A premise: Flash Crashes

- In recent years, an increasing number of incidents known as “flash crashes” has roiled financial markets.

- The most infamous event is probably the equity market flash crash on May 6, 2010 (“The Flash Crash”).

**Flash crash: (Bank of England, 2019)**

A **large and rapid** change in the price of an asset that does not coincide with or in some cases substantially **overshoots** changes in economic fundamentals, before typically **retracing** those moves shortly afterwards.

<table>
<thead>
<tr>
<th>Date</th>
<th>Year</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep. 17</td>
<td>2012</td>
<td>Commodities (oil)</td>
</tr>
<tr>
<td>Apr. 23</td>
<td>2013</td>
<td>Twitter flash crash</td>
</tr>
<tr>
<td>Oct. 15</td>
<td>2014</td>
<td>US Treasury bonds</td>
</tr>
<tr>
<td>Mar. 18</td>
<td>2015</td>
<td>US Dollar FX rates</td>
</tr>
<tr>
<td>Oct. 7</td>
<td>2016</td>
<td>British Pound</td>
</tr>
<tr>
<td>Jan. 3</td>
<td>2019</td>
<td>Japanese Yen</td>
</tr>
<tr>
<td>March 12</td>
<td>2020</td>
<td>Italian Government Bonds</td>
</tr>
</tbody>
</table>

- Open debate: Is this a problem for **financial stability**?
Contributions of this paper

We contribute to this literature in different directions:

1. By arguing that a market inefficiency of flash-crash type (a V-shape) is signaled by a sudden change in the sign of the price drift, we uncover an additional channel by which a pandemic is costly for taxpayers.

2. We analyze data from the secondary Italian bond market, and we show that the auction premium spiked anomalously on Thursday 12 March 2020.

3. We quantify the Treasury issuance cost at 136 bps of the auction size.

4. Our results also indicate that subsequent monetary policy measures effectively reduced the size of the premium during the second wave of the pandemic.
Il Sole 24 Ore Econopoly blog – *Dal coronavirus una sfida per il futuro: disegnare mercati meno fragili*

Bank Underground blog post – *Market fragility in the pandemic era* – Our post has received some good traction so far, helped in part by being a recommended reading of the Financial Times

The V-statistic was used in the Financial Stability Report of the Bank of England (August 2020) to assess the presence of market distress
An example: Market distress during March 2020

Source: Market fragility in the pandemic era, Bank Underground post, 2020
How does price react to news?

Source: V-shapes, Maria Flora and Roberto Renò, working paper, 2020
Our main dataset mainly consists of all transactions in the Monte Titoli (MOT) up to 31 October 2020 of the 10-year fixed-rate bond which was incepted on 30 August 2019. This bond was auctioned in 7 additional ordinary tranches on:

- 27 September 2019
- 30 October 2019
- 28 November 2019
- 30 December 2019
- 30 January 2020
- 12 March 2020
- 31 March 2020

The daily COVID-19 data for Italy come from the website of the European Centre for Disease Protection and Control (ECDC).
Figure: Intraday prices of the 10-year BTP in the MOT market for various days in which it was auctioned. The dashed-red line is at 11:00 (auction time).
Relevant literature: a selective review

- Flora and Renò (2020) show how to capture movements of the price away from fundamentals
- Duffie (2020), to improve financial stability, advocates the introduction of a broad central clearing mandate
- Menkveld and Yueshen (2019) show that cross-arbitrage may break during a severe liquidity shock, and point at fragmented markets (like the Italian secondary market for Treasury bonds) as a potential source of flash crashes
- Schrimpf, Shin, and Sushko (2020) point at hedge funds as a major amplifier of the events in the U.S. Treasury market
- Colliard (2017) shows that flash crashes can be exacerbated by the presence of traders with superior information on liquidity, instead of fundamentals
- Lou, Yan, and Zhang (2013) show that the average auction premium on the US bond market is between 9.07 and 18.43 bps.
The model

Assume that the log-price process $X$, observed in the interval $[0, 1]$, is driven by

$$dX_t = dt \left( \mu_t + \frac{c_{1,t}^-}{(\tau_{db} - t)\alpha} \mathbb{1}_{\{t < \tau_{db}\}} + \frac{c_{1,t}^+}{(t - \tau_{db})\alpha} \mathbb{1}_{\{t > \tau_{db}\}} \right)$$

$$+ dW_t \left( \sigma_t + \frac{c_{2,t}}{|\tau_{db} - t|\beta} \right) + dJ_t ,$$

