



Investment Sciences

Forecasting CarMax Sales with Alternative Data

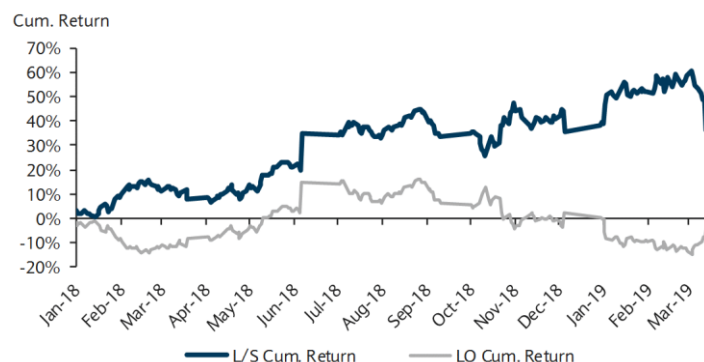
We have developed a model for CarMax (KMX) quarterly sales growth driven by alternative data that can provide timely forecasts. In historical testing, the relative growth in our alt estimate vs consensus would have been a strong indicator for stock price movement, with a simple back-test generating a 35% return since January 2018. Our model is forecasting F1Q19 total revenue of \$5,292 million (up 10.4% Y/Y) versus the consensus estimate of \$5,148 million (up 7.4% Y/Y). For the backup data product, please see [CarMax, Inc Alt Data Estimates 06-17-2019](#). CarMax is not covered by Barclays Equity Research.

CarMax is the largest used-car retailer in the United States, and like many other publicly traded retail companies, its stock price movement is highly correlated with comparable store sales. Unlike most other used-car retailers, CarMax operates a website with intraday updates of its used-car inventory, making it possible to scrape snapshots of their inventory on a daily basis. Using this inventory data, gathered by Thinknum, we can generate a signal for CarMax's daily sales by summing up the prices of the cars that have disappeared from the prior day's inventory. After some additional adjustments (detailed on pages 3-4), this approach appears to be more accurate than consensus in predicting CarMax's quarterly sales.

Typically, we are able to start forecasting CarMax quarterly sales two weeks into the quarter, but we find estimates generally become more stable and accurate after 45 days into the quarter. A long/short trading strategy based on whether our forecast is above or below consensus would have outperformed a long position in KMX stock, that was hedged with an equal notional short in the S&P 500, since 2018.

FIGURE 1

Back-testing our sales model using a simple rule between our estimate and consensus implies a return of ~35% since the start of 2018



Source: Refinitiv, Barclays Research

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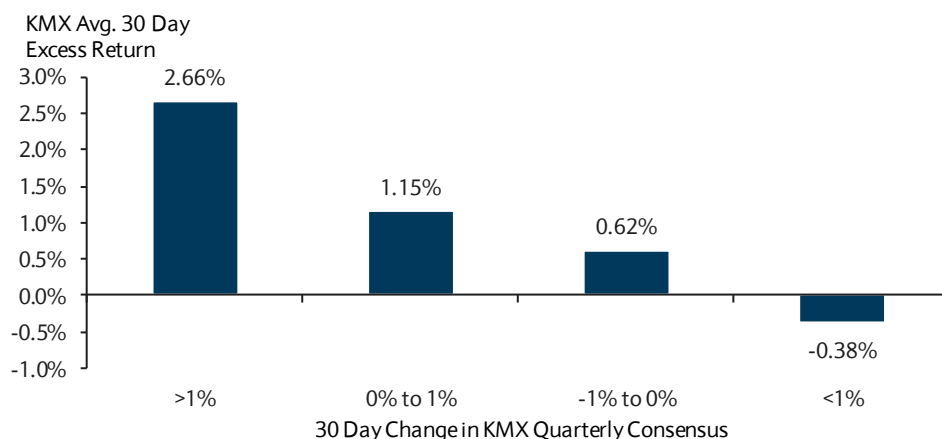
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Forecasting CarMax's Sales Using Web Scraped Data

CarMax (KMX) is the largest used-car retailer in the United States, and like many other publicly traded retail companies, its stock price movement is highly correlated with comparable store sales performance and with the migration of consensus estimates toward the actual reported values (Figure 8). Timely and more accurate forecasts for CarMax's quarterly sales can provide investors with opportunities to trade around earnings and potentially generate outsized returns (Figure 2).

