Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Trinity Business School

Digital-Money Never Sleeps:

New digital-currency indices

UCRY indices; ICEA; CBDCUI and CBDCAI

Yizhi Wang*, Prof. Brian M. Lucey, Prof. Samuel A. Vigne, Prof. Larisa Yarovaya

wangy27@tcd.ie

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Basic Takeaway

1. In this talking, I introduce three new families of indices around the digital-currency space: on cryptocurrency uncertainty, on cryptocurrency environmental, and on central bank digital currencies.

2. These are developed from largescale text mining to reflect the mimetic and emergent nature of the issues.

3. We show that these indices capture well movements and moments in the key digital-currency space.

4. We further apply the IRF and the FEVD to analyse the structure shocks of these indices on other financial and economic variables. Moreover, we decompose these indices' historical evolution into various drivers. In addition, we apply DCC-GJR-GARCH model to investigate interconnections between CBDC indices and financial variables.

Research background and Motivations for UCRY indices

How uncertainty are investors about cryptocurrencies, and what drives this?

However, there is no method can capture uncertainty in cryptocurrency markets!

Our paper poses a construction and analysis of two indices of policy and price uncertainty for cryptocurrencies in order to address the level of uncertainty that investors experience and the motivating factors of such in regards to cryptocurrencies.

Research background and Motivations for ICEA

There has been, to date, very limited research on the extent, or determinants, of cryptocurrency's growing energy consumption problem to make any conclusive and scientifically confirmed conclusions on its contributions to climate change.

+

Few studies have comprehensively investigated the impacts of cryptocurrency environmental attention and concerns on the cryptocurrency markets

+

No existing literature that examined which financial or economic variables were susceptible to shock transmitted from cryptocurrency environmental attention

We introduce a new index named Index of Cryptocurrency Environmental Attention (ICEA) that aims to capture the relative extent of media discussion around the environmental impact of cryptocurrencies. Moreover, examining how the ICEA index impacts financial or economic variables.

Research background and Motivations for CBDC indices

All of the existing studies have not explained how the CBDC as a 'stablecoin' can enhance the stability of financial markets.

+

Can CBDC really help to achieve financial stability?

+

What are the potential impacts of CBDC on financial markets?

Motivated by these questions, we seek to uncover CBDC's effects on financial markets by developing two CBDC indices – the CBDC Uncertainty (CBDCUI) and the CBDC Attention (CBDCAI), that can be used to track CBDC's trends and variations.

Data for UCRY indices

- **Time period:** 01/01/2014 - 01/01/2021, weekly time series data.
- **Data source:** Using 726.9 million data from LexisNexis News & Business database.
- **Theoretical supporting:** We build our index on the construct found in (Baker et al, 2016; Huang and Luk, 2020; Rice et al, 2020).
- **Search strings:**

Cryptocurrency Policy Uncertainty: *[(uncertain or uncertainty) and price and atl1(Bitcoin or Ethereum or ripple or litecoin or tether or cryptocurrency or cryptocurrencies) and atl1(regulator or regulators or central bank or government)]*

Cryptocurrency Price Uncertainty: *[(uncertain or uncertainty) and price and atl1(Bitcoin or Ethereum or ripple or litecoin or tether or cryptocurrency or cryptocurrencies)]*

Notes: set search engine as MODERATE group duplicate to avoid as much as possible double counting.

Data for ICEA

- **Time period:** 30/12/2013 - 02/05/2021, weekly time series data.
- **Data source:** Using 778.2 million data from LexisNexis News & Business database.
- **Theoretical supporting:** We build our index on the construct found in (Baker et al, 2016; Huang and Luk, 2020; Rice et al, 2020; Lucey et al, 2021).
- **Search strings:**

Index of Cryptocurrency Environmental Attention: *[("cryptocurrency" or "bitcoin" or "ethereum") and atl1("energy" or "energy consumption" or "energy footprint" or "climate change" or "carbon footprint" or "environment" or "environmental" or "environmental impact" or "carbon footprint")]*

Notes: set search engine as MODERATE group duplicate to avoid as much as possible double counting.

Data for CBDC indices

- **Time period:** 01/01/2015 - 30/06/2021, weekly time series data.
- **Data source:** Using 663.9 million data from LexisNexis News & Business database.
- **Theoretical supporting:** We build our index on the construct found in (Baker et al, 2016; Huang and Luk, 2020; Rice et al, 2020; Lucey et al, 2021; Wang et al, 2021).
- **Search strings:**

