



IHS Markit®

Automotive factors drive returns



A transformative period

The automotive industry is one of the world's largest drivers of economic growth and cultural change and is a catalyst for exciting new technologies. Today, the industry is facing the most transformative period of change in its history as three key technologies converge:

- Connectivity
- Autonomous driving
- Electrification

Securing a competitive advantage

Largescale disruption from technological and social change has increased the difficulty of predicting the future of the automobiles sector. Although automobile sales and production results remain key components to stock performance, it has become more challenging to find information relevant to the global markets. In addition, the changing importance of electrification, trade tariffs and emerging markets has led to stock prices driven by factors that may not be captured in standard financial statement ratios. Access to additional insight to understand potential trends among automobile manufacturers could provide a key competitive advantage.

Increasingly investors are looking towards alternative data for alpha generation. IHS Markit has introduced a suite of automotive signals that tap into our proprietary automotive datasets designed to generate signals which can improve stock selection models and provide deeper insight into the operations of original equipment manufacturers (OEMs).

This study will analyze our automobile research signals, whilst reviewing factor performance and correlations with other standard factors.

Methodology framework

- Utilizing robust statistical automotive datasets from IHS Markit that include vehicle sales and production history, aggregated registration information, manufacturing volumes and vehicle pricing insight across various geographies, Research Signals offers 32 quantitative equity factors that complement both fundamental and quantitative methods
- Factors are backtested over a universe of various geographies and manufacturers going back to 2008

Key findings

- The strongest performance with factors comes from monthly trend in sales growth (2.46%) and YOY change in unit sales (2.13%) as measured by monthly average quintile return spread, with low correlations to existing growth, momentum and value factors
- Factors based on production, including YOY change in production output (1.62%), also demonstrate positive monthly average quintile return spreads, driven specifically by strong performance by companies increasing production
- Unique factors measuring electrification, such as monthly change in electric ratio (1.25%), show promise as diversifying signals with positive results and low correlation to sales and production factors

Automobile research signals

IHS Markit provides historical and forecasted automotive industry insights for the US and global markets. Traditionally used for decision-making by OEMs and suppliers, the data provides market-driven intelligence on historical production and sales volumes across segments (light vehicles, medium- and heavy-duty vehicles and commercial vehicles), along with analysis on various technology and components in the industry. On a global level, IHS Markit also measures statistical data on new and used vehicle registrations, vehicles in operation and predictive consumer behavior with granularity down to transaction type, brand loyalty and other metrics. Our extensive automotive dataset supports its forecasts of trends shaping the future of the automotive industry.

Our datasets have traditionally been leveraged for product planning, marketing, sales and aftermarket measurement. As savvy investors look toward alternative data for alpha generation, the breadth and depth of our metrics can offer a strong value.

We combine our Research Signals team's quantitative research capability with key elements of this proprietary data, specifically looking for factors that are drivers of stock price performance. These signals can improve stock selection models within the automotive industry and provide deeper insights into the operations of OEMs.

Critical data and insight

For decades, financial institutions, automotive manufacturers, suppliers and dealers, along with their agency partners, have relied on IHS Markit as a trusted source of critical information and insight.

Today, our data, analysis and forecasts fuel a broad range of solutions that support long-term decisions and everyday execution from product, strategy and planning to engineering, manufacturing, supply chain, marketing, sales and the aftermarket.

For this research, we have utilized the following proprietary IHS Markit data sources for historical data:

- **Light vehicle production (global)** - Light vehicle production data offers an in-depth view of historical production levels across 50 countries, 600 plants and 2,300 models, plus information about alternative-propulsion-powered light vehicles.
- **Light vehicle sales (global)** - With 10 years of historical data, our light vehicle sales data provides comprehensive geographic coverage of model sales in 70+ countries across 11 regions, representing more than 97% of global light vehicle sales volume.
- **US & global new vehicle registrations/sales** - National monthly new registration/sales data for various markets provides various technical details, pricing and specification data, sales channel and emissions details and varies from market to market.

