PLATINUM ESSENTIALS

WPIC's platinum price attribution model examines the factors that establish platinum value in the market

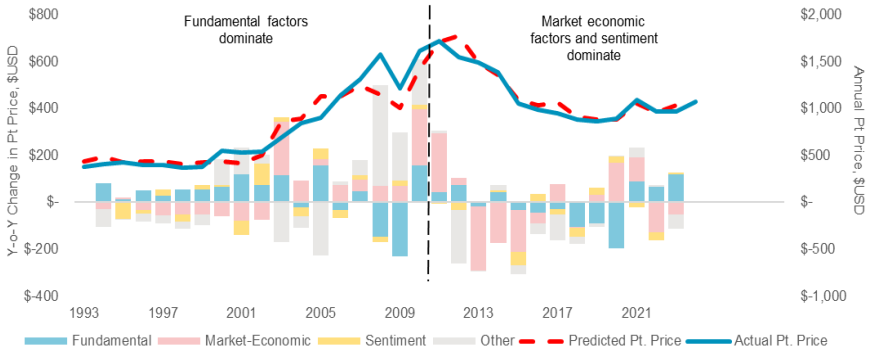
A key question market participants are asking is why hasn't the platinum price reacted to recent market deficits? In response the WPIC has developed a Platinum Price Attribution Model to explain which key observable variables can be utilised as indicators to explain price movements. This report explains how the model has been constructed and what the key takeaways are.

WPIC has utilised multiple regression analysis to create a multi-factor model (fig. 1) to explain historical platinum price movements from 1993-2023. We have divided these factors into three categories, fundamental (demand linked), market-economic (interest rates, gold price, exchange rates), and sentiment (futures positioning). The model accurately explains how changes to independent variables within fundamental, market-economic and sentiment categories have an aggregated impact on the annual platinum price. In addition, we can see the importance of the price setting factors evolves through time and why the platinum price has not yet reacted to the significant deficits of 2023 and 2024. Specifically, a structural break appears to occur in value setting following the end of the China led commodity Supercycle in 2011, which also coincides with the commencement of physically backed ETFs. Prior to this, underlying fundamentals were the key driver of platinum value and post this market-economic and sentiment have been the main drivers.

Looking ahead, with a series of deep market deficits expected – see our latest 2-5 year supply/demand outlook – the model suggests that that supply/demand fundamentals (deficits) are likely to return to being the key drivers of establishing platinum market value. The attractive outlook for the underlying fundamentals is likely to influence sentiment, which in combination with an easing rate cycle and high gold price (market-economic) will provide additional support to the outlook.

The link between a mathematic model such as this, and commodity market economics is not always straightforward. Nonetheless, the model does suggest that the aggregate impact of different market factors is likely to be supportive of a higher platinum price in the future.

Figure 1. The WPIC platinum price attribution model suggests that underlying fundamentals were the most important factor in establishing platinum market value pre-2011. Since then, market-economic and sentiment factors have had a greater influence. An expected return to underlying fundamentals being the key driver would be supportive of a higher platinum price.



Source: WPIC Research

Edward Sterck
Director of Research
+44 203 696 8786
esterck@platinuminvestment.com

Wade Napier
Analyst
+44 203 696 8774
wnapier@platinuminvestment.com

Jacob Hayhurst-Worthington
Associate Analyst
+44 203 696 8771
jworthington@platinuminvestment.com

Brendan Clifford
Head of Institutional Distribution
+44 203 696 8778
bclifford@platinuminvestment.com

World Platinum Investment Council
www.platinuminvestment.com
Foxglove House, 166 Piccadilly
London W1J 9EF

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Executive summary

Platinum prices are shaped by a complex interplay of factors including supply and demand. While market equilibrium theory suggests that prices should rise when demand exceeds supply and fall in the opposite scenario, platinum's pricing is complicated by the opacity of above-ground stocks, platinum supply being influenced by the economics of other commodities (particularly palladium and rhodium, see page 14), and the general price inelasticity of demand. These factors make it difficult to accurately gauge true supply availability, unlike more transparent commodities such as base metals and oil. Consequently, platinum prices do not always correlate well with short-term supply-demand balances. This is illustrated in figure 2. For example, although during platinum's rise to peak prices through the early 2010's in response to multi-year deficits, price has declined since 2011 despite having 7 deeper deficits since then.

So, what can be used to help contextualise platinum price movement?

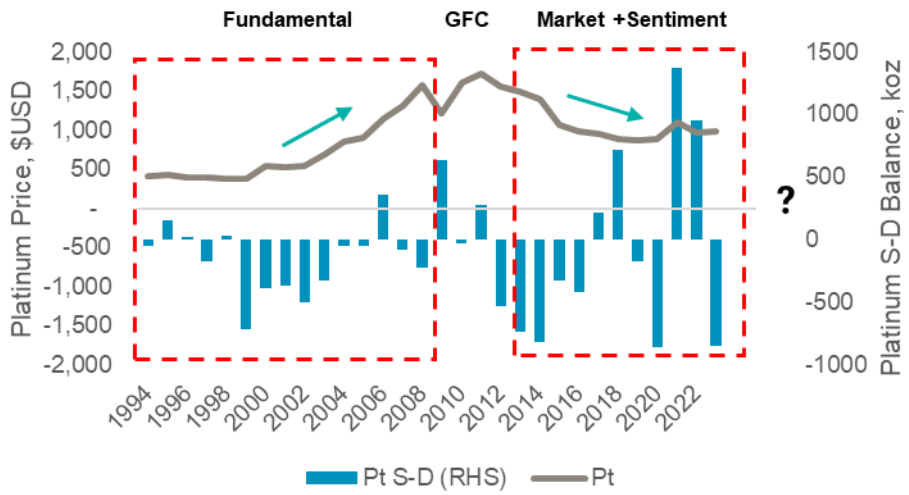
This report sets out to investigate and help develop a better understanding of price movements through statistical tools. The WPIC has developed a platinum price attribution model using multiple regression analysis to quantify the explanatory power of various factors on platinum's price and clarify how these influences evolve over time. After examining and dismissing a number of factors, the model incorporates fundamental variables, such as demand from key industrial segments like autocatalysts and jewellery, as well as market economic and sentiment factors, including interest rates, foreign exchange, correlations, the price movement of gold, and managed money futures positioning. The price attribution model allows us to quantify which drivers most significantly impact annual price performance, track how these influences shift over time, and identify periods when selected drivers fall short in explaining price movements. Such discrepancies may point to one-off events or the emergence of new, impactful variables.

Key conclusions

The key conclusions coming from analysis of the model and subsequent back-testing, is that the importance of the major factors that contribute to establishing the price of platinum in the market have changed over time. In effect, underlying fundamentals (e.g. demand growth) were the most important input in establishing the platinum price up until around 2011. From then until the present, we can see that market economic (e.g. exchange rates) and sentiment (futures positioning) have had a greater bearing on establishing market value.

We believe that the market is poised for a shift back towards underlying fundamentals again being the key driver of platinum price in the future. The model has demonstrated that the relative importance of factors evolve over time. Whereas demand growth has been the main fundamental driver in the past, the shortfall in supply is leading to ongoing market deficits that are rapidly depleting above ground stocks, an unsustainable situation. As this is absorbed by the market, it will begin to be reflected in positioning in the futures market (sentiment), compounding the effect of underlying fundamentals, in this case the consecutive deficits.

Figure 2. Price responded to S-D balances through the early 2000's. Following the GFC price has deteriorated as market and sentiment driven trading has driven price.



Source: Johnson Mathey (1994-2012), SFA (Oxford) 2013-2018, Metals Focus 2019-2024f, WPIC Research

Key risks and limitations

The platinum price attribution model is a mathematical construct that is only as good as the data that goes into it during the time that is in question. Our model is limited in time by the availability of platinum future's positioning data (1993), and in resolution (annual) by the lack of quarterly supply/demand data prior to 2014.

In addition, events which occurred in the period examined can result in unexpected mathematical outcomes. For example, a positive correlation between price and supply. This makes sense at the level our model operates at, when for much of the period pre-2011, the platinum price went up even as supply increased because whilst supply was increasing it continuously lagged demand. Similarly, supply/demand economics 101 inform us that imbalances in the supply and demand of a good or commodity should result in reciprocal price action. This is not picked up for platinum in our model because whilst true for the model pre-2011, other factors obscure this relationship since then, which results in a low correlation for the purpose of this model. The net impact is that demand drivers are mathematically seen as being more important and these are therefore what are used in the model as our fundamental factors, ignoring supply and market imbalances.

