An Intraday Analysis of the Dow-30 Stocks during the Early Stages of the COVID-19 Pandemic

Agnieszka Jach

Abstract

This paper presents a high-frequency analysis of the Dow-30 stocks during the early stages of the COVID-19 pandemic in February and March 2020. Using a wide range of proxies for stock activity, liquidity, and volatility in 1-min resolution, the impact of the COVID-19 on the stock markets is visually assessed. To gauge the immediate effect of the COVID-19 on the Dow-30 stocks, robust descriptive statistics are used to compare variables during "normal" times in February and "abnormal" times in March 2020. A 2-to-3-fold change in the level of the indicators and a 2-to-6-fold change in the variability of the indicators is found after the outbreak of the COVID-19 pandemic.

Keywords:

COVID-19, coronavirus, stock markets, high-frequency

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1 Introduction

In February and March of 2020, the whole world witnessed the emergence of the COVID- 19 (henceforth, coronavirus) outbreak and how the virus penetrated all walks of life. The reaction of the global financial system to the pandemic was unprecedented and so were the actions undertaken by the central banks and governments in their quest to mitigate the effects of coronavirus on the economies and public health.

In this article, we present the unfolding of the early stages of the coronavirus pandemic as seen through the high-frequency-trading (HFT) tick-by-tick data for the Dow-30 stocks, the largest stocks on the largest financial market. The goal of our analysis is to describe the trends in market activity, liquidity, and volatility during the period 03.02.2020-27.03.2020 using 1-min-binned high-frequency (HF) data for individual stocks. In particular, we are interested in the behaviour of the HF traders during 'normal' times (February 2020) as compared to the 'abnormal' times (March 2020) during the spread of the coronavirus pandemic.

Among studies that take a historical perspective on the impact of the COVID-19 on stock markets, Baker et al. (2020) report an unprecedented reaction of the US stock market to the pandemic (text-based analysis starting in the 1900s) in terms of a large number of daily stock market moves. Using daily data from 2006 onwards, Zhang and Hamori (2021) examine return and volatility spillovers between Infectious Disease Equity Market Volatility Tracker, stock markets from the US, Japan, Germany, and crude oil futures. The analysis based on a Vector Moving Average representation (time, frequency, static and time-varying connectedness) indicates that the return spillover mainly occurs in the short term, while the volatility spillover in the long term. A similar type of analysis is employed by Shahzad et al. (2021), who use high-frequency data between January 2019 and September 2020 to obtain daily realized variance of the market and sector indices from China. They find the dominance of 'bad' volatility spillover shocks over 'good' volatility spillover shocks during the COVID-19 period.

Of the articles that focus on the first few months of 2020, Izzeldin et al. (2021) assess the impact of the COVID-19 on the volatility of the G7 stock market and sector indices. The use of a ST- HAR model allows for ranking of the markets and sectors with respect to the intensity of transition to the COVID-19 crisis regime (abrupt/smooth), the timing of the transition (early/late), and the type of response (homogeneous/heterogeneous). Using the S&P500 market and several ETFs from different industrial sectors, Navratil et al. (2021) find evidence of market inefficiency by showing that Merton's optimal-portfolio trading strategy had a strong out-of-sample performance over the period February-May 2020. Cheng (2020) shows that in late February and early March of 2020, VIX premia sank to some of the most extreme negative values in the history of the market. Among the authors who consider individual firms in the context of the COVID-19 pandemic, Ramelli and Wagner (2020) study individual stocks from the Russell 3000 index and their abnormal returns between January and March 2020. They highlight the importance of trade and financial policy on firm value. Bretscher et al. (2020) perform an event-study analysis on individual US firms to assess the impact of the COVID-19 on the market and examine four transmission channels through which the outbreak of the COVID-19 affects firm-level returns.