- $\mu_t$ is locally bounded and predictable;
- $\sigma_t$ is locally bounded, adapted, càdlàg and positive;
- $J_t$ is a pure jump process;
- $\tau_{db}$ is the explosion time;
- $0 \leq \alpha < 1$ and $0 \leq \beta < \frac{1}{2}$
The V-statistic (Flora and Renò, 2020)

The V-statistic

\[ V_{\tau,n} = \sqrt{h_n} \cdot T_{\tau,n}^+ \cdot T_{\tau,n}^- \]

Similarly to Christensen, Oomen, and Renò (2021), the test can be formally expressed at time-point \( \tau \) as follows

\[ T_{\tau,n}^- = \sqrt{\frac{h_n}{K^-_2} \hat{\sigma}^{-}_{\tau,n} - \hat{\mu}^{-}_{\tau,n}} \]

where

\[ \hat{\mu}^{-}_{\tau,n} = \frac{1}{h_n} \sum_{i=1}^{n} K^- \left( \frac{t_{i-1} - \tau}{h_n} \right) (X_i - X_{i-1}) \], \hspace{1cm} \text{for } \tau \in (0, 1] ,

and

\[ \hat{\sigma}^{-}_{\tau,n} = \left( \frac{1}{h_n} \sum_{i=1}^{n} K^- \left( \frac{t_{i-1} - \tau}{h_n} \right) (X_i - X_{i-1})^2 \right)^{\frac{1}{2}} \], \hspace{1cm} \text{for } \tau \in (0, 1] .

What happened on Thursday 12 March 2020?

The ECB prepares to act as virus crisis escalates

Christine Lagarde is set to announce stimulus package to shield the eurozone from the outbreak

Lagarde in damage-control mode after saying ECB ‘not here to close spreads’ amid Italy bond selloff

Published: March 12, 2020 at 12:58 p.m. ET

By William Watts

Investors call ECB response underwhelming
Results on Italian bonds

Figure: The $\nu_{\tau,n}$ computed on the intraday clean prices at each transaction time using a bandwidth $h_n = 5$, $h_n = 15$, and $h_n = 30$ minutes. Confidence bands are reported for the 15-minute bandwidth only with a parametric bootstrap technique.
## Comparison

<table>
<thead>
<tr>
<th>Time at minimum</th>
<th>V-statistics minimum</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-Mar-2020</td>
<td>10:55:53</td>
<td>-3.53</td>
</tr>
<tr>
<td>12-Mar-2020</td>
<td>10:59:19</td>
<td>-7.35</td>
</tr>
<tr>
<td>30-Jan-2020</td>
<td>10:55:11</td>
<td>-0.55</td>
</tr>
<tr>
<td>30-Dec-2019</td>
<td>11:00:56</td>
<td>-0.96</td>
</tr>
<tr>
<td>28-Nov-2019</td>
<td>10:59:48</td>
<td>-0.03</td>
</tr>
<tr>
<td>30-Oct-2019</td>
<td>11:07:17</td>
<td>-0.00</td>
</tr>
<tr>
<td>27-Sep-2019</td>
<td>11:04:29</td>
<td>-0.69</td>
</tr>
</tbody>
</table>

**Table:** Shows the minimum of the $V_{\tau,n}$, the time at which it was attained and its p-value in the seven days in which the 10-year BTP was auctioned by using a bandwidths of 15 minutes.
Estimated cost for taxpayers: I

Figure: Yields of the three bonds auctioned on 12 March 2020 in the secondary market (MOT). Each point represents a transaction in the MOT.
The auction of 12 March 2020 offered four different bonds, all fixed-rate BTPs with maturity 3 (€3.5 bln), 7 (€0.795 bln), 10 (€1.205 bln) and 20 (€1.5 bln) years.

The cost for taxpayers is estimated to be -0.90%, -1.39% and -1.57% for the 7, 10 and 30 year BTP respectively. The corresponding loss amounts to 47.55 million euros, 1.36% of the amount offered (€3.5 bln).

Note: This estimated total auction premium has to be considered a lower bound, since the computation ignores the 3.5 billion euros auction on the first tranche of a 3-year BTP for which a secondary market was still not available.
Volatility and size of the auction cycle: I

Figure: The difference between hourly returns before and after the auction versus the logarithm of 5-minute realized variance computed in the previous day.
Volatility and size of the auction cycle: II

Lou, Yan, and Zhang (2013) explain the transient price decrease by the limited risk-bearing capacity of primary dealers. Their theory has two ingredients.