A key point here is that our statement that underlying fundamentals are likely to return to being the most important price setting factors looks a bit beyond the mathematics of the model and speaks to broader commodity economics. For example, if the platinum price were to appreciate as a result of the market deficits, the model will not necessarily ascribe this to fundamentals (unless there is also strong growth in demand). Instead, given we are in an easing rate cycle with a high gold price, plus the likelihood of underlying fundamentals influencing futures positioning, the model would be more likely to mathematically ascribe the price response to market-economic and sentiment factors.

The key risk therefore is in interpreting the results without a full and comprehensive understanding of the underlying market that allows one to see through the noise to the true driving influences and what they mean for the future.

Building the model

We employed a multiple regression (ordinary least squares) model to analyse platinum price performance. This statistical method examines the relationship between one dependent variable—platinum price—and several independent variables, such as interest rates, gold prices, and automotive platinum demand. By combining these factors, the model helps us understand how changes in each variable influence platinum price simultaneously. We used multiple regression due to its well documented use and ease of implementation.

The model follows this general form:

$$P_T = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \varepsilon$$

Here, each coefficient (β) represents the contribution of an independent variable to the platinum price, providing a clear picture of how different forces shape market trends.

Where:

- P_T is the actual platinum price at a time T.
- α is the y intercept and constant.
- $\beta_n X_n$ is the coefficient multiplied by the explanatory variable for each variable (n).
- ε is the unexplained price variance or, put another way, the difference between the predicted platinum price and the actual price.

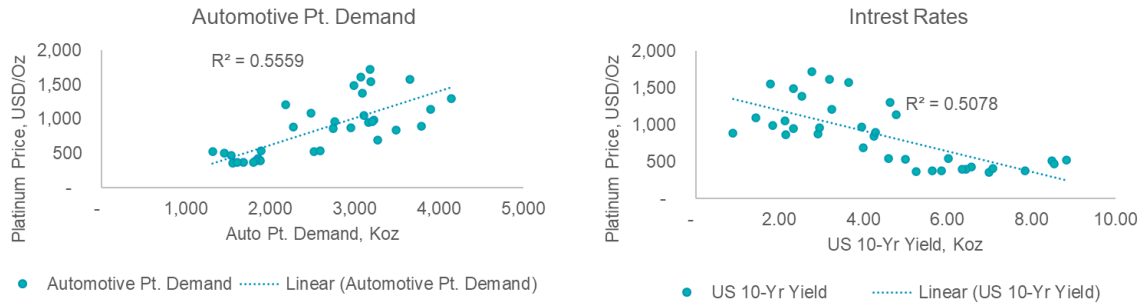
The development of our regression model began with a top-down analysis to identify variables impacting platinum prices. We chose to analyse prices on an annual basis for two reasons. Firstly, supply and demand data is only available on an annual basis before 2014. Secondly, a longer-term perspective better captures fundamental value-setting mechanisms, as short-term fluctuations can be more heavily influenced by transient market conditions and sentiment. Examining prices on a short-term basis—whether quarterly, monthly, or daily—tends to reveal movements primarily driven by economic indicators, market sentiment, and speculative trading. These short-term price changes are often reactions to temporary events, such as shifts in inflation expectations, interest rate movements, or geopolitical risks. These indicators are crucial for understanding market sentiment and price volatility, but a short-term analysis supresses the impact of underlying fundamentals on value establishment.

We first examined key drivers of our supply-demand forecast, along with broader market factors influencing these dynamics. To assess each variable's impact on price, we conducted an r^2 analysis (fig 3) and evaluated trends over time, exploring potential lagged or complex relationships and how they might evolve. In order to settle on a model we followed the following process:

1. **Start with theory & domain knowledge**: Identifying the key factors that theoretically affect platinum prices based on our research and understanding of the market. This is supply, demand, market-economic and market sentiment factors.
2. **Check data availability and quality**: Check quality and availability of data over a thirty year time series (1993-2023). In contrast to other commodities, platinum data is typically of more recent duration and of a lower resolution. This is why our time series begins in 1993; it is the first year of full data for a breakdown of NYMEX managed money futures positioning.
3. **Exploratory data analysis**:
    a. Check correlations between potential predictor variables and the dependent variable (the platinum price). High correlations with price are often good candidates for inclusion.
    b. Multicollinearity check: Assess correlations among the potential predictor variables themselves. If two variables are highly correlated, including both can lead to multicollinearity (which can distort the model).
    c. Stationarity test to check stability of relationships within the data and suitability for prediction. Stationarity check is performed via a simple Augmented Dickey Fuller test.

4. **Initial model with core variables**: Starting with the highest r^2 for each core variable category, markets, supply and demand.
5. **Add/Subtract variables incrementally**:
    a. incrementally add other factors that might influence the platinum price and assess their impact on the model.
    b. Test these factors for statistical significance (p-values), and observe whether they improve the overall model (i.e., increase r^2, reduce residual errors, etc.)
6. **Select highest adjusted r^2**: Simplicity is key in most regression models. While more variables might improve the fit, each new variable should bring a substantial improvement in accuracy. It's better to have a model with fewer, well-justified predictors than an overcomplicated model that's hard to interpret and prone to errors.
    a. Adjusted r^2 penalises adding too many variables. A higher adjusted r^2 suggests the variable is improving the model without overfitting.

Figure 3. Variables with strong correlations were included into the model.



Source: Bloomberg, WPIC Research

After iterating through steps 1-6, we ultimately selected six key factors that together statistically explained up to 89% of the price movement. Importantly, each chosen variable had to have a sound economic rationale for influencing price, and we ensured the exclusion of multicollinearity—a phenomenon where intercorrelated variables distort predictions. In cases of multicollinearity, we prioritised ratios or the most significant variable to maintain model accuracy. All tested variables are available in the appendix.

We iteratively tested variables to optimise the model's explanatory power and goodness of fit while preserving economic logic. However, not all price movements are fully explained by the model. The residual variance, attributed to factors outside our selected variables, is captured as the "other" category.

To further simplify analysis of the six-factor model, variables were grouped into three broad categories that describe a shift in price: fundamental, market-economic, and sentiment. The selected variables are shown in figure 4.

Figure 4. Summary of variables utilised in six-factor model.

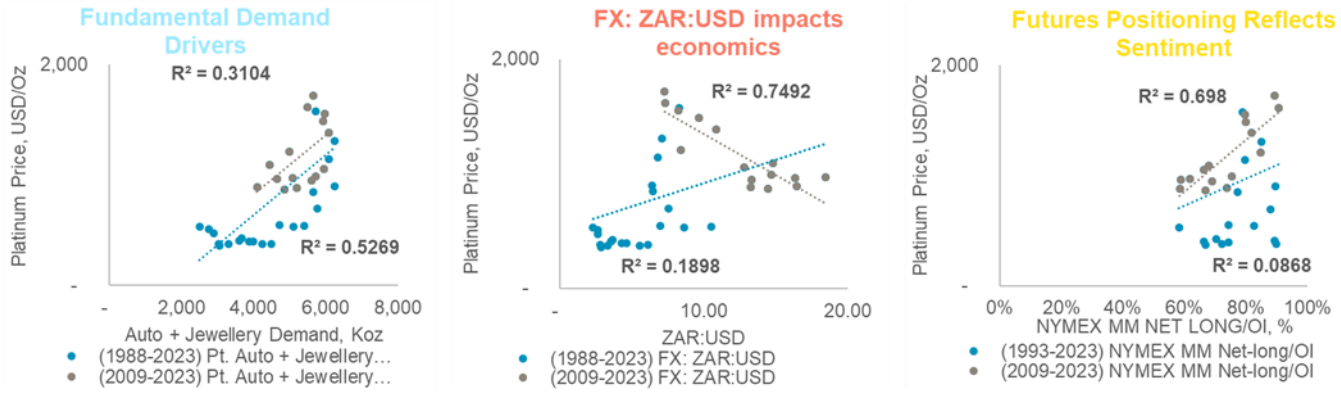
Group	Variable	Var	Description
Fundamental	Automotive demand	X_1	Annual Automotive demand
	Jewellery demand	X_2	Annual Jewellery demand
Market-economic	Gold Price	X_3	Annual average $XAU price
	Intrest rates	X_4	10-Yr US Yield
	USD:ZAR	X_5	USD:ZAR FX
Sentiment	NYMEX % Net Long	X_6	Net long managed money/ Managed money open interest.