((“Central Bank Digital Currency") OR (“CBDC”) OR ("央行数字货币") OR ("Moneda digital del banco central") OR ("Moeda Digital do Banco Central") OR ("Национальная криптовалюта") OR ("中央銀行のデジタル通貨") OR ("Merkez Bankası Dijital Para Birimi") OR ("Monnaie numérique de la Banque centrale") OR ("Digitales Zentralbankgeld") OR ("Digital currency") OR ("Digital money") OR ("Electronic currency") OR ("Electronic money") OR ("E-currency") OR ("E-money") OR ("Digital dollar") OR ("Electronic dollar") OR ("E-dollar") OR ("Digital USD”) OR ("Electronic USD”) OR (“E-USD”) OR ("Digital Euro") OR ("Electronic Euro") OR ("E-Euro") OR ("Digital EUR”) OR ("Electronic EUR”) OR (“E-EUR”) OR ("Digital pound") OR ("Electronic pound") OR ("E-pound") OR ("Digital GBP”) OR ("Electronic GBP”) OR (“E-GBP”) OR ("Digital RMB") OR ("Electronic RMB") OR ("E-RMB") OR (“Digital CNY") OR (“Electronic CNY") OR ("E-CNY") OR ("Digital CNH”) OR ("Electronic CNH”) OR (“E-CNH”) OR ("Digital Renminbi”) OR ("Electronic Renminbi”) OR (“E-Renminbi”) OR ("电子人民币") OR ("数字人民币") OR ("E-人民币") OR ("Digital ruble") OR ("Electronic ruble") OR ("Cryptoruble") OR ("Digital RUB”) OR ("Electronic RUB”) OR (“E-RUB”) OR ("Цифровой рубль") OR ("крипторубль") OR ("Digital Yen") OR ("Electronic Yen") OR ("E-Yen") OR ("Digital JPY”) OR ("Electronic JPY”) OR (“E-JPY”) OR ("デジタル通貨") OR ("電子通貨") OR ("E-通貨") OR ("Euro numérique") OR ("Monnaie numérique") OR ("Digitaler Euro") OR ("Elektronischer Euro") OR ("E-Währung") OR ("Digital Swiss franc") OR ("Electronic Swiss franc") OR ("E-franc") OR (“Digital CHF”) OR ("Electronic CHF”) OR (“E-CHF”)) and (uncert!)

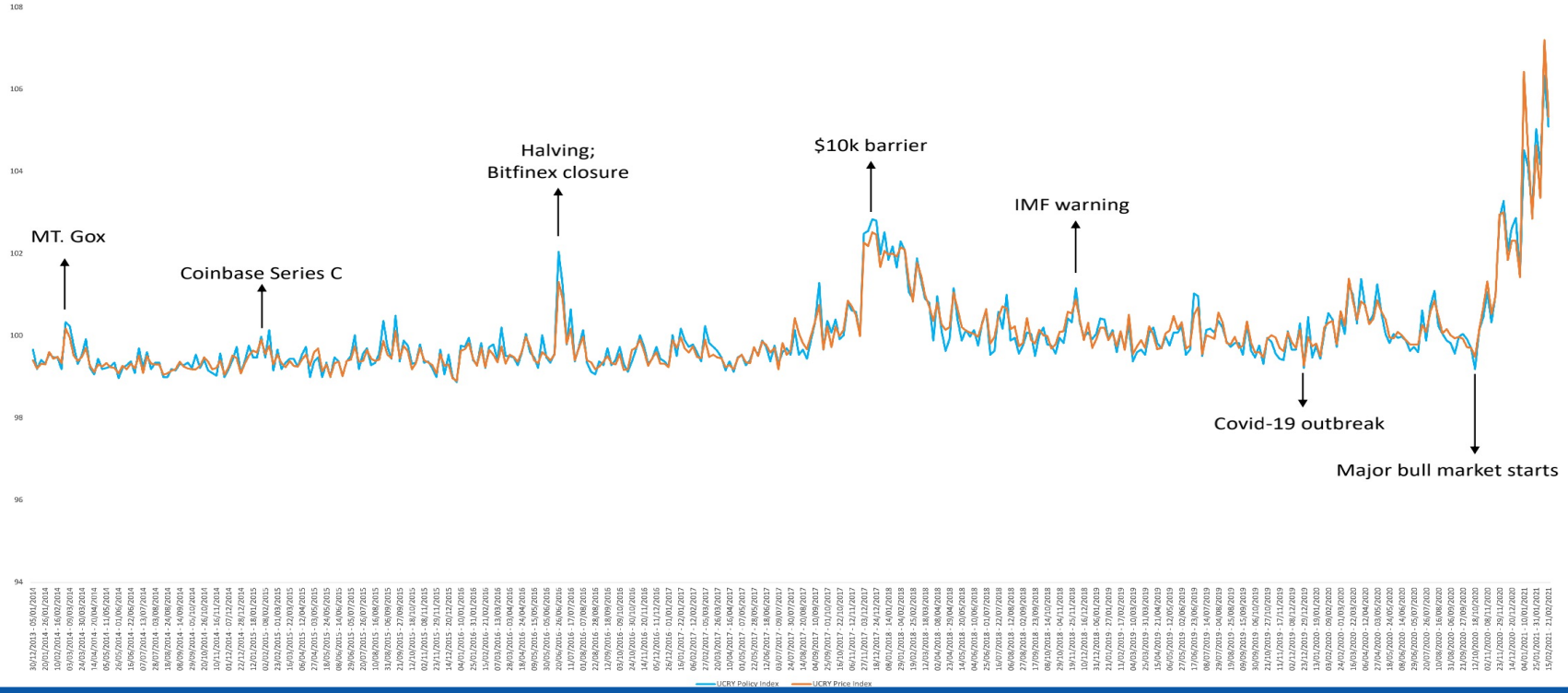
("Central Bank Digital Currency") OR (“CBDC”) OR ("央行数字货币") OR ("Moneda digital del banco central") OR ("Moeda Digital do Banco Central") OR ("Национальная криптовалюта") OR ("中央銀行のデジタル通貨") OR ("Merkez Bankası Dijital Para Birimi") OR ("Monnaie numérique de la Banque centrale") OR ("Digitales Zentralbankgeld") OR ("Digital currency") OR ("Digital money") OR ("Electronic currency") OR ("Electronic money") OR ("E-currency") OR ("E-money") OR ("Digital dollar") OR ("Electronic dollar") OR ("E-dollar") OR (“Digital USD”) OR ("Electronic USD”) OR (“E-USD”) OR ("Digital Euro") OR ("Electronic Euro") OR ("E-Euro") OR ("Digital EUR”) OR ("Electronic EUR”) OR (“E-EUR”) OR ("Digital pound") OR ("Electronic pound") OR ("E-pound") OR ("Digital GBP”) OR ("Electronic GBP”) OR (“E-GBP”) OR ("Digital RMB") OR ("Electronic RMB") OR ("E-RMB") OR (“Digital CNY") OR (“Electronic CNY") OR ("E-CNY") OR ("Digital CNH”) OR ("Electronic CNH”) OR (“E-CNH”) OR ("Digital Renminbi”) OR ("Electronic Renminbi”) OR (“E-Renminbi”) OR ("电子人民币") OR ("数字人民币") OR ("E-人民币") OR ("Digital ruble") OR ("Electronic ruble") OR ("Cryptoruble") OR ("Digital RUB”) OR ("Electronic RUB”) OR (“E-RUB”) OR ("Цифровой рубль") OR ("крипторубль") OR ("Digital Yen") OR ("Electronic Yen") OR ("E-Yen") OR ("Digital JPY”) OR ("Electronic JPY”) OR (“E-JPY”) OR ("デジタル通貨") OR ("電子通貨") OR ("E-通貨") OR ("Euro numérique") OR ("Monnaie numérique") OR ("Digitaler Euro") OR ("Elektronischer Euro") OR ("E-Währung") OR ("Digital Swiss franc") OR ("Electronic Swiss franc") OR ("E-franc") OR (“Digital CHF”) OR ("Electronic CHF”) OR (“E-CHF”)