- Primary dealers hedge the supply shock by selling substitute bonds in the secondary market before the auctions, which creates a temporary downward pressure in prices.

- Harsher liquidity conditions and higher volatility should magnify the effect because of the risk aversion of the primary dealers.
Figure: Volatility of the 10-year BTP under auction, measured as the square root of 5-minute realized volatility, and number of new hospitalizations with Covid-19 symptoms.
Testing methodology

We test the impact of COVID-19 on the BTP volatility using a modification of the additive cascade model of volatility components defined over different time periods in Corsi (2009), as follows

\[ \sqrt{RV_t} = \alpha + \beta_d \sqrt{RV_{t-1}} + \beta_w \sqrt{RV_{t-1:t-5}} + \beta_m \sqrt{RV_{t-1:t-22}} + \gamma COVID_{t-1} + \delta ECB_t + \varepsilon_t. \]

Note: The first three explanatory variables (\( \sqrt{RV_{t-1}} \), \( \sqrt{RV_{t-1:t-5}} \) and \( \sqrt{RV_{t-1:t-22}} \)) are meant to model the “normal” volatility dynamics and its long-term persistence.
### Results of the testing methodology

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Pre-Covid</th>
<th>Coefficient</th>
<th>t-stat</th>
<th>First wave</th>
<th>Coefficient</th>
<th>t-stat</th>
<th>Second wave</th>
<th>Coefficient</th>
<th>t-stat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
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<td>2.07***</td>
<td>2.86</td>
<td>5.42***</td>
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<td>3.44</td>
<td>2.59***</td>
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<td>3.11</td>
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<tr>
<td>$\sqrt{RV_{t-1}}$</td>
<td>0.16</td>
<td>1.60</td>
<td></td>
<td>0.43***</td>
<td></td>
<td>5.13</td>
<td>0.16</td>
<td>1.31</td>
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<tr>
<td>$\sqrt{RV_{t-1:t-5}}$</td>
<td>0.39**</td>
<td>2.23</td>
<td></td>
<td>0.09</td>
<td></td>
<td>0.62</td>
<td>−0.31</td>
<td>−1.14</td>
<td></td>
</tr>
<tr>
<td>$\sqrt{RV_{t-1:t-22}}$</td>
<td>0.09</td>
<td>0.58</td>
<td></td>
<td>−0.05</td>
<td>−0.43</td>
<td></td>
<td>0.51**</td>
<td>2.52</td>
<td></td>
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<tr>
<td>ECB decisions</td>
<td>6.15***</td>
<td>5.64</td>
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<td>25.63***</td>
<td>10.95</td>
<td></td>
<td>1.05*</td>
<td>1.83</td>
<td></td>
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<tr>
<td>COVID$_t$−1</td>
<td>−</td>
<td>−</td>
<td></td>
<td>2.73**</td>
<td>2.44</td>
<td></td>
<td>1.42***</td>
<td>2.66</td>
<td></td>
</tr>
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<td>Observations</td>
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<td>88</td>
<td>76.83</td>
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<td>89</td>
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<td>$R^2$</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>16.27</td>
</tr>
</tbody>
</table>

Note:
- First wave -> 2 Sep 2019-22 Feb 2020
- Second wave -> 23 Feb 2020-30 Jun 2020
- Third wave -> 1 Jul 2020-31 Oct 2020
Pandemic emergency purchase programme (PEPP): I

The Governing Council decided to increase the initial €750 bln amount releases on 18 March 2020 by €600 bln on 4 June 2020 and by €500 bln on 10 December, for a new total of €1,850 billion.

![Figure](chart.png)

**Figure**: Cumulative figures represent the difference between the acquisition cost of all purchase operations and the redeemed nominal amounts. Source: ECB data

**Note**: The monthly purchase volumes are reported on a settlement basis and net of redemptions.
**Figure**: 1-minute closing price bids of the 10-year BTP futures on 29 October 2020. The dashed red line represents the auction time.
Conclusions

- V-shapes indicate market dysfunctions, and we should use local drift to detect distress.

- We uncover an additional channel by which a pandemic is costly for taxpayers.

- What should be on our agenda?
  - Understand reasons that may cause abnormal price movement and improve monitoring of financial markets.
  - Can we avoid market dysfunctions? We show the effectiveness of the ECB interventions.

- Thanks for your attention!
Bibliography