Source: WPIC Research

A final step was to then to shift the time window of sampling to observe how correlations changed over time. We built a second model looking at price performance after 2009

where correlation weighting re-balances (fig 5). Specifically, fundamental price contribution weakens, and sentiment becomes more important. It should be issued with a health warning that this data set only consists of 15 annual data points.

Figure 5. Whilst drivers remain the same, the weighting and importance can evolve over time.



Source: Bloomberg, WPIC Research

Economic rationale of the six factors included in the price model:

Automotive and **jewellery demand** have been identified as primary ***fundamental drivers*** of platinum demand, both showing a strong positive correlation with platinum prices. Supply was assessed but dismissed as a factor as it returned a positive correlation to the platinum price. Our analysis suggests that this correlation between supply and price rather reflects the long-run supply reaction to expected demand. That is, supply follows demand expectations. However, since prices are correlated to demand the analysis therefore shows a relationship between price and supply. While we rule out supply underpinning long-run prices, clearly, a significant short-term supply disruption could be a driver of price.

Three key ***market-economic*** variables, the **gold price, interest rates, and currency exchange rates,** were found to have a material impact:

- **Gold** has traditionally been closely correlated with platinum due to their shared status as precious metals and portfolio diversifiers. However, this correlation has weakened since 2015 when prices began to diverge. The deterioration in this relationship is related to the magnitude of negative factors decreasing platinum's price exceeding the positive precious metal pull of gold (see the evolution of the platinum market in the appendix). We believe gold - whilst at a lower correlation coefficient today - still holds explanatory power.

- **Interest rates** play a crucial role in determining the opportunity cost of investing in platinum. Investors constantly assess the potential returns and risks of various assets to optimise their portfolios. Platinum, like other assets, is evaluated against alternatives such as Treasury bonds, which are considered low-risk investments. Consequently, the yield on these bonds is inversely related to the price of platinum, as higher bond yields make holding non-yielding assets like platinum less attractive.

- **Exchange rates** have a major impact as 75% of global platinum mine supply is concentrated in South Africa whilst metal prices are US dollar denominated. The relationship between platinum and the USD/ZAR exchange rate has grown increasingly significant given the rand's sharp depreciation over the past two decades, a strong negative correlation with USD-denominated platinum prices has emerged. The rationale for this is that if one assumes that in a balanced market price typically sits at around the 90th percentile on a cash cost curve, a weaker rand lowers operating costs in US dollar terms for South African producers, which means that a lower US dollar platinum price maintains the price/cost curve relationship on a constant margin basis.

Sentiment drivers, reflecting market perception of the outlook for a commodity, in contrast to what actually transpires, can be tracked by managed money net long/short speculation in futures contracts. For platinum we can gauge sentiment through NYMEX managed money positioning relative to open interest, revealing whether traders are bullish or bearish on platinum. Whilst there are always two sides to every trade, this

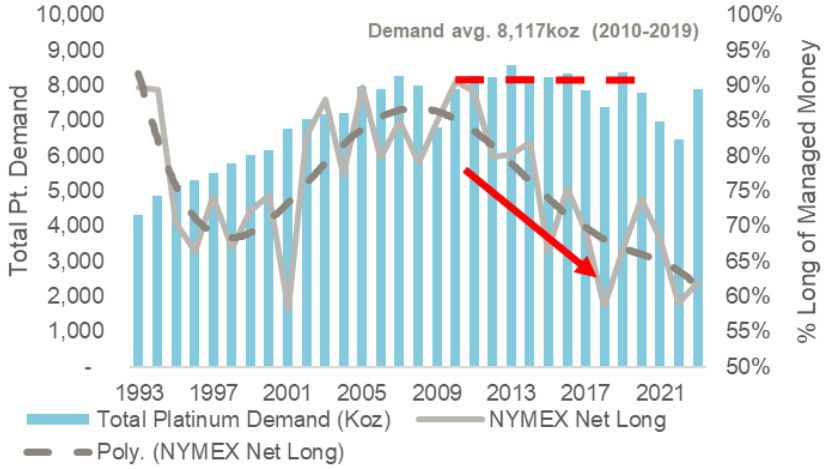
measure helps explain price momentum shaped by market perception of speculators hoping to profit from price movement. Sentiment is independent and can diverge from fundamental drivers. For instance, despite a 10-year average high demand of 8,117 koz, managed money short positions increased (figure 6). This could indicate that those speculators had less certainty about the investment case outlook at this time.

As explained above, it is also worth noting that **some variables were investigated but not included in the price model**. S-D balances were excluded because changes in demand alone had a significantly better correlation with price and appears to be a substantially more important value determining factor. The intuitive explanation is that the existence of above ground stocks distorts price reaction in both time and magnitude to any annual S-D balance.

Similarly, supply was excluded from the model due to a positive correlation with price. This makes sense at the level our model operates at when for much of the period pre-2011, the platinum price went up even as supply increased because whilst supply was increasing it continuously lagged demand (the exclusion of supply is considered more fully in the appendix). In short, rising demand supports rising platinum prices which in turn supports supply growth. This would be in contrast to positing that supply growth would underpin rising prices.

Finally, ETF demand was excluded as the first platinum ETFs were only launched in 2007, which means that the dataset is of too short a duration to analyse meaningfully; although it is interesting to note that the change in market behaviour identified by our model coincides with the acceleration of platinum ETF holdings.

Figure 6. Whilst volatile, short positions have increased on average by speculators since 2009. This measure gives an indication of the proportion of long/short trades by managed money participants during a year, where 50% is equal long and short positioning.



Source: Johnson Mathey (1994-2012), SFA (Oxford) 2013-2018, Metals Focus 2019-2024f, Bloomberg, WPIC Research

Using the model to interpret price attribution (1993-2023):

To illustrate how this model helps us understand platinum prices, consider the following equation derived from running the regression analysis over the period from 1993 to 2023:

$$P_T = -654 + 0.28X_1 + 0.23X_2 + 0.68X_3 - 24X_4 - 60X_5 + 370X_6 + \varepsilon$$

In this equation, each variable represents a key driver of platinum prices. For instance, each thousand ounces (koz) of automotive demand (X_1) adds $0.28/oz to the platinum price, while the USD exchange rate (X_5) has a negative correlation, meaning that for each rand unit depreciation against the dollar, the platinum price decreases by $60/oz. The model captures the interplay of fundamental, sentimental, and macroeconomic factors, showing how they contribute positively or negatively to the overall price based on the prevailing conditions each year. Figure 7 illustrates the impact in price for each change in the underlying.

Figure 7. Summary of variables utilised in six-factor model.

Variable	Var	Underlying change	Impact on Price
Automotive demand	X_1	+/-100koz	+/-$28
Jewellery demand	X_2	+/-100koz	+/-$23
Gold Price	X_3	+/-100$/oz	+/-$68
Interest rates	X_4	+/-100bps	-/+$24
USD:ZAR	X_5	+/-1 USD:ZAR	-/+$60
NYMEX % Net Long	X_6	+/-10% Long/OI	+/-$37

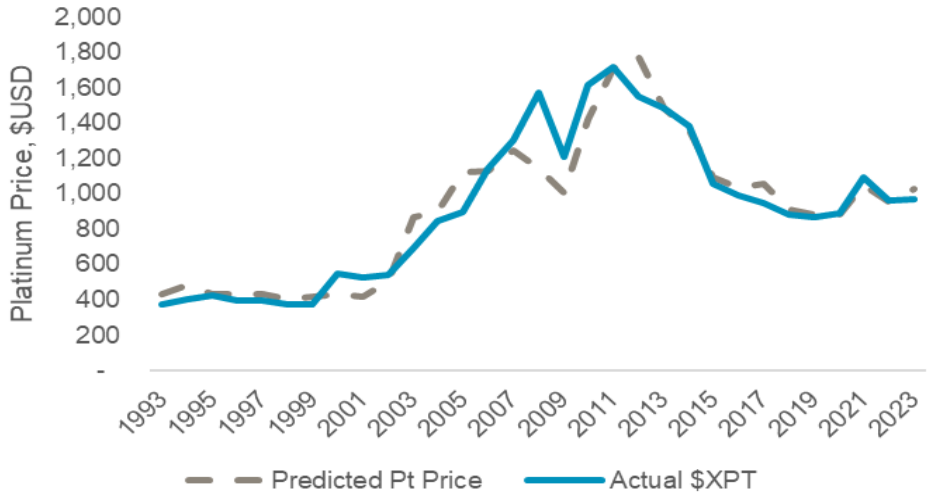
Source: WPIC Research

Testing the model for accuracy:

Figure 8 compares the expected price with the actual price over the regression period, while figure 9 illustrates the model's directional accuracy and the difference in year-on-year returns. The model has shown good explanatory power with an average annual price variance of ±9.4% between the estimated and actual prices. It correctly predicted the direction of price movement, whether up or down, in 80% of the years analysed.