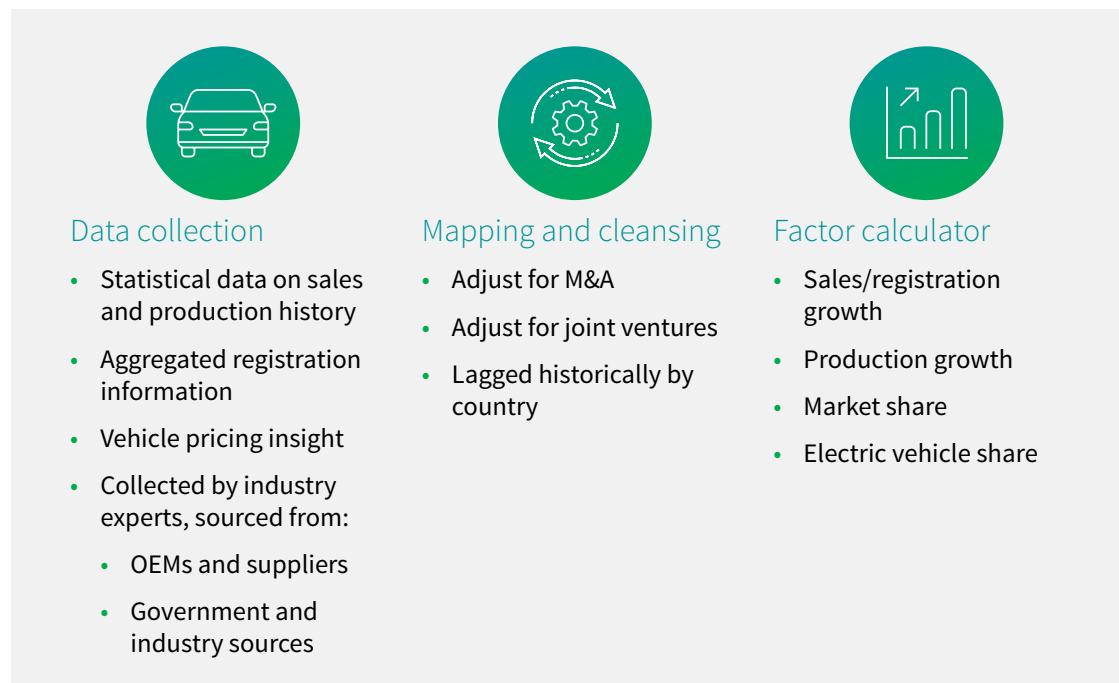
These datasets have a deep history, going back to 2008 in most cases, and global coverage. They are updated on a monthly basis, much more timely than standard financial statement reports. The following steps (Figure 1) outline our data collection process:

- **Data collection** – Automotive analysts at IHS Markit are experts in the automotive space, working hand-in-hand with OEMs and members of the supply chain to solve business problems. The team collects robust automotive insight from a variety of sources, including OEMs, suppliers, industry associations, ancillary businesses and government entities.
- **Mapping and cleansing** - The Research Signals team has taken care to map the automotive data to the appropriate companies and equity securities. This mapping accounts for joint ventures and mergers and acquisition activity that has occurred historically. Additionally, appropriate lags have been applied to the data to ensure there is not look-ahead bias in the factors. The data collected by the automotive analyst team is published monthly with different lags for each country and/or OEM. We have

applied conservative lags to the data in our backtests as appropriate to account for data availability in different markets. For example, due to different times of publication, US sales data is lagged one month while China sales data is lagged two months.

- **Factor calculation** - Using the unique automotive statistical data, we produce factors that detail the operations of automotive manufacturers using industry-specific measures across a few categories. Sales-based factors measure historic sales growth, implied revenue, market share in key markets like US and China and sales surprise based on seasonally adjusted unit sales and registrations. Production factors look at the trend in production output and measures of plant utilization. Vehicle trends factors look at changes in model life cycle and changes in a company’s involvement in the electric vehicle market.

Figure 1



As an example of the granularity of the data used, we show the following sample (Table 1) of historic unit sales/registrations of the Chevrolet Cruze across the top 10 countries in 2017:

Table 1

Chevrolet Cruze – Top 10 countries unit sales/registrations in 2017													
Country	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
United States	19,949	15,368	18,608	21,317	17,120	12,828	12,278	16,500	15,268	11,129	10,982	13,407	184,754
China	8,558	3,589	3,402	5,333	3,273	6,191	6,720	5,056	7,228	7,938	10,165	11,882	79,335
Canada	1,884	1,715	2,711	3,174	4,097	2,843	2,233	1,995	2,202	1,724	1,892	1,487	27,957
Brazil	1,513	1,278	2,152	2,256	2,498	2,308	2,571	2,789	2,284	2,300	2,386	2,168	26,503
Argentina	1,563	1,289	1,552	1,236	1,239	1,435	1,325	1,710	1,590	1,506	1,387	735	16,567
South Korea	232	6	2,147	1,518	1,160	1,434	1,050	429	416	297	821	1,076	10,586
Mexico	477	450	1,045	1,333	663	578	488	341	141	262	266	305	6,349
Vietnam	283	254	325	170	261	187	211	148	220	208	186	194	2,647
India	171	188	192	68	71	219	48	48	-	-	-	-	1,005
Israel	129	125	95	62	94	62	117	59	80	61	69	6	959

