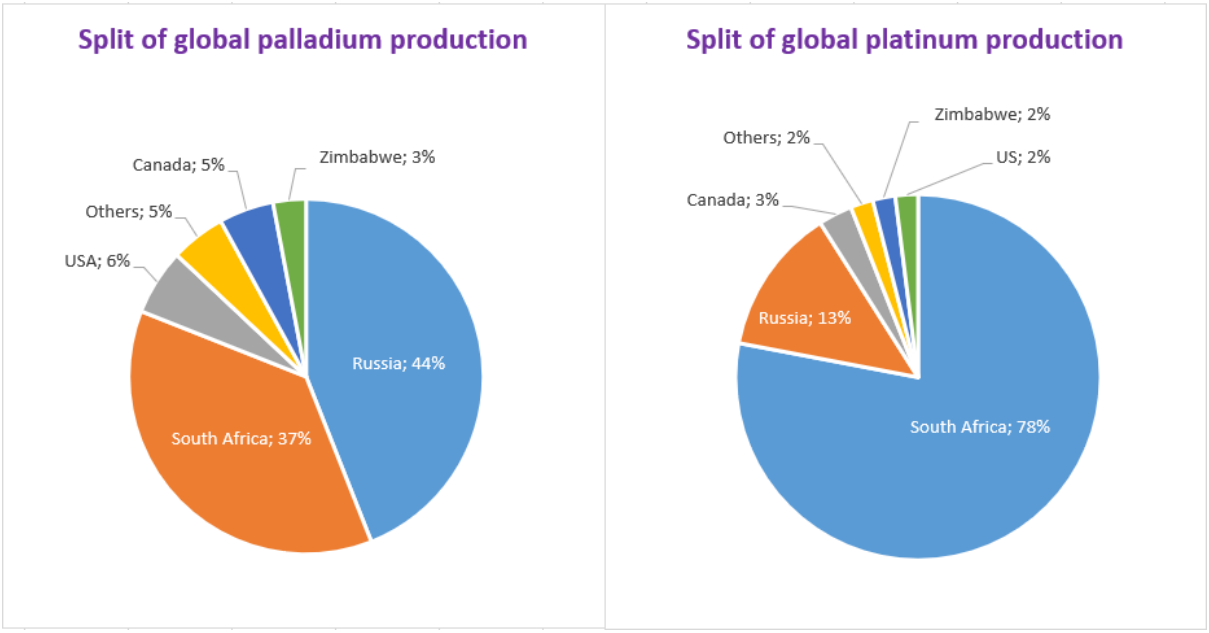
Back to the issue of substitution. To quote a recent exert from a PGM report from Johnson Matthey – a company who builds catalytic converters – "Looking forward, there may be near-term potential to replace some palladium with platinum in the light duty diesel sector. Substitution in gasoline (read petrol) three-way catalysts will take longer to achieve and will require significant improvements in technology. Any meaningful substitution is likely to take two to three years".

Priority

The regulatory environment today is also very different to the last time substitution took place. The onerous vehicle emission standards that Europe, the UK, and China are implementing – and the severe fines for not obeying them – demand the attention of car manufacturers. Given the stakes, the marginal dollar is probably better spent on trying to fast track hybrid and electric vehicles into their product mix, rather than trying to save a few hundred dollars per car by reconfiguring their catalytic converters to use platinum instead of palladium.

Geographic supply

Another dynamic supporting the continued use/rise of palladium, rather than platinum, stems from the geographical concentration of supply. As you can see in the pie charts below, Russia and South Africa account for 80% of the world's palladium production. Contrast this with platinum where nearly 80% comes from one country, being us.



Source: US Geological Survey, usgs.gov

Now, if you're a car manufacturer concerned with the reliability of supply, then palladium makes more sense because they can tap either Russia or SA, whereas for platinum they are wholly reliant on SA. And with shaft closures, the perennial threat of strike action, and the fact that our power keeps going out (which reduces output from our mines), you can't blame them for not putting all their eggs in our basket – which is what they'd do by going back to platinum.

Any hope for platinum?

Without wholesale substitution taking place, are then any levers that might get pulled to increase the demand for platinum? We touch on three below.

Diesel

Perhaps the most impactful would be a resurgence in demand for diesel cars. The VW scandal in 2015 denuded the de facto diesel emissions, which turned out to be worse than originally thought. The same was true of many other diesel brands. Demand for these vehicles has fallen precipitously as a result.

The difficulty with diesel engines is that their exhaust gases have more O_2 and are cooler than those in petrol engines. As a result, the *reduction* reaction (which breaks nitrogen oxides into nitrogen and oxygen) isn't possible. Their failure to deal with the NOx gases is problematic in the context of tightening emission standards and the righteous furore over global warming.

Diesel car manufacturers are confident that the newer models (equipped to handle NOx) are now compliant with emission standards. But the consumer, who will be taxed on their cars if they aren't, doesn't seem to have the confidence to buy. Uncertainty around resale value is a plausible contributor to their hesitancy. Diesel cars now account for just 24% of the UK car market after being at parity with petrol two years ago.

Lastly, India and China will shortly implement much stricter emission standards for heavy duty diesel vehicles (think trucks and yellow equipment). Manufacturers will be forced to load their respective catalysts with up to three times more platinum than they used in the past.