Examining figures 8 and 9 reveals that significant discrepancies in price accuracy occurred during major price rallies in the early 2000s and following the Global Financial Crisis (GFC), although the model's directional accuracy remained largely intact. These unexplained price variances are captured as the “other” category, which accounts for factors that had an abnormal impact on price due to one-off events like the GFC or factors not incorporated in the model that have become more or less significant over modelled period.

Figure 8. Predicted platinum price tracks the actual annual price well. Variances when other explanatory variables occur, such as the GFC highlights diversions from estimated price.



Source: Bloomberg, WPIC Research

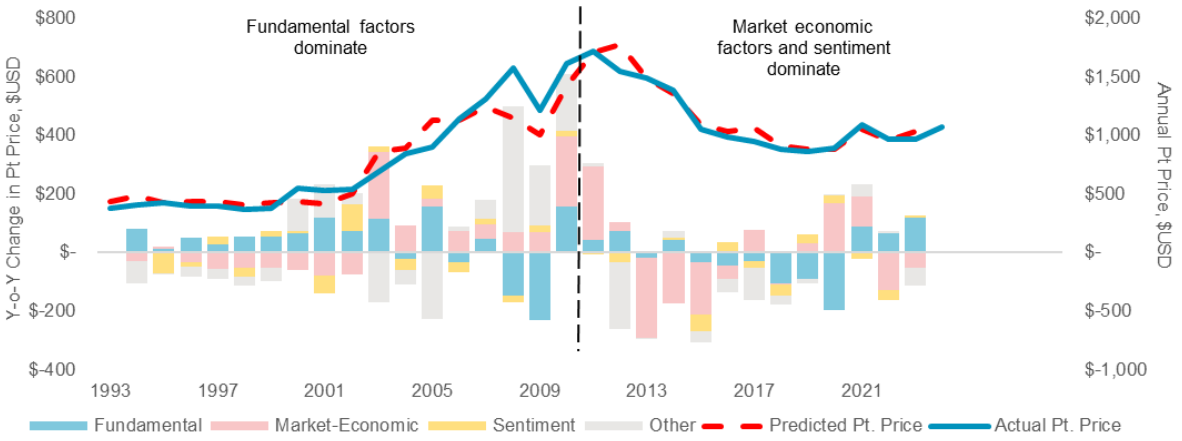
Figure 9. Model correctly predicted the direction of price movement—whether up or down—in 80% of the years analysed

Source: WPIC Research

Highlighting contributing factors:

To bring everything together, we can break down the estimated price action into its constituent positive and negative changes for each year, categorised into the three broad areas outlined in figure 4: fundamentals, market-economic, and sentiment plus the 'other' or unidentified category. This breakdown will assist in outlining a clearer understanding of how platinum prices have evolved over time.

Figure 10. Growing fundamental influence drove prices to 2011, before ZAR depreciation coupled with deteriorating demand weighed on prices despite market deficits.



Source: WPIC Research

Analysis: What can the price attribution model tell us about platinum's price performance?

The primary question being asked is why has the platinum price failed to respond to the significant platinum market deficit in 2023, followed by the larger projected deficit for 2024. By extension the same question should be asked of declining prices from 2010 to 2019 (despite six deficits in that time period).

We introduce three key charts to analyse platinum price evolution over time, linking price drivers to their impact. Figure 11 contains three charts that revisit the general supply-demand balance against price trends. From top to bottom these show:

- Platinum supply/demand and market imbalances
- Platinum above ground stocks and the platinum price
- The platinum price model influencing factors and the platinum price versus the predicted platinum price.

Together, these charts reveal key price trends, explain past movements, and help infer future platinum price behaviour based on forecasted underlying conditions.

The following analysis of how the market and price setting factors have evolved over time is a high-level overview with a focus on the conclusions from the price model. We have included a more in-depth analysis with cross referenced annotations on the charts on page 16 of the appendix for readers who want to understand the evolution of the market in more detail.

Understanding the evolution of price drivers over time

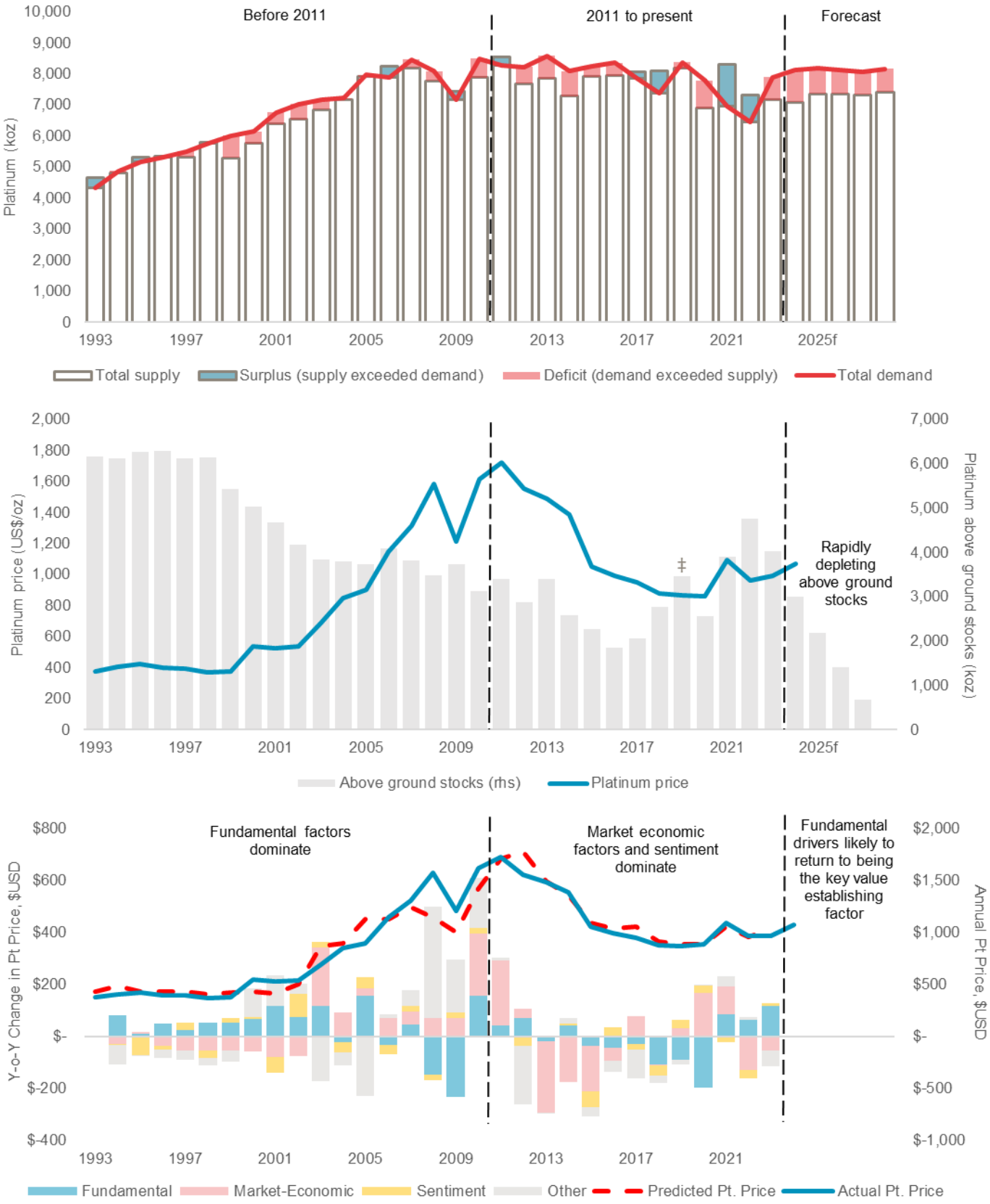
With reference to figure 11, we have divided the charts into two periods, before 2011 and 2011 to present. These periods broadly align with the China led commodity Supercycle that ran from 1996 to a peak in 2011, and the subsequent slowing in the rate of growth in demand for commodities.

