SALES FORECASTING WITH FINANCIAL INDICATORS AND EXPERTS’ INPUT

Nikolay Osadchiy (Emory)
joint work with Vishal Gaur (Cornell) and Sridhar Seshadri (ISB)
Agenda for this talk

- Motivation and literature
- Forecast evolution model
- Empirical study
  - Firm-level data
    - Retail
    - Wholesale and manufacturing
  - Aggregate data
  - Discussion of the results
- Example
Research questions

- What is the correlation between sales forecast errors and the returns on a broad financial index for different types of firms?
- Are financial data useful for improving the accuracy of sales forecasts?
- Are they useful in operational hedging decisions such as postponement of inventory procurement or capacity reservation?
Why study correlation?

- Market can be a source of information
  - If forecasts do not reflect recent market performance, they can be improved
- Systematic component in sales uncertainty
  - Priced by the market
- Affects the cost of capital (McDonald, Siegel (1985, 1986))
- Sales-based measures more valuable than Beta to price a firm’s risk (Hendricks, Singhal (2005))
- Supply chain structure
- Opportunities for hedging and risk management
  - Financial vs. operational
  - Customers’ base diversification
Recent examples: Retail sales and stock market

Change in retail sales from January 2003
3-month moving average, adjusted for seasonal variation, population growth and inflation, shown in 2000 dollars

- Sales are now higher than in 2000
- Sales are now lower than in 2003

Building materials stores: Peaked in early 2006, with housing prices.

Computer stores: When the Nintendo Wii was released, sales at computer stores soared. Guitar Hero and other games were also popular purchases at the holidays.

Restaurants and liquor stores: Sales for the two sectors were growing in step until the stock market tumble, when dining in — with a bottle of who — gained favor.

Grocery stores: Sales have remained fairly consistent.

Clothingstores: Designers are concerned that sales are far below previous highs.

Department stores: The slow decline in sales started well before the economic slump. More customers chose boutiques and big boxes over the department-store middle ground.

Auto dealers: After falling sharply from mid-2007, sales at dealerships have started to recover.

Warehouse stores: Growth outstripped other sectors as Americans sought to save money by buying purchases in bulk.

Stock market peak

Mar 2009
Stock market low

Jan 2003

Jul 2009

Grocery stores

Furniture and home stores


Nikolay Osadchiy, “Sales forecasting with financial indicators”
Office Depot Falls on Gloomy Forecast

Fri Sep 7, 2007 5:09 PM BST

NEW YORK (Reuters) - Office Depot Inc<ODP.N> shares fell as much as 10.25 percent on Friday, a day after the office supplies retailer said third and fourth quarter earnings would likely fall below year-ago levels as small business customers cut back on spending in response to the housing slowdown.

"Our small-business customers have changed their buying habits as a result of this environment, and traffic remains slower than normal in our retail stores," Chief Financial Officer Patricia McKay said at a Goldman Sachs retailer conference in New York on Thursday.

"...The macro backdrop is no doubt presenting some headwinds, though given ongoing industrial production and GDP growth, we are surprised by the magnitude of spillover to the office products retail segment," Goldman Sachs analyst Matthew Fassler wrote in a research note. "Office Depot seems to be bearing more than its fair share of the fallout."
Correlation of sales growth with return on S&P 500 index (using Redbook Average data)

\[ y = 0.0659x + 3.1066 \]

\[ R^2 = 0.8111 \]

- Redbook Average: seasonally-adjusted sales-weighted average of year-to-year same-store sales growth in a sample of 60 large US general merchandise retailers representing about 9000 stores. Released by Instinet Research on the first Thursday of every month.


Gaur and Seshadri (2005)
Literature

- Operational and financial hedging when demand is correlated with the return on a financial asset
  - McDonald and Siegel (1985, 1986)

- Demand forecasting models
  - MMFE: Graves et al. (1986, 1998), Heath and Jackson (1994)
  - Other predictors: Kesavan et al. (2009), Lundholm et al. (2009)

- Propensity and structure of the consumption
  - Friedman (1957): permanent income hypothesis; Ando and Modigliani (1968), Brayton and Tinsley (1996), Dynan and Maki (2001), Banks et al. (1997)
Sales uncertainty and the market

Forecasts of the total sales for the next fiscal year can be generated by equity analysts or time series models.