UCRY indices construction

- UCRY indices construction (data standardization + 100):

$$UCRY\ Policy_t = \left(\frac{N_{1_t} - \mu_1}{\sigma_1}\right) + 100, \qquad UCRY\ Price_t = \left(\frac{N_{2_t} - \mu_2}{\sigma_2}\right) + 100,$$

where, N_t is the weekly observed value of news articles on LexisNexis business concerning the uncertainty of cryptocurrency policy or price, μ is the mean of these same articles and σ is the standard deviation of such.

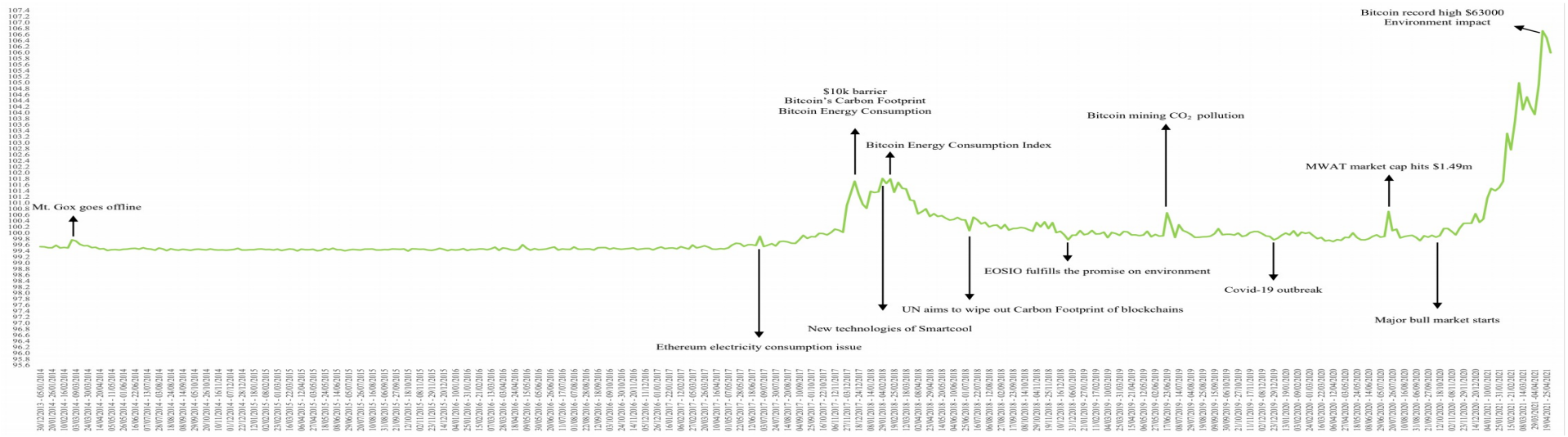


ICEA construction

- ICEA construction (data standardization + 100):