As can be seen in the period before 2011, demand grew consistently, and growing supply struggled to keep up, leading to a depletion of above ground stocks and a rising platinum price. With reference to the price model chart, the most important factors in establishing platinum's market value are the underlying fundamentals in blue.

From 2011 to present, demand flattens off, and although supply does also, there is a period of growing above ground stocks until the significant deficit of 2023. Referring to the price model chart, as shown in pink, market-economic factors and sentiment appear to have been more influential than underlying fundamentals during this period. Note that this period was heavily influence by a number of factors that are explained in more detail in the appendix, notably the decline of light duty diesel market share in Europe, the rise of EVs, and substitution of platinum for palladium in gasoline vehicles.

Looking at the future, the key observation is that although demand growth is muted, supply constraints result in sustained deficits and rapid depletion of above ground stocks, underlying fundamentals are likely to return to being the key input in establishing market value in the future. This is likely to be compounded by rate cutting cycles having started in a number of regions around the world, and the high gold price, both key market-economic inputs. **Essentially, these trends point towards a price supportive outlook being more likely than a flat or price negative outlook.** We examine this more fully from page 13.

Figure 11. From top to bottom: Platinum supply/demand and market imbalances, Platinum above ground stocks and the historical platinum price, Platinum price model influencing factors and the historical platinum price versus the predicted historical platinum price.



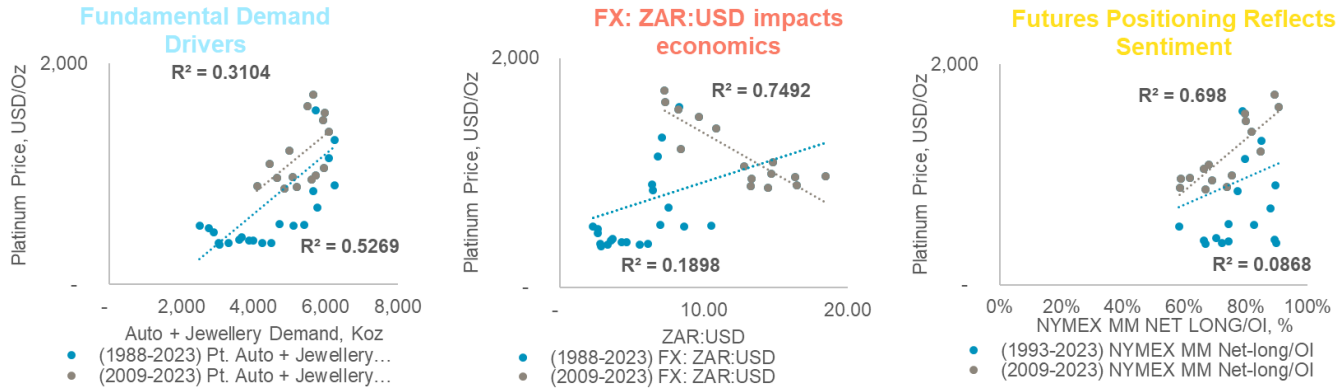
Source: Johnson Mathey (1994-2012), SFA (Oxford) 2013-2018, Metals Focus 2019-2024f, WPIC Research, ‡ A change in above ground stock estimation methodology occurred at the end of 2018 as a result in the transition from SFA (Oxford) to Metals Focus

Testing our conclusions:

We identified a potential structural break around 2010/11, indicating a shift in established correlations. To explore this, we adjusted the model's time window to cover 2009–2023 (2009 was chosen as a starting point to have a meaningful number of data points).

A simple correlation plot for the periods 1988-2023 and 2009-2023 revealed a decreased platinum price correlation with fundamentals over the more recent timeframe. In contrast, market-economic and sentiment variables showed stronger correlations. Figure 12 shows one example each from each of the price setting categories to illustrate this point. The changing correlations reinforces our conclusion that the key determinants of platinum market value have shifted since the end of the China led commodity Supercycle.

Figure 12. Growing fundamental influence drove prices to 2011, before Rand depreciation coupled with deteriorating demand weighed on prices despite market deficits.



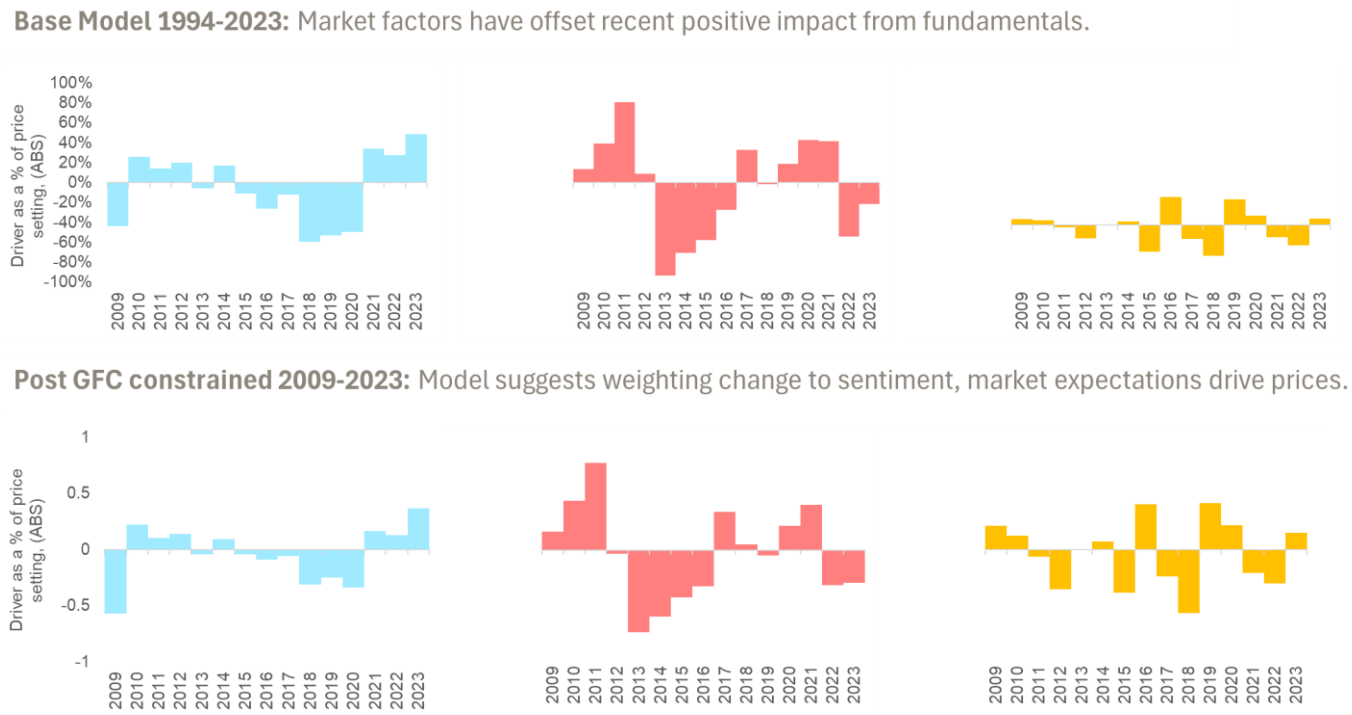
Source: WPIC Research

We then re-ran the regression model over the condensed time window (2009-2023). While the model's findings should be interpreted cautiously due to the reduced, and rather limited number of data points, the results underscore a shift towards economic factors over fundamentals. Modelled price variance from actual improved from 5.5% to 3.9% (although this is to be expected over a shorter time horizon), directional accuracy remained intact at 79% and an adjusted r^2 value of 0.95 (0.89 previously).

The major changes to the condensed price model are as suggested by the correlation analysis, but more acutely so. The impact of sentiment on platinum value establishment increased from an average of 10% to 26%, whereas the role of fundamentals declined by 11% to only 19%. The changing contribution of market-economic factors is less marked, with a slight reduction to the influence of these factors (40% to 36%). Essentially, market perception of fundamentals became more influential than the fundamentals themselves.

This shift doesn't suggest the underlying drivers have changed, i.e. we would still include the same underlying contributing metrics in the price model, but rather that their perceived impact on price has evolved.

Figure 13. Testing a more recent time window (2009-2023) revealed drivers remain the same, but, there is a shift in quantum. Sentiment increases its importance in price setting implying market expectations over fundamentals become more important in value setting.



