Impulse Response of Economy Policy Unstability Dynamics to Monetary Policies: VAR Model Analysis

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Abstract

The study investigates the impact of monetary policy on economy policy uncertainty to discuss the policy implications for China. The study applied Vector Autoregressive (VAR) methodology for the time-series data from 2002 to 2022 to test impacts of changes in inflation, real money supply and interest rate on the economy policy uncertainty reflected by the standardized scaled frequency counts of economy policy uncertainty characters on newspapers' monthly series. The study showed that the only M2 is stationary at lag first difference I(1) and all other variables are stationary after CPI deflation at 1% significance level. Trace test indicates at least one cointegrating equations at the 5% significance level. The study also conducted the robustness test with economy policy uncertainty from other resource than the main experiment, and the results are robust under the test. The conclusion of the research is that, EPU responses the most strongly to itself and the impact lasts the shortest; secondly strongly to bond and inflation, as the decrease-increase fluctuates due to one unit of shocks are less severe but last longer, diminish until up to 5 months; least strongly to the currency amount but the influence continue up to 6 months. Therefore, when government want to stabilize media economy policy uncertainty, the government should pursue economic growth by maintaining the inflation rate and interest rate in the long term.

Keywords: *Macroeconomic Policies, Vector Autoregressive, Variance Decomposition, Monetary Policy.*

1 Introduction

Since the reform and opening up, China has always pursued the principle of "stability overrides everything". Huang (2022). On the other hand, China is experiencing monetary policy framework transition Das and Song (2022), and according to a growing literature, as the transmission is resulting in a structure similar to those of the advanced economies, monetary policy overwhelms the monetary aggregates on economy activities (Fernald, Spiegel, and Swanson (2014), Harjes (2017),Kim and Chen (2021)). Therefore, it is crucial to assess the effects that monetary policy shocks have had on economic uncertainty, and discuss what can be attributed to forward guidance's role in further ensuring a stable environment for economic development and panic elimination.

About the methodology, Vector Autoregression (VAR) model is considered conventional in the literature (Husted & Sun, 2020). Furthermore, this paper expands the range of causality from uncertainty shock to other measures to the opposite, namely, the uncertainty shock caused by other potential channels of monetary policies. About the subject of the research, most of the Chinese literature limits analysis data within the scope of price, including the monetary policy and fluctuations of interest rates, such as impacts of currency supply shock on real estate prices (Wang, 2007), and different impacts of the same shock on the market in different stages (Xu & Zhang, 2016). Acknowledged the limitation of past literature, the research expands the scope to economic uncertainty, and analysis under the VAR system allows directly comparison of shifts in dynamics of economic uncertainty due to monetary policy.

Therefore, this paper contributes to the growing strand of literature by focusing on economic uncertainty, and examining its response to shocks led by monetary policy in the broader economy, relating to the use of forward policy suggestions. The main contribution of this work comes from empirical analysis exploring the evidence on the economic uncertainty in China, accounting for the nonlinearities arising from factors affected by monetary policy. First, at a high level, this research workhorses theoretical model derives the explanatory factors that may influence economic uncertainty from the New Keynesian Monetary Equilibrium. However, the general equilibrium may not account for non-linearities

in the economy, regarding the transmission of monetary policy, and uncertainty and the response to other policy shocks. Therefore, the paper applies VAR model for dynamically analyzing the impulse response among variables. Secondly, this paper uses unique measures of economic uncertainty, and the currency-related variables from a variety of data resources in conjunction of the CPI-deflator ensures the credibility of the analysis. Lastly, besides the unit root test, Johnasen cointegration test and Granger Causality test before building the VAR system, the paper used economic uncertainty index from alternative source and conducted the robustness test. The valid result of tests for both the main VAR model and the robustness test further ensures credibility of the research. Multiple data resources and unique data of economic uncertainty measurement, a stylized theoretical model that provides a structural framework for analyzing the dynamics of uncertainty, as well as the robustness test, bring clarity to the empirical analysis.

Summarizing findings, this paper finds that EPU responses most quickly to the shock of itself. The fluctuations responding to one unit of interest rate or inflation are less severe and diminishes until up to 5 months. At the same time, one unit shock of currency amount increase result in mild but consistent positive influence of the EPU, showing that higher uncertainty further ties the hands of policymakers when considering monetary policies.