$$ICEA_t = \left(\frac{N_{1t} - \mu_1}{\sigma_1}\right) + 100,$$

where $ICEA_t$ is the value of the Index in the weeks t between 30/12/2013-02/05/2021. N_{1t} is the weekly observed value of news articles on LexisNexis News & Business matching the search string above, μ_1 is the mean number of these same articles and σ_1 is the standard deviation of such.

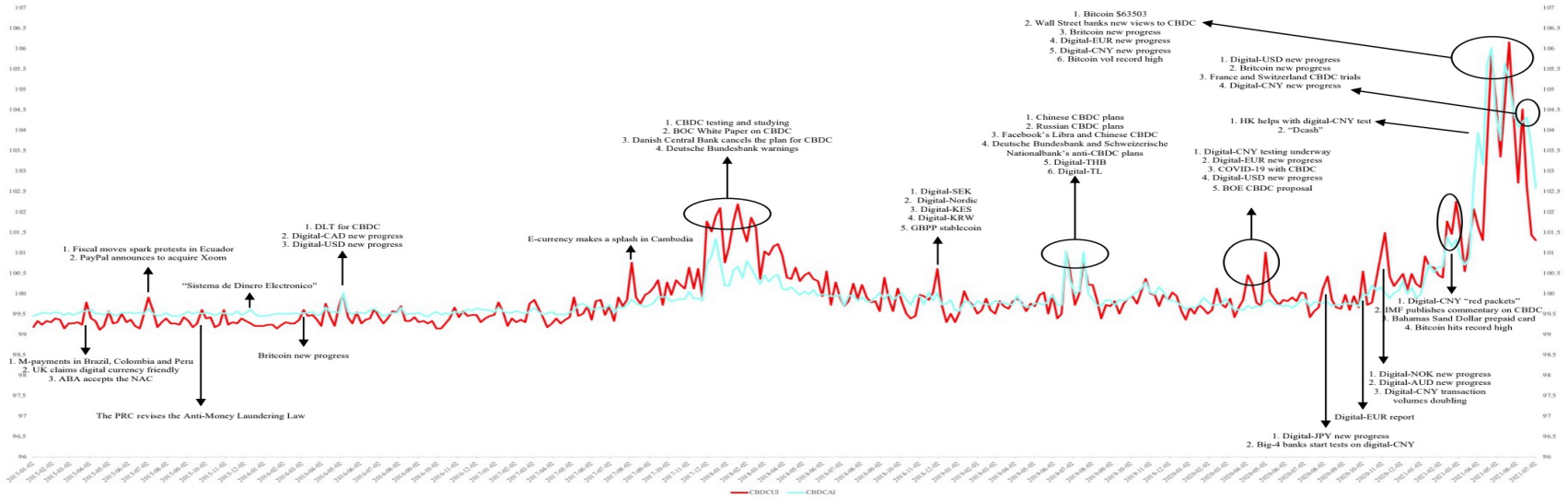


CBDC indices construction

- **CBDC indices construction (data standardization + 100):**

$$CBDCUI_t = (\frac{N_{1t} - \mu_1}{\sigma_1}) + 100, \qquad CBDCAI_t = (\frac{N_{2t} - \mu_2}{\sigma_2}) + 100,$$

where, N_t is the weekly observed value of news articles on LexisNexis business concerning the CBDC uncertainty or attention, μ is the mean of these articles and σ is the standard deviation of such.



The Effects of the UCRY indices on Other Variables

- **Financial and economic variable selection:**

1. The UCRY indices *V. S.* cryptocurrency markets: **Bitcoin**.
2. The UCRY indices *V. S.* other popular economic or policy uncertainty measures: **VIX**; **GlobalEPU; USFS; USEPU**.
3. The UCRY indices *V. S.* the safe-haven property: **Gold**.

The Effects of the ICEA on Other Variables

- **Financial and economic variable selection:**

1. The ICEA *V. S.* cryptocurrency markets: **Bitcoin**.
2. The ICEA *V. S.* cryptocurrency price and policy uncertainty: **UCRY Policy; UCRY Price**.
3. The ICEA *V. S.* crude oil market: **Brent Crude Oil.**
4. The ICEA *V. S.* other popular global economic or policy uncertainty measures: **VIX**; **GlobalEPU**.
5. The ICEA *V. S.* the output of the economy's industrial sectors: **The OECD 37 members industrial production Index**.
6. The ICEA *V. S.* the environmental issues caused by cryptocurrency mining and transactions: **Global Temperature Uncertainty Index**.