Source: WPIC Research

The outlook for key inputs and what the regression model tells us these mean

Having satisfied ourselves that the model produces valid results, we can examine the trends in the underlying value establishing fundamentals and impute what the model would calculate in terms of a price direction. Note, that it is beyond WPIC's remit to run the model on this basis and publish price forecasts on the back of the output. It is also worth noting that following that process would equate to forecasting six different underlying factors to produce a forecast for the one dependent factor, the platinum price.

Directional trends in the underlying factors:

- **Fundamental factors:**
    - We ended up including automotive and jewellery demand in the model and not supply or supply/demand imbalances. Although there are upside opportunities in future demand growth our outlook is relatively flat through to 2028. Although the current and future deficits are a function of supply being inadequate to meet demand and platinum supply was excluded from the model due to the positive price correlation, they are resulting in a rapid and unsustainable depletion of above ground stocks. Additionally, although supply was excluded from the model, this is on purely mathematical grounds as the movements in supply and demand tracked each other during in the period examined.
    - Platinum demand is diversified and shows significant growth potential. The metal is poised to benefit from a prolonged reliance on internal combustion engines (ICE), as the growth of hybrid vehicles accelerate. Additionally, it is early days, but jewellery demand for platinum may be experiencing a recovery, driven by higher gold prices that prompt fabricators to pivot to more affordable materials. The expanding hydrogen economy is another major driver, with expectations of exceeding 850 koz of platinum demand by 2030.

- **Market-economic factors:**
    - From an investment perspective, non-yielding assets appear less appealing during periods of higher interest and relatively more attractive during interest rate downcycles. With a number of central banks around the world having started to cut rates, platinum investment interest should stand to gain. Moreover, platinum has traditionally shown a strong correlation with gold. Although this relationship has weakened in recent years, the return of positive sentiment towards platinum, driven by its robust fundamentals, could re-strengthen its historical connection to gold, providing additional support given that gold is trading at record levels.
- **Sentiment**:
    - Whilst sentiment is related to fundamentals it is more akin to the market's future expectations of fundamentals. In recent years these have diverged. As confidence returns in higher for longer automotive demand we would expect this to begin to reflect in futures positioning, in particular behaviour around price inflection points.

Referring to our regression model, we can see that the trends identified above are broadly aligned with the directional movements in modelled factors required to support platinum prices based upon past trends.

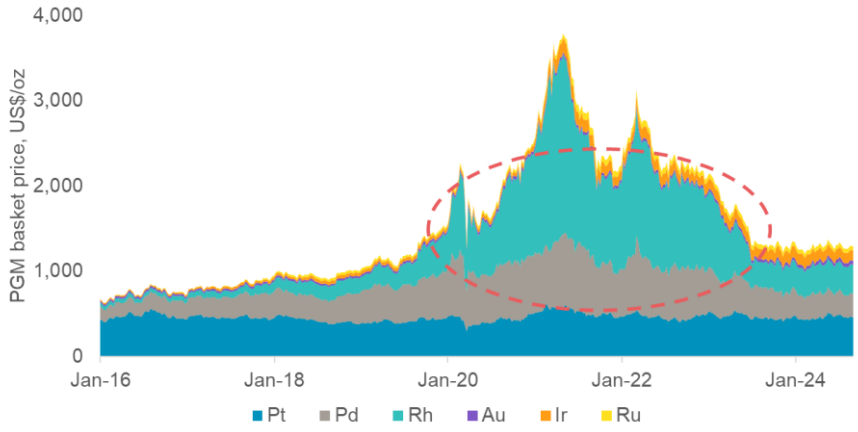
A final word on the impact of mine supply

There is one other nuance to primary mine supply, and to a lesser extent secondary supplies from autocat recycling. Platinum is not produced in isolation but in combination with palladium and rhodium (both primary and secondary), the other PGMs, gold and base metals (primary only). Thus, the economics of platinum supply are dependent upon the prices of other commodities, in particular palladium and rhodium. This means the causal link between platinum supply and price, which is what the model examines, may at times be obscured by the impact of the pricing of these other commodities.

Taking mine supply as an example, this means that there has been a significant erosion of mine profitability, with a number of operations currently loss making. Thus, even with the significant platinum market deficits there is no incentive to increase supply without a substantial increase in platinum prices.

A final point of note is that mine supply tends to matter more when inventory is low, as there is no buffer in the chain to accommodate supply shortfalls. A prime current example is copper where price trades at a consistent premium to cost curve to keep all mine supply incentivised.

Figure 14. Revenue contribution by South African PGM miners by metal, calculated as a basket price per ounce – a period of super-profitability has come to an end with the reset in palladium and rhodium prices (US$/oz)



Source: WPIC Research

Conclusion

We can summarise the outcome from this exercise by drawing three key conclusions.

Firstly, the platinum price regression model is shown to be an accurate predictor of price based upon the movements in the selected underlying inputs.

Secondly, the model can explain changes in the influences of the price driving factors through time and why the platinum price has not yet reacted to the significant deficits of 2023 and 2024.

Thirdly, looking at the outlook for the different price driving factors, we can predict that underlying fundamentals are likely to return to being the key drivers of establishing platinum market value, and that this is likely to be supported by market-economic and sentiment factors, which in aggregate are expected to be supportive of a higher platinum price.

APPENDIX:

Explaining the exclusion of supply from the model

As previously mentioned, supply does not correlate in a way that adds meaningful explanatory power to the model. Over time, supply has shown a positive correlation with price, which aligns with the broader trend of platinum supply increasing during periods of high prices and decreasing during periods of lower prices. In short, platinum prices drive supply as opposed to supply driving platinum prices. Furthermore, this positive correlation is clearly unhelpful in explaining price reactions to supply shocks effectively.

Consider the following illustrative example:

Automotive demand: +100 koz & coefficient of +1 = +$100 in platinum price

Supply: -100 koz & coefficient of +1 = -$100 in platinum price

In this hypothetical example, a supply shock of -100 koz, combined with strong automotive demand of +100 koz, would theoretically yield a net price change of $0, implying no price movement. However, in reality, basic supply and demand principles suggest that this combination would result in upward price pressure. This disconnect demonstrates that supply, as a variable, lacks the explanatory power needed to rationalise price responses accurately.

Moreover, over the long run, supply tends to adjust to meet demand. Mine plans and investment decisions are largely based on demand and price expectations, meaning supply can be viewed as a dependent variable rather than a leading indicator. With a correlation of 0.4 between supply and demand, and both variables showing positive correlations, it can be inferred that demand is the main driver, and including supply does not significantly improve the model. This is supported by the fact that the adjusted r^2 remains unchanged when supply is added, confirming that it does not contribute additional explanatory value to the model.

A comprehensive breakdown of market evolution

When a commodity market is in deficit, one would normally expect competition for limited supply to drive the price of the commodity higher to a point where demand is priced out of the market, or new supply is incentivised into the market. With a series of deficits, clearly, this has not happened as expected for platinum in recent years. Why is this?

Referring to charts in figure 15, we can explain how the market has evolved over time, how different factors have fed into platinum's market value and how this is evidenced in the price model. We start by dividing the time from 1993 to 2028f into six periods.

1994 – 1999: Despite growing demand, the market is balanced generating a period of stable prices

As shown in the top chart in figure 15 rising platinum demand (**A**) driven by growth in jewellery sales and industrial end uses. Despite this, above-ground stock (AGS) levels averaged a healthy 14 months of demand (**B**) with the market remaining broadly in balance as platinum supply grew at the same pace as demand (**C**). In short, demand growth was offset by adequate supply, with fundamental, macroeconomic and sentiment factors all balancing each other out and resulting in a flat platinum price performance (**D**).

2000 – 2011: substitution reverses bringing positive fundamentals, demand out strips supply and economic growth.

From the platinum price low in 1999 to its peak in 2011, the platinum market was consistently in deficit (10 out of 13 years, **E**) as the growth in platinum supply lagged the growth in demand. This resulted in a rapid depletion of above ground stocks (**F**). Total demand growth was underpinned by automotive demand growing by over 150%, industrial demand by almost 50%, the rapid growth of Chinese jewellery demand, and the growth in both bar and coin investment demand and the launch of physically

backed ETFs from 2007.

