**Inflation expectations, volatility and Covid-19: Evidence from the US inflation swap rates**

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**ABSTRACT**

The goal of this work is to explore the role of the Covid-19 pandemic event in the course of inflation expectations and their volatility through US inflation swap rates. The findings document that inflation expectations and their volatility are positively affected by the Covid-19 pandemic. These results have real activity implications, while close monitoring of inflation expectations could signal inflation expectations un-anchoring risks.

**KEYWORDS***:* inflation swaps; inflation volatility; Covid-19; GARCHX model

**JEL CLASSIFICATION**: E31; Q54

**I. Introduction**

The Covid-19 crisis is an unprecedented shock for many economies; its impact on real activity has been clearly negative, while its role for the course of inflation is still unexplored. There are downward pressures, i.e. the collapse in consumption due to the lockdown; in contrast, there are upward pressures, such as the reduction in real output. Prices have been also affected by a potential change in demand as consumers stockpiled. Lower energy prices, meanwhile, reflect a collapse in the demand for energy as a result of the shutdown of activity in sectors, such as transportation.

The only close works to ours is that by Armantier et al. (2020) who use the Survey of Consumer Expectations and examine how the Covid-19 outbreak affects inflation expectations, documenting that inflation expectations have not exhibited any upward or downward trend since the emergence of the pandemic, while they illustrate unprecedented increases in disagreement across respondents about future inflation, and by Coleman and Nautz (2020) who use the wording of the ECB’s definition of price-stability, start a representative online survey of German citizens designed to measure the time-varying credibility of the inflation target. Their analysis indicates that credibility has significantly decreased, particularly in the course of the Covid-19 pandemic. This decline is primarily due to the fact that Germans increasingly expect that inflation will be much higher than 2% over the medium term.

While most of the analysis focuses on the expected mean of inflation, monitoring inflation uncertainty/risk and understanding the role of Covid-19 in driving this uncertainty is substantially relevant in calibrating appropriate policy responses, but has not been examined yet. Central banks are heavily relying on inflation uncertainty to understand economic and financial risks. The negative consequences of inflation volatility are of substantial concern. In a framework with nominal contracts that induce risk premia for long-term arrangements, uncertainty raises costs for hedging against inflation risks and leads to the unanticipated redistribution of wealth. Hence, inflation volatility impedes growth even if mean inflation remains restrained.

The goal of this work is to shed light on the role of the Covid-19 pandemic in changing the course of inflation expectations and their volatility. The novelties of the study are, that to the best of our knowledge, there is limited research that explores the role of the Covid-19 pandemic event in the US inflation expectations process (Armantier et al., 2020; Coleman and Nautz, 2020), and second, that it makes use of inflation swap rates. Such swaps are derivative transactions in which one party agrees to swap fixed payments for floating payments tied to the inflation rate. Inflation swaps are frequently used by market participants to hedge inflation risks and to speculate on the path of inflation, as well as by market observers to infer inflation expectations (Krishnamurthy and Vissing-Jorgensen, 2011). Their advantage is that they are used to transfer/hedge inflation risks.

The empirical analysis is a version of the Phillips curve, i.e. the model that links inflation to its main drivers, i.e. oil prices, equity return volatility (Gilchrist et al., 2017), and the Covid-19 metric. This framework has received positive assessments that it can successfully deal with important shocks, such as the Covid-19 (Eser et al., 2020).