Market process is the price of a broad equity index, such as value-weighted NYSE/NASDAQ/AMEX market index.

Sales forecast error for the forecast made at time $t_0$.

First forecast date; Forecast $F_0$, Market price $M_0$.

Fiscal year starts at $T_1$, ends at $T$; Actual sales realization revealed at $T$. 

Term of the first forecast, $T$.
Timeline: \([0, T]\), where 0 denotes the date of first available forecast, and \(T\) denotes end of a fiscal year

\(D_t\): value of sales to be realized during \([T_1, T]\) as seen at time \(t\); converges to the realized sales at time \(T\).

\(\ln D_t\) evolves as a martingale, for a given company in a given year

\[
\mathbb{E}[\ln(D_t)|\mathcal{F}_s] = \ln(D_s), \quad 0 \leq s \leq t \leq T \\
d(\ln D_t) = \sigma_D dB_D
\]

Forecast at time \(t\):

\[
F_t = \mathbb{E}[D_T|\mathcal{F}_t] = D_0 e^{\sigma_D B_{D_t}} e^{\sigma_D^2 (T-t)/2}
\]

Under this specification, the forecast is martingale

\((\ln)\) Error of time \(t\) forecast:

\[
\delta_t = \ln D_T - \ln F_t
\]

Stock market evolution:

\[
\frac{dM_t}{M_t} = \mu_M dt + \sigma_M dB_M \\
\]  
\[
dB_D dB_M = \rho dt
\]

Correlation of the sales forecast error (not just sales!) and the market return:

\[
\text{Corr}(\delta_t, \ln(1 + r_{tT})) = \rho
\]
Estimation equations

- Given the market return up to time $T$, the conditional expectation and variance of the sales are:

**Proposition 1: Ex-post uncertainty resolution**

\[
\begin{align*}
\mathbb{E}[\ln D_T|\mathcal{F}_0, M_T] &= \ln F_0 + \frac{\rho \sigma_D}{\sigma_M} \ln(1 + r_0T) + T \frac{\rho \sigma_D}{\sigma_M} \left(-\mu_M + \frac{\sigma_M^2}{2} - \frac{\sigma_D \sigma_M}{2 \rho}\right), \\
\text{Var}[\ln D_T|\mathcal{F}_0, M_T] &= \sigma_D^2 \text{Var}[B_{DT}|\mathcal{F}_0, M_T] = \sigma_D^2 T (1 - \rho^2),
\end{align*}
\]

- Effect of the market on the mean is proportional to $\rho \sigma_D$
- The variance of sales is reduced by $\rho^2 \times 100\%$
- Parameters $\rho$, $\sigma_D$ can be estimated by MLE
Forecast updating

\[ \ln(\text{\$ amount}) \]

\[ \ln D_T \]

\[ \ln F_0 \]

\[ \ln M_0 \]

\[ t_0 = 0 \quad t_1 \quad t_2 \quad T_1 \quad T \]

First forecast date; Forecast \( F_0 \), Market price \( M_0 \).

Sales forecast error for the forecast made at time \( t_0 \).

Updated forecast 1

Updated forecast 2

Term of the first forecast, \( T \)

Fiscal year starts at \( T_1 \), ends at \( T \); Actual sales realization revealed at \( T \).
Forecast updating formulae

- Use the estimates of $\rho$, $\sigma_D$, and the market return $r_{0t}$ to update the initial forecast in real time.

\[
\begin{align*}
\mathbb{E}[\ln D_T | \mathcal{F}_0, M_t] &= \ln F_0 + \frac{\rho \sigma_D}{\sigma_M} \left( \ln(1 + r_{0t}) - \left( \mu_M - \frac{1}{2} \sigma_M^2 \right) t \right) - \frac{1}{2} \sigma_D^2 T, \\
\text{Var}[\ln D_T | \mathcal{F}_0, M_t] &= \sigma_D^2 (T - t \rho^2).
\end{align*}
\]