The platinum price model reflects these fundamental drivers as being positive for the platinum price, but it also captures increasingly positive macroeconomic factors as well (**G**), which reflect a rising gold price and consistently low interest rate environment offsetting the ongoing weakening of the rand versus the US dollar. The biggest commodity market event during this period was the China led commodity Supercycle, which resulted in broad-based demand growth and strengthening prices of all commodities, including gold which part the relationship between gold and platinum in this period. Reflecting these factors, the platinum price rose steadily from US$500/oz to $1,500/oz at the beginning of 2008 before spiking to US$2,300/oz on unencumbered China/commodity enthusiasm, and a near collapse of the electricity grid in South Africa, to a short duration peak of US$2,300/oz.

This meteoric rise was interrupted by the GFC crash and subsequent recovery between 2008 and 2009. This dented demand by 11% but the platinum price fell from its highs to below US$750/oz, a drop of almost 70%. However, the commodity Supercycle was not yet over (see China GDP below as the driving factor, including a surge in platinum jewellery demand on the price dip and rebound) and both demand and price rebounded to previous and close to previous highs respectively. The full intricacies of these moves are not captured explicitly in the annual model but are expressed in the 'other' category for the years 2008-2010 (**H**), as well as within the macroeconomic category, which reflects low real rates, a rising gold price, and a weakening rand.

2012 – 2015: End of the China driven Supercycle weighed on price whilst South African rand depreciation provided support for supply

The year 2011 was a watershed in terms of marking the beginning of the end of the China driven commodity Supercycle together with the advent of some fundamental changes to platinum demand that would influence sentiment until the present day. The end of the Supercycle prompted a general reset for demand assumptions/sentiment for all commodities (**I**) as the markets downgraded China's consumption expectations from one of voracious demand growth to a more nuanced outlook. Platinum did not escape this shift in expectations and although the market was in deficit from 2012 through 2014 (**J**), the price eased off its highs but remained elevated.

This narrative is illustrated by the price attribution model. Despite the ending Supercycle, platinum demand remained elevated (**K**), but price setting factors shifted away from underlying fundamentals with primarily macroeconomic and then sentiment factors having a greater influence on setting platinum's market value (**L**). The most significant price negative factor in the macroeconomic category was the decline in gold prices, followed by the ongoing depreciation of the rand.

Platinum market sentiment took a significant setback with 'Dieselgate' in 2015 which seriously undermined consumer and regulator confidence in diesel cars when VW illegally installed emissions control defeat devices and all other automakers installed emissions control systems that passed tests but were not fit-for-purpose in real world driving conditions. The global light-duty passenger vehicle fleet is dominated by gasoline, but in Europe by 2015, government incentives and consumer preference had resulted in diesel having a greater than 50% market share. It is worth recalling that automotive demand for platinum was historically biased to diesel vehicles and palladium to gasoline vehicles. On its own, European diesel light-duty passenger vehicle demand for platinum represented 16% of total platinum demand in 2016.

2016 – 2023: Dieselgate and the rise of EV's mislead the market on underlying demand trends

Consumers reacted to Dieselgate by switching to gasoline vehicles, diesel's share of the light duty passenger market has fallen to 12%, which in combination with the rise of BEVs dictated market sentiment that automotive demand for platinum (45% of total demand) was heading for perpetual decline. This perception was ultimately incorrect as substitution of platinum for palladium into gasoline vehicles in combination with growth in vehicle production numbers and higher loadings broadly offset the decline in light-duty diesel. Jewellery demand did decline over the period, however, initially dragging down total demand before being offset by growth in industrial demand (**M**).

The negative demand associated with the change in the drivetrain mix was ultimately reflected in both fundamentals and also sentiment through positioning in the futures

markets. Referring back to our validation exercise this ultimately led to increasing the importance of sentiment in terms of establishing platinum market value.

COVID: Systemic system failures

COVID impacted the platinum market in a number of ways but also coincided with one significant completely unrelated market shock. COVID was a hammer-blow for automotive, jewellery and industrial demand for platinum, but this was initially offset by exception investment demand (**O**). Positive investment demand was supported by mine and recycling supply challenges with the outage of Anglo American's ACP furnace and the beginning of the downturn in scrap supply on a shortage of end-of-life vehicles.

From a model perspective the demand hit was offset by the strong price of gold (**P**), which likely reflects the investment demand for gold ETFs at the same time as the significant demand for platinum ETFs. But as automotive demand recovered, this was offset by ETF outflows, in 2022 in particular (**Q**).

2023 to 2028f: Strong fundamentals combined with basket price collapses provides opportunity for price appreciation.

By 2023, fundamental demand drivers had recovered. Automotive demand for platinum nearly matched the 2016 highs, with 3,260 koz in 2023 compared to 3,215 koz in 2016. Jewellery demand also stabilized at ~2,000 koz. Combined with a constrained outlook for both primary and secondary supply, this resulted in the second-largest deficit in our dataset, at 1,028 koz. While fundamentals have returned as a strong price driver (see figure 13), market and sentiment factors have capped any significant breakout.

Sentiment has acted as a drag on prices in two of the last three years. The market remains uncertain about the future of PGM demand, weighing concerns over the rise of BEVs and the decline of ICE vehicles. In our view, this has caused an over-discounting of fundamentals in price-setting. Additionally, rising interest rates and a depreciating rand have exerted downward pressure. Despite the flat price movements in 2023, our supply-demand forecast for 2024–2028 suggests we may be approaching a value-setting inflection point.

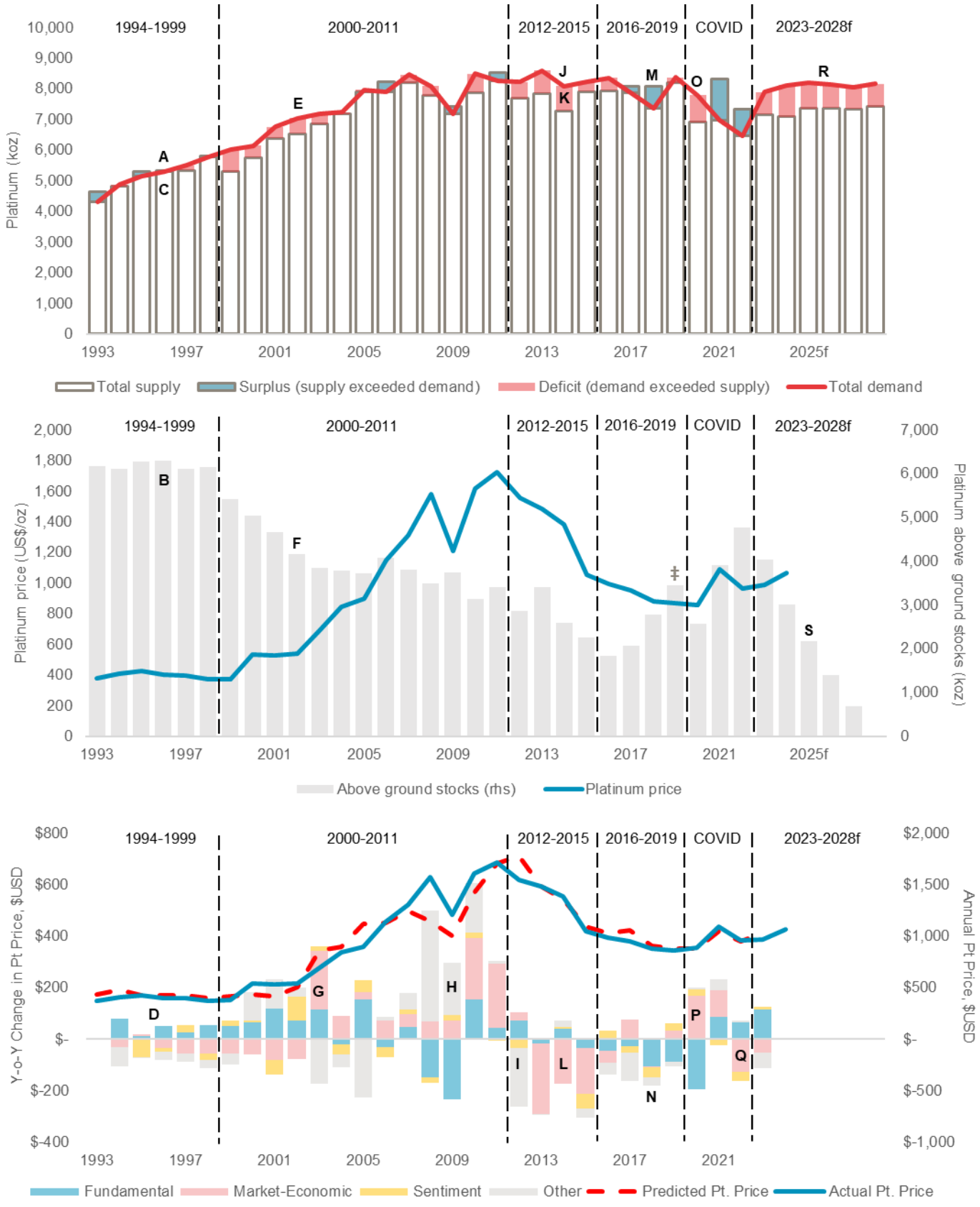
Platinum sentiment must improve:

Platinum's importance to primary supply has increased.