Source: IHS Markit

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In total, using the historical set of automotive data back to 2008, we have created several factors that capture historical sales trends, production trends, market exposures and electrification policies of the automobile manufacturers. We note that we are not utilizing our analysts' proprietary forecasts for these factors. In total, we have constructed 32 factors designed to predict global automotive stock returns. For reporting purposes, we have selected key factors (Table 2) that are representative of the factor group, while the others may be highly correlated to these factors.

Table 2

Research Signals Automotive factors		
Factor type	Factor	Definition
Model life cycle	YOY change in life cycle	YOY percent change in weighted average model life cycle for the auto manufacturer
Production	Plant utilization	Current level of plant utilization
	Monthly trend in production growth	Monthly change of trend component of # of units produced
	YOY change in production output	YOY percent change in number of units produced
Market share	Monthly trend in China market share	Monthly percent change of trend component of market share of China (sales)
	Monthly change in market share in dominant market	Monthly percent change of market share of the OEMs dominant market, as measured by market share over the past 12 months
Sales/registrations/revenue	Monthly trend in implied revenue	Monthly change of trend component of implied revenue, based on number of units sold/registered multiplied by benchmark model price
	YOY change in implied revenue	YOY percent change in implied revenue, based on number of units sold/registered multiplied by benchmark model price
	Trend in 3-month sales/registrations growth	The rolling 3-month trend component of unit sales/registrations growth
	3-month unit sales/registrations surprise	The deviation of the last rolling 3-month sales/registrations from expectation based on trend line of number of units sold/registered
	Monthly trend in sales/registrations growth	Monthly percent change of trend component of number of units sold/registered
	Unit sales/registrations surprise	The deviation of last month's sales/registrations from expectation based on trend line of number of units sold/registered
	YOY change in unit sales/registrations	YOY percent change in number of units sold/registered
	YOY change in US market share	YOY percent change in share of the US market
Electrification	Monthly change in electric ratio	Monthly percent change in company's electric vehicle share as measured by weighted average electric vehicle exposure

Source: IHS Markit

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For the purposes of this research, we study factor performance on a universe of nearly 60 OEMs (see Table A1 in the Appendix). We have applied appropriate lags and historical mapping to the data. Because data is reported and collected with different lags varying by market, our factors use the freshest data available for the major markets. Further details of the lags applied can be found in the Appendix (see Table A2).

Factor performance

Next, we analyze factor performance for the newly introduced Automotive factors. To test factor efficacy, we capture performance at the extremes by computing quintile returns in excess of the universe. We begin by sorting the universe into five quintiles at the beginning of each month, with the top ranked, or buy-rated, names assigned to quintile 1 (Q1) and the bottom ranked, or sell-rated, names in Q5. At the end of each month, we then compute the equal-weighted quintile return using USD total returns and report the return spread between Q1 and Q5, simulating a global automotive long-short portfolio.

Average monthly quintile return spreads (Table 3) are reported for the full backtest period from July 2008 through November 2018, for which all factors have available data, though some factors may have earlier available data. We also break out results from January 2010 through November 2018 to remove the effect of volatile returns around the financial crisis period. To check robustness, we also report results in the Appendix (see Table A3), for a universe where stocks with market caps below \$500m are filtered out on a monthly basis to remove the effects of market frictions often associated with trading microcaps. The results are consistent with the full universe results reported below.

Top performing factors since July 2008 include monthly trend in sales/registrations growth (2.46%) and YOY change in unit sales/registrations (2.13%). Several similar factors followed closely behind including trend in 3-month sales growth (1.76%) and YOY change in production output (1.62%), along with YOY change in implied revenue (1.89%), which is derived from the actual sales/registration data and benchmark prices. Since the financial crisis, the top performing factors were again monthly trend in sales/registration growth (1.57%) and YOY change in unit sales/registrations (1.31%), along with other factors of interest including YOY change in US market share (1.27%) and monthly trend in China market share (1.26%).

