Think About Tomorrow Morning: Opening Stock Returns May Show Reversals

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In present study, I explore the dynamics of the interday stock price reversals. Employing intraday price data on thirty stocks currently making up the Dow Jones Industrial Index, I document that stock returns in opening trading sessions tend to be higher following days with relatively low (either negative, or lower than the same day's average and median for the total sample of stocks) open-to-close returns. This kind of price behavior seems to contradict stock market efficiency. Based on this finding, I construct three portfolios based on the opening trading sessions and involving a long position in the stocks on the days when their opening returns are expected to be high and a short position in the stocks on the days when their opening returns are expected to be low. All the portfolios are found to yield significantly positive returns, providing an evidence for the practical applicability of the "overnight reversals" pattern in stock prices.

Keywords: Investment Portfolios; Opening Returns; Open-to-Close Returns; Overreaction; Stock Price Reversals; Stock Return Autocorrelations
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Introduction

One of the most widely-documented facts in empirical finance is the autocorrelation of stock returns at various time intervals (daily, weekly, monthly). It presents a challenge to some of the most important models in continuous-time finance, which are based on some form of the random walk hypothesis. Consequently, there is an extensive literature on stock return autocorrelation (see Campbell, Lo, and MacKinlay (1997)). Most authors suggest explanations relying on non-synchronous trading as a possible cause of the positive return autocorrelations observed across international stock markets (e.g., Fisher (1966), Scholes and Williams (1977), Atchinson et al. (1987), Ahn et al. (2002)). Kadlec and Patterson (1999) establish that non-synchronous trading can explain 85%, 52%, and 36% of daily autocorrelations on portfolios of small, random, and large stocks, respectively. Accordingly, since daily returns are usually calculated based on a stock market index, the inclusion in the index of stocks that are traded infrequently could potentially cause positive stock return autocorrelations. However, bacause a significant level of autocorrelation has been documented for common stock portfolios of large and actively traded firms (e.g., Perry (1985), Safvenblad (2000)), non-synchronous trading appears to be not the only cause of correlation in daily market index returns. In this context, a number of studies assume that the gradual incorporation of market-wide information may lead to serial correlations in short-term stock returns (e.g., Lo and MacKinlay (1990), Sias and Starks (1997), Chordia and Swaminathan (2000)). Other potential explanations for stock return autocorrelations include bid-ask bounce (e.g., Rhee and Wang (1997)); partial price adjustment, i.e. the fact that a trade takes place at prices that do not fully reflect the information available to traders (e.g., Campbell, Lo, and MacKinlay (1997)); and the time-varying risk premium (e.g., Anderson (2006)).

In the recent years, as increasing computer power and new statistical methods have permitted to analyze very large datasets of intraday data, the focus has shifted to intraday patterns in stock returns and trading volumes. Blandon (2007) shows that close-to-close stock returns are highly autocorrelated, while daily returns calculated on an open-to-close basis do not exhibit significant levels of autocorrelation. Amihud and Mendelson (1987) and Stoll and Whaley (1990) report that the interday stock returns calculated using open-to-open prices have greater variance and provide more evidence of reversals than comparable returns computed based on close-to-close prices. They attribute this result to differences in trading mechanisms between the opening and closing trading sessions. Gerety and Mulherin (1994) estimate intraday volatility throughout the trading day from hourly Dow Jones sixty-five Composite price index data, and find that the interday 24-hour volatilities continuously decline, reflecting information processing. A wide literature on intraday stock price patterns identifies a clear U-shaped pattern in stock returns and return volatilities over the trading day (e.g., Wood et al. (1985), Harris (1986), Jain and Joh (1988), Pagano et al. (2008)). That is, these studies indicate that average stock returns and return volatilities are on average higher at the beginning and end of the trading day.