**II. Methodology**

The GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model (Bollerslev, 1986), is a popular framework to model risk. The empirical analysis uses the GARCHX variant (Engle et al., 1990). This model allows to include information on additional controls that impact the mean and the volatility of inflation. The standard model is made up of two equations: a conditional mean and a conditional variance equation. We allow the Covid-19 factor to enter both equations. Following certain works in the literature (Grier and Perry, 1998; Fountas, 2001; Hartmann and Herwartz, 2012), in the starting point, an ARMA(p, q) inflation process is used to calculate errors:

p q

πt = a + Σbi πt-i + Σci vt-i + εt (1)

i=1 i=1

where the first sum represents the autoregressive (AR) component, and the second the moving average (MA) component, with a and ε being a constant and an error term, respectively. Next, we add certain variables in the mean equation, i.e. oil prices (oil), equity volatility (evol), and the Covid-19 factor, turning the model into the GARCHX specification:

p q

πt = a + Σbi πt-i + Σci vt-i + d1 evolt + d2 oilt + d3 Covid-19t + ηt (2)

i=1 i=1

Within a GARCH(1, 1) framework, the equation of conditional volatility turns out to be:

ht = f + g1 ht-1 + g2 ε2t-1 (3)

where h denotes the conditional volatility and ε proxies the residuals from (1). In the GARCHX version, we also add the Covid-19 variable that explicitly considers the impact of the pandemic on conditional inflation volatility:

ht = f + g1 ht-1 + g2 η2t-1 + g3 Covid-19t (4)

with the restriction of the stability conditions remaining similar to those in the traditional GARCH(1, 1) model, i.e. g1+g2<1. The empirical analysis will estimate Equation (2) and (4) over the pre-Covid19 era and during the pandemic regime.

**III. Data**

We study the effect of Covid-19 on US inflation, spanning the period January 2, 2019- July 31, 2020 using daily data. We employ four proxies for the Covid-19: i) total confirmed cases (Covid19-1), ii) death cases (Covid19-2), iii) worldwide confirmed cases (WCovid19-1), and iv) total death cases worldwide (WCovid19-2). The analysis uses daily crude oil prices measured as spot West Texas Intermediate (WTI) prices, and equity volatility data, proxied by the VIX index. Finally, the analysis uses 5-year maturity inflation swap rates. All data come from Datastream, except those on swap rates coming from the FRB of Saint Louis database. Figure 1 depicts the 5-yr inflation swap rate. It is observed that there was a sudden (downward) break in March 2020, when the Covid-19 incidences and deaths escalated; next, a continuous rise was followed afterwards. Figure 2 illustrates the US and Worldwide Covid-19 deaths, respectively.

**Fig. 1**. US inflation swap rates

**Fig. 2**. US and Worldwide Covid-19 deaths

# IV. Empirical analysis

The coefficient estimates for the model in Equations (2) and (4) are presented in Table 1. The findings are with respect to the four specifications corresponding to the four alternative proxies of the Covid-19 variable: i) Covid19-1: daily total confirmed incidences in the US, ii) Covid19-2: total daily deaths in the US, iii) WCovid19-1: total confirmed daily incidences worldwide, and iv) WCovid19-1: total daily deaths Worldwide. Panel A reports the pre Covis-19 results (January 2, 2019-February 28, 2020), while Panel B those in the Covid-19 regime (March 2, 2020-July 31, 2020). Finally, the variables entering the mean equation have been normalized by subtracting their mean and then dividing by its standard deviation.

The results document that the estimated coefficients of the GARCHX model meet the required condition that g1+g2<1, i.e., ensuring mean reversion across both regimes. The estimates illustrate that all estimated coefficients in the conditional variance equation are statistically significant, while the findings provide strong evidence that the Covid-19 exerts a positive impact on mean breakeven inflation. These results hold across all four models corresponding to the four alternative definitions of the Covid-19 measure, with the positive impact of the Covid-19 being more pronounced when we use total deaths to proxy this infectious disease. Similarly, the results of the conditional volatility document that the Covid-19 has a positive effect on the volatility of breakeven inflation, with the results remaining consistently similar across both definitions Again we find that these effects are stronger with the total number of deaths as a proxy for Covid-19. In terms of the economic interpretation of the estimates, a one standard deviation of Covid-19 deaths in the US and worldwide, increases mean inflation by 0.84 and 0.91, respectively (given that the mean inflation in the Covid-19 regime is 1.75). In addition, oil prices and equity volatility/uncertainty carry a similar positive impact on the mean of breakeven inflation across both regimes, although equity uncertainty gets stronger during the pandemic regime.

