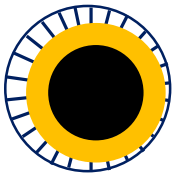
Forecasting platinum supply and demand

January 2016



Glaux Metal

Executive Summary

The following report was commissioned by the World Platinum Investment Council (WPIC) to explore the current fundamental state of the platinum market and the outlook for this market over the next six-year period. The contents of the report, including the forecast figures themselves and the views contained, are independent and entirely my own[1].

It is widely thought that supply and demand fundamentals of commodities are relevant to their longer-term price formation with their impact on price movements in the shorter term perhaps less relevant. This report examines historical supply and demand trends to gain some understanding of the current situation and forecasts these in order to give an independent view for supply and demand through to 2021.

The report concludes that the platinum market is likely to be in deficit for each of the years from 2016 to 2021 at an average annual deficit of roughly 250,000 ounces, an imbalance that should help drive higher metal prices over this timescale.

This report asserts that mine supply in 2021 is likely to be close to today's level (at a forecast 5.91 million ounces in 2021 versus 2015's estimated 5.96 million ounces) with the potential for more downside risk to the production forecast than upside potential. The analysis highlights the challenges associated with raising primary supply in the current environment of political complexity in key producing countries, low prevailing metal prices and the impact of sustained price weakness over the past six years. However, with recycling set to grow as a percentage of overall supply, there is a reasonable likelihood that overall platinum supply will edge higher over this period.

If we consider primary and secondary supply together, then the growth in recycling suggests that total platinum supply could grow at a compound annual growth rate (CAGR) of between 1.1 and 1.2 per cent between 2015 and 2021 if metal prices rebound sufficiently to prevent further cuts in mine production from taking place.

On the demand side of the equation, this report identifies the key areas for current and future demand. Based purely on historical trends, platinum demand should be expected to remain relatively flat or rise marginally over the next five years. However, four factors will also impact demand over the next five years: the impact of overall global economic growth, any increase in the requirements for platinum from existing applications, the continuing process of thrifting of metal content in existing applications and the development of new end uses for this metal.

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1 Glaux Metal is the trading name for the independent research of David Jollie in the precious metals sector. Dr. Jollie has over eighteen years' experience of the precious metals sector in a range of roles from R&D to market research. He previously wrote Johnson Matthey's market-leading reports on the platinum group metal sector from 2006 to 2010 before leading Mitsui & Co. Precious Metals' research on the same sector from 2010 to 2015.

This report asserts that global economic growth should be strong enough to drive demand from roughly 8.1 million ounces of platinum in 2015 to an estimated 8.63 million ounces in 2021, at an estimated CAGR of close to one per cent, driven primarily by increased automotive demand as car manufacturers look to meet ever-tightening emissions targets. In my view, this growth should be relatively insensitive to metal prices over the longer term although shorter term price movements might affect demand in any given segment in a specific year. There is also scope for further growth in demand in the investment and jewellery sectors in particular over the time period covered by this report, providing an asymmetric upside risk to demand.

Overall, this report sees platinum remaining in a modest yet significant deficit for each year through to 2021, a scenario that supports a bullish price forecast over the same period.

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Introduction

During the last few years of widespread commodity weakness, there has been much debate over whether an understanding of commodity fundamentals allows investors and other market participants to forecast price movements more accurately. Over the longer term higher prices generally tend to dampen demand and lower prices tend to stimulate it, while prevailing prices also have a longer term impact on mine production. Viewed from the opposite perspective, market deficits will, over the long term, tend to strengthen prices while surpluses generally help to weaken metal prices. Other factors are, of course, also relevant in price formation over the longer term, from exchange rates to technological developments but I remain confident that a fundamental understanding of precious metal markets provides a valuable foundation on which investors can build in order to make informed investment decisions.