- Combine the experts forecasts and the model (assn: experts do not completely incorporate the financial information).

\[
\begin{align*}
F_{tc}^c &= \ln \hat{F}_t + \frac{\rho \sigma_D}{\sigma_M} \left( \ln(1 + r_{0t}) - \left( \mu_M - \frac{1}{2} \sigma_M^2 \right) t \right) - \frac{1}{2} \sigma_D^2 T, \\
\text{Var} F_{tc}^c &= \sigma_D^2 (T - t).
\end{align*}
\]
Empirical Study

- Firm-level data
  - Retail
  - Manufacturing and wholesale trade
- Aggregate data
Firm level study: data set

- Fit (FY1997-2007) and test (FY2008) samples
- Data sources: I/B/E/S (summary file), S&P’s Compustat NA, CRSP
- Includes both market growth and decline periods of the stock market
- I/B/E/S: experts’ consensus forecasts; Compustat: sales, operational parameters; CRSP: market return
- Market indices:
  - Value-weighted market return including dividends (all stocks at NYSE/AMEX/Nasdaq)
  - SP500, Equal-weighted market return

<table>
<thead>
<tr>
<th>Primary NAICS</th>
<th># obs.</th>
<th># firms</th>
<th>Coverage, % sales (FY2005)</th>
<th>Filters</th>
<th>Examples of companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>6860</td>
<td>105</td>
<td>32%</td>
<td>Sel. segm., Non-US, 3 year data, mergers*</td>
<td>Wal-Mart, Best Buy, Office Depot</td>
</tr>
<tr>
<td>Wholesale</td>
<td>4541</td>
<td>123</td>
<td>11%</td>
<td>Non-US, 3 year data</td>
<td>Ingram Micro, AmerisourceBergen</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>38931</td>
<td>1335</td>
<td>76%</td>
<td>Non-US, 3 year data</td>
<td>Apple, K2, Boeing, Nike, Coca-Cola</td>
</tr>
</tbody>
</table>

*- no significant selection bias due to filtering found (Heckman sample selection test)
Methodology

- MLE naturally incorporates the relationship between the regression coefficients and the heteroskedasticity structure.
- Bias in forecasts is controlled by introducing intercept and the forecast coefficient.
- Reinstatement of the analysts’ forecasts in the same firm-year is controlled:
  - Subsampling (Politis et al., 1999)
    - 1 observation per company, per year.
- The martingale assumption is verified using the trajectories of forecast updates
  - Variance ratio tests (Lo and MacKinlay, 1998).
- Robustness checks:
  - Random coefficients model
    - Estimates are similar under both methods.
## Retail: Segment-wise estimates