Several recent studies detect interday correlations between different intraday return measures. Kudryavtsev (2012) finds that daily returns of given stocks tend to be higher following the days when the stocks' upside volatility measures are higher than their downside volatility measures. Kudryavtsev (2013) documents that daily stock returns tend to be higher following the days with relatively large end-of-the-day price decreases, and lower following the days with relatively large end-of-the-day price increases. These findings are interpreted as reversals following stock price overreactions.

The concept of overreaction is widely-discussed in previous financial literature. Since the pioneering studies by Shiller (1984) and De Bondt

and Thaler (1985), a large number of theoretical and empirical studies have analyzed the phenomenon of price overreaction in financial markets, reflecting some form of market inefficiency. In most cases, the literature closely connects price overreaction to stock price forecastability, potentially allowing investors to earn above-average returns. In order to distinguish stock price overreaction, resulting in market inefficiency, from predictable changes in expected returns, Lehman (1990) examines returns over short time intervals. Actually, the focus on long-term dynamics in stock returns (e.g.,Shiller (1984) and De Bondt and Thaler (1985)) is more recently moved to short-term stock price behavior, ranging over time periods from a few days up to a month, in the major part of the subsequent literature (e.g., Zarowin (1989), Atkins and Dyl (1990), Cox and Peterson (1994), Park (1995), Bowman and Iverson (1998), Nam et al. (2001)). The main goal of these studies is to identify potentially profitable contrarian strategies based on a reverting behavior of stock prices in the short run. For example, Lehmann (1990) and Jegadeesh (1990) demonstrate that contrarian strategies that exploit the short-term return reversals in individual stocks may provide abnormal returns of about 1.7% per week and 2.5% per month, respectively. Importantly, Conrad et al. (1994) document that reversal profitability increases with trading activity.

The main goal of this study is to follow the line by Kudryavtsev (2012, 2013) and to establish if there also exist stock price reversals following some "regular", rather than extreme, price changes. In this context, I expect short-term stock price reversals to follow previous days' tendencies. I analyze intraday price data on thirty stocks currently making up the Dow Jones Industrial Index, and find supporting evidence for my research hypothesis. Employing open-to-close stock returns as a proxy for intraday stock price tendencies, and the next trading day's opening returns, as a measure of potential interday

reversals[2], I document that opening returns tend to be higher following the days with relatively low (either negative, or lower than the same day's average and median for the total sample of stocks) open-to-close returns. Based on these findings, I construct a number of daily-adjusted portfolios involving a long (short) position in the opening session in the stocks on the days when, according to the findings, their opening returns are expected to be high (low), and demonstrate that the returns on these portfolios are significantly positive.

Data Description

For the purposes of present research, I employ daily opening and closing prices of thirty stocks currently making up the Dow Jones Industrial Index over the period from January 2, 2002 to September 30, 2011 (overall, 2456 trading days), as recorded at www.finance.yahoo.com. I adjust the prices to dividend payments and stock splits, by multiplying each actual price by the ratio of the respective day's reported adjusted (by Yahoo finance) closing to actual closing price. For each stock i in the sample and for each trading day t, except for the first day of the sampling period, I calculate:

• Opening return ($R_{O,it}$), as a price change from last day's closing price to this day's opening price, and

• Open-to-close return ($R_{O-C,it}$), as a price change from this day's opening price to this day's closing price[3].

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[2] The focus on the next days' opening sessions as potential "reversal periods" is motivated by the short-time nature of the reversals, in general, and by the observation (e.g., Harris (1986)) that the predominant portion of stock price moves takes place within the first minutes of trading

[3] During the sampling period, the database on Yahoo Finance was missing only two trading days for Kraft Foods stock and one trading day for The Travelers Companies stock. I assumed the missing days' opening and closing prices to be equal to the average of the previous and the next trading days' opening and closing prices, respectively, for the respective stock

Table 1 comprises the basic descriptive statistics of the two types of returns for the thirty sample stocks. At this stage, we may note that for 18 out of 30 stocks, the mean opening returns are higher than the mean open-to-close returns, 13 of the latter being negative, which seems in line with the U-shaped pattern of intraday returns, or at least, with the left-hand side of the "U". On the other hand, for all 30 stocks, the standard deviations of opening returns are lower than those of open-to-close returns and of daily returns.