As discussed above the overall basket price impacts the availability of supply of the individual PGM elements. Following 2022 the prices of palladium and rhodium have effectively collapsed, removing the support provided to primary mine supply, which is increasingly distressed and in turn led to significant restructuring announcements from all of the major producers. Since 2023, platinum has become the highest revenue generator by weight in the basket once more. Despite this the upper quartile of the primary mine supply cost curve is essentially loss making or marginal at current prices.

While short-term price rallies may occur, we see little long-term fundamental support for palladium's support to the basket price from palladium. Our forecast highlights palladium transitioning into significant and growing surpluses from 2026f. This is contingent on growing recycling supply of Pd-rich vehicles reach their end-of-life following years of emission related increases to loadings. This is a palladium biased trend with an 8.9% CAGR in recycle supply vs 4.5% CAGR for platinum. Palladium will be increasingly available, whilst its demand profile is flat. On the other hand, platinum is expected to enter into sustained and significant deficits averaging -821koz over the next 5-years (2024f-2028f inclusive). In summary, the price support from palladium and rhodium that kept primary mine supply afloat is unlikely to return. With ~20% of the cost curve underwater, the market will either need to adjust platinum's price point or face reductions in primary supply.

Figure 15. From top to bottom: Platinum supply/demand and market imbalances, Platinum above ground stocks and the historical platinum price, Platinum price model influencing factors and the historical platinum price versus the predicted historical platinum price. These charts should be considered in reference to the preceding text analysis which links back to the annotated letters in the charts below.



Source: Johnson Mathey (1994-2012), SFA (Oxford) 2013-2018, Metals Focus 2019-2024f, WPIC Research, ‡ A change in above ground stock estimation methodology occurred at the end of 2018 as a result in the transition from SFA (Oxford) to Metals Focus

Supporting tables and charts

Figure 16. Summary of variables utilised in six-factor model and those excluded

Variable	Included/Reason for exclusion?
Automotive demand	Included
Jewellery demand	Included
Gold Price	Included*
Interest rates	Included*
USD:ZAR	Included
NYMEX % Net Long	Included
Mine supply	Flawed Rationale: Positive coefficient
Pt Recycling	Flawed Rationale: Positive coefficient
Industrial Demand	Multi-Collinearity, demand captured by auto and jewellery
SD Balances	Insignificant R^2
Investment Demand	Insignificant R^2
Above Ground Stocks	Insignificant R^2
CNY:USD	Insignificant R^2
S&P 500	Multi-Collinearity
US 10 Yr Break Even	High p value
Pt ETF Flows	No data time series before 2007

Source: WPIC Research

**We recognise that using log changes for price and either log changes or first differences for explanatory variables provides a clearer measurement of relative elasticity. Additionally, using constant real variables over a mix of real and nominal variables is considered best practice. While we tested logarithmic transformations and CPI-adjusted prices, the overall trends and magnitudes across fundamental, market-economic, and sentiment drivers remain consistent. For clarity and accessibility, we chose to present the model using straightforward variable inputs, prioritising ease of interpretation over complexity.*

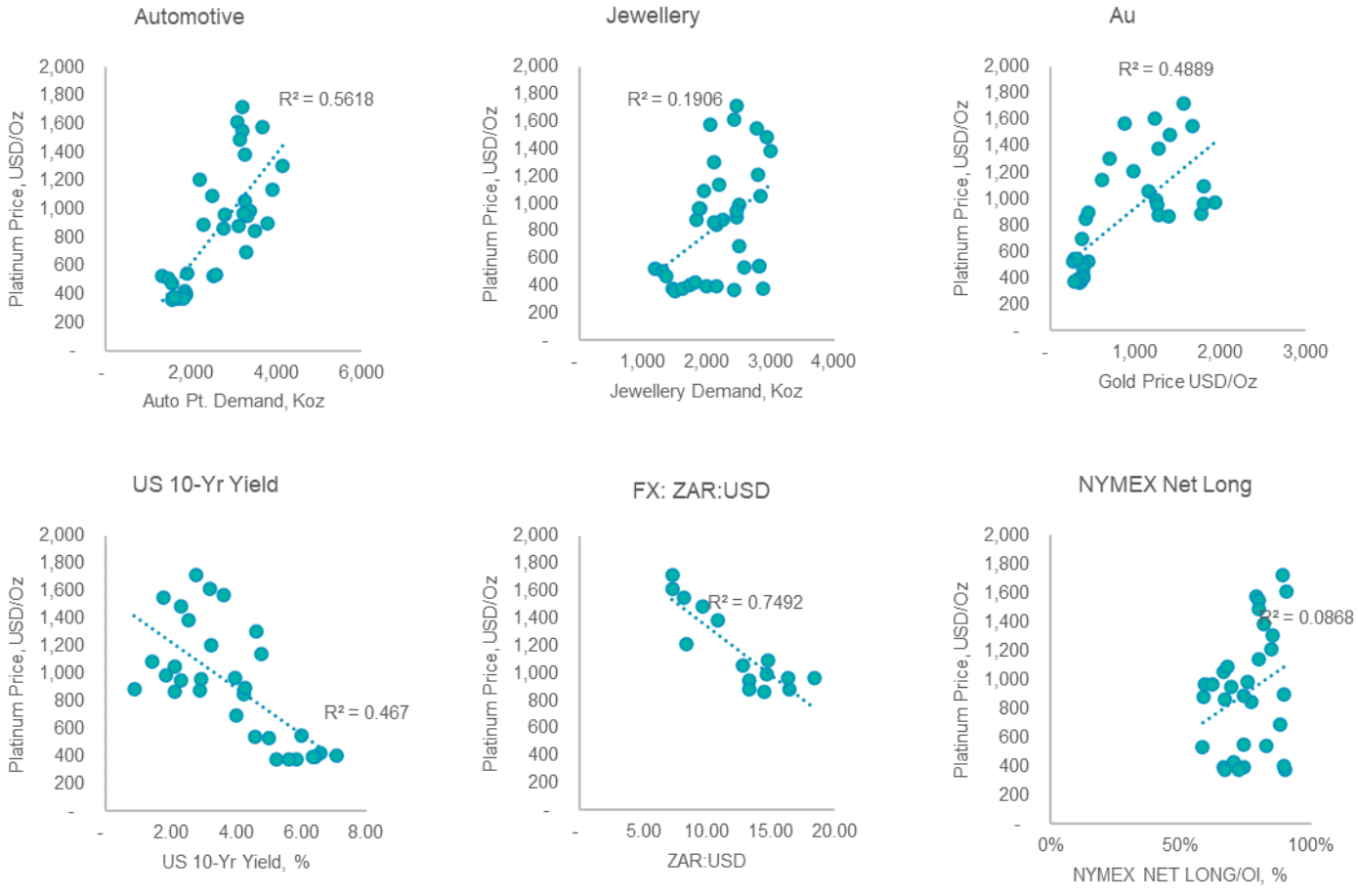
Figure 17. Example of correlations utilised in six-factor mode (1993-2023).

Regression Statistics	
Multiple R	0.954811
R Square	0.9116641
Adjusted R Square	0.8895801
Standard Error	139.28667
Observations	31

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	-653.97	526.56	-1.24	0.23	-1740.72	432.79
X Variable 1	0.28	0.04	6.53	0.00	0.19	0.36
X Variable 2	-59.57	13.42	-4.44	0.00	-87.27	-31.87
X Variable 3	369.68	354.05	1.04	0.31	-361.04	1100.41
X Variable 4	0.23	0.08	3.09	0.00	0.08	0.39
X Variable 5	0.68	0.10	6.85	0.00	0.48	0.89
X Variable 6	-23.98	36.83	-0.65	0.52	-99.99	52.04

Source: WPIC Research

Figure 18. Example of correlations utilised in six-factor mode (1988-2023).



Source: WPIC Research

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