Historical background

To understand the future for platinum, one should look first at the shape of this market in recent years. Fortunately, we have a range of published sources which we can examine for this purpose: Thomson Reuters GFMS, Johnson Matthey, Metals Focus and WPIC have all released data giving their views on the scale of supply and of demand in the platinum market, with the first two organisations providing over ten years of data.

Looking first at Johnson Matthey (JM), it recently reported that, according to its estimates, mine supply fell from 6.05 million ounces in 2010 to 5.80 million ounces in 2013 (for the purposes of this analysis, I have excluded supply side estimates for 2014 since mine production was hugely negatively affected by the widespread strike action that took place in South Africa in the first part of that year). It forecast a similar level of mine sales of platinum in 2015 to that seen in 2013. Over the same time period, JM reported a roughly ten per cent increase in the weight of metal recovered from recycling annually from 1.83 to 2.02 million ounces.

On the demand side, 2013 figures were boosted by extremely strong investment flows and very healthy Chinese jewellery purchasing. Looking at the trend from 2010 to 2014 but excluding 2013, JM reported that gross demand for platinum climbed modestly, rising from just under 8 million ounces of metal to just above that round figure.

According to GFMS, which uses slightly different definitions to those used by Johnson Matthey and has not published a value for 2015, mine production of platinum slipped from 6.18 million ounces in 2010 to 5.95 million ounces in 2013; interestingly this was almost a tenth lower than it had been a decade earlier. At the same time, they estimate that recycling climbed from 1.42 to 1.57 million ounces, a slower increase than many in the market might have expected.

On the demand side, GFMS estimates that gross demand for platinum was fairly steady, rising only from 7.17 million ounces in 2010 to 7.28 million ounces in 2014, although this was substantially lower than it had been a decade earlier. Although a protracted mining strike left the platinum market in deficit in 2014, the cumulative balance in the other years (2010 to 2013) was a surplus of roughly 1.05 million ounces.

Unlike Johnson Matthey, GFMS does not define net Exchange Traded Fund (ETF) purchasing as a form of demand but treats it instead as one component of the movement of market stocks. If this is included in demand (as I believe it should be), then this results in a combined deficit of roughly 800,000 ounces from 2010 to 2013. Analysis of Johnson Matthey's figures, shows a combined deficit of roughly 600,000 ounces for the same period, suggesting that the market has been somewhat undersupplied in general in a typical recent year.

Although I see 2013 and 2014 as anomalous years in terms of the overall supply and demand balance, adding these to the preceding four years, gives a more meaningful cumulative deficit of almost 2.5 million ounces of platinum based on the Johnson Matthey approach. These cumulative platinum deficits have been met each year by either the reduction of producer, fabricator and consumer inventories or sales from unpublished investor holdings. I believe the dominant source since 2012 has been the latter. (It is worth noting that since late 2014 WPIC has published estimates of the size of vaulted investor stocks from the end of 2012.)

Differences between the historical models

Examining the estimates of these organisations, and my own models, for supply and demand in detail reveals a number of discrepancies, which, as expected, reflect any error margins in measurement and the relative areas of competence for each. However, all tell a similar story of a platinum market which is in a relatively modest fundamental deficit. Both point to a market where primary supply of platinum is shrinking, although this has been largely offset to date by growth in end-of-life recycling from the car industry and elsewhere. Likewise, indications are that demand has risen gently over this period. If these trends continue, we should expect the platinum market to remain in deficit, on average, over

the next few years, and for the scale of this deficit to start to climb. So, what should one expect to happen to supply and demand over the next few years?

THE SUPPLY AND DEMAND OUTLOOK

Mine supply over the medium term

South Africa is and will remain the most important producer of platinum. The bulk of world platinum reserves and production come from the Bushveld Complex, north of Johannesburg, and this will certainly remain the case over the medium term (which we interpret as the next six years for the purposes of this report). Here, platinum is generally the most valuable metal produced in terms of value although a range of other platinum group metals is produced too, alongside base metals such as chrome, copper and nickel.

