



Data Science High Frequency Indicators

Nitrogen dioxide concentration halves in Italy

We analysed NASA satellite images of the nitrogen dioxide (NO₂) density in the areas more affected by Covid-19. The impact of the Italian lock-down in mid-February is clearly shown in a 60% effective decrease in pollution, whilst we observe a gentler fall in emissions in South Korea.

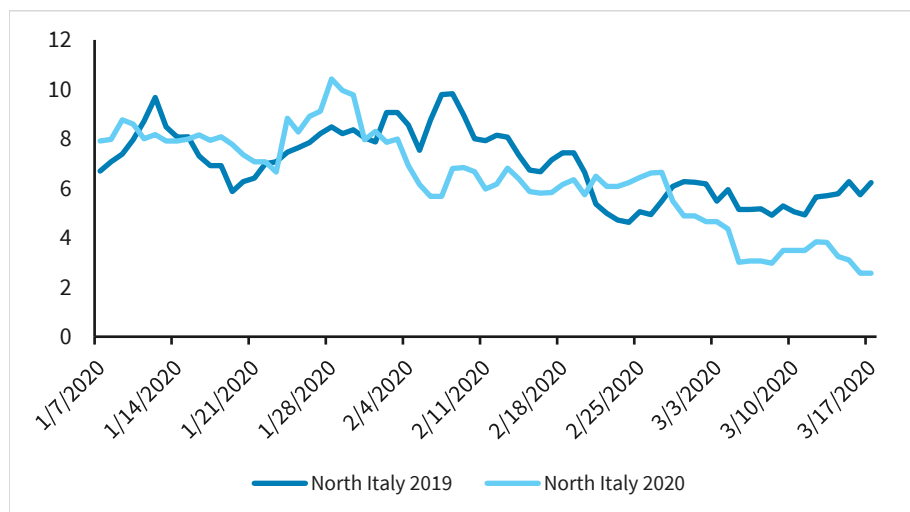
However, we do not yet see significant decreases in pollution in Western Germany or South East England. This suggests that the measures taken place in these regions have not had a significant effect on economic activity.

Other areas such as the North East US remain inconclusive for now. We will continue to monitor emissions in these regions, as well as those recovering areas in China, for any changes.

The challenge of NO₂ a proxy for economic growth is that the regular noise is often as large as the signal we can see from even significant changes in activity. The gas is produced from combustion, both in industrial contexts and from personal vehicles. Due to the large dispersion of pollution, we observe large areas around conurbations, reflecting both inputs. Seasonality, weather, renewable production and other factors contribute to significant noise on the signal, with significant variation observed in 2019.

FIGURE 1

NO₂ satellite data shows the decline in pollution post Italian lockdown. Seven-day rolling average of NO₂ comparing 2020 to the same day of the week in 2019



Source: Barclays Research, NASA OMI satellite

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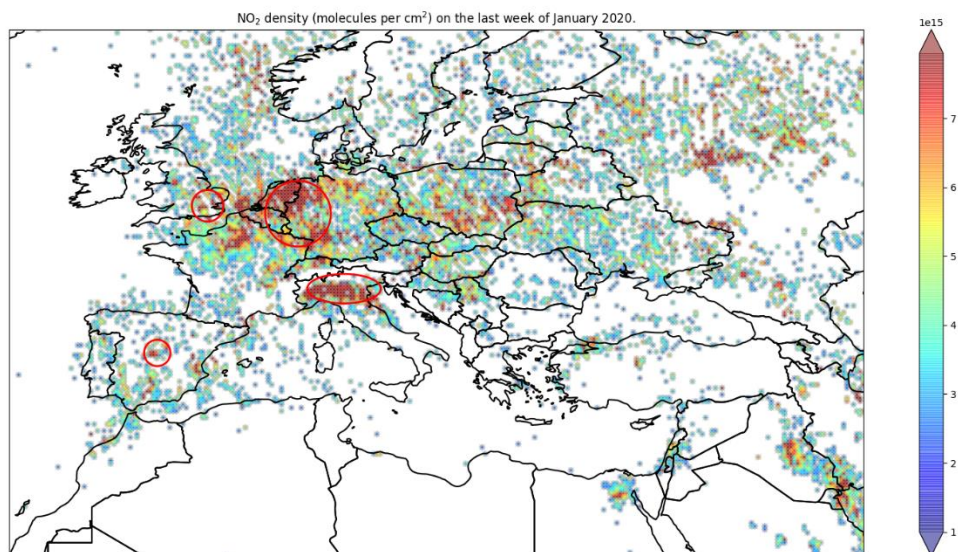
Investment Sciences