The contribution of the current article to the existing literature is as follows. We provide new insights into the onset of the coronavirus pandemic by using intraday data for individual stocks. We consider a wide range of variables and assess the overall impact of the COVID-19 pandemic on market activity, liquidity, and volatility. Finally, by resorting to descriptive statistics our analysis is simple, and by employing time-series plots covering eight weeks in February

and March 2020, we can visualize the effects of the coronavirus on stock markets in a high-frequency resolution.

2 Data and methodology

Tick-by-tick trading data for the Dow-30 stocks during the period 03.02.2020-27.03.2020 was retrieved from LOBSTER, https://lobsterdata.com; tickers of the individual stocks can be found in the legend of Figure 1. The methodology of this article boils down to monitoring relevant variables (or their cross-sectional averages/aggregates) in time, once these have been converted from sampled-in-transaction-time to sampled-in-calendar-time quantities. We use 1-min intervals for sampling in calendar time. Descriptive statistics are used to accompany the graphical results. The employed variables that act as proxies for stock activity, liquidity, and volatility are (1) price, (2) simple return, (3) 5-min realized variance, (4) sample standard deviation, (5) the number of shares traded, (6) the number of trades, (7) bid-ask spread, and (8) inter-trade duration. The definitions of these variables as well as the pre-processing steps are standard (detailed description available upon request).

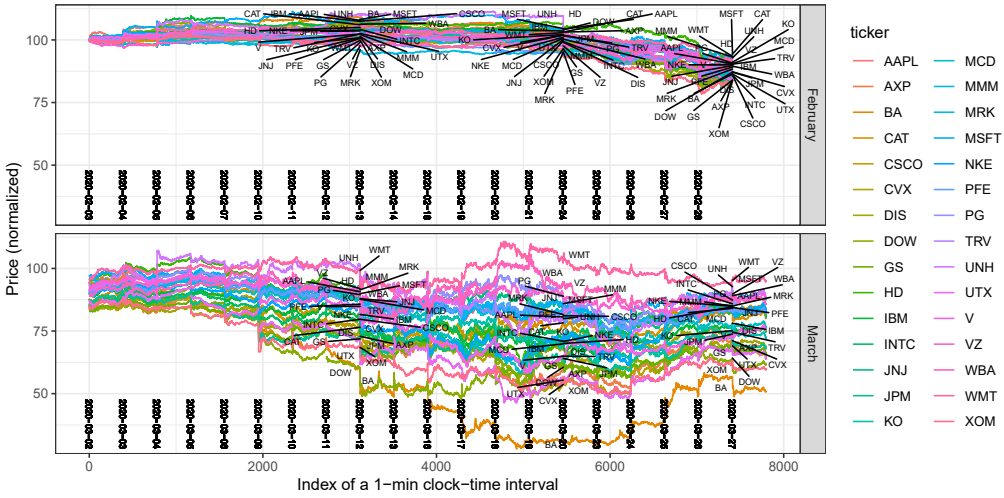

Figure 1: Price normalized to a common starting point of 100, per 1-min interval per stock between 03.02.2020-27.03.2020.