III.   Research hypothesis and Results
1.   Effect of the open-to-close returns on the next day's opening returns

Wide strand of financial literature deals with stock return autocorrelations. Several studies explicitly concentrate on the effect of the end-of-the-day stock price moves on the subsequent days' returns, and document stock price reversals (e.g., Kudryavtsev (2012, 2013)). In this study, I make an effort to establish if there also exist interday stock price reversals following some "regular", rather than extreme, price changes. Namely, I test the hypothesis that relatively high (low) open-to-close returns may lead to relatively low (high) opening returns on the next trading day.

Table 1

Descriptive statistics of sample stocks' opening and open-to-close returns

Company (Ticker symbol)	Opening return, %		Open-to-close return, %	
	Mean	St. Deviation	Mean	St. Deviation
Alcoa Inc. (AA)	0.158	1.551	-0.164	2.303
American Express (AXP)	-0.008	1.212	0.060	2.240
Boeing (BA)	0.033	1.004	0.013	1.667
Bank of America (BAC)	0.104	2.045	-0.095	2.884
Caterpillar (CAT)	0.086	1.198	-0.009	1.838
Cisco Systems (CSCO)	0.026	1.410	-0.007	1.883
Chevron Corporation	0.032	0.808	0.025	1.489
(CVX)	0.039	0.879	-0.010	1.636
E.I. Du Pont de Nemours	-0.048	1.094	0.086	1.688

(DD)	0.086	1.275	-0.089	1.821
Walt Disney (DIS)	0.001	1.047	0.011	1.781
General Electric (GE)	-0.116	1.386	0.148	1.819
Home Depot Inc. (HD)	-0.061	0.956	0.094	1.316
Hewlett-Packard (HPQ)	0.038	1.377	-0.020	1.929
IBM (IBM)	0.005	0.715	0.016	1.046
Intel Corporation (INTC)	0.043	1.436	0.003	2.514
Johnson & Johnson (JNJ)	-0.013	0.829	0.035	1.248
JP Morgan Chase & Co	-0.009	0.663	0.043	1.149
(JPM)	0.007	0.860	0.065	1.378
Kraft Foods Inc. (KFT)	0.017	0.756	0.012	1.294
Coca-Cola (KO)	-0.022	1.110	0.034	1.561
McDonald's Corporation	0.017	1.020	-0.002	1.554
(MCD)	0.054	1.047	-0.056	1.436
3M Company (MMM)	-0.043	0.625	0.078	1.055
Merck & Company Inc.	0.053	0.933	-0.030	1.555
(MRK)	0.042	0.996	-0.004	1.896
Microsoft Corporation	0.042	0.824	0.011	1.466
(MSFT)	0.035	0.839	-0.011	1.496
Pfizer Inc. (PFE)	0.018	0.735	-0.006	1.235
Procter & Gamble (PG)	-0.005	0.801	0.052	1.451
AT&T Inc. (T)				
The Travelers Companies (TRV)				
United Technologies Corp. (UTX)				
Verizon Communications (VZ)				
Wal-Mart Stores Inc. (WMT)				
Exxon Mobil Corporation (XOM)				

As the first and the most obvious proxy for the relatively high or low open-to-close stock returns, I employ their sign. Table 2 compares, for each of the sample stocks, mean opening returns following the days with positive ($R_{O-C,it} > 0$) and non-positive ($R_{O-C,it} \leq 0$) open-to-close returns.