<table>
<thead>
<tr>
<th>Retail Segment</th>
<th>Segment-wise MLE</th>
<th></th>
<th></th>
<th>Firm-wise MLE of $\rho$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\rho$</td>
<td>$\sigma_D$</td>
<td>$\alpha$</td>
<td>$\text{Coeff. of }$  $\ln F_{ijy}$ $b_1$</td>
</tr>
<tr>
<td>Pooled (overall)</td>
<td><strong>0.129</strong>*</td>
<td><strong>0.179</strong>*</td>
<td>0.105</td>
<td>0.990</td>
</tr>
<tr>
<td>Sports and Hobby</td>
<td>-0.035</td>
<td>0.079***</td>
<td>-0.036</td>
<td>1.001</td>
</tr>
<tr>
<td>Home Furnishings</td>
<td>0.001</td>
<td>0.072***</td>
<td>0.001</td>
<td>0.999</td>
</tr>
<tr>
<td>Discount. and Whse Clubs</td>
<td>0.035</td>
<td>0.359</td>
<td>0.426</td>
<td>0.969</td>
</tr>
<tr>
<td>Cons. Electronics</td>
<td>0.071</td>
<td>0.194**</td>
<td>0.118</td>
<td>0.991</td>
</tr>
<tr>
<td>Shoe Stores</td>
<td>0.094</td>
<td>0.079***</td>
<td>0.011</td>
<td>0.999</td>
</tr>
<tr>
<td>Supermarkets</td>
<td>0.222</td>
<td>0.189</td>
<td>0.234</td>
<td>0.98</td>
</tr>
<tr>
<td>Apparel Stores</td>
<td>0.237***</td>
<td>0.112***</td>
<td>0.142***</td>
<td>0.982***</td>
</tr>
<tr>
<td>Department Stores</td>
<td>0.339***</td>
<td>0.058***</td>
<td>0.206**</td>
<td>0.974***</td>
</tr>
<tr>
<td>Home Improvement</td>
<td>0.412***</td>
<td>0.047***</td>
<td>-0.042</td>
<td>1.003</td>
</tr>
<tr>
<td>Jewelry Stores</td>
<td>0.495***</td>
<td>0.073***</td>
<td>-0.072</td>
<td>1.009</td>
</tr>
<tr>
<td>Auto Parts and Acc.</td>
<td>0.531***</td>
<td>0.083***</td>
<td>0.462***</td>
<td>0.937***</td>
</tr>
<tr>
<td>Pharmacies</td>
<td>0.543***</td>
<td>0.066***</td>
<td>-0.1</td>
<td>1.009</td>
</tr>
<tr>
<td>Office Supplies</td>
<td><strong>0.763</strong>*</td>
<td><strong>0.088</strong>*</td>
<td>-0.346</td>
<td>1.033</td>
</tr>
</tbody>
</table>
## Selected firms

<table>
<thead>
<tr>
<th>Name</th>
<th>$\rho$</th>
<th>st.err. $\rho$</th>
<th>$\sigma_D$</th>
<th>st.err. $\sigma_D$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAMILY DOLLAR STORES</td>
<td>-0.588***</td>
<td>0.136</td>
<td>0.018***</td>
<td>0.005</td>
</tr>
<tr>
<td>ROSS STORES INC</td>
<td>-0.425**</td>
<td>0.215</td>
<td>0.040***</td>
<td>0.006</td>
</tr>
<tr>
<td>WAL-MART STORES INC</td>
<td>0.224</td>
<td>0.178</td>
<td>0.261</td>
<td>0.423</td>
</tr>
<tr>
<td>BEST BUY CO INC</td>
<td>0.456***</td>
<td>0.129</td>
<td>0.048***</td>
<td>0.005</td>
</tr>
<tr>
<td>AMAZON.COM INC</td>
<td>0.624***</td>
<td>0.072</td>
<td>0.373***</td>
<td>0.045</td>
</tr>
<tr>
<td>HOME DEPOT INC</td>
<td>0.717***</td>
<td>0.155</td>
<td>0.038***</td>
<td>0.006</td>
</tr>
<tr>
<td>COSTCO WHOLESALE CORP</td>
<td>0.796***</td>
<td>0.160</td>
<td>0.030***</td>
<td>0.006</td>
</tr>
<tr>
<td>GAP INC</td>
<td>0.813***</td>
<td>0.108</td>
<td>0.092***</td>
<td>0.027</td>
</tr>
<tr>
<td>LIMITED BRANDS INC</td>
<td>0.816***</td>
<td>0.067</td>
<td>0.111**</td>
<td>0.010</td>
</tr>
<tr>
<td>TIFFANY &amp; CO</td>
<td>0.826***</td>
<td>0.075</td>
<td>0.080***</td>
<td>0.010</td>
</tr>
<tr>
<td>OFFICE DEPOT INC</td>
<td>0.878***</td>
<td>0.045</td>
<td>0.081***</td>
<td>0.011</td>
</tr>
<tr>
<td>STAPLES INC</td>
<td>0.891***</td>
<td>0.044</td>
<td>0.084***</td>
<td>0.008</td>
</tr>
</tbody>
</table>
### Margin and $\rho$