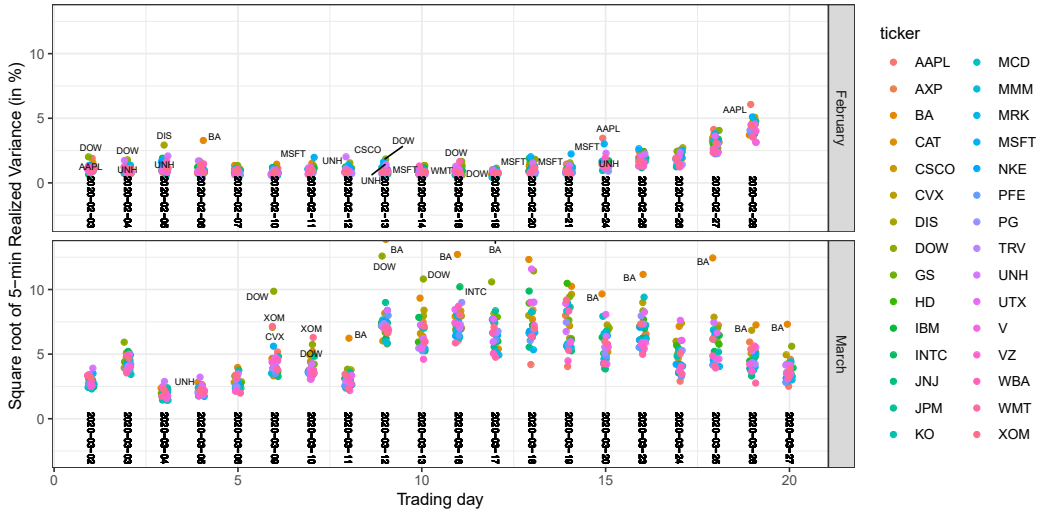

Figure 2: Square root of 5-min realized variance per trading day per stock between 03.02.2020-27.03.2020 (value for BA of 18.65% on the 17th of March of 2020 not shown).

3 Results

We present our results in a series of time-series plots (Figures 1-6), which are complemented by descriptive statistics (Table 1), focusing on six variables: price (normalized), square root of 5-min realized variance, (simple) return, bid-ask spread, number of shares traded, inter-trade duration.

Table 1: Cross-sectional summary statistics (per trading day or per selected 1-min clock-time interval of a trading day) temporally averaged, month-wise; the square root of 5-min RV and simple return are in %, bid-ask spread in USD, the number of shares traded rounded to a whole number, inter-trade duration in seconds.

VARIABLE	1-MIN INTERVAL	MEDIAN		INTERQUARTILE RANGE		MINIMUM		MAXIMUM	
		FEBRUARY	MARCH	FEBRUARY	MARCH	FEBRUARY	MARCH	FEBRUARY	MARCH
$\sqrt{RV5}$	–	1.3355	4.8250	0.4058	1.2893	0.8768	3.4839	2.4304	8.8343
return	09:30-09:31h	–	–	–	–	–	–	–	–
return	13:00-13:01h	−0.0076	−0.0498	0.0418	0.1649	−0.0850	−0.4389	0.0898	0.2599
return	15:59-16:00h	0.0153	−0.0578	0.0489	0.3102	−0.0963	−0.6897	0.1044	0.6550
spread	09:30-09:31h	0.1472	0.2507	0.1937	0.3897	0.0260	0.0466	0.7991	1.7613
spread	13:00-13:01h	0.0301	0.0712	0.0339	0.0918	0.0118	0.0143	0.1577	0.3903
spread	15:59-16:00h	0.0205	0.0523	0.0207	0.0691	0.0107	0.0126	0.1000	0.2500
size	09:30-09:31h	3242	5324	8314	13826	84	277	168103	142362
size	13:00-13:01h	992	2251	1878	4369	118	290	14474	25453
size	15:59-16:00h	7429	16241	12765	30118	1216	4257	113989	309806
duration	09:30-09:31h	1.5762	0.9251	2.1839	1.2042	0.0825	0.0746	17.5771	7.5269
duration	13:00-13:01h	6.3868	2.1742	7.1597	2.2740	0.7040	0.2660	48.1859	11.3278
duration	15:59-16:00h	1.2218	0.4051	0.9093	0.3455	0.1490	0.0417	8.7897	1.3556

Normalized prices (Figure 1), which started at 100 on the first trading day of February, experienced a small synchronized downward jump on 24.02 (US 10-year Treasury yield close to 1 percent) and another one on 28.02 (statement from Federal Reserve Chair), causing all stocks to lose about 5-10% of their value by the end of the month. The first trading week of March saw the divergence of price paths in both directions before the heterogeneity unfolded on Monday, 09.03. This trend intensified on the 12th and 13th of March and led to even moreextreme behaviour in the subsequent trading days between 16-23.03, flattening out somewhatin the fourth trading week of March. High demand for medical and food supplies during the spread of coronavirus, increased reliance on telework and telecommunication, the Saudi-Russia oil price war and various travel restrictions could explain price trajectories realized for the particular stocks.