2 Data and Variable Selection

2.1 Explained variables

The explained variable is the EPU Index for China (EPU), newspaper-based indices of policy uncertainty in China developed by Steven J. Davis, Dingqian Liu and Xuguang S. Sheng, based on their working paper, "EPU in China Since 1949: The View from Mainland Newspapers." They quantify uncertainty-related concepts from October 1949 onwards using two mainland Chinese newspapers: the Renmin Daily and the Guangming Daily (Davis & Sheng, 2019).

2.2 Explanatory variables

The explanatory variables are selected based on the Keynesian currency market equilibrium demand function in equation (2).

$$\frac{M}{P} = L(i, Y) = L_1(Y) + L_2(i) \tag{1}$$

where M is the currency supply, P is the price, Y is the output, i is the interest rate. Taking logarithm of both sided and express log values with lower letters:

$$m - p = l_1(y) + l_2(i) = ky - hi \tag{2}$$

$$y = \frac{m-p}{k} + \frac{hi}{k} \tag{3}$$

where k and h are coefficients. With the conclusion, this paper selects the variables which may influence the output as explanatory variables, including change rate of money supply, change rate of inflation rate, and change rate of interest rate.

2.3 Data

Data sample of this research range from February, 2005 to January, 2022. This paper uses M2 for currency supply, which is a customary approach by former literatures Sheng and Wu (2008). Interest rate is approximated by the return rate of one-year national bond, and inflation rate is calculated by the change in CPI to the past period. The change in currency supply rate change in interest rate are deflated by the CPI deflator. The data are from the Chinese National Bureau of Statistics.

3 Model

3.1 VAR Model

This research adopts the methodology of Vector Autoregression (VAR) Model for the following reasons. Firstly, the VAR model is also used by many leading scholars to study inflation and economic growth, so it is easier to continue using VAR in comparing re-

search results KUMAR and PARAMANIK (2020). Secondly, the VAR model considers the dynamic and causal relationships among economic variables, which is an advantage to classical regression models making it appropriate in policy analysis as well as macroeconomic planning. Lastly, the variables in the model are in the form of time series and autocorrelated variables, and hence, the VAR model which is suitable for handling such time series and autocorrelation problems may be adopted to construct the analysis framework. The VAR model describes the evolution of a set of k endogeneous variables over the same sample period$(t = 1, ..., T)$as a function of only their past values. The variables are collected in a k-dimensonal vector $((k * 1)$ matrix. The $i - th$ element, $Y_{i,t}$ of the Y_t is the observation at time t of the i th variable. Assuming, if the i th variable is GDP, then $Y_{i,t}$ is the value of GDP at time t The VAR model is considered as follows:

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + B_1 x_t + ... + B_r x_{t-r} + \epsilon_t \tag{4}$$

where y_t is m-dimensional endogenous variable, x_t is n-dimensional exogenous variable, $A_1 ... A_p$ are matrices of parameters that are to be estimated. Endogenous variables are with lags of p while exogenous variables are with lags of q, and variables are not simultaneously correlated. ϵ_t is a random error term which is not correlated with endogenous and exogenous variables.

3.2 Unit Root test and

The paper first conducts unit root test to determine the stationarity. Results are shown in Table 1. As change in inflation rate, change in interest rate and EPU are with the test statistics smaller than 1% critical value, all variables except change in money supply are stationary time series at 1% confidence level. Besides, as the MacKinnon p-value of change in money supply after taking the first-order differential is 0.000, the change in money supply is a stationary time series at the first difference.

Variable Name	Test Statistics	1% Critical Value	MacKinnon p-value
Δ inflation rate	-12.021	-3.996	0.0000
Δ interest rate	-14.027	-3.996	0.0000
Δ money supply	-2.782	-3.996	0.2037
D(Δ money supply)	-15.557	-3.996	0.0000
EPU	-48.198	-3.996	0.0000
bond	-14.027	-3.995	0.0000

Table 1: Unit root at Lag Length 0 with seasonal trend hypothesis

3.3 VAR optimum lag selection criteria

After confirming the data to be included in the VAR model are stationary time series, the paper selects the optimum lag for the VAR Model based onthe Likelihood-ratio (LR), Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SC) criterion. Results are shown in Table 2. In the VAR model, the LR, FPE, and AIC standard suggest an optimum lag of 4, which is selected as the lag for the VAR model.