$\rho$ increases with margin

<table>
<thead>
<tr>
<th>Margin percentile</th>
<th>Median firm-wise $\rho$</th>
<th>Pooled MLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>[0, 0.2]</td>
<td>0.082</td>
<td>-0.008</td>
</tr>
<tr>
<td>(bottom 20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.2, 0.4]</td>
<td>0.141</td>
<td>0.121***</td>
</tr>
<tr>
<td>(0.4, 0.6]</td>
<td>0.122</td>
<td>0.160***</td>
</tr>
<tr>
<td>(0.6, 0.8]</td>
<td>0.260</td>
<td>0.196***</td>
</tr>
<tr>
<td>(0.8, 1]</td>
<td>0.360</td>
<td>0.268***</td>
</tr>
<tr>
<td>(top 20%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Margin percentile is based on the margin rank within each retail segment.
Forecast updating (test sample)

Forecast updating formulae

\[
E[\ln D_T | \mathcal{F}_0, M_t] = \ln F_0 + \frac{\rho \sigma_D}{\sigma_M} \left( \ln(1 + r_{0t}) - \left( \mu_M - \frac{1}{2} \sigma_M^2 \right) t \right) - \frac{1}{2} \sigma_D^2 T,
\]

\[
F_t^c = \ln \hat{F}_t + \frac{\rho \sigma_D}{\sigma_M} \left( \ln(1 + r_{0t}) - \left( \mu_M - \frac{1}{2} \sigma_M^2 \right) t \right) - \frac{1}{2} \sigma_D^2 T.
\]

Bias is corrected by adding intercept and the coefficient on the forecast.
Forecast updating performance (test sample)

- Time-series forecasts are generated from quarterly sales data using the Holt-Winters method (Winters, 1960).
- Errors are standardized before pooling.
- Difference between (E0) and (M), and (E) and (C) is statistically significant at .05 level according to the Brown-Forsythe and Levene equal variance tests.
- % of forecasts improved (abs. error(C)<abs. error(E)):
  - Analysts: 56%, Binomial test P=0.0002;
  - Time series: 54%, Binomial test P=0.022.
- Results are consistent under various performance measures (MAPE, MedAPE)
- Reason for improvement:
  - Forecast updates do not incorporate financial information.

<table>
<thead>
<tr>
<th>Input forecast</th>
<th>Standardized RMSE values</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(E0)</td>
<td>(E)</td>
<td>(M)</td>
</tr>
<tr>
<td>Analysts (N=876)</td>
<td>2.06</td>
<td>1.84</td>
<td>1.71</td>
</tr>
<tr>
<td>Time-series (N=665)</td>
<td>1.54</td>
<td>1.35</td>
<td>1.47</td>
</tr>
</tbody>
</table>
Value of the sourcing flexibility

- Single period newsvendor-type model, log-normal demand.
- Forecast issued 12 month ahead, $\rho$ – correlation between sales forecast error and the market return
- Postponement time: 6 months
- Tradeoff: more accurate demand forecast vs. higher sourcing cost
- The benefit of postponement is conservatively estimated:
  - Market information is the only source of extra profit
  - Other sources of profit possible:
    - e. g., reaction to early sales, Fisher and Raman (1996)
Value of the sourcing flexibility (contd.)

- Effects of decision postponement:
  - Expected profit increases for high $|\rho|$, $\sigma_D$ firms
    - 1% expected profit increase if $|\rho| > .6$: 37 firms in the dataset
    - 2% expected profit increase if $|\rho| > .8$: 13 firms in the dataset
  - Profit variance decreases for high $|\rho|$ firms
Results: wholesalers and manufacturers

- Intuitively, the correlation should ...
  - Bullwhip effect (assn: covariance does not change)
    - Decrease

- In reality

<table>
<thead>
<tr>
<th></th>
<th>$\rho$</th>
<th>$\sigma_D$</th>
<th>Intercept, $a$</th>
<th>Coeff. of $\ln F_{ijy}$, $b_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>0.128***</td>
<td>0.179***</td>
<td>0.104</td>
<td>0.990</td>
</tr>
<tr>
<td>Wholesale</td>
<td>0.177***</td>
<td>0.344***</td>
<td>0.089</td>
<td>0.999</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.356***</td>
<td>0.220***</td>
<td>-0.093*</td>
<td>1.012</td>
</tr>
</tbody>
</table>