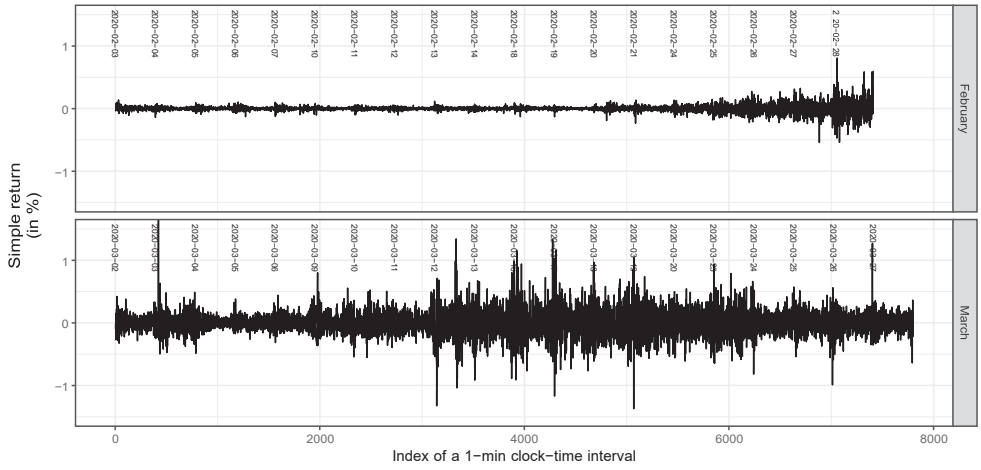

Figure 3: Cross-sectional average of return per 1-min interval between 03.02.2020-27.03.2020.

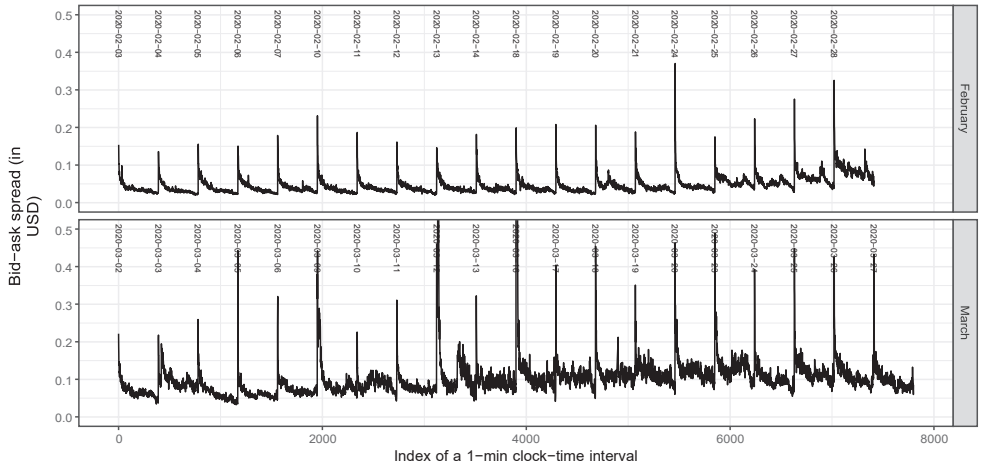

Figure 4: Cross-sectional average of bid-ask spread per 1-min interval between 03.02.2020–27.03.2020.

The behaviour of prices is well matched by that of volatility, proxied by the square root of 5-min realized variance (Figure 2), and of the cross-sectional average return (Figure 3). Volatility levels of individual stocks began to increase in the last trading week of February; for the whole month ('contaminated' by that somewhat unusual last week), a typical daily level of volatility was 1.3355%, give-or-take 0.4058/2% (first row of Table 1). The first week of March was somewhat in-line with the last week of February, with higher levels on 03.03 (FOMC meeting), but essentially from 09.02 the volatility and variability in volatility increased markedly, realizing new highs between 12-23.03. For March ('contaminated' by that somewhat unusual first week), a typical daily level of volatility was 4.8250% ± 1.2893/2%, which posts a 3-fold increase in both, the level and range between the 'normal' and 'abnormal' times.