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1589.97			1.0e-11	-13.9733	-13.9489	-13.9129	
1	1656.41	132.88	16	0.000	6.4e-12	-14.4177	-14.2959*	-14.1159*
2	1678.56	44.311	16	0.000	6.1e-12	-14.4719	-14.2527	-13.9288
3	1698.79	40.45	16	0.001	5.9e-12	-14.5091	-14.1926	-13.7246
4	1716.28	34.98*	16	0.004	5.8e-12*	-14.5223*	-14.1083	-13.4963

Table 2: VAR Optimum Lag Selection

3.4 Dynamically Stable Test

After fitting the VAR model, the research conducted dynamically stable test by Roots of Characteristic Polynomial to check the dynamical stability condition. Results are shown in Figure 1. If all the eigenvalues lie inside the unit circle, the VAR satisfies stability condition. Because the modulus of each eigenvalue is strictly less than 1, the estimates satisfy the eigenvalue stability condition. In the graph, the points represent the eigenvalues, indicateing visually that these eigenvalues are well inside the unit circle, and therefore, the

VAR system is stable.

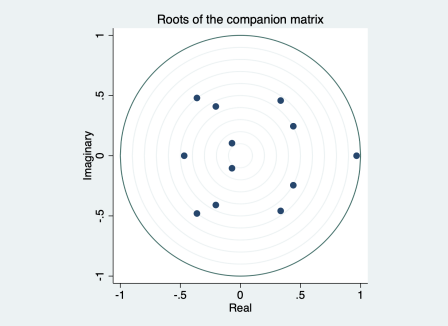

Figure 1: Inverse Roots of AR Characteristic Polynomial

3.5 Cointegration Test

Finally, the research conducts the Johansen Cointegration Test and results are shown in Table 6. Because trace statistics is larger than the critical value at 5% when maximum rank is 0, the null hypothesis that there does exist cointegration is rejected. At rank 3, the tract statistics is smaller than critical value at 5%, indicating at the 0.05 confidence level, there exist at least one cointegration function.

maximum rank	parms	LL	eigenvalue	trace statistic	critical value
0	52	506.38641		185.3781	47.21
1	59	543.89151	0.27626	110.3679	29.68
2	64	580.23069	0.26895	37.6896	15.41
3	67	597.56002	0.13877	3.0309*	3.76
4	68	599.07547	0.01298		

Table 3: Johansen Cointegration Test

3.6 Impulse Response Analysis

The impulse response graph of the above mentioned VAR system is shown in Figure 2. Each row represents the impact of same shock on different variables while each column represents the impacts of different variables on the same variable. Horizontal axis represents the unit time of the VAR model estimation, which is one month in this research, and the graph shows the impulse response from the first month which the shock takes place up to 10 months. The vertical axis represents the change in percentage because all variables are in percentage management in this study.

