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Did Bubble Activity Intensify During COVID-19?

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In this note, we utilize hourly exchange rate data for Japanese Yen, Canadian dollar, European Euro and the British pound to search for possible bubble type behavior. We identify evidence that bubble activity characterizes all four exchange rates more so in the COVID-19 period. We also show that bubble activity intensified during the COVID-19 period, implying markets became relatively more inefficient compared to the pre-COVID-19 period.

I. Introduction

Searching for bubble activity or bubble type behavior in asset prices has occupied historical interest, beginning with the Dutch tulipmania in 1634-1637 (Garber, 1989). Bubbles have been documented in recent work; such as, inter alia, Phillips et al. (2011), Phillips et al. (2015), Bettendorf & Chen (2013), Narayan et al. (2016) and Hu & Oxley (2017). The message is that bubbles and crises have a direct link and the literature on bubbles has been motivated by extreme events or crises. The presence of bubbles in prices indicates market inefficiency—from a theory point of view, evidence on bubbles allows a test of the market efficiency hypothesis.

The subject of this note is no different. Inspired by the ramifications of COVID-19 (see Sha & Sharma, 2020), we ask whether bubble activity in exchange rates has intensified in the COVID-19 period. We use the Phillips et al. (2011) bubbles test model (described in Section II) to examine bubble type behavior in four exchange rates, namely, the Canadian dollar (CAD), the Japanese Yen (YEN), the European Euro (EURO), and the British pound (GBP). Our main finding is that overall bubble activity intensified in the period marked by the COVID-19 pandemic. In the pre-COVID-19 period (July 2019 to Dec 2019) based on hourly exchange rate data, we find the number of hours of bubbles to be 80, 97, 99 and 115 for CAD, YEN, EURO, and GBP, respectively. The corresponding number of bubbles in the COVID-19 sample (January 2020 to September 2020) was 101, 241, 134, and 170 hours. This implies that bubble activity in the exchange rate market increased in all markets in the COVID-19 period and it more than doubled in the case of the YEN. The implication is clear: exchange rate markets became inefficient in the COVID-19 period.

This note, by exploring exchange rate bubble activity, sets the agenda for future research to expand on this theme. To this effect, given the preliminary nature of our work and constrained by space in a letters journal, there are several limitations of our work. First, we leave robustness testing to future research. Second, while we utilize single bubbles test there are also multiple bubbles test, such as the generalized sup augmented Dickey-Fuller (ADF, 1979) test, which is essentially a rolling version of the sup ADF test (see Phillips et al., 2015) . Future studies can explore this too. Our point is that if one-bubble activity is intense in the COVID-19 period, the two-bubble test will be even stronger. We leave this for future studies to verify. Third, our empirical work is rooted in the market efficiency theory. While the existence of greater bubble activity implies that exchange rate markets became inefficient during the COVID-19 period, we do not engage in trading strategies in the exchange rate market. We leave this for future studies.

In closing, we highlight that there is scarce literature on the exchange rate—COVID-19 nexus despite a large and growing literature on COVID-19 (see Al-Awadhi et al., 2020; Devpura & Narayan, 2020; Ertuğrul et al., 2020; Fu & Shen, 2020; Gil-Alana & Monge, 2020; Gu et al., 2020; Haroon & Rizvi, 2020a, 2020b; Huang & Zheng, 2020; Iyke, 2020a, 2020b; Liu et al., 2020; Narayan, 2020; Qin et al., 2020; A. Salisu & Adediran, 2020; A.A. Salisu et al., 2020; Afees A. Salisu & Vo, 2020; Xiong et al., 2020; Zaremba et al., 2020; Zhang et al., 2020). In this literature, we come across only two studies that explore the dynamics of exchange rates vis-à-vis the pandemic. Narayan et al. (2020) show that the Yen predicted the Japanese stock market returns more strongly over the COVID-19 period, suggesting that the information content in the Yen was richer during the pandemic. We contribute by showing greater bubble activity which can be perceived as a source of information during the pandemic. Iyke (2020a) show that COVID-19 predicts exchange rates, suggesting like in our study that there is a relation between the pandemic and the exchange rate.