The cross-sectional average return (Figure 3) indicates a gradual increase in heterogeneity of return for individual stocks (increased vertical spread) in the course of the last trading week of February. In March, the period between 12-23.03 stands out in terms of elevated heterogeneity (this segment of Figure 3 can be aligned with its counterparts from Figures 1 and 2). We also observe a somewhat understated diurnal pattern in the average return, coinciding with the opening and closing of the market. Focusing on the return in the 13:00h-13:01h interval (third row of Table 1), the interquartile range increased from 0.0418% in February to 0.1649% in March, a nearly 4-fold increase; for the end-of-trading-day interval (fourth row of Table 1) the change was over 6-fold, from 0.0489% to 0.3102%.

The diurnal pattern is much more discernible in Figure 4 (and likewise in Figures 5 and 6), which shows cross-sectional average bid-ask spread, a proxy for overall liquidity: disproportionately elevated spread at the beginning of the trading day, which subsides after the first few minutes of trading to then gradually decrease towards the minimum level at the end of the trading day. Between February and March, generally speaking, this periodic pattern became stretched in the vertical direction and jittered, with the magnitude of a typical start-of-day spike increasing from \$0.1472 ± \$0.1937/2, to \$0.2507 ± \$0.3897/2 (fifth row of Table 1), hence a nearly 2-fold increase in the level and a 2-fold in variability. For the other two time-intervals (sixth and seventh rows of Table 1), the increase was 2-fold, also indicating a reduction in liquidity by a factor of two.

The diurnal pattern in cross-sectional aggregated size is reversed compared to bid-ask spread in that volume is elevated at the end of the trading day and not at the beginning, and otherwise, it follows the well-known U-shape (Figure 5). This indicator of market activity was subjected to a similar increase in the level and variability between February and March, to that of the bid-ask spread. Additionally, the four circuit breakers on the 9th, 12th, 16th and 18th of March are manifested by the four drops to 0. The magnitude of a typical end-of-day spike increased from 7429 ± 12765/2 shares, to 16241 ± 30118/2 shares (10th row of Table 1), with the 13:00h-13:01h-bin value going from 992 ± 1878/2 in February, to 2251 ± 4369/2 in March (9th row of Table 1), and thus doubling the level and variability in activity.

A more symmetrical diurnal pattern can be observed in cross-sectional average inter-trade duration, with its signature inverted-U-shaped pattern, contaminated by four spikes induced by the four circuit breakers, and somewhat flatter humps in March compared to February (Figure 6). Due to an inverse relationship between size/count and inter-trade duration, the tendency for the duration is that of a decreasing level and variability. For example, a typical duration reported in February between 13:00h-13:01h was 6.3868*s* ± 7.1597/2*s*. For March, the respective values decreased approximately three times to 2.1742*s* ± 2.2740/2*s*.