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FIGURE 2

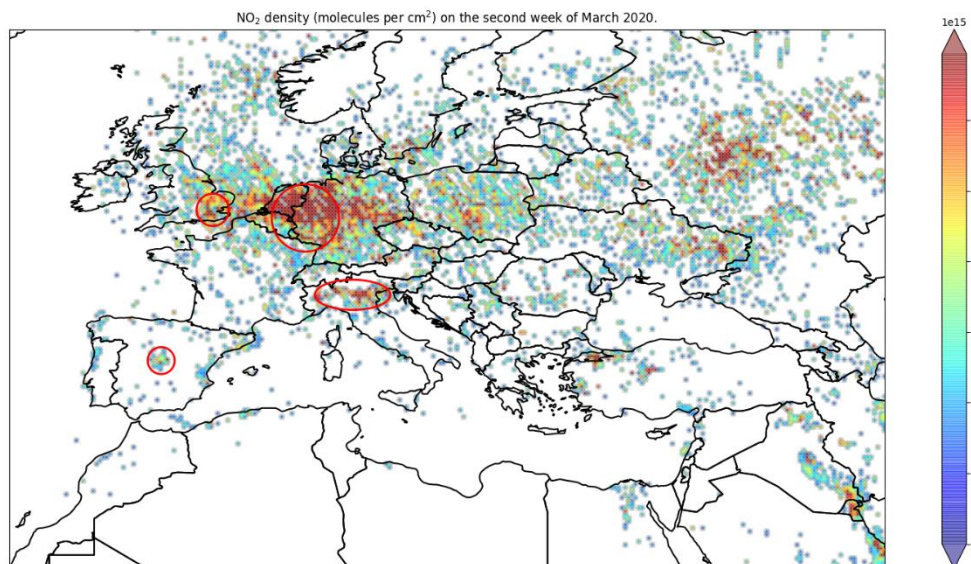
NO₂ density (molecules per cm²) on the last week of January 2020. Red circles encompass the analysed regions.



Source: Barclays Research, NASA OMI satellite

FIGURE 3

NO₂ density (molecules per cm²) on the second week of March 2020. Red circles encompass the analysed regions.



Source: Barclays Research, NASA OMI satellite

Nitrogen dioxide pollution as a proxy for economic activity

NO₂ pollution as a proxy for industrial activity + vehicles

The NASA OMI satellite measures various chemicals in the earth's atmosphere. NO₂ is a gas created in large volumes from combustion in industrials, transportation and power-plants. Hence we believe pollution metrics for this gas will correlate with the economic activity in a region. We acknowledge that factors such as weather contribute to significant noise on the signal, as discussed later in this report. However, as a high frequency signal, we believe trends from significant economic changes may be visible, with readers cognisant of the limitations of the data.

In Figure 1, we show a rolling average pollution level for Northern Italy, noting that the lock-down that started in the week to February 23th has had a clear impact on pollution levels. To compare weekdays with their equivalent, we offset 2019 by one day to match the ISO week date systems.

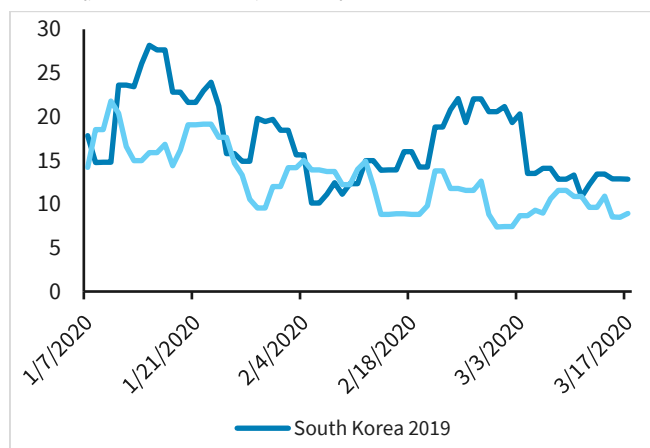
We also show pollution maps of Europe in the last week of January and the second week of March, Figures 3 and 4. By the latter, Italy was already in full lock-down. Madrid and Paris had already reduced free movement. In central Europe, the picture is more mixed, with some reduced centres of industry (e.g. Rhine Valley) but less obvious broad declines.

FIGURE 4
Seven-day rolling average of daily NO₂ pollution in the Madrid area (peta molecules per cm²)



Source: Barclays Research, NASA OMI satellite

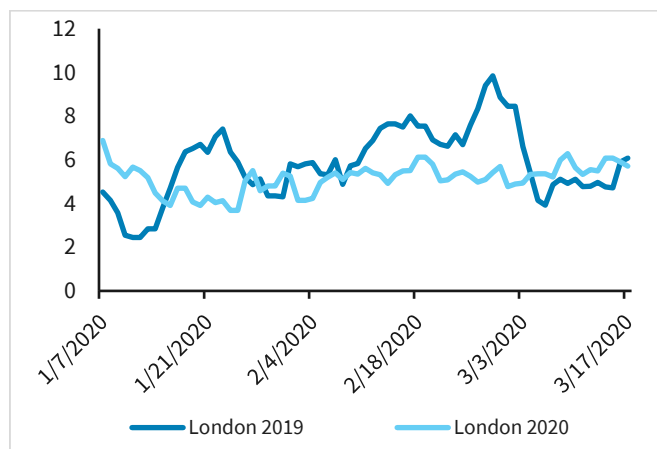
FIGURE 5
Seven-day rolling average of daily NO₂ pollution in South Korea (peta molecules per cm²)