FIGURE 2

CarMax excess returns are correlated with evolutions in quarterly consensus estimates



Source: Refinitiv, Compustat, Barclays Research

The fact that CarMax operates a website with intraday updates of its used car inventory makes it possible to scrape their website and take snapshots of their inventory on a daily basis. Starting with these publicly disclosed inventory values, we can build models to forecast CarMax's quarterly sales by following this procedure:

- Capture CarMax's inventory history;
- Add up the value of the cars that disappear to produce a daily sales estimate;
- Trim the estimate to account for the potential for cars to reappear in the inventory;
- Aggregate the trimmed daily sales up to quarterly values;
- Use regression models to empirically normalize for differences between the sales we observe and the sales that CarMax reports, which includes unobserved discounts, auction sales, and a small number of revenue items we can't discern from the website.

We think this method works well enough to pass the “can it help me make a better decision” test. When viewed historically, our alt estimates would have been directionally more correct than consensus, especially early in each quarter. Second, a back test of a simple trading strategy based on the differences between our alt estimates and consensus would have generated substantial excess returns.

Building the Alt Data Quarterly Sales Model for CarMax

Data – Webscraped Inventory Data from Thinknum

The starting point for any alternative data-based model is the data. Thinknum is a data vendor that specializes in pre-packaged webscrapes. It provides a dataset that has daily information on CarMax's historical inventories, including vehicle identification number (VIN), price, make, model mileage and location of each car, with history back to March 2016.

FIGURE 3
CarMax total vehicles in inventory



Source: Thinknum, Barclays Research

Basic Estimates – Add Up the Prices of the Cars That Disappear from Inventory

The basic idea behind turning this inventory dataset into daily sales estimates is to record the last observed date and price for each VIN as its sold date and sold price. Then, we can sum up the price of each car that left the inventory on a given day, and treat that as the preliminary estimate for the daily sales.

Initial Refinements – Trimming to Account for Inventory Changes that Aren't Final Sales

The biggest refinement necessary from the initial approach is that VINs often disappear for reasons other than sales, and reappear at a later time, producing an upward bias to the basic sales estimate. VINS can reappear up to a year later, though most of these non-sales return to the site within a few weeks. To solve for this, we estimated a series of trimming factors (Figure 4) based on the empirical likelihood of an apparent sale reversing within a given number of days from the current date:

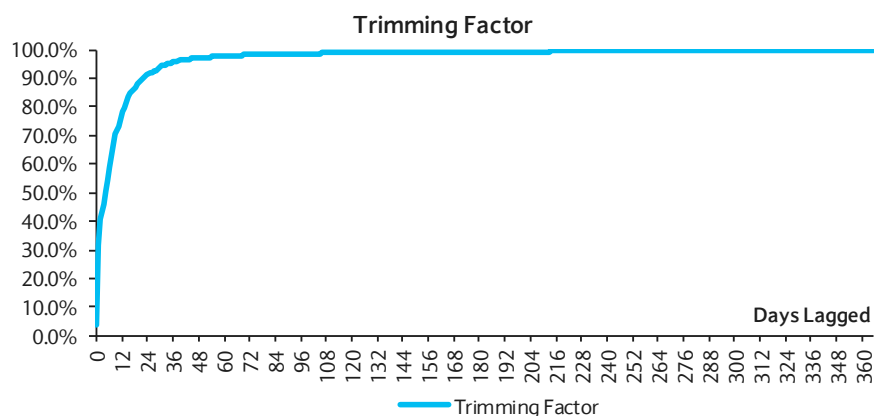
$$TF_{i,t} = Sales_{i,t} / Sales_{0,t}$$

where i is number of days from current date, and t is date

This trimming factor is applied to each day's sales estimate to produce a more appropriate preliminary estimate.

FIGURE 4

Trimming factor applied daily sales as a function of number of days lagged



Source: Barclays Research

Scaling up to Quarterly Sales

Since CarMax reports sales on a quarterly basis, we will need to aggregate daily sales to quarterly sales in order to build models for forecasting. For all historical quarters, this means simply summing daily values according to CarMax's fiscal quarter range, but for the current quarter, since we want to provide forecasts as early as just two weeks in, we need to scale up the observed QTD values by assuming that the QTD Y/Y growth, compared to the previous year, will stay the same through the rest of the quarter:

$$Full_{Current} = Full_{Last\ Year} \times \frac{QTD_{Current}}{QTD_{Last\ Year}}$$