The Effects of the CBDC indices on Other Variables

- **Financial and economic variable selection:**

1. The CBDC indices *V. S.* cryptocurrency volatility and uncertainty: **UCRY Policy; UCRY Price**.
2. The CBDC indices *V. S.* cryptocurrency environmental concerns: **ICEA**.
3. The CBDC indices *V. S.* cryptocurrency markets: **Bitcoin**.
4. The CBDC indices *V. S.* commercial banks: **The MSCI World Banks Index**.
5. The CBDC indices *V. S.* fiat currencies of countries: **EUR/USD; GBP/USD; JPY/USD; RUB/USD; CNY/USD**.
6. The CBDC indices *V. S.* other popular global economic or policy uncertainty measures: **VIX**; **USEPU**.
7. The CBDC indices *V. S.* equity markets: **the FTSE All-World Index**.
8. The CBDC indices *V. S.* the safe-haven property: **Gold**.

Financial Econometrics Model (1): Structural shock analysis

Forecasting and do structural analysis → **Vector Autoregression (VAR)**

↓

Link forecast errors and fundamental structural shocks together

→ **Structural Vector Autoregression (SVAR)**

↓

Unit root test and Johansen test → Unit roots in all variables and variable forms are cointegrated

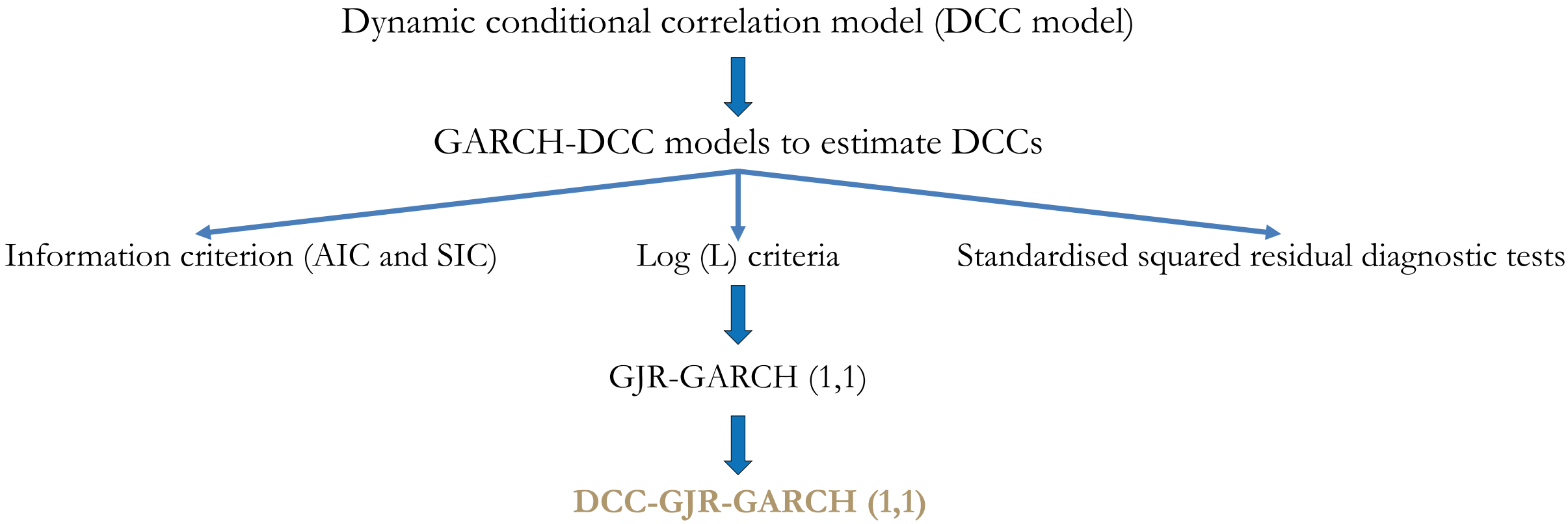
→ **Vector Error Correction Model (VECM) & Structural Vector Error Correction Model (SVECM)**

↓

For the gathering of information on the contribution of structural shocks to a system of variables

- Impulse Response Function
- Forecast Error Variance Decomposition
- Historical decomposition ▲

Financial Econometrics Model (2): interconnection analysis



Structural analysis of UCRY indices

- **Variable system for UCRY indices:**

$$\mathbf{Y}_t = \begin{bmatrix} UCRY\,Policy_t \\ GlobalEPU_t \\ Vix_t \\ Bitcoin_t \\ USFS_t \\ USEPU_t \\ Gold_t \\ UCRY\,Price_t \end{bmatrix}$$

UCRY Policy Index was ordered first because we find that GlobalEPU, Vix, Bitcoin, USFS, USEPU and the gold can react at the same time to uncertainty shocks. Due to the fact that other indexes are generally react faster than UCRY Price Index, the UCRY Price Index was ordered last.