The historical performance of the South African mining sector over the last decade gives us some strong clues to what might happen over the next few years. Looking back a decade or so, there were widespread plans amongst the platinum mining companies to grow their South African output. Large amounts of capital were expended but there was little to show for this in terms of increased mine output. Indeed, many of the older mines showed their age, with mining efficiencies dropping at first generation mines. Together with constraints on power and water availability, labour issues and other problems facing the industry, this makes it clear that, even in a positive economic environment (i.e. if prices were to rally strongly and/or the Rand were to further weaken significantly) there is no realistic likelihood of South African mine supply growing meaningfully over the next six year period.

Instead, faced with a low spot price for platinum and their other mineral by-products, the major producers have slashed capital expenditures. Numerous projects have been delayed and scaled back and further cuts and disposals are expected, while falling capex has hit and will continue to hit output at mines which are currently producing. My belief is that prices are likely to rebound over this period and that further cuts may be limited in scale but there is certainly potential for more cuts to be seen and for mine output to fall further if spot prices remain below $1,000 an ounce for an extended period of time.

There are, of course, some plans for new mines, although challenging operating and economic conditions have the potential to delay these further. Three entirely new major mines are currently expected to come onstream within our forecast period, at Ivanplats, the Western Bushveld Joint Venture and Wesizwe. My model assumes that these mines will be built and will come into production but any delays in these or other projects would likely mean that platinum production from South Africa would decline over this time period.

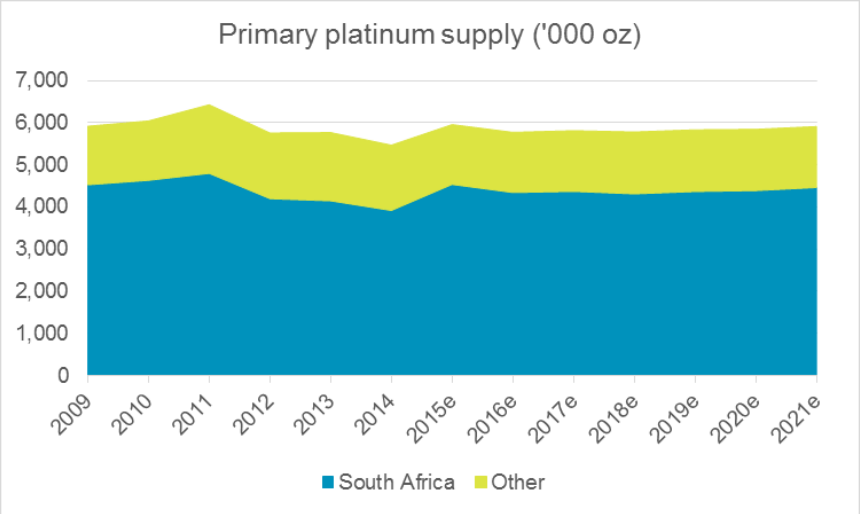

Figure 1: It seems unlikely that primary supply of platinum will rise above 2015 levels before 2021 with low capital investment levels and long lead times posing some downside forecast risk.

Source: Johnson Matthey, Glaux Metal

Zimbabwe also holds some potential to be a more meaningful producer of platinum over the longer term. However, a complex political and operating environment makes it unlikely that any significant additional investment will be made in the platinum mining sector there in the next few years. Instead, we expect production to rebound gently as the Bimha mine returns to full production, and then to remain close to 400,000 ounces of platinum per year.

Elsewhere, platinum is typically produced as a by-product either of palladium, or of nickel. The price of palladium has retreated some forty per cent from its mid-2014 highs and some of the mines producing palladium as their primary product have already announced minor planned cuts at their operations, which will result in lower platinum production on this timescale.