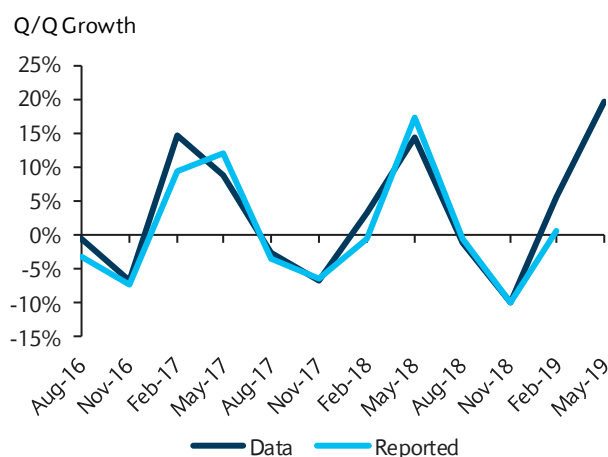
Now we have quarterly sales data aligned with quarterly reported sales, and can build models to make forecasts.

Normalizing Our Estimates to Better Match Reported Sales Values

There is clearly a linear relationship between the data we gathered and reported values we are trying to model, so we believe a simple OLS regression model is our best choice for estimating reported sales from our preliminary estimate. Still, we have three options to set up our OLS regression model – using Level (raw data), Q/Q, or Y/Y as the input. Our experiments show that using Q/Q as the input generates the best back-test results, and Y/Y data has great potential if we have longer history. We will stay with the Q/Q model for now.

FIGURE 5

Data vs. reported values, Q/Q



Source: Refinitiv, Barclays Research

FIGURE 6

Naïve OLS regression model, live back-test

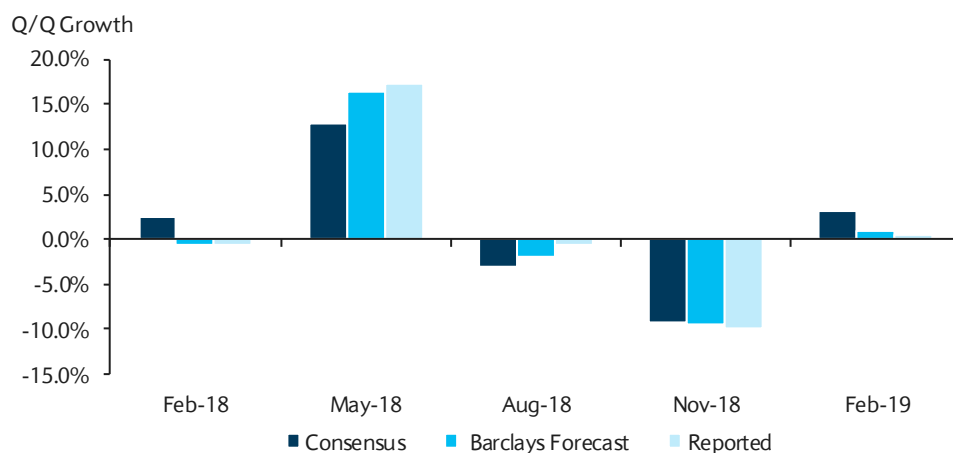
Quarter	Barclays Forecast	Reported	Error
8/31/2017	-2.3%	-3.4%	1.1%
11/30/2017	-6.6%	-6.4%	-0.2%
2/28/2018	2.0%	-0.6%	2.5%
5/31/2018	11.3%	17.3%	-6.0%
8/31/2018	-1.6%	-0.6%	-1.1%
11/30/2018	-10.0%	-9.9%	-0.1%
2/28/2019	5.0%	0.5%	4.5%

Source: Refinitiv, Barclays Research

We noticed that our Q/Q data (and estimates) are always too high in the fiscal fourth quarters (ending February), resulting in subsequent underestimation in the fiscal first quarters (ending May). We have not found a clear qualitative explanation for what we can observe mechanically, which is that more inventory is sold at lower than listed prices in FQ4 than any other quarter. Fortunately, we found that our over/underestimates in these two quarters are generally stable over time, so the introduction of dummy variables is a tidy solution for the problem.

FIGURE 7

Q/Q regression model with dummy variables, consensus vs. Barclays forecast vs. reported, live back-test