Structural analysis of ICEA

- **Variable system for ICEA:**

$$\mathbf{Y}_t = \begin{bmatrix} ICEA_t \\ UCRY\ Policy_t \\ UCRY\ Price_t \\ GlobalEPU_t \\ Vix_t \\ BCO_t \\ Bitcoin_t \\ GTU_t \\ IP_t \end{bmatrix}$$

To further isolate the effect of ICEA, ICEA was ordered first, since it captures the cryptocurrency environmental attention, while the UCRY Policy Index, the UCRY Price Index, GlobalEPU, VIX, BCO, Bitcoin, GTU and IP can react contemporaneously to the attention shocks.

Structural analysis of CBDC indices

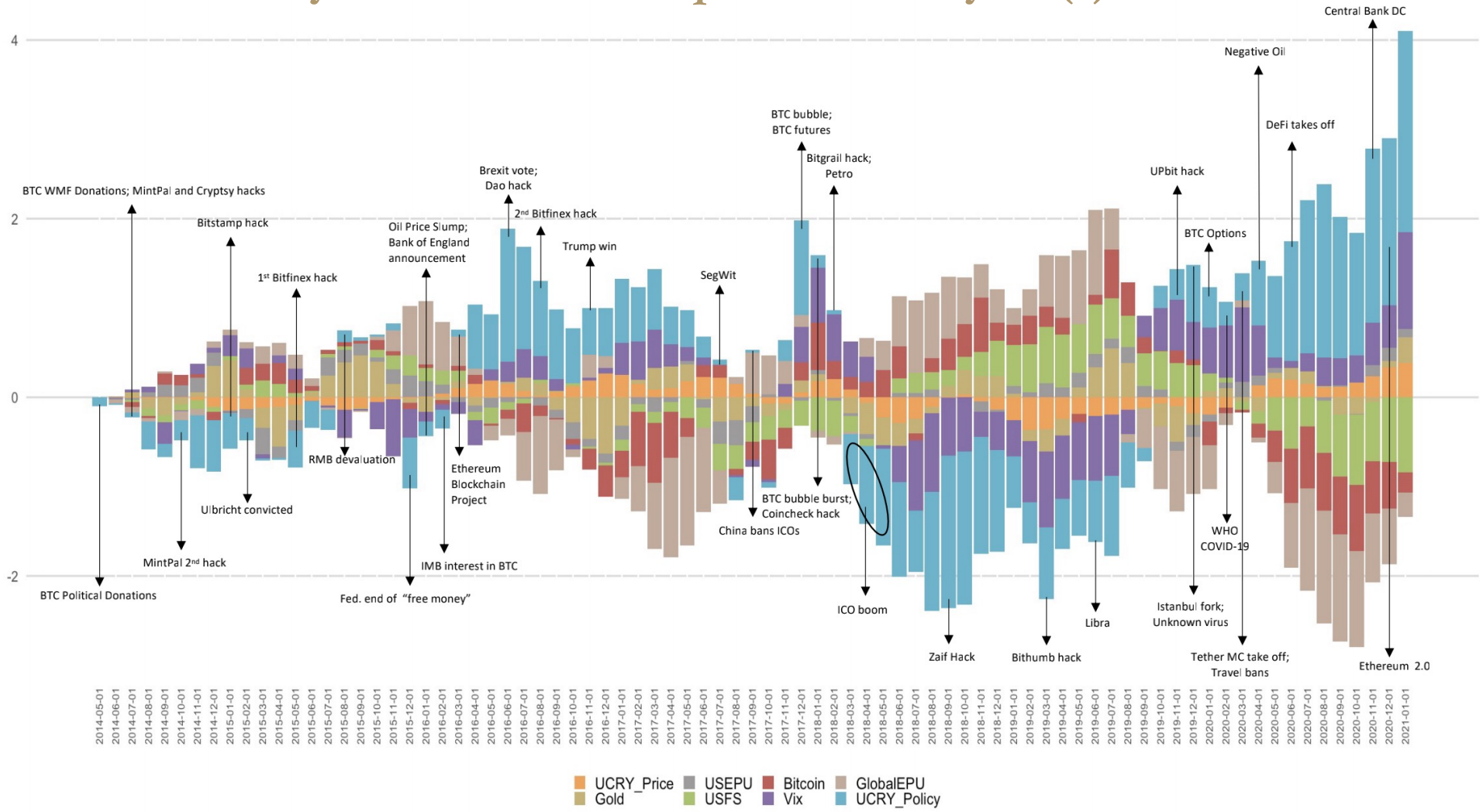
- Variable system for CBDC indices:

$$\mathbf{Y}_t = \begin{bmatrix} CBDC1_t \\ CBDC2_t \\ UCRY\ Policy_t \\ UCRY\ Price_t \\ ICEA_t \\ MSCI\ World\ Banks\ Index_t \\ VIX_t \\ USEPU_t \\ FTSE\ All\ World\ Index_t \\ EUR/USD_t \\ GBP/USD_t \\ JPY/USD_t \\ RUB/USD_t \\ CNY/USD_t \\ Gold_t \\ Bitcoin_t \end{bmatrix}$$