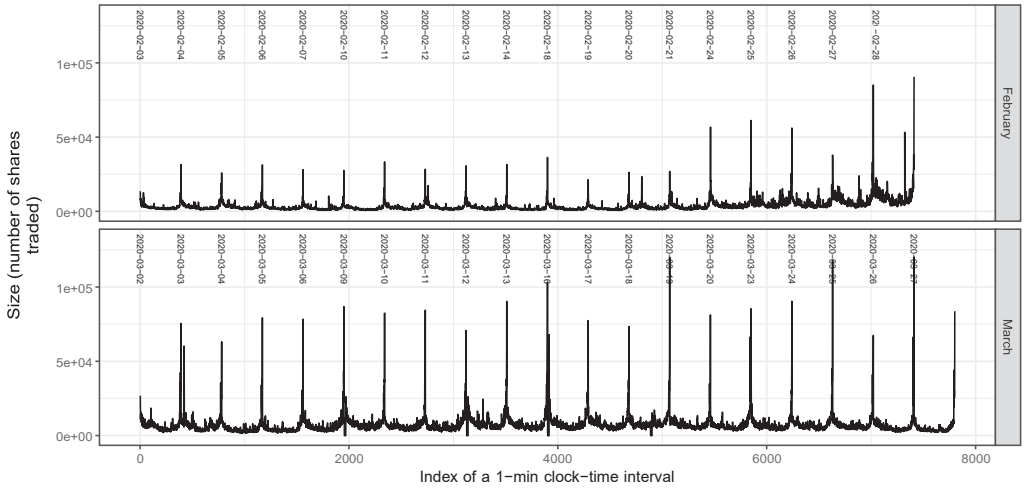

Figure 5: Cross-sectional aggregate of size per 1-min interval between 03.02.2020-27.03.2020.

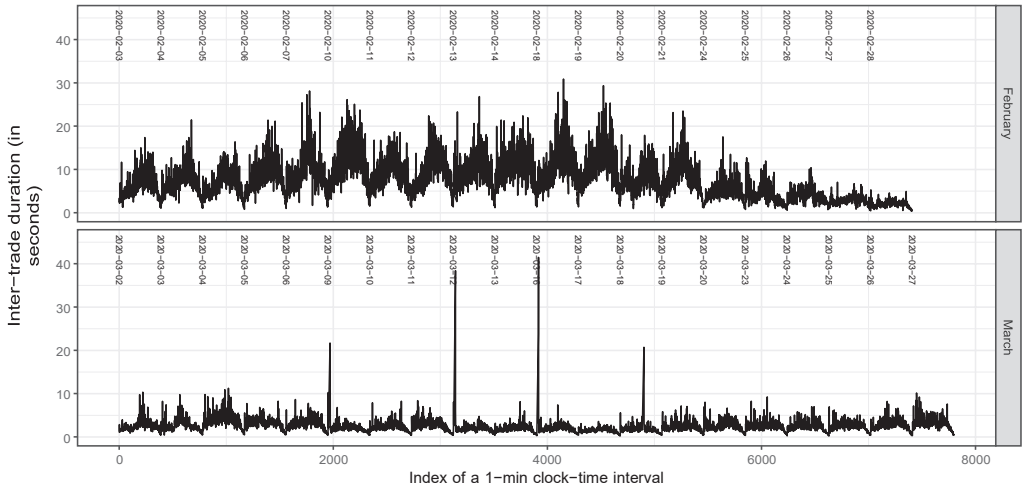

Figure 6: Cross-sectional average of duration per 1-min interval between 03.02.2020-27.03.2020

4 Conclusions

In this article, we tracked the emergence of the coronavirus pandemic by following the 30 US blue-chip stocks included in the Dow-30 index using intraday data. Based on standard indicators of activity, liquidity, and volatility, we monitored the unfolding of the pandemic on the market in 1-min resolution; the spread gradually began to take its toll on the stocks in the last trading week of February, continued to unravel in the first week-and-a-half of March, before the mayhem of 12-23 of March took place.

The prices of all stocks on the 27th of March were below those on the 3rd of February. The other variables experienced level- and variability-shifts between the 'control' period of February and that of March. Level-change for volatility and inter-trade duration was 3-fold (up for volatility and down for duration), while that for bid-ask spread and the number of shares traded was a 2-fold increase. With respect to variability-change, it was largest for the return: a 6-fold increase at the end-of-day 1-min interval and 4-fold at the mid-day 1-min interval. For the remaining variables, it was 3-fold in volatility and inter-traded duration (increase for volatility and decrease for duration) and a 2-fold increase for bid-ask spread and volume.

The medium- and long-term effects of the COVID-19 pandemic on societies and economies are still unfolding. Here we presented the immediate ones as inflicted on the Dow-30 stocks at the microscopic level.

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