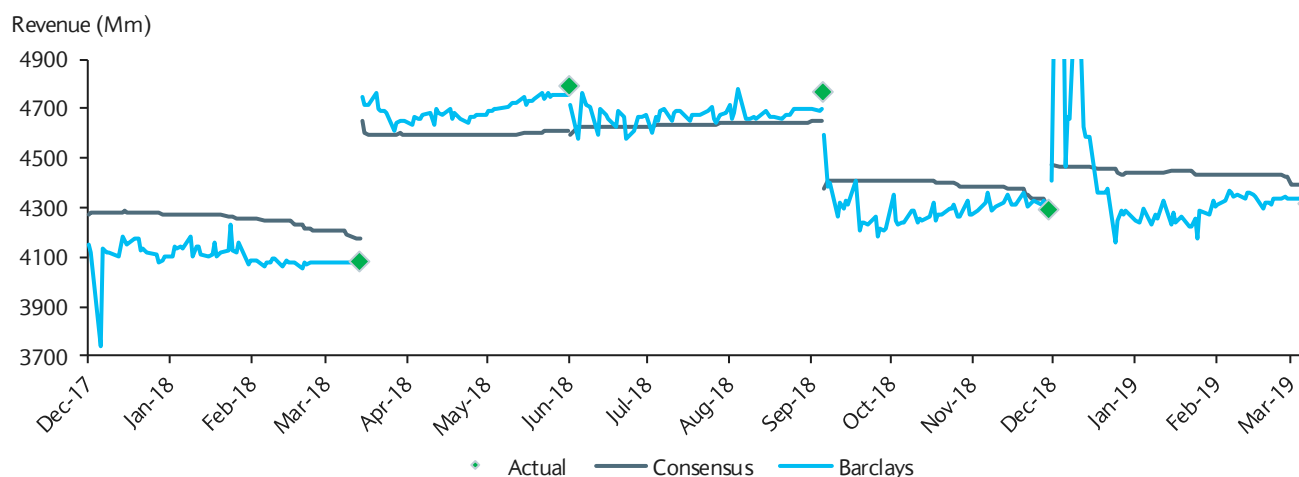


Source: Refinitiv, Barclays Research

As demonstrated in Figure 8, our model would have outperformed consensus in every quarter since 2018, which indicates that it could be part of a profitable trading strategy around CarMax earnings.

FIGURE 8

Our sales model output has consistently been closer to the eventual reported revenue than consensus



Source: Refinitiv, Barclays Research

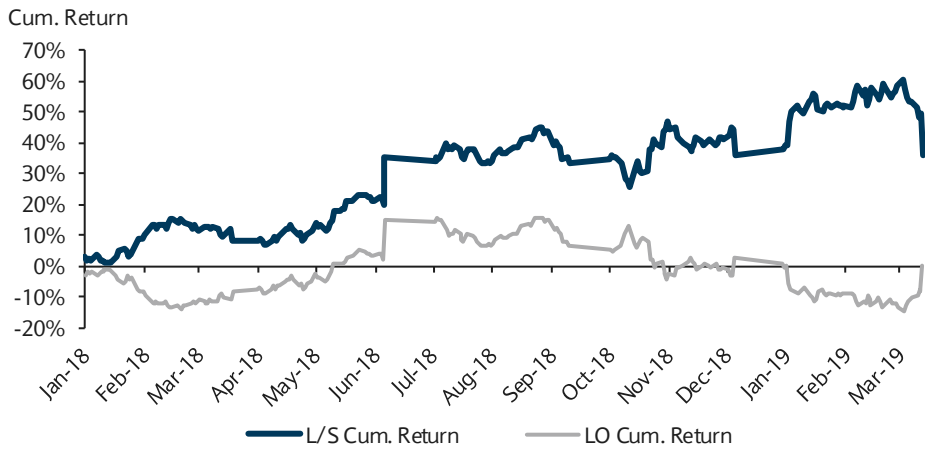
But Is It Useful? A Simple Trading Strategy Based on Our Forecasts Performed Well in a Back-test

Figure 8 shows the progression of our estimates throughout each quarter. In general, we find our estimates become more stable and accurate after halfway (45 days) into the quarter. To establish whether our alt estimate could contribute value to investors beyond the information available in consensus numbers, we tested a simple trading strategy:

- From the 45th day of each quarter, if our estimate is above consensus, take a long position in KMX, hedged by an equal notional short in the S&P 500 (SPX). If our estimate is below consensus, short KMX hedged by a long in SPX.
- Close the trade at the close one day after KMX reports earnings.
- We don't account for costs of trading, borrowing, leverage, or market impact.

That simple strategy performs well, generating an annualized excess return of 29.5% since the beginning of 2018. Figure 9 shows the cumulative excess return since 2018. Of course, we believe there are many other considerations when making single-name investment decisions: e.g., margins, net earnings, and strategic evaluations of the company's business. But we also believe that this model can allow clients to make better decisions about those investments than they would be able to relying on consensus alone, and that makes it useful.

FIGURE 9
Cumulative return of long/short strategy compared to long only strategy, both hedged by SPX



Source: Refinitiv, Barclays Research

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