The decline in the price of nickel has been even more dramatic, from close to $30,000 a tonne in 2010 to its current levels of closer to $8,000. So far, there have been relatively few closures of nickel mines but we would expect capital expenditures to fall and end-of-life mines or more marginal projects to be closed or halted in the next two to three years. Even if the nickel price were to rebound, we do not see any likelihood of platinum output from nickel mines increasing on this timescale.

Overall, then, our forecast *(Figure 1)* shows mine supply in 2021 at close to today's levels but we feel that there is more downside risk to our production forecast than upside potential.

Secondary supply to 2021

Given the high monetary value of platinum (even at current prices) it is widely recycled, whether from end-of-life scrap, old jewellery or by industrial users. Although the trajectory and absolute level of the platinum price do have an impact on secondary flows of metal in the short term, this metal will eventually return for recycling and reuse at some point. Cumulative flows are therefore rather insensitive to price and we can therefore be relatively confident in forecasting overall recycling volumes on average.

Although there has been no growth in primary supply of platinum in the last five years, according to Johnson Matthey's most recent market report (November 2015), so-called open loop recycling of platinum climbed from 1.83 million ounces in 2010 to 2.06 million ounces in 2011 before then remaining stable over the next few years (with weaker prices resulting in lower recycling flows in 2015, as the catalyst collection industry held onto stock in the hope of a price recovery: we believe that this stock build will be reversed in 2016). Most of this metal is recovered from end-of-life automobiles.

I confidently expect platinum recoveries to rise further over the medium term. Gross platinum use by the automotive sector peaked at over four million ounces in 2007 and the typical life cycle distribution of a new car means that we expect total platinum recovery from this source to increase over the next five years, adding perhaps another half million ounces to supply in the final year of this medium term forecast, although growth in recycling flows is likely to slow towards the end of the decade, regardless of metal price movements *(Figure 2)*.

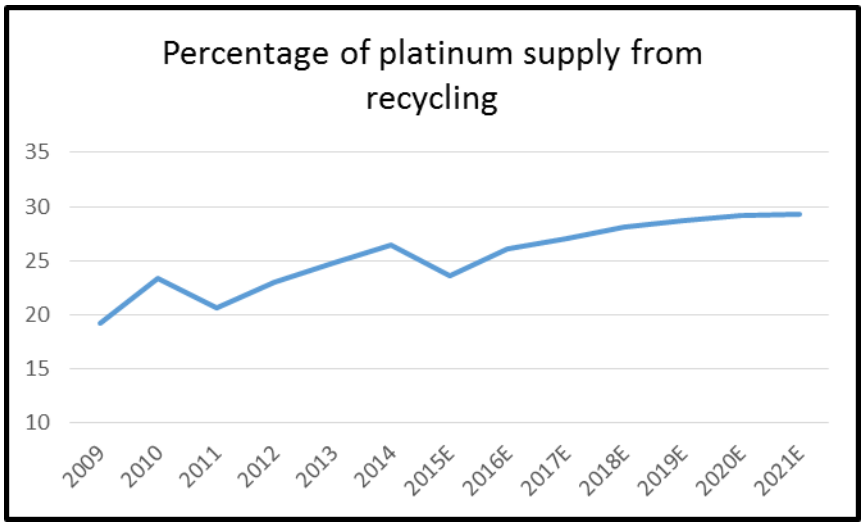

Figure 2: Platinum reclaimed from end-of-life recycling has become an increasingly important source of supply and is expected to continue increasing over the forecast period.

Source: Johnson Matthey, Glaux Metal

If one considers primary and secondary supply together, then this growth in recycling suggests that total platinum supply could grow at a CAGR of between 1.1 and 1.2 per cent between 2015 and 2021 if metal prices rebound sufficiently to prevent further cuts in mine production from taking place.

The future development of demand

Assuming that historical trends in platinum demand have any relevance to the immediate future, then we should expect platinum demand to remain relatively flat or to rise marginally over the next five years, having done so over the last five years. If we choose to view platinum demand from a high level, we must look at four additional factors: the impact of overall global economic growth, any increase in the requirements for platinum from existing applications, the continuing process of thrifting of metal content in existing applications and the development of new end uses for this metal.