- Segment by segment (example)

<table>
<thead>
<tr>
<th></th>
<th>Consumer electronics</th>
<th>Apparel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NAICS</td>
<td>Estimate</td>
</tr>
<tr>
<td>Retail</td>
<td>443</td>
<td>0.071</td>
</tr>
<tr>
<td>Wholesale</td>
<td>42343, 42362</td>
<td>0.394</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3341-3344</td>
<td>0.472</td>
</tr>
</tbody>
</table>
Forecast updating: wholesale and manufacturing

- Forecasting performance (test sample)

<table>
<thead>
<tr>
<th>Errors explained by the market</th>
<th>$\rho$</th>
<th>$\sigma_D$</th>
<th>% improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>0.128</td>
<td>0.179</td>
<td>16%</td>
</tr>
<tr>
<td>Wholesale</td>
<td>0.177</td>
<td>0.344</td>
<td>20%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.356</td>
<td>0.220</td>
<td>27%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In absolute terms</th>
<th>Volume FY2007, Bil</th>
<th>$\rho^*\sigma_D$</th>
<th>Market adjustment, Bil$^*$</th>
<th>% of Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>4432</td>
<td>0.023</td>
<td>35.5</td>
<td>0.8%</td>
</tr>
<tr>
<td>Wholesale</td>
<td>5782</td>
<td>0.061</td>
<td>115.6</td>
<td>2.0%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>5339</td>
<td>0.078</td>
<td>138.8</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

*-computed using 5% excess return
Alternative dataset: US Census

- value-weighted market index (detrended)
- sales (detrended, seasonally, and price-adjusted)

- Sources: US Census Bureau monthly surveys of Manufacturers, Retail, and Wholesale trade; BEA NIPA price deflators.
- Dataset is an expanded version of the data studied by Cachon et al. (2007)
  - Documented presence of the bullwhip effect in the seasonally-adjusted data.
Results using US census data

- Regress sales growth (price and seasonally adjusted) on the market return

\[ \Delta S_t = \text{Sales}_t - \text{Sales}_{t-12} = a + b \cdot r_t + \varepsilon_t \]

where \( r_t = \ln(1 + r_{t-1, t}) \)

<table>
<thead>
<tr>
<th>Price adjusted (red line)</th>
<th>Corr((\Delta S_t, r_t))</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>0.36</td>
<td>9485***</td>
</tr>
<tr>
<td>Wholesale</td>
<td>0.42</td>
<td>11399***</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>0.52</td>
<td>32857***</td>
</tr>
</tbody>
</table>

Chow test of structural break indicate significant increase in coefficient b from the Retail to Wholesale and to Manufacturing segments

Results are robust with respect to the term of forecasts (6 to 18 months)
Can data explain increase in $\rho$?

- Supply chains are serial
  
  - Use imputed production series (Cachon et al. 2007)
    
    \[ P_t = S_t + I_t - I_{t-1} \]
  
  - Production growth is less correlated with the market than sales growth
    
    - Retail: 0.17 vs 0.33
    - Wholesale: 0.29 vs 0.41
    - Manufacturing: 0.44 vs 0.50

- Supply chains have network structure
  
  - Reconstruct flows between industries using NIPA I/O tables (year 2002)
    
    - Summary level, agg. to 24 industries, to match M3 segments

![Graph showing correlation of aggregate production growth with market return and sales growth with market return.](attachment:graph.png)

\[ y = 1.0274x - 0.0162 \]
\[ R^2 = 0.5238 \]
Conclusions

- Financial market information can be used to update sales forecasts
  - Effect varies across segments; is greater for higher margin retailers.

- Experts do not fully take financial information into account when updating forecasts.

- Correlation between sales forecast errors/growth and the market returns increases for upstream levels of a supply chain.
  - Supported by the data at:
    - Company level;
    - Aggregate level;
    - Industry segment level.