Fuel Cells

Unlike a battery – the other potential power source for electric vehicles – fuel cells need no recharging and will run indefinitely when supplied with fuel. The cells produce electricity by combining hydrogen (the fuel) and oxygen (from air) over a catalyst like platinum. Fuel cell cars will need anything between 15-30 grams of platinum; that's a chunk of metal compared to the 3-7 grams that urban combustion vehicles use in their converters.

The amount of platinum used in fuel cells is growing at a double-digit pace. But until the cost of producing these cells moderates, rendering them competitive with batteries, platinum used in fuel cells will remain a decimal of total platinum demand.

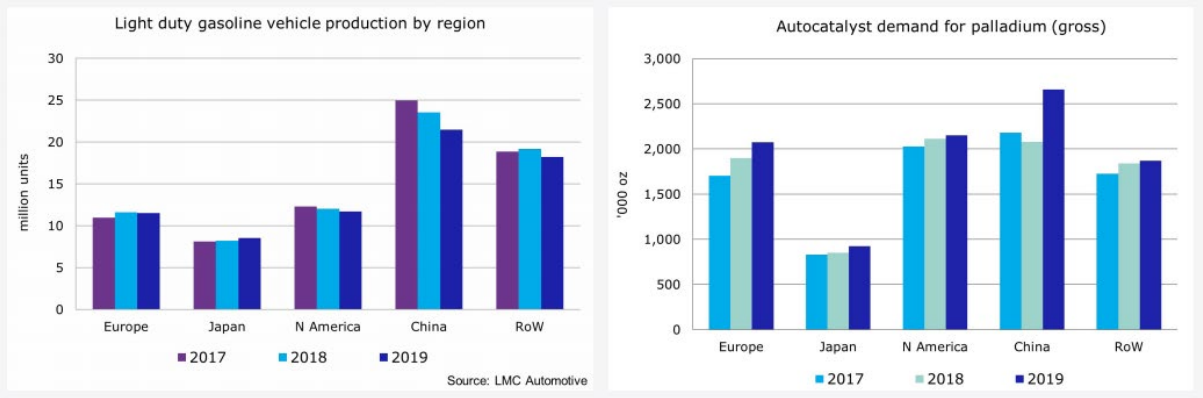
Investment

The platinum market went into deficit in 2019, not on the back of auto, industrial or jewellery demand, but on investment appeal. Investors bought 1,1 million ounces of platinum in 2019. With the price of palladium having run so hard, they are betting on platinum catching up. With the dollar differential still very wide between the two metals, investors may continue to plough this trade. But don't expect fireworks in the platinum price based off this alone.

Supply constraints reinforcing the PSG basket

Making a call on whether palladium or platinum perform best from here is difficult. The palladium price has run very hard and, purely on the balance of probability, it may be due a pullback. But at the same time, it's very difficult to get sight of when substitution will start to take effect in a meaningful way, or whether diesel vehicles will come back into vogue, or if/when fuel cells will become commercially viable – all of which would help the platinum price.

The big picture is that the demand for PGM's in the autocatalytic converter industry is a given if the trajectory of vehicle emission standards continues. It is important to note that the 14% increase of palladium used in the auto industry in 2019 happened in the face of *falling* vehicle production. What might palladium demand look like in 2020 if vehicle production was to increase?



Source: Johnson Matthey February 2020 PGM Report

On the other side of the equation, supply remains inelastic, even in the face of prices well above what's called the 'incentive' level. The reason for this is twofold.

First, the capital expenditure and lead times required to bring more PGM supply online are significant. There is also psychological scarring to overcome; remember, many of these miners flirted with bankruptcy in 2015 due, in part, to their over capitalisation during the commodity super-cycle that ended in 2008. This is a mistake they won't want to make again.

And second, EU and UK legislators are calling for the complete removal of combustion engines by the 2030's. If you're a miner, would you pump money into the ground knowing the first ounces of platinum or palladium will only reach the surface in an electric vehicle future?

The irony is clear. A threat of a future collapse in PGM prices is fuelling the boom in current prices.

Conclusion

Autocatalytic converters are required to balance the global desire to own a car with the urgent need to reduce the negative impact our species is having on the earth's ecosystems. Palladium and platinum are the two investable metals that will play a significant part in achieving this equilibrium. As things stand, palladium is in the driver's seat, so to speak, and the road is stretching out in front of it.

But no matter which precious metal ends up in your converter, you now know how your car uses them and why. You also know that the next car you buy will probably have more catalyst than your last, even though it's becoming harder and more expensive to source. And if you want to invest in platinum or palladium, you largely know what drives their prices – pun intended.

Glacier Research would like to thank Warren Kelly for his contribution to this week's Funds on Friday.

Warren Kelly, Investment Professional

Warren graduated from UCT with a B.Bus.Sci in Finance. His early career experience was as a business analyst in the FMCG and hospitality industries where he focused on improving company profitability. He joined Obsidian Capital in March 2014. Warren heads up Obsidian's business development and marketing function, part of which involves providing a window into the thinking of the investment team. Warren is married, has two children, enjoys running, reading, and travelling, and is increasingly drawn to the study of human psychology.