My forecast *(Figure 3, next page)* is that global economic growth should be strong enough to drive demand from roughly 8.1 million ounces of platinum in 2015 to an estimated 8.63 million ounces in 2021, at an estimated compound annual growth rate (CAGR) of close to one per cent. In our view, this growth should be relatively insensitive to metal prices over the longer term although shorter term price movements might affect demand in any given segment in a specific year.

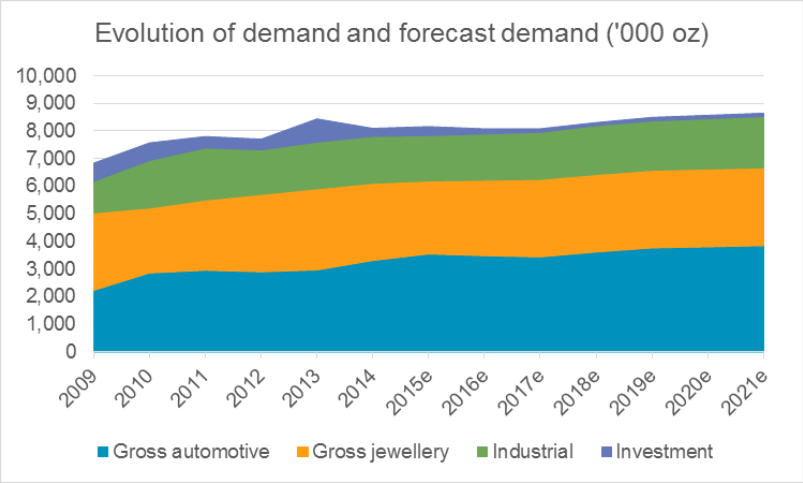

Figure 3: Although most growth is expected to come from the automotive market over the next six years, demand elsewhere seems set to rise too.

Source: Johnson Matthey, Glaux Metal

However, looking at demand for this metal, it readily breaks down into four segments which can sensibly be assessed independently to give us a better understanding of the supply-demand balance for platinum: automotive, jewellery, industrial and investment.

Automotive demand

The use of platinum in the automotive sector, almost all of it for emissions control catalysts, has accounted for almost 40 per cent of total platinum demand since the start of the decade. During that period, platinum has only been used to a limited extent in catalytic converters fitted to new gasoline-fuelled vehicles, with the cheaper and equally effective combination of palladium and rhodium widely used instead.

However, platinum is used in the catalysts or other aftertreatment technologies fitted to almost every diesel-fuelled vehicle manufactured globally. According to Johnson Matthey's November 2015 market report, 2.25 million ounces of platinum was expected to be used on light duty diesel vehicles in 2015, with some 520,000 ounces used on heavy duty trucks and a further 205,000 ounces used on "non-road" vehicles including construction vehicles. In contrast, a total of only 485,000 ounces of platinum was forecast to be used on gasoline cars and motorbikes, a figure which we believe is falling as improving gasoline fuel quality makes the use of cheaper palladium more attractive.

Platinum demand in the wider automotive sector is therefore quite reliant on the health of the diesel sector. Looking first at heavy duty trucks, the financial advantages of using more efficient diesel engines rather than gasoline technology means that diesel remains almost entirely dominant. A growing world economy should mean that more vehicles will be produced in five years than is the case today. A growing popular and governmental focus on the environment means that ever-tighter emissions rules are being implemented around the world, meaning that emissions aftertreatment becomes ever more complex. With most of these technologies being reliant on platinum, heavy duty diesel demand for platinum could more than double over the next five years.