CBDCUI or CBDCAI was ordered first and second because we believed that the UCRY Policy Index, UCRY Price Index, ICEA, MSCI World Banks Index, VIX, USEPU, FTSE All-World Index, EUR/USD, GBP/USD, JPY/USD, RUB/USD, CNY/USD, gold, and Bitcoin could react contemporaneously to uncertainty or attention shocks.

Main empirical results for UCRY indices (1)

- UCRY Policy historical decomposition analysis (1): HD results



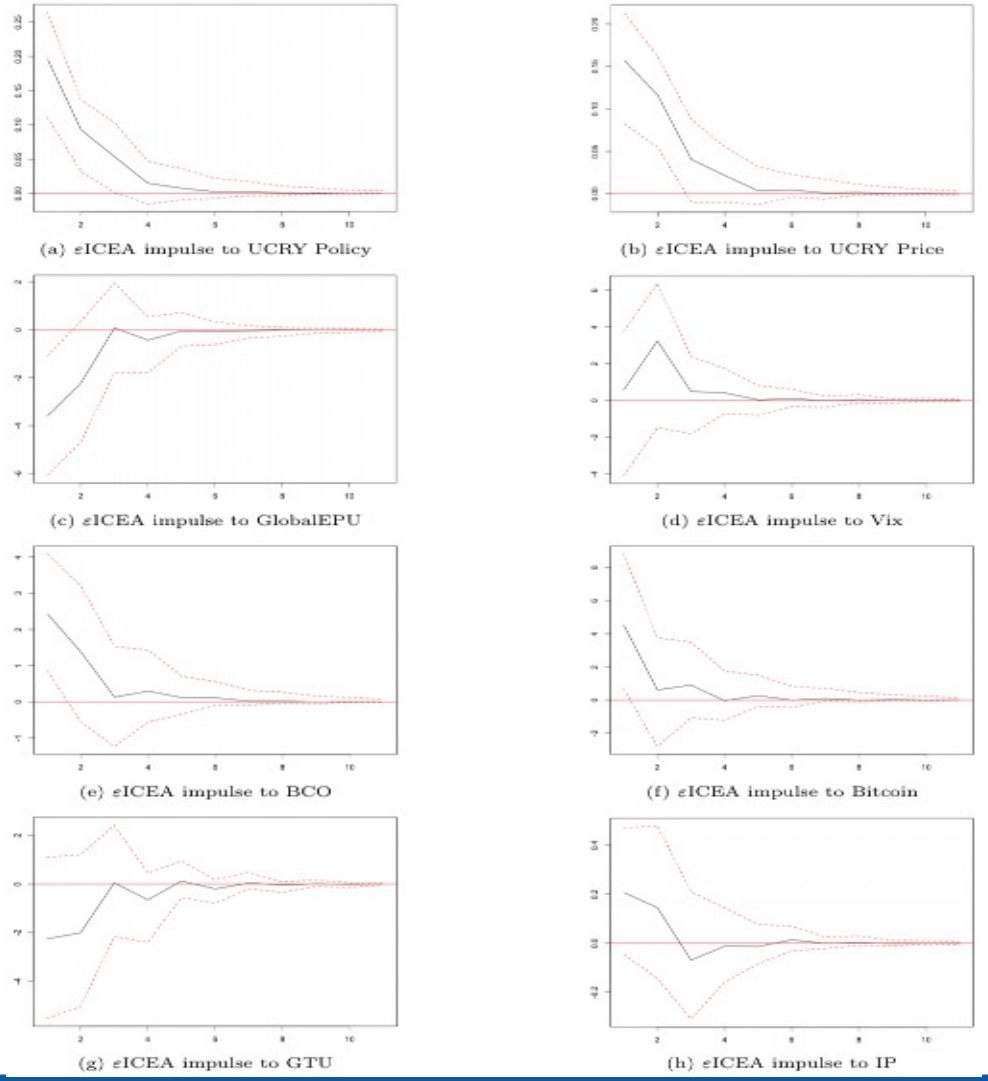
Main empirical results for UCRY indices (2)

- **UCRY Policy historical decomposition analysis (2): HD findings**

- These shocks match the expectations of the public to a certain extent.
- Fiscal policy adjustments contributed to the small shifts in the UCRY Policy.
- UCRY Indices captured uncertainty that could be more distinctively attributed to the major events in cryptocurrencies in comparison to the VIX, EPU and Global EPU indices.
- UCRY Policy and UCRY Price indices appear to capture uncertainty beyond Bitcoin prices.
- UCRY Policy and UCRY Price indices can be used as an effective measure of uncertainty during the pandemic.