Table 3

Automotive factor performance		Average quintile return spread (%)	
Factor type	Factor	Jul 2008 - Nov 2018	Jan 2010 - Nov 2018
Model life cycle	YOY change in life cycle	-1.66	-0.95
Production	Plant utilization	0.17	0.52
	Monthly trend in production growth	1.41	0.93
	YOY change in production output	1.62	1.26
Market share	Monthly trend in China market share	1.44	1.26
	Monthly change in market share in dominant market	0.18	0.10
Sales/revenue	Monthly trend in implied revenue	1.61	0.80
	YOY change in implied revenue	1.21	0.47
	Trend in 3-month sales/registrations growth	1.76	0.95
	3-month unit sales/registrations surprise	1.01	1.11
	Monthly trend in sales/registrations growth	2.46	1.57
	Unit sales/registrations surprise	1.36	1.20
	YOY change in unit sales/registrations	2.13	1.31
	YOY change in US market share*	0.52	1.27
Electrification	Monthly change in electric ratio**	1.25	0.63

Source: IHS Markit

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*YOY change in US Market Share does not have uniform quintile coverage due to the number of companies with 0 or 100% US market share

**Monthly change in electric ratio does not have uniform quintile coverage due to the number of companies with electric ratio equal to zero

Detailed factor results

In this section we show detailed results for three of the factors we have created – YOY change in historic unit sales/registrations, unit sales/registrations surprise and YOY change in production output. All results are again measured on an equal-weight basis, using USD total returns with a 1-month holding period.

YOY change in unit sales/registrations

YOY change in unit sales/registrations measures the percentage change in the current number of units sold/registered compared with one year prior. Based on this gauge of the growth in sales, the average quintile return spread over this factor's longer available period beginning in April 2008 through November 2018 was 2.14% (Figure 2). The overall hit rate, or percent of months with positive performance, was 65%.

To gain a view of the full distribution of returns on a cross-sectional basis, we also report the average monthly return for each of the five quintiles (Figure 3). Quintile 1 average returns (2.01%) outperformed the remaining quintiles, with returns decreasing monotonically across quintiles, a preferred property when implementing both quantitative and fundamental strategies.

Figure 2

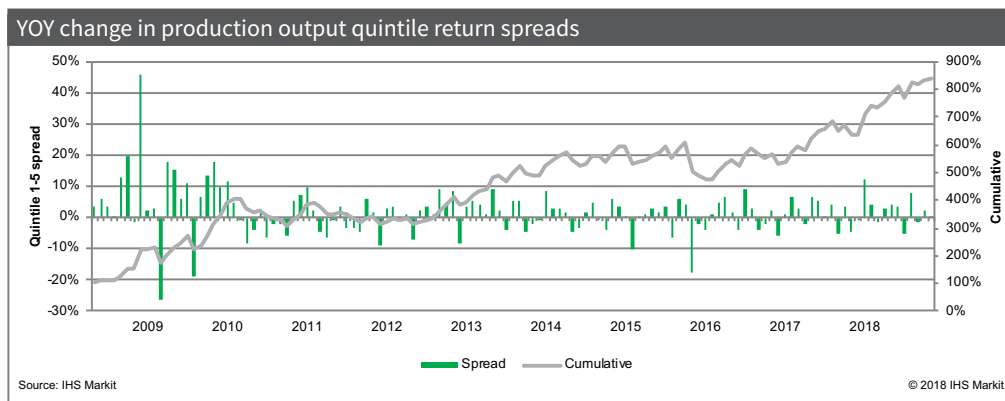
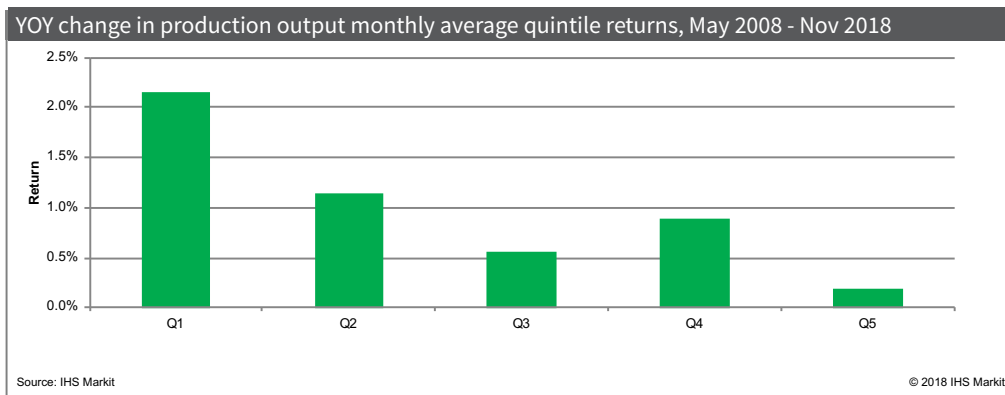