Table 2

Opening stock returns following the days with positive and non-positive open-to-close returns

Company	Mean opening returns, %, for the days when:		
	$R_{O-C,it-1} > 0$ (No. of days)	$R_{O-C,it-1} \leq 0$ (No. of days)	Difference (t-statistic)
Alcoa Inc. (AA)	0.208 (1127)	0.114 (1327)	0.094 (1.50)
American Express (AXP)	-0.009 (1240)	-0.007 (1214)	-0.002 (-0.03)
Boeing (BA)	0.026 (1221)	0.039 (1233)	-0.013 (-0.32)
Bank of America (BAC)	0.179 (1194)	0.033 (1260)	0.146 (1.58)
Caterpillar (CAT)	0.129 (1207)	0.044 (1247)	0.085 (1.48)
Cisco Systems (CSCO)	0.007 (1206)	0.044 (1248)	-0.037 (-0.65)
Chevron Corporation (CVX)	0.043 (1277)	0.020 (1177)	0.023 (0.69)
E.I. Du Pont de Nemours	0.020 (1192)	0.057 (1262)	-0.037 (-1.05)
(DD)	-0.073 (1252)	-0.025 (1202)	-0.048 (-1.09)
Walt Disney (DIS)	0.108 (1136)	0.069 (1318)	0.039 (0.77)
General Electric (GE)	-0.017 (1203)	0.019 (1251)	-0.036 (-0.83)
Home Depot Inc. (HD)	-0.104 (1323)	-0.129 (1131)	0.025 (0.44)
Hewlett-Packard (HPQ)	-0.097 (1311)	-0.020 (1143)	**-0.077 (-1.98)
IBM (IBM)	0.019 (1176)	0.054 (1278)	-0.035 (-0.63)
Intel Corporation (INTC)	0.003 (1225)	0.008 (1229)	-0.005 (-0.15)
Johnson & Johnson (JNJ)	0.024 (1201)	0.061 (1253)	-0.037 (-0.63)
JP Morgan Chase & Co (JPM)	-0.039 (1256)	0.015 (1198)	-0.054 (-1.60)
Kraft Foods Inc. (KFT)	-0.045 (1266)	0.028 (1188)	***-0.073 (-2.70)
Coca-Cola (KO)	-0.039 (1294)	0.057(1160)	***-0.096 (-2.75)
McDonald's Corporation	-0.005 (1231)	0.039 (1223)	-0.043 (-1.47)
(MCD)	-0.052 (1204)	0.006 (1250)	-0.058 (-1.28)
3M Company (MMM)	-0.055 (1187)	0.085 (1267)	***-0.140 (-3.40)
Merck & Company Inc. (MRK)	0.008 (1152)	0.094 (1302)	**-0.086 (-2.03)
Microsoft Corporation (MSFT)	-0.094 (1316)	0.017 (1138)	***-0.111 (-4.43)
Pfizer Inc. (PFE)	0.034 (1184)	0.071 (1270)	-0.037 (-0.97)
Procter & Gamble (PG)	0.043 (1184)	0.042 (1270)	0.001 (0.05)
AT&T Inc. (T)	0.039 (1220)	0.045 (1234)	-0.006 (-0.16)
The Travelers Companies	0.013 (1193)	0.056 (1261)	-0.043 (-1.28)
(TRV)	-0.021 (1175)	0.054 (1279)	**-0.075 (-2.54)
United Technologies Corp.	-0.039 (1281)	0.031 (1173)	**-0.070 (-2.15)
(UTX)			
Verizon Communications (VZ)			
Wal-Mart Stores Inc. (WMT)			
Exxon Mobil Corporation (XOM)			

Asterisks denote two-tailed p-values: **p<0.05; ***p<0.01

The results support the research hypothesis. For 23 out of 30 sample stocks, mean opening returns are higher following the days with non-positive open-to-close returns, that is, following the days characterized by price decreases. 8 of the respective negative mean return differences are statistically significant at the 5% level, including 4 at the 1% level, while all the 7 positive differences are non-significant. Thus, the results demonstrate that in opening trading sessions, stock prices display a reverting behavior following previous day's price tendencies. Such behavior may be regarded as "overnight reversals", and seems to contradict market efficiency.