Finally, our work and findings are consistent with those on exchange rate bubbles. In this regard, Hu & Oxley (2017) find mixed evidence of bubbles in a large number of currencies while Bettendorf & Chen (2013) find explosive behavior in the GBP but argue that this maybe driven by relative prices of traded goods such that GBP may not be char-

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acterized by rational bubbles. We differ on two fronts: first, we use high frequency (hourly data) as opposed to monthly data predominantly used by the literature; and, second, we consider the COVID-19 pandemic data.

We discuss the data, model and results in the next section. A summary is provided in Section III as a conclusion to this note.

II. A test of bubbles in exchange rate

A. Model

Our approach to computing bubbles follows a recent econometric procedure developed by Phillips et al. (2011). The testing procedure is based on the familiar ADF regression model, which is of the following form:

$$\Delta ER_t = \pi + \rho ER_{t-1} + \sum_{j=1}^{k} \psi_j \Delta ER_{t-j} + \mu_t,\ \mu_t \sim NID\left(0, \sigma^2\right) \tag{1}$$

In this model, *ER* is one of the four exchange rates we have. We have a dataset that is sampled hourly. We have a 17-hour day, starting at 1:00am and ending at 5:00pm. The data sample is from 01/07/2019: 2:00am to 04/09/2020: 5:00pm. We source all data from REFINITIVE, Datascope. The full-sample of data is split into a pre-COVID-19 (01/07/2019: 2:00am to 31/12/2019: 5:00pm) and the COVID-19 sample (1/01/2020: 1:00am to 04/09/2-2-: 5:00pm). The optimal lag length, *k*, is Schwarz Information Criterion based. The null hypothesis is that there is a unit root, which is tested as $H_0 : \rho = 0$ against the alternative hypothesis $H_1 > 0$, suggesting an explosive root. Phillips et al. (2011) propose estimating the ADF model using least squares. Our approach is the same as the recursive regression procedure, whereby the ADF model is estimated recursively using subsets of the sample data. The corresponding *t*-test statistics are generated following the procedure outlined in Phillips et al. (2011). We set the initial window to 100 hours. The critical values used for testing the null hypothesis are given by $\mathrm{CV}(s) = \frac{\log(\log(ns))}{100}$. By generating these *t*-statistics and comparing them with the critical value, we obtain the number of hours for which the computed *t*-statistic is greater than the critical value. This follows the approach of Narayan et al. (2016). To circumvent the limitations of the ADF test, we also use the sup-ADF test which is rolling window based and its critical values are computed using Monte Carlo simulations; see Phillips et al. (2015) for details on the procedure and Table 1 for details on critical values.

B. Results

Our results are summarized in Table 1. To start, we refer to Panel A where full-sample results are described. The first point of note is about the sub-ADF test results reported in the last column of the table. Over the full-sample period of data, the null hypothesis of a unit root is rejected only for the CAD, suggesting that of the four currencies only the Canadian exchange rate is characterized by explosive behavior. We compare now the explosiveness of currencies in the pre-COVID-19 and the COVID-19 samples. We find that in the pre-COVID-19 sample, none of the series displays any evidence of explosive behavior. That is, the null hypothesis of a unit root cannot be rejected at the 10% level. By comparison, we see that in the COVID-19 period the unit root null is rejected in favor of explosiveness for YEN, CAD, and GBP, suggesting that only for the EURO there is no evidence of bubbles type behavior.

The next set of results is about the intensity of bubble activity. As mentioned in Section II.A, our approach follows the literature in estimating the number of hours of bubbles in the two sub-samples of data. We start with the Canadian dollar and see that in the pre-COVID-19 period, there were 80 hours over which bubble activity was detected. In the COVID-19 sample, it increased by 26.25% to 101 hours. For the EURO, bubble activity jumped from 99 hours (pre-COVID-19) to 134 hours (COVID-19 sample)—a 35.35% increase in bubble activity. In the case of the GBP, the corresponding increase was from 115 hours to 170 hours, representing a growth in bubble activity of 47.83%. Finally, we notice that the Japanese Yen saw the largest jump in bubble activity, from 97 hours in the pre-COVID-19 period to 241 hours in the COVID-19 period. This amounts to a 148.45% increase in bubble activity.