Figure 3



Unit sales/registrations surprise

To compute unit sales/registrations surprise, we first determine the trend line in the monthly number of units sold/registered over the past year and then calculate the percentage deviation of the recent most sales/registrations from expectation. The average monthly quintile return spread for this factor since April 2008 (Figure 4) was 1.39% with a hit rate of 55%. Top quintile returns (Figure 5) were concentrated in Q1 with a monthly average of 1.79%, clearly outstripping the remaining quintiles.

Figure 4

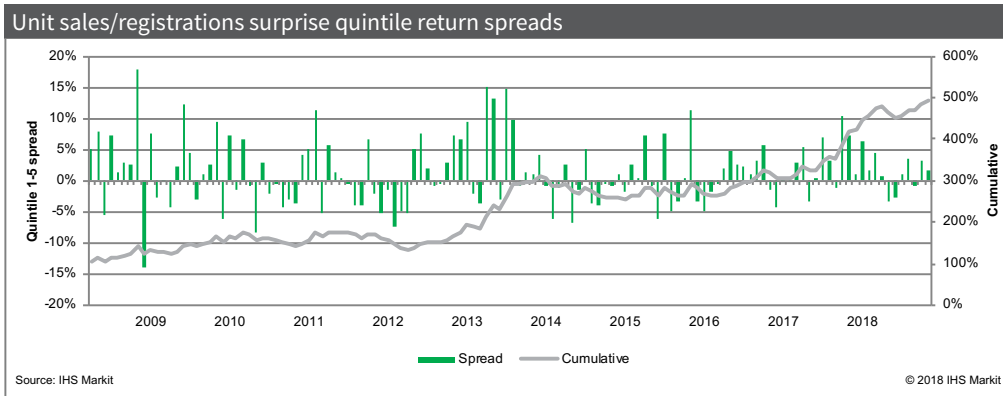
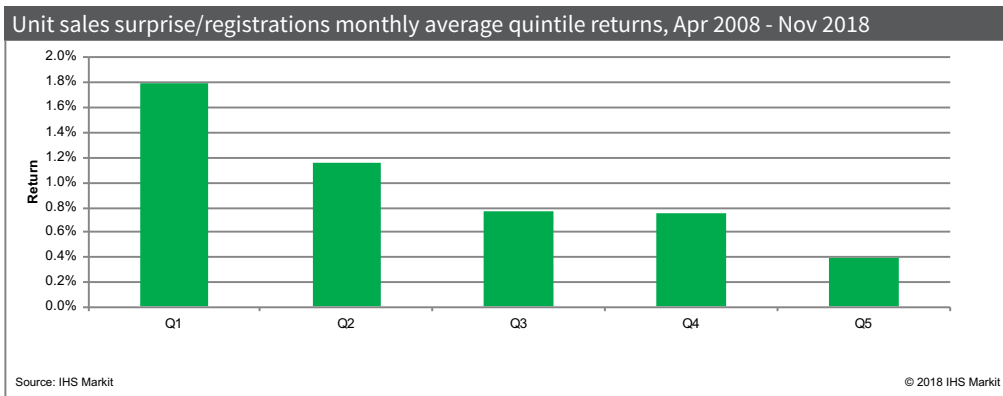


Figure 5



YOY change in production output

As a gauge of the rate of production, YOY change in unit production output measures the percentage change in the current number of units produced compared with one year prior. We find companies which increase their production on a year-over-year basis tend to outperform the peer group. Over the full backtest period, the quintile return spreads averaged 1.97% on a monthly basis (Figure 6), with no extended periods of underperformance with outperformance in 65% of months. Looking across quintiles (Figure 7), Q1 monthly average returns reached 2.15%, nearly double that of each of the remaining quintiles.