- Hypothesis of increase in the correlation due to the aggregation of demand is supported by the data.
Example: Forecasting FQ4 2009 sales

<table>
<thead>
<tr>
<th></th>
<th>Intel</th>
<th>Kohl’s</th>
<th>Coca-Cola</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>0.665</td>
<td>-0.563</td>
<td>0.755</td>
</tr>
<tr>
<td>Q4 2008 guidance</td>
<td>11.0</td>
<td>5.01</td>
<td>7.21</td>
</tr>
<tr>
<td>(TS-1Q ahead)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our Q4 2008 forecast</td>
<td>7.9</td>
<td>5.32</td>
<td>7.09</td>
</tr>
<tr>
<td>Actual Q4 2008 sales</td>
<td>8.23</td>
<td>5.24</td>
<td>7.13</td>
</tr>
<tr>
<td>Q4 2009 guidance</td>
<td>10.13</td>
<td>5.62</td>
<td>7.20</td>
</tr>
<tr>
<td>Our Q4 2009 forecast</td>
<td>10.50</td>
<td>5.54</td>
<td>7.34</td>
</tr>
</tbody>
</table>

**Realized sales**

- **10.65B**

**Negative sales surprise possible**

**Positive sales surprise possible**
Thank you!
# Details: Retailers

<table>
<thead>
<tr>
<th>NAICS ID</th>
<th>Retail Segment Name</th>
<th># of firms</th>
<th># of firm-years</th>
<th># of obs.</th>
<th>Examples of firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>441</td>
<td>Automotive Parts and Acc. Stores</td>
<td>5</td>
<td>35</td>
<td>302</td>
<td>Autozone, Pep Boys</td>
</tr>
<tr>
<td>442</td>
<td>Home Furnishings Stores</td>
<td>7</td>
<td>61</td>
<td>598</td>
<td>Haverty Furniture, Bed Bath &amp; Beyond</td>
</tr>
<tr>
<td>443</td>
<td>Consumer Electronics Stores</td>
<td>5</td>
<td>39</td>
<td>388</td>
<td>Circuit City, Best Buy</td>
</tr>
<tr>
<td>444</td>
<td>Home Improvement Stores</td>
<td>3</td>
<td>27</td>
<td>274</td>
<td>Home Depot, Lowe’s</td>
</tr>
<tr>
<td>445</td>
<td>Supermarkets</td>
<td>8</td>
<td>60</td>
<td>570</td>
<td>Albertson’s, Safeway</td>
</tr>
<tr>
<td>446</td>
<td>Pharmacies</td>
<td>3</td>
<td>28</td>
<td>260</td>
<td>CVS, Rite Aid</td>
</tr>
<tr>
<td>4481</td>
<td>Apparel Stores</td>
<td>30</td>
<td>209</td>
<td>2121</td>
<td>GAP, Limited Brands</td>
</tr>
<tr>
<td>4482</td>
<td>Shoe Stores</td>
<td>4</td>
<td>27</td>
<td>264</td>
<td>Foot Locker, Shoe Carnival</td>
</tr>
<tr>
<td>4483</td>
<td>Jewelry Stores</td>
<td>4</td>
<td>24</td>
<td>245</td>
<td>Tiffany &amp; Co., Zale’s</td>
</tr>
<tr>
<td>451</td>
<td>Sports and Hobby Stores</td>
<td>9</td>
<td>50</td>
<td>461</td>
<td>Big 5 Sporting Goods, Michael’s</td>
</tr>
<tr>
<td>4521</td>
<td>Department Stores</td>
<td>5</td>
<td>39</td>
<td>366</td>
<td>JC Penney, Saks Fifth Avenue</td>
</tr>
<tr>
<td>4529</td>
<td>Discounters and Warehouse Clubs</td>
<td>11</td>
<td>78</td>
<td>795</td>
<td>Costco, Wal-Mart, Dollar Tree</td>
</tr>
<tr>
<td>45321</td>
<td>Office Supplies Stores</td>
<td>3</td>
<td>23</td>
<td>216</td>
<td>Office Depot, Staples</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>97</strong></td>
<td><strong>700</strong></td>
<td><strong>6860</strong></td>
<td></td>
</tr>
</tbody>
</table>