The outlook for the light duty, or passenger vehicle, sector is more complex. New emissions rules will make diesel cars cleaner in Europe (where the vast majority are manufactured and sold) and will require more complex emissions aftertreatment. I am confident that this will result in an increase in the price premium of a typical diesel vehicle over its gasoline equivalent, with the diesel engine losing some market share as a result. However, it will also require additional use of platinum per car or truck and, with the European car market now growing once again, this could actually lead to additional demand for platinum overall.

In the shorter term, however, we do see some potential for a drop in platinum consumption in this specific sector. The recent scandal over the diesel emissions of some cars manufactured by the Volkswagen group has resulted in lower product availability in North America as some cars were pulled from sale and has hurt consumer and regulator confidence in diesel technology more generally. However, there is clear evidence that diesel vehicles can meet today's and tomorrow's tight emissions rules and can play an important role in helping the car manufacturers meet their carbon dioxide or fuel efficiency targets cost-effectively. Accordingly, I believe that the market share of the diesel car is unlikely to fall below 45 per cent of new European sales during the forecast period.

Overall, the increase in global vehicle production and higher platinum loadings on both heavy duty and light duty diesel vehicles should more than offset the expected reduction in use in gasoline vehicles and any possible decline in the market share of the diesel car.

Jewellery demand

Platinum is a particularly interesting metal in that it finds use not only in a range of technical applications but also in jewellery and as a financial asset. This means that factors driving growth in one end use are often less relevant elsewhere, making the accuracy of our understanding of the overall picture for demand rather better than each of its parts. Additionally, demand is spread quite widely in geographical terms: where much automotive usage of platinum is in Europe, the majority of jewellery demand for this metal is in Asia, providing an effective counterbalance.

Jewellery holds a very different status throughout Asia, where it plays a role as a form of savings, a status symbol and a luxury good, in contrast to its emotional role within Europe, Japan and North America. Gold has traditionally been the metal of choice for jewellery in China but platinum has established a secure niche and brand presence in urban markets in particular over the last decade.

Further growth in platinum demand within China is certainly possible although continued competition with other luxury goods (and forms of investment) means that growth in the wider jewellery sector in China is likely to be slower than it has been in recent years. Growth in the number of retail jewellery outlets in China is expected but at a slower rate with the associated reduction in the platinum required to initially stock these new stores may soften manufacturing demand growth for platinum even if consumer demand firms. One interesting aspect of demand is that Chinese consumers can show unusual price sensitivity, often buying more as prices rise due to precious metals' joint roles as adornment and investment. If prices rise, as my analysis suggests is likely to be the case, this could introduce a positive feedback mechanism to strengthen demand further.

In contrast, platinum jewellery demand in India is substantially smaller but growing more rapidly. Gold remains the dominant jewellery metal here but a marketing effort to build platinum's brand in some niches and to increase product availability has been successful and we expect to see further growth in demand over the next few years. Overall, therefore, we expect global jewellery demand to grow by one percent per annum (CAGR) over our forecast period, even if China fails to deliver significant growth.

Industrial platinum demand

So-called "industrial" demand for platinum has grown gradually in the last five years according to Johnson Matthey's figures and can be expected to climb at a similar rate over the medium term according to our models.

This catch-all category includes the use of platinum in the chemical and petroleum industries, where it often finds use as a catalyst; the dental and medical sectors, where it has a range of chemical and metallurgical properties; the glass industry, where platinum is often used to extend the working lifetime of components used in glass manufacturing; and a range of other end uses. As such, growth in one area is often offset by a decline in demand in another, entirely different application. As a result, overall rates of demand growth or decline tend to be more modest than elsewhere.

For instance, looking ahead over our timescale, the recent decline in prices across the commodity complex is likely to have a complex impact on platinum. Platinum's use in nitric acid manufacturing could decline in the short term due to its use in the manufacture of explosives used by the mining sector although it could rise in the longer term due to increased demand for crops and the associated use of nitric acid in fertilisers. Lower oil prices also equate to lower feedstock prices for the chemical industry and should therefore boost demand for platinum, while the increased availability of shale gas has disrupted chemical manufacturing chains resulting in increased requirements for platinum catalysis in numerous processes. Overall, assuming that the global economy continues to grow at above two per cent per annum, I believe that total industrial demand for platinum is likely to rise steadily, albeit a little more slowly than the past six years, over the forecast period.