Figure 6

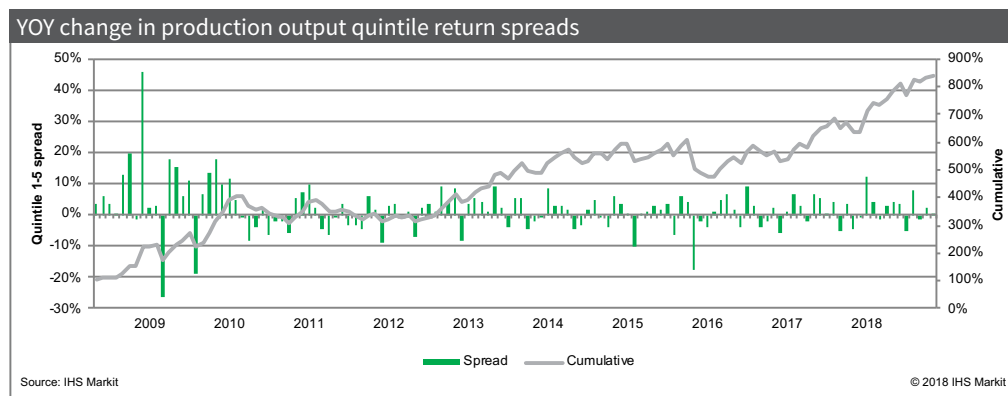
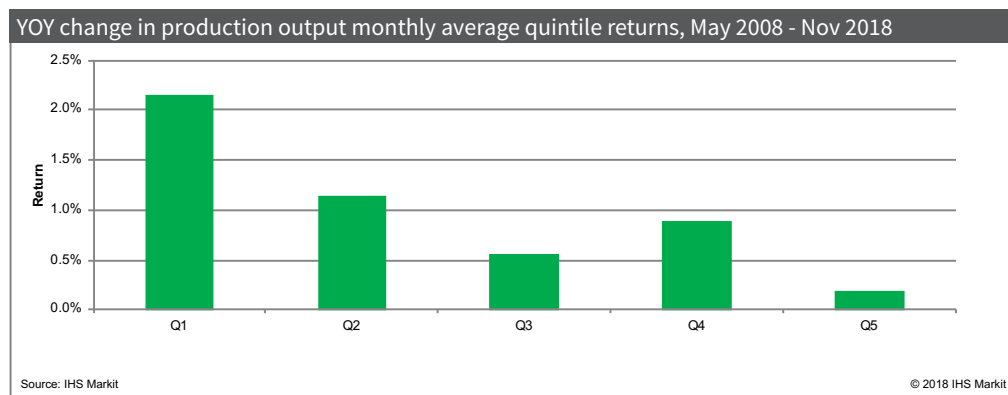


Figure 7



Factor correlations

Lastly, we analyze correlations among the Automotive factors along with other pertinent factors in our factor library. To begin with, we report the correlations of the monthly quintile return spreads for the three factors detailed above with the full suite of Automotive factors from April 2008 to November 2018 (Table 4).

YOY change in life cycle, plant utilization and YOY change in US market share, while not strong performing factors, have very low correlations to the other factors, a trend that carries over to the other factors not reported here. We especially draw attention to the negative average correlation (-20%) of YOY change in life cycle with the remaining factors.

YOY change in unit sales/registrations quintile return spreads tend to have high co-movement with the other factors, with an average correlation of 37% and the highest levels associated with monthly trend in sales/registrations growth (83%) and trend in 3-month sales/registrations growth (69%). On the other hand, unit sales/registrations surprise is more neutrally correlated with the other factors, with an average correlation of just 14%.

As expected, another pattern that persists across the full correlation matrix (not shown here) is high correlations between factors capturing similar types of trends. For example, the factors measuring production growth tend to have positive correlations.