Source: Barclays Research, NASA OMI satellite

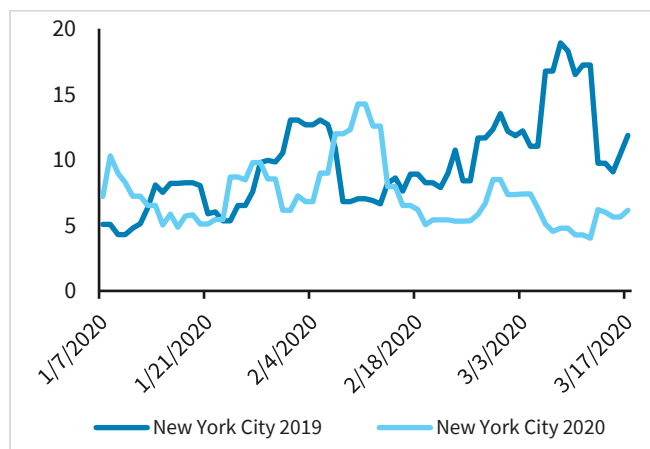
South Korea has not had strict restrictions but strong encouragement of isolation and very widespread testing since mid-February. Figure 5 shows pollution tailing off since this period, without a large fall. Has this high level of testing enabled non-infected South Koreans to continue to work, with industrial production suffering less? Our data seems to suggest so.

FIGURE 6
Seven-day rolling average of daily NO₂ pollution in the London area (peta molecules per cm²)



Source: Barclays Research, NASA OMI satellite

FIGURE 7
Seven-day rolling average of daily NO₂ pollution in the New York City area (peta molecules per cm²)



Source: Barclays Research, NASA OMI satellite

Data from London shows a broadly flat 2020, suggesting the UK government's light approach has had little effect on pollution so far. However, with stricter restrictions imposed as of March 20th, we believe the data will soon begin to show activity dropping. West Germany and Benelux, despite isolated spots of lower activity, also show no larger trends.

The data for New York City is far from conclusive, with spikes in pollution in early January and February 2020. Furthermore, pollution increased significantly in mid-March 2019, making comparisons difficult. We aim to further refine the area selection and other variables for better measurement of this region.

We had also hoped to include data for the Wuhan region in China; however, the data is infrequent and very noisy.

Methodology

NO₂ is produced mainly from burning fossil fuels. In Figure 8, we show UK sources of NO₂ emissions, with transport representing c46% of the total estimated. We note that diesel engines can produce up to 50% more NO₂ than petrol, such that one might expect the contribution of road transport to be higher in geographies such as Europe.

FIGURE 8

Annual NO₂ emission estimates for the UK by source, 2018

Source	Thousand tonnes	Percentage
Energy	165	20.0%
Manufacturing and Construction	144	17.5%
Road Transport	259	31.5%
Non Road Transport	118	14.3%
Other	137	16.6%

Source: Defra, Recardo Energy and Environment

With one-fifth of emissions from the energy sector, colder weather should result in larger emission rates, as could the performance of renewables in the energy mix. However, wind and other environmental factors will have impacts on the spread and measurement of emissions. We have not modelled to account for this.

The resolution of the OMI satellite is 0.25 x 0.25 degrees, which corresponds to roughly 28 x 28 km. This is roughly the size of London. To best measure the economic effects of inner cities and their surroundings, including associated energy and industrial production, we defined large regions up to 200 km in order to capture both cities and larger regions. Large areas additionally aid in capturing pollution blown away from inner cities by strong winds.

FIGURE 9

Name, location, and radius of our defined regions

Region	Centre (longitude, latitude)	Radius	Notes
North-Italy	10.50, 45.30	170 km	Ellipse major-axis
South Korea	127.76, 36.5	180 km	Most of the North-West, including Seoul
West Germany & Benelux	7.00, 51.00	200 km	West Germany, Netherlands and West Belgium
London	0.13, 51.60	120 km	Including most of the commuter belt
Madrid	-3.70, 40.41	40 km	
New York City	-74.0, 40.7	80 km	

Source: Barclays Research

*Look at lowest atmosphere
available when <30% cloud
cover*

Heavy cloud cover can obscure pollution; hence we remove areas with >70% cloud cover at each measurement time. Remaining measurements for the lowest layer to the earth's surface (troposphere) within each radius are averaged over a weekly period.

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