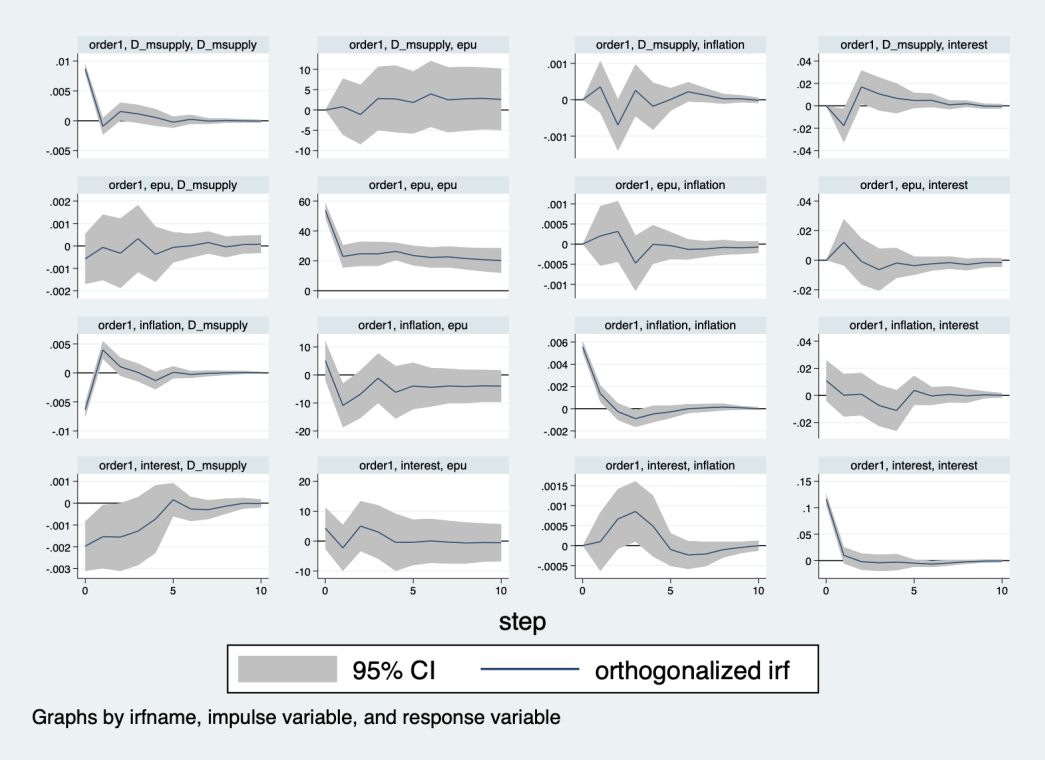

Figure 2: Impulse Response among variables

The first row shows impacts from one unit of money supply shock to the VAR system. The currency supply amount shock is fully absorbed by itself in 1 month, while the impact on inflation is more volatile, fluctuates up to 8 months. The impact on interest rate fluctuates as well, but diminishes more quickly, as the influences arfe hardly observable after 5months. However, the impact on EPU experiences a stable increase until the end of 10 months.

The second row shows impacts from one unit of EPU shock to the VAR system. The impact on money supply are negative at first, but fluctuates then diminishes after 5 months. The EPU quickly absorbs the one unit shock from itself by decreasing for 50% and does not recover after 10 months, revealing that the previous period shock on EPU may have an everlasting effect in the future. Impacts on interest rate and inflation experience similar flictuates and diminishes after 4 months.

The third row shows impacts from one unit of inflation shock to the VAR system. The negative impact on money supply recovers in 3 months, but positive impact on interest rate is milder and lasts longer, up to 5 months. Inflation itself quickly absorbs the full shock in 3 months. The negative influence on interest rate is the least violent and fluctuates until 5

months.

The last row shows impacts from one unit of interest rate shock to the VAR system. The impact on money supply shock is negative at first, and gradually diminish after 5 months. The fluctuateing impact on EPU also diminishes in 5 months. The impact on inflation reaches the peak at the 3rd month, and weakens after 5 months. The interest rate quickly absorbs the full shock in 1 month by decreasing the corresponding percentages, and the impact is not influential after 2 months.

To focus on the impacts from shocks of monetary policy on the economic uncertainty, this paper focuses on the second column, which represents impacts from one unit of shock of multiple variables on the EPU. Among all variables, EPU responses the most strongly to itself, with a decrease up to 60%, and the impact remains stable until 10 months, indicating that economy uncertainty is influenced by itself both in the short-term and in the long-term. The positive responses monetary supply and negative responses to inflation and the second strongest, and the contrary signs result from the contrary effects of monetary supply and inflation. the EPU absorbs the shock in 5 months but does not recover until 10 months, indicating that effects of money supply shock and inflation shock on EPU is long-lasting. Lastly, the EPU does not respond strongly to the interest rate shock.

4 Robustness Test

To further ensure the robustness of the research, the paper changes the measure of economic uncertainty using the statistics independently measured by a different group of researchers, a scaled frequency count of articles about policy-related economic uncertainty in the South China Morning Post (SCMP), Hong Kong's leading English-language newspaper (Baker, Bloom, & Davis, 2016). The paper first conducts unit root test and results are shown in Table 4. With the MacKinnon p-value 0.0010 smaller than 0.05 at 5% confidence level, the SCMP is also a stationary time series.