Table 4

Automotive factor monthly quintile return spread correlations, Apr 2008 – Nov 2018				
Factor type	Factor	YOY change in unit sales/registrations	Unit sales/registrations surprise	YOY change in production output
Model life cycle	YOY change in life cycle	-0.35	-0.17	-0.31
Production	Plant utilization	0.07	0.10	0.00
	Monthly trend in production growth	0.57	0.15	0.60
	YOY change in production output	0.61	0.21	1.00
Market share	Monthly trend in China market share	0.35	0.03	0.33
	Monthly change in market share in dominant market	0.35	-0.09	0.37
Sales/revenue	Monthly trend in implied revenue	0.44	0.04	0.31
	YOY change in implied revenue	0.41	0.02	0.37
	Trend in 3-month sales/registrations growth	0.69	0.11	0.53
	3-month unit sales/registrations surprise	0.39	0.47	0.37
	Monthly trend in sales/registrations growth	0.83	0.35	0.53
	Unit sales/registrations surprise	0.54	1.00	0.21
	YOY change in unit sales/registrations	1.00	0.54	0.61
	YOY change in US market share*	-0.05	-0.05	0.12
Electrification	Monthly change in electric ratio**	0.31	0.29	0.21

Source: IHS Markit

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We also run correlations of our proprietary factors to other factors in our library over the same automotive manufacturer universe (Table 5). Again we focus our presentation on the same three factors highlighted above. All three factors tend to be neutrally to negatively correlated with these common factors, a desirable feature in multifactor applications. In particular, YOY change in unit sales and YOY change in production output have negative average correlations (-13%) with the full set of common factors. For the former, the most negative co-movements were associated with 3-yr Compound Annual Sales Growth (-26%) and 1-yr Growth in TTM Earnings per Share (-23%), which was also negatively correlated (-27%) with the latter, along with 12-month Active Return with 1-month Lag (-22%).

Furthermore, we look at average monthly rank correlations of the automotive factors to our standard factors. Here we again find low correlations with the common factors, highlighting the additional information provided by the proprietary factors beyond traditional signals, as demonstrated by the neutral average correlation of unit sales surprise with the other measures.

Lastly, while we again do not report all factor correlations here, we remark that our findings suggest the automotive factors are quite orthogonal to existing factors based on the quintile return spread correlations. The highest correlation is seen between YOY change in US market share and return on assets at just 26%. Also of interest for rank correlations, we find moderate correlations, generally in the 0-25% range with sales growth factors.

Table 5

Automotive factor monthly correlations, Apr 2008 – Nov 2018							
Factor type	Factor	Quintile return spread correlation			Rank correlation		
		YOY change in unit sales / registrations	Unit sales / registrations surprise	YOY change in production output	YOY change in unit sales / registrations	Unit sales / registrations surprise	YOY change in production output
Earnings Revisions	3-M Revision in FY1 EPS Forecasts	0.00	0.01	-0.11	0.12	0.05	0.11
Growth	3-yr Compound Annual Sales Growth	-0.26	-0.05	-0.12	0.19	-0.03	0.13
	1-yr Chg in QTR Inventory as % of Sales	-0.14	0.15	-0.20	0.03	-0.09	0.04
	1-yr Growth in TTM Earnings per Share	-0.23	0.17	-0.27	0.14	-0.05	0.10
	1-yr Change in Sales	-0.18	0.13	-0.17	0.29	0.00	0.25
	12-Month Active Return with 1-month Lag	-0.13	-0.02	-0.22	0.22	0.08	0.18
Quality	Net Profit Margin	-0.15	0.11	-0.11	0.22	0.02	0.18
	Return on Assets	-0.19	0.08	-0.06	0.18	0.00	0.14
Value	Book-to-Market	0.00	0.02	0.08	-0.09	0.02	-0.11
	TTM EPS before Extra Items-to-Price	-0.05	0.19	-0.11	0.10	0.01	0.08

Source: IHS Markit

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Conclusion

IHS Markit has a long track record of providing critical analysis for US and global automotive industry participants. Using our proprietary analytics and datasets, we introduce 32 Automotive signals constructed from factors that quantify a company's historic sales/registrations growth, production trends, market share, production utilization and involvement in the electric vehicle market to systematically score stocks within the global automotive industry.

We evaluate factor performance over the universe of global automotive manufacturers going back to 2008. Top performing factors based on average monthly quintile return spreads (Q1-Q5), include monthly trend in sales growth (2.46%) and YOY change in unit sales (2.13%). More detailed results are also presented for YOY change in unit sales/registrations, unit sales/registrations surprise and YOY change in production output, where we find attractive average monthly quintile spreads of 2.14%, 1.39%, and 1.97%, respectively, over the full backtest period, driven by particularly favorable Q1 returns and hit rates approaching 60%.

We conclude with analysis of correlations among the Automotive factors along with other pertinent factors in our factor library. Some key findings include high correlations between factors capturing similar types of trends, though YOY change in life cycle, plant utilization and YOY change in US market share, while not strong performing factors, have very low correlations to the other factors. Quintile return spread correlations also show our proprietary factors are orthogonal to existing growth, momentum and value factors.