We also estimate and report the number of continuous hours of bubble activity in both periods. Except for the CAD, all currencies have seen greater number of continuous hours of bubble activity in the COVID-19 period compared to the pre-COVID-19 period. Again, the Yen sees the largest jump in bubble activity.

III. Concluding remarks

In this note we start on exploring bubble activity in exchange rates motivated by the broader implications of the COVID-19 pandemic. Using four currencies (CAD, YEN, EURO, and GBP) sampled at hourly frequency, we show that in the pre-COVID-19 period (July 2019 to Dec 2019) there is no evidence of explosiveness in exchange rates except for CAD. In the COVID-19 sample (Jan 2020 to Sept 2020), we find stronger evidence of exchange rate explosiveness: except for the EURO, all currencies are characterized by explosive behavior. In terms of bubble activity, we find greater number of hours of bubble activity in the COVID-19 period compared to the pre-COVID-19 sample. We conclude that the intensity of bubble activity has increased in the COVID-19 period, implying that on average the exchange rate market has become more inefficient in the pandemic than it was prior to it.

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Table 1: Bubbles test results

Panel A: Full-sample period (01/07/2019: 2:00am to 04/09/2020: 5:00pm), *T*=5270			
	No. of hours of bubbles	Longest continuous period of bubbles	SDAF test
YEN	338	37	0.537
CAD	190	46	5.917***
EURO	236	41	-0.191
GBP	297	42	1.160
Panel B: Pre-COVID-19 sample period (01/07/2019: 2:00am to 31/12/2019: 5:00pm), *T*=2244			
	No. of hours of bubbles	Longest continuous period of bubbles	SDAF test
YEN	97	22	0.537
CAD	80	21	-0.204
EURO	99	16	-0.606
GBP	115	38	1.160
Panel C: COVID-19 sample period (01/07/2019: 2:00am to 31/12/2019: 5:00pm), *T*=3026			
	No. of hours of bubbles	Longest continuous period of bubbles	SDAF test
YEN	241	37	3.068***
CAD	101	14	4.577***
EURO	134	17	0.753
GBP	170	42	5.737***
Panel D: Critical values			
Sample size, *T*	1%	5%	10%
T=5270	2.343	1.639	1.393
T=2244	2.328	1.611	1.271
T=3026	2.037	1.569	1.316

This table reports the bubbles test results for the four currencies, namely, the Canadian dollar (CAD), the Japanese Yen (YEN), the European Euro (EURO), and the British pound (GBP). The data sample is from 01/07/2019: 2:00am to 04/09/2020: 5:00pm. The full-sample of data is split into a pre-COVID-19 (01/07/2019: 2:00am to 31/12/2019: 5:00pm) and the COVID-19 sample (1/01/2020: 1:00am to 04/09/2-2-: 5:00pm). The null hypothesis is that there is a unit root, which is tested against the alternative hypothesis of an explosive root. The idea is based on Phillips et al. (2011), where an augmented Dickey-Fuller (ADF) model is estimated using least squares. We estimate the ADF model recursively using subsets of the sample data. The corresponding *t*-test statistics are generated following the procedure outlined in Phillips et al. (2011). We set the initial window to 100 hours. The critical values used for testing the null hypothesis are given by$CV(s) = \frac{\log(\log(ns))}{100}$. By generating these *t*-statistics and comparing them with the critical value, we obtain the number of hours for which the computed *t*-statistic is greater than the critical value (column 2) and the longest continuous hourly period of bubbles (column 3). The critical values for the sup-ADF test (last column) are generated using Monte Carlo simulations using 500 replications specific to the three samples of data. The critical values at the 1%, 5% and 10% levels are presented in Panel D. Finally, *** denotes statistical significance at the 1% level—that is, the null hypothesis of a unit root is rejected in favor of an explosive series.

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