Variable Name	Test Statistics	1% Critical Value	MacKinnon p-value
China EPU Index (South China Morning Post)	-4.613	-3.995	0.0010

Table 4: Unit root at Lag Length 0 with seasonal trend hypothesis

After verifying the stationarity, the paper conducts VAR optimum lag selection and

results are shown in Table 5. According to maximization of FPE and AIC, the paper selects 3 as the lag rank for the VAR model using interest rate change, inflation rate change, first differential of money supply and SCMP.

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	163.23		3.0e-06	-1.37267	-1.3487	-1.31324		
1	436.91	547.36	16	0.000	3.2e-07	-3.59405	-3.47422*	-3.29692*
2	462.196	50.573	16	0.000	3.0e-07	-3.6741	-3.45841	-3.13927
3	486.344	48.296	16	0.000	2.8e-07*	-3.74435*	-3.43279	-2.9718
4	501.359	30.029*	16	0.018	2.8e-07	-3.73585	-3.32843	-2.7256

Table 5: VAR optimum lag selection criteria

The Dynamically Stable Test of the VAR system with the SCMP is generated with a similar process. The figure 3 below indicates visually that, as these eigenvalues are well inside the unit circle, and therefore, the VAR system is stable.

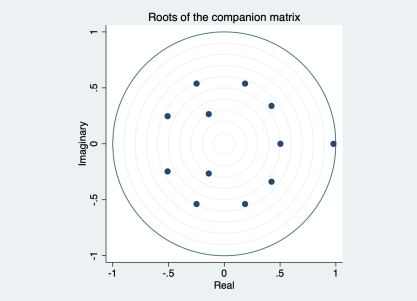

Figure 3: Inverse Roots of AR Characteristic Polynomial

Johansen Cointegration Test and results are shown in Table 6. Similarly, null hypothesis that there does exist cointegration is rejected. The tract statistics at rank 3 smaller than critical value at 5% indicates that there exist at least one cointegration function at the 5% confidence level.

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	36	378.83439		217.1216	47.21
1	43	424.10074	0.32196	126.5889	29.68
2	48	461.52682	0.27476	51.7367	15.41
3	51	486.31444	0.19166	2.1615*	3.76
4	52	487.39518	0.00923		

Table 6: Johansen Cointegration Test

The impulse response graph of the VAR system with SCMP is shown in Figure 4.

The first row shows impacts from one unit of money supply amount shock to the

VAR system with SCMP, and the impact on SCMP contradicts to the VAR system with EPU. The impact on SCMP fluctuates until 3 months, but remains negative until the end of 10 months, which is contrary to the positive impacts of the original model using EPU. This may result in that EPU being a domestic measurement and SCMP being a foreign measurement of China's economic uncertainty. Hence, the money supply shock may be interpreted differently according to different stands.

The second row shows impacts from one unit of SCMP shock to the VAR system with SCMP. Impact on money supply and interest rate are negative at first but fluctuates then diminishes after 5 months. Impacts on interest rate change experience a similar pattern except for the positive original impact, and mildly diminishes after 3 months. The SCMP quickly absorbs the unit shock from itself by decreasing for 50% and the influence continues until 10 months. All behaviors are similar to that of the original model.

The third row shows impacts from one unit of inflation shock to the VAR system with SCMP. The negative response of SCMP is the least violent, even milder than that of EPU, but lasts for 10 months.

The last row shows impacts from one unit of interest rate shock to the VAR system with SCMP. The negative impact on SCMP also fluctuates but continues until 10 months.

Similarly, this paper focuses on the second column, which represents impacts from one unit shock of multiple variables on the SCMP. Similar to that of the EPU, Among all variables, EPU responds the most strongly to itself, with a decrease up to 50%, and the impact remains stable until 10 months. The positive responses to monetary supply and negative responses to inflation are the second strongest, lasting for 10 months. However, contrary to the EPU, the unit interest rate shock on SCMP also leads to negative responses that continue for 10 months. Overall, the SCMP behaves similarly to EPU with respect to shocks from monetary policy, which means the robustness test is valid.