Appendix

Table A1

Automotive companies covered		
Company name		
ANHUI JIANGHUAI AU	GAC CHANGFENG MOTO	NISSAN MOTOR CO
ASTON MARTIN LAGON	GAZ	OTOKAR OTOMOTIV
AUDI AG	GEELY AUTOMOBILE	PEUGEOT SA
AVTOVAZ PJSC	GENERAL MTRS CO	PIAGGIO
BAIC MOTOR CORP LT	GREAT WALL MOTOR	PORSCHE AUTO
BAYER MOTOREN WERKS	GUANGZHOU AUTOMOBIL	PROTON HLDGS BHD
BRILLIANCE CHINA	HAIMA AUTOMOBILE	QINGLING MOTORS
BYD COMPANY LTD	HINDUSTAN MOTORS	RENAULT SA
CHINA MOTOR CO	HONDA MOTOR CO	SAIC MOTOR CORP
CHONG QING CHANGAN	HYUNDAI MOTOR CO	SOLLERS PJSC
DAIHATSU MOTOR CO	ISUZU MOTORS	SSANGYONG MOTOR
DAIMLER AG	JIANGLING MOTORS	SUBARU CORPORATION
DONGFENG MOTOR GRO	KARSAN OTOMOTIVE S	SUZUKI MOTOR CORP
FAW CAR CO	KIA MOTORS CORP	TATA MOTORS LTD
FDG ELECTRIC VEHIC	LIAONING SG AUTOMO	TESLA INC COM
FERRARI NV	LIFAN INDUSTRY	TIANJIN FAW XIALI
FIAT CHRYSLER AUTO	MAHINDRA MAHINDRA	TOYOTA MOTOR CORP
FIAT CHRYSLER AUTOMOBILES	MAZDA MOTOR CORP	VOLKSWAGEN AG
FIAT SPA	MITSUBISHI MOTOR CORP	YULON MOTOR
FORD MTR CO	NIO INC	

Source: IHS Markit

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Table A2

Lags applied in Automotive factor calculation		
Country	Months lag applied to sales	Months lag applied to production
Argentina	1	1
Australia	1	N/A
Belgium	1	2
Brazil	1	1
Canada	1	2
China	2	2
France*	1	2
Germany	1	2
India	2	5
Indonesia	2	2
Iran	2	2
Italy	1	2
Japan	2	3
Malaysia	2	2
Mexico	2	2
Netherlands	1	2
Philippines	3	2
Poland	1	2
Russia	2	2

Lags applied in Automotive factor calculation		
Country	Months lag applied to sales	Months lag applied to production
South Africa	1	2
South Korea	2	2
Spain	1	2
Sweden	1	2
Taiwan	1	2
Thailand	2	2
Turkey	2	2
United Kingdom	1	2
United States	1	2

Source: IHS Markit © 2018 IHS Markit
 *Varies by producer

Table A3

Automotive factor performance with a \$500m market cap filter applied monthly				
		Average quintile return spread (%)		
Factor type	Factor	Jul 2008 - Nov 2018	Jan 2010 - Nov 2018	
Model life cycle	YOY change in life cycle	-1.76	-0.98	
Production	Plant utilization	-0.18	0.51	
	Monthly trend in production growth	1.56	0.85	
	YOY change in production output	1.64	0.92	
Market share	Monthly trend in China market share	1.52	1.14	
	Monthly change in market share in dominant market	0.82	0.49	
Sales/revenue	Monthly trend in implied revenue	1.94	0.76	
	YOY change in implied revenue	1.11	0.41	
	Trend in 3-month sales/registrations growth	2.45	1.08	
	3-month unit sales/registrations surprise	1.21	1.23	
	Monthly trend in sales/registrations growth	2.63	1.26	
	Unit sales/registrations surprise	1.13	0.90	
	YOY change in unit sales/registrations	1.95	0.67	
	YOY change in US market share*	0.66	1.27	
Electrification	Monthly change in electric ratio**	1.53	0.60	

Source: IHS Markit © 2018 IHS Markit

*YOY change in US Market Share does not have uniform quintile coverage due to the number of companies with 0 or 100% US market share

**Monthly change in electric ratio does not have uniform quintile coverage due to the number of companies with electric ratio equal to zero

For more information ihsmarkit.com/researchsignals

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