Investment demand for platinum

The final leg of demand for platinum comes from its purchase as an investment asset. This can take the form of coins and bars but can also be in other, newer products such as physically-backed exchange traded funds (or ETFs). We consider these, and other forms of investment where metal is generally held for an extended period, as a form of demand. Changes in shorter term or less visible holdings, such as unpublished vaulted investor metal, are interpreted instead as a movement in stock.

Investment flows of platinum include bars and coins and, since 2007, ETFs. Short term price movements and macroeconomic events influence buying or selling in a given period with some dramatic year-on-year changes related to the launch of new ETF products in particular. As a result, forecasting investment demand in a specific year is challenging (although the availability of more granular quarterly data through the WPIC may make this task easier as insights into demand seasonality and price sensitivity allow more detailed analysis).

However, forecasting longer term flows is somewhat simpler. Over an extended period of time, existing investors tend to disinvest, either to liberate cash, to invest elsewhere, to limit losses incurred, or to take profits when investment objectives are met. In the absence of other market developments, investment flows would tend to be negative, with investors selling more metal than they purchase.

This is, though, typically balanced by the broader global growth in savings and retirement funds and generation of new platinum investment interest over time. Some of this should be expected naturally as new investors appear and find this metal interesting. But there is also the possibility of new products being launched. The launch of platinum ETFs in Europe generated some 195,000 ounces of demand in 2007 and the launch of analogous products in South Africa stimulated very considerable buying in 2013, suggesting that there is potential for additional demand to be created in this sector if new products become available. The launch of the World Platinum Investment Council in 2014 may help to drive this process through its market and product development efforts.

Nonetheless, my forecast of investment demand is rather cautious. From 2010 to 2015, net investment demand for platinum averaged close to 500,000 ounces per year. Yet, looking forwards, this report forecasts only an average offtake of some 135,000 ounces annually. A key assumption is

that demand for physical products and other existing investment products is likely to remain at close to current levels. However, any increase in availability of appropriate products does have the potential to drive several hundred thousand ounces of additional demand over and above our forecast, providing an asymmetric upside risk to demand.

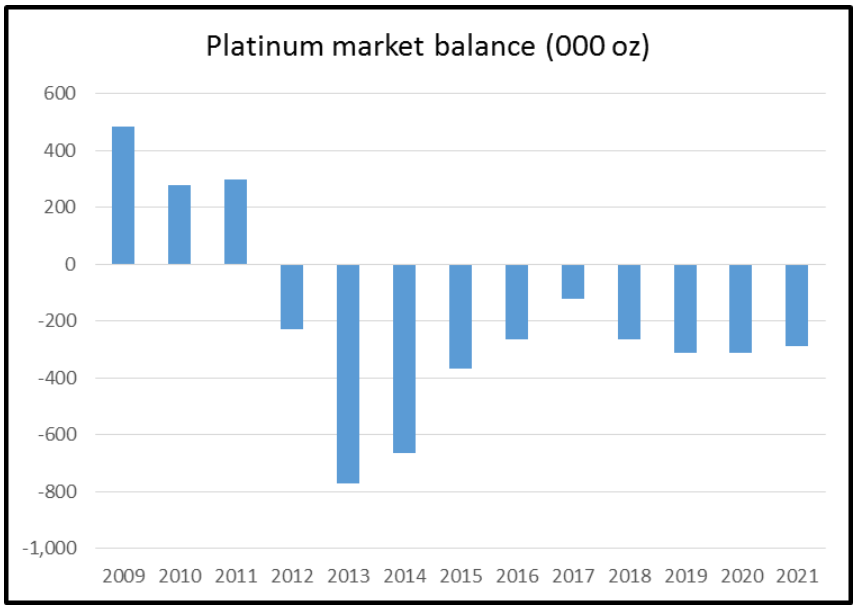

Figure 4: This analysis gives a forecast annual deficit of close to a quarter of a million ounces between 2016 and 2021, suggesting that market fundamentals should support higher prices over this period.