**Table 1.** GARCHX estimates: the role of Covid-19 in US inflation swap rates.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Model 1** | **Model 2** | **Model 3** | **Model 4** |
| **Mean equation** | **CCovid19-1** | **CCovid19-2** | **WCovid19-1** | **WCovid19-2** |
| **Panel A: Pre Covid-19 regime**  5-yr inflation swap(-1) | 0.697\*\*\* | 0.713\*\*\* | 0.694\*\*\* | 0.719\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| Oil prices | 0.58\*\*\* | 0.62\*\*\* | 0.59\*\*\* | 0.71\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| VIX | 0.51\*\* | 0.54\*\* | 0.59\*\*\* | 0.63\*\*\* |
|  | [0.02] | [0.02] | [0.01] | [0.00] |
|  |  |  |  |  |
| **Panel B: Covid-19 regime** |  |  |  |  |
| 5-yr inflation swap(-1) | 0.619\*\*\* | 0.638\*\*\* | 0.654\*\*\* | 0.669\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| Covid-19 | 0.436\*\*\* | 0.478\*\*\* | 0.473\*\*\* | 0.521\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| Oil prices | 0.54\*\* | 0.61\*\* | 0.58\*\* | 0.68\*\*\* |
|  | [0.02] | [0.02] | [0.02] | [0.01] |
| VIX | 0.63\*\*\* | 0.67\*\*\* | 0.66\*\*\* | 0.79\*\*\* |
|  | [0.01] | [0.00] | [0.00] | [0.00] |
| **Conditional volatility equation** |  |  |  |  |
| **Panel A: Pre Covid-19 regime** |  |  |  |  |
| h(-1) | 0.546\*\*\* | 0.550\*\*\* | 0.563\*\*\* | 0.571\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| η2(-1) | 0.298\*\*\* | 0.309\*\*\* | 0.325\*\*\* | 0.347\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
|  | 0.082\*\* | 0.119\*\*\* | 0.099\*\*\* | 0.147\*\*\* |
|  | [0.02] | [0.00] | [0.00] | [0.00] |
| **Panel B: Covid-19 regime** |  |  |  |  |
| h(-1) | 0.518\*\*\* | 0.524\*\*\* | 0.527\*\*\* | 0.532\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| η2(-1) | 0.256\*\*\* | 0.268\*\*\* | 0.269\*\*\* | 0.275\*\*\* |
|  | [0.00] | [0.00] | [0.00] | [0.00] |
| Covid-19 | 0.095\*\*\* | 0.128\*\*\* | 0.116\*\*\* | 0.142\*\*\* |
|  | [0.01] | [0.00] | [0.00] | [0.00] |
| *Diagnostics (pre Covid-19 regime)* |  |  |  |  |
| Log-likelihood | 3,355.2 | 3,697.4 | 3,613.8 | 3,884.3 |
| LM test for Heteroscedasticity | [0.68] | [0.76] | [0.78] | [0.82] |
| No of obs. | 290 | 290 | 290 | 290 |
| *Diagnostics (Covid-19 regime)* |  |  |  |  |
| Log-likelihood | 3,247.8 | 3,299.6 | 3,276.3 | 3,489.7 |
| LM test for Heteroskedasticity | [0.64] | [0.69] | [0.68] | [0.77] |
| No. of obs. | 111 | 111 | 111 | 111 |

A constant was included, but it was dropped due to its statistical insignificance. Figures in brackets denote p-values, Covid19-1 denotes Covid-19 incidences, Covid19-2 denotes Covid-19 deaths, WCovid19-1 denotes world Covid-19 incidences, and WCovid19-2 denotes world Covid-19 deaths.

**V. Conclusion**

This study found that inflation expectations, and their volatility, measured through swap inflation have received a positive effect since the emergence of the Covid-19 pandemic. These results may have real activity implications; close monitoring of such expectations is warranted since they may signal a risk of inflation expectations un-anchoring.

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