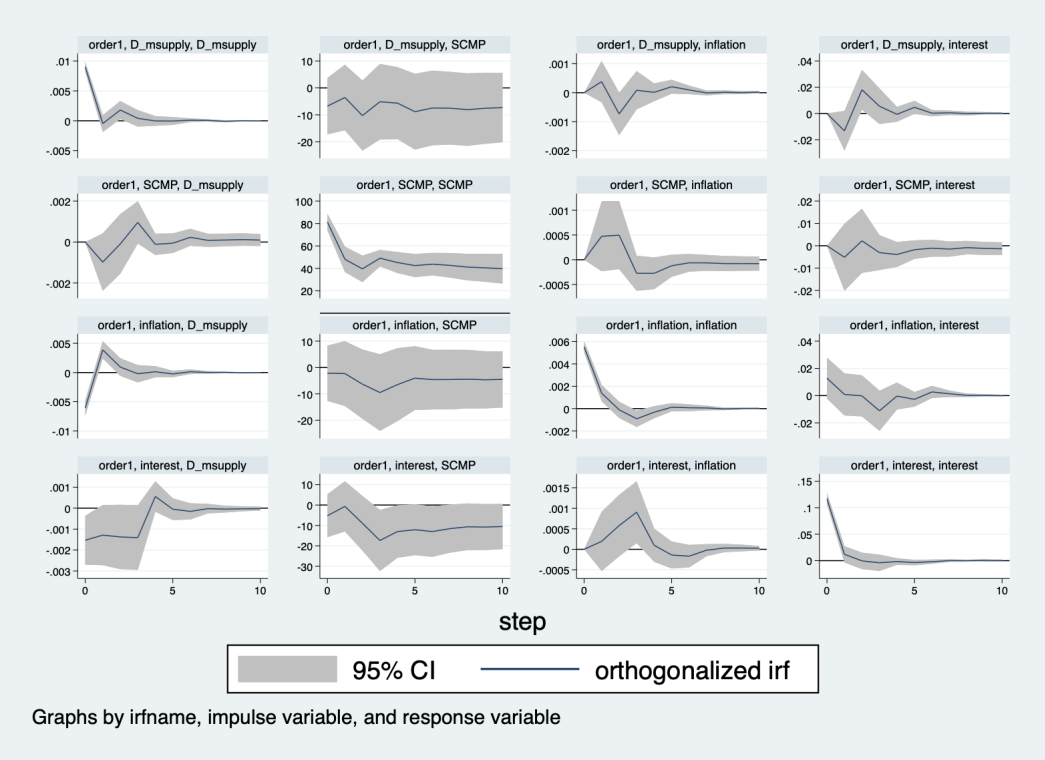

Figure 4: Impulse Response among variables

5 Conclusion

With the emphasis of the Chinese governmental on stability, and the process of monetary policy transmission, the short and long-term relationship between monetary policy and economic stability concerns is worth discussing. Therefore, this paper selected the theoretical monetary supply model and VAR methodology to analyze and evaluate monetary policy. As for the economic uncertainty, this paper selects the which is the economic uncertainty using two mainland Chinese newspapers, the Renmin Daily and the Guangming Daily (EPU) for main model estimation, and used the economic uncertainty measured using the South China Morning Post ($SCMP$) as the robustness test.

Results show that changes in inflation rate, changes in interest rate and changes in currency supply amount are in cointegration with the EPU and SCMP, which indicates the correlation relationship among the variables. Furthermore, unit shocks of inflation and interest rate change cause economic uncertainty to fluctuate and negative influences continues up to 10 months. However, unit shock of money supply may have positive or negative impact on Economic Policy Uncertainty, depending on measurements, but the

influence is consistent after 10 months. Lastly, the economic uncertainty is able to absorb the shock from itself in 3 months quickly.

As the monetary policy is both valuable and inevitable in China, considering impulse response, scholars and macro managers should consider the following issues: In the short term, economic uncertainty fluctuates with shocks of change in the inflation rate, change in the interest rate and change in the money supply. Therefore, short-term preparation to calm the people and the media is necessary. In the long term, influences from shocks of change in the interest rate and change in inflation on the Economic Policy Uncertainty diminishes after less than 5 months, while influences from the shock of the change in currency supply last up to 8 months. Therefore, in the long term, the Government should be prepared for long-term increase of economic uncertainty on the media for more than half a year.

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