3.   Portfolios based on reversals in opening returns

In order to test for practical applicability of the above results, I construct a number of portfolios based upon the idea of holding during the opening sessions and daily adjusting a long position in the stocks that according to the "overnight reversals" pattern are expected to yield high opening returns, that is, the stocks that on the previous trading day showed relatively low open-to-close returns, and a short position in the stocks that according to "overnight reversals" pattern are expected to yield low opening returns, that is, the stocks that on the previous trading day showed relatively high open-to-close returns. To get a proxy for the "relatively high (low)" open-to-close returns, for each of the stocks and for each of the trading days, I first employ their sign, as in the previous Subsection, and also compare them to the respective mean and median open-to-close returns for the total sample on the respective day. The total values of the long and the short positions are supposed to be equal, that is, the total market value of each portfolio is supposed to be zero[4].

Portfolio N: Portfolio implying an equally-weighted long position for a day's opening session in the stocks whose previous day's open-to-close

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[4] I construct portfolios based on actual closing prices, assuming that open-to-close returns can be calculated and the transactions can be performed sufficiently close to the market closing time

returns were Non-positive, and an equally-weighted short position for a day's opening session in the rest of the sample stocks.

Portfolio A: Portfolio implying an equally-weighted long position for a day's opening session in the stocks whose previous day's open-to-close returns were smaller than the sample Average, and an equally-weighted short position for a day's opening session in the rest of the sample stocks.

Portfolio M: Portfolio implying an equally-weighted long position for a day's opening session in the stocks whose previous day's open-to-close returns were smaller than the sample Median, and an equally-weighted short position for a day's opening session in the rest of the sample stocks.

Table 3 concentrates the portfolios' daily performance measures. Strikingly, all the portfolios yield positive opening returns that are highly significant. That is, opening stock returns are significantly higher following the days with relatively low open-to-close returns. From the practical point of view, at least if the trading commissions are not a problem, the three portfolios represent potentially profitable investment strategies, yielding annual returns of about 9-16% (recall that the portfolios do not request any initial investments and yield significantly positive returns).

Table 3

Historical performance measures of the portfolios based on the "overnight reversals" stock price behavior

Daily-adjusted portfolios	Daily portfolio over the sampling period		
	Mean, %	Standard Deviation, %	t-statistic (Mean=0)
Portfolio N	0.059	0.485	***5.96
Portfolio A	0.034	0.424	***3.94
Portfolio M	0.037	0.374	***4.92

Asterisks denote two-tailed p-values: ***p<0.01

III Conclusion

This paper explores intraday and interday patterns in stock price behavior. In particular, I follow the line by Kudryavtsev (2012, 2013) and try to shed light on correlations between stock returns in opening trading sessions with the respective stocks' previous day's returns following the opening sessions.

I employ daily opening and closing prices of thirty stocks currently making up the Dow Jones Industrial Index, and document that stock price tendencies, as reflected in open-to-close returns, tend to be reversed during the opening session of the next trading day. That is, relatively, with respect to the sample average or median for the respective day, high (low) open-to-close returns appear to lead to lower (higher) opening returns on the next trading day. Furthermore, I construct a number of portfolios based upon the idea of holding during the opening sessions and daily adjusting a long position in the stocks that according to the "overnight reversals" pattern are expected to yield high opening returns, that is, the stocks that on the previous trading day showed relatively low open-to-close returns, and a short position in the stocks that according to "overnight reversals" pattern are expected to yield low opening returns, that is, the stocks that on the previous trading day showed relatively high open-to-close returns. All the portfolios yield significantly positive average returns, demonstrating practical applicability of the results.

My findings amplify the results documented in the previous literature with respect to short-term stock price reversals, by showing that systematic interday stock price reversals may also be exhibited following some "regular", rather than extreme, price changes. This may prove a valuable result for both financial theoreticians in their discussion about stock market efficiency, and practitioners in search of potentially profitable investment strategies. An important potential direction for further research may include analyzing additional stock markets and greater samples of data.

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