Source: Johnson Matthey, Glaux Metal

The supply demand balance itself

Given my base case forecast of slow growth in demand, no overall growth in mine supply but some expansion in secondary supply (or recycling), I believe that the platinum market will be in deficit for each of the years from 2016 to 2021 at an average annual deficit of roughly 250,000 ounces, as shown in Table 1 below *(and Figure 1 above)*, something that should help drive higher metal prices over a similar timescale. While acknowledging that unexpected changes in a particular demand segment or in mine production could reduce or increase such deficits, I feel that the risks within the platinum market point towards more upside potential in demand and more downside risk in supply. This suggests that overall risks towards the platinum price are biased towards the upside from this base case scenario.

Supply	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015e**	**2016e**	**2017e**	**2018e**	**2019e**	**2020e**	**2021e**
South Africa	4,530	4,635	4,800	4,200	4,150	3,920	4,538	4,347	4,374	4,314	4,371	4,392	4,466
Other	1,390	1,410	1,630	1,560	1,620	1,551	1,420	1,428	1,440	1,469	1,463	1,454	1,447
Recycling	1,405	1,800	1,669	1,722	1,901	1,964	1,840	2,045	2,149	2,263	2,354	2,413	2,451
Total Supply	**7,325**	**7,850**	**8,099**	**7,482**	**7,671**	**7,435**	**7,797**	**7,820**	**7,963**	**8,046**	**8,188**	**8,259**	**8,364**
Demand	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015e**	**2016e**	**2017e**	**2018e**	**2019e**	**2020e**	**2021e**
Gross automotive	2,230	2,860	2,960	2,904	2,970	3,313	3,552	3,487	3,443	3,622	3,770	3,809	3,851
Gross jewellery	2,810	2,355	2,543	2,803	2,941	2,798	2,644	2,737	2,809	2,808	2,813	2,817	2,821
Industrial	1,140	1,719	1,887	1,615	1,688	1,700	1,642	1,672	1,704	1,767	1,788	1,823	1,855
Investment	660	640	413	388	843	290	325	188	130	114	128	123	123
Total Demand	**6,840**	**7,574**	**7,803**	**7,709**	**8,442**	**8,101**	**8,162**	**8,083**	**8,086**	**8,310**	**8,499**	**8,572**	**8,650**
Surplus (+) / Deficit (-)	**485**	**277**	**296**	**-227**	**-771**	**-665**	**-365**	**-263**	**-123**	**-264**	**-311**	**-313**	**-286**

Table 1: Historical and forecast supply for platinum in thousands of Troy ounces. Source: Johnson Matthey, Glaux Metal

Disclaimer

The author of this report (David Jollie/Glaux Metal) acknowledges the limitations and challenges of forecasting supply and demand fundamentals in the platinum market given the complex interaction between platinum prices, the prices of other materials, economic growth and supply and demand. The author acknowledges that external and internal factors could affect the balance of the platinum market over this time period and could cause actual results to differ materially from any forward-looking statements made here. Although the author believes the expectations reflected in the forward-looking statements to be reasonable, he does not guarantee future results.

In preparing this research report, the author has utilised information from the public domain, which has not been verified and internal, proprietary models. This report therefore uses our best estimates of how the platinum market might develop over the period 2016 to 2021. Accordingly, any forward-looking statements contained in this report are based on the opinions of the author at the time of writing.

The facts, analysis and findings presented in this research report do not constitute investment advice. The author does not accept liability for any losses arising from reliance upon the information presented in this research report, or in any excerpts from this report.