Main Empirical Results for ICEA (1)

- Impulse from ICEA to variable system (1): IRF results



(a) εICEA impulse to UCRY Policy

(b) εICEA impulse to UCRY Price

(c) εICEA impulse to GlobalEPU

(d) εICEA impulse to Vix

(e) εICEA impulse to BCO

(f) εICEA impulse to Bitcoin

(g) εICEA impulse to GTU

(h) εICEA impulse to IP

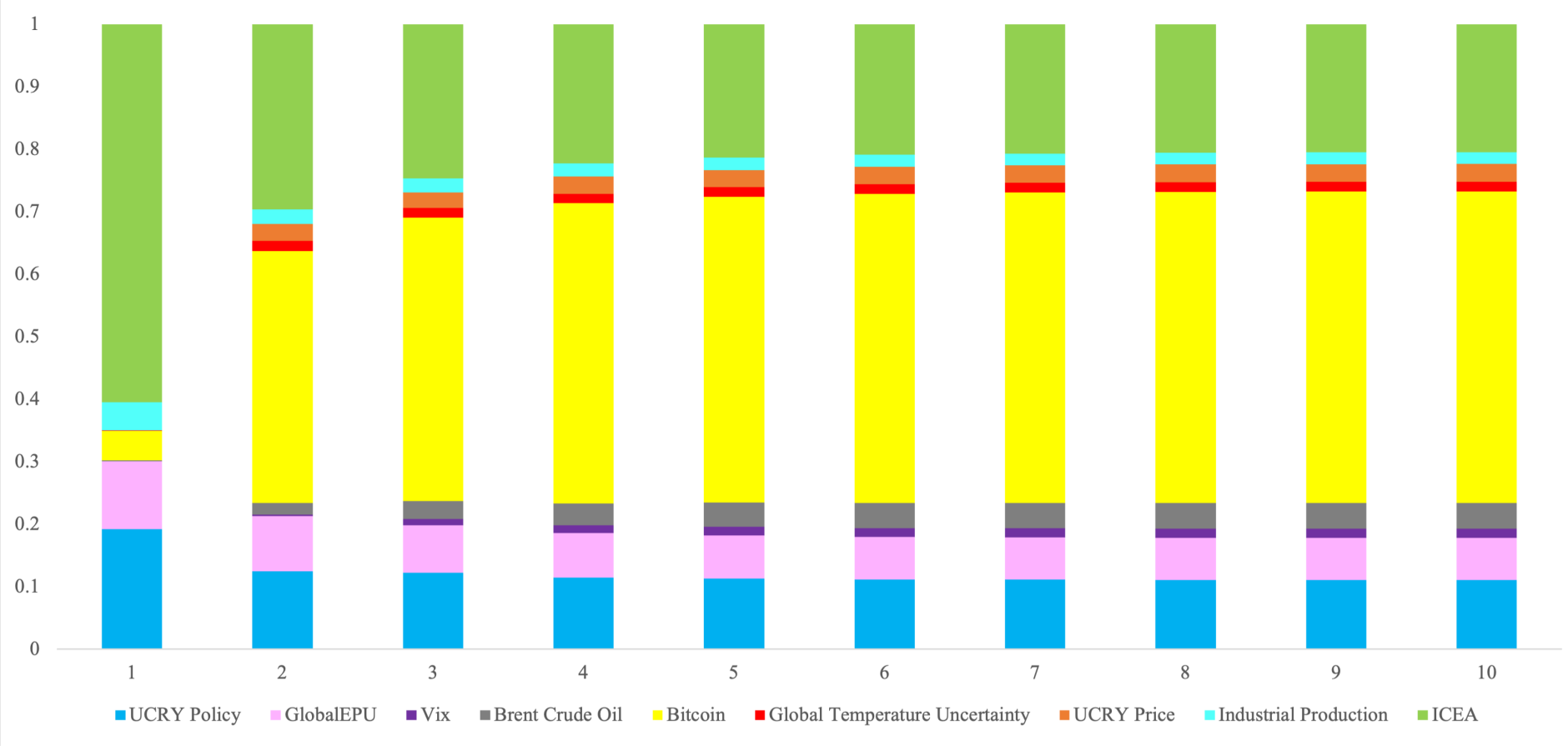
Main Empirical Results for ICEA (2)

- **Impulse from ICEA to variable system (2): IRF findings**

1. ICEA has a significantly positive impact on the UCRY Policy, the UCRY Price, VIX, BCO, and Bitcoin.
2. ICEA has a significantly negative impact on the GlobalEPU and GTU.
3. ICEA has a significantly positive impact on the IP in the short-term, while having a significantly negative impact in the long-term, and the short-term positive impact is leading.
4. Bitcoin has the strongest reactions from the ICEA variation shocks.

Main Empirical Results for ICEA (3)

FEVD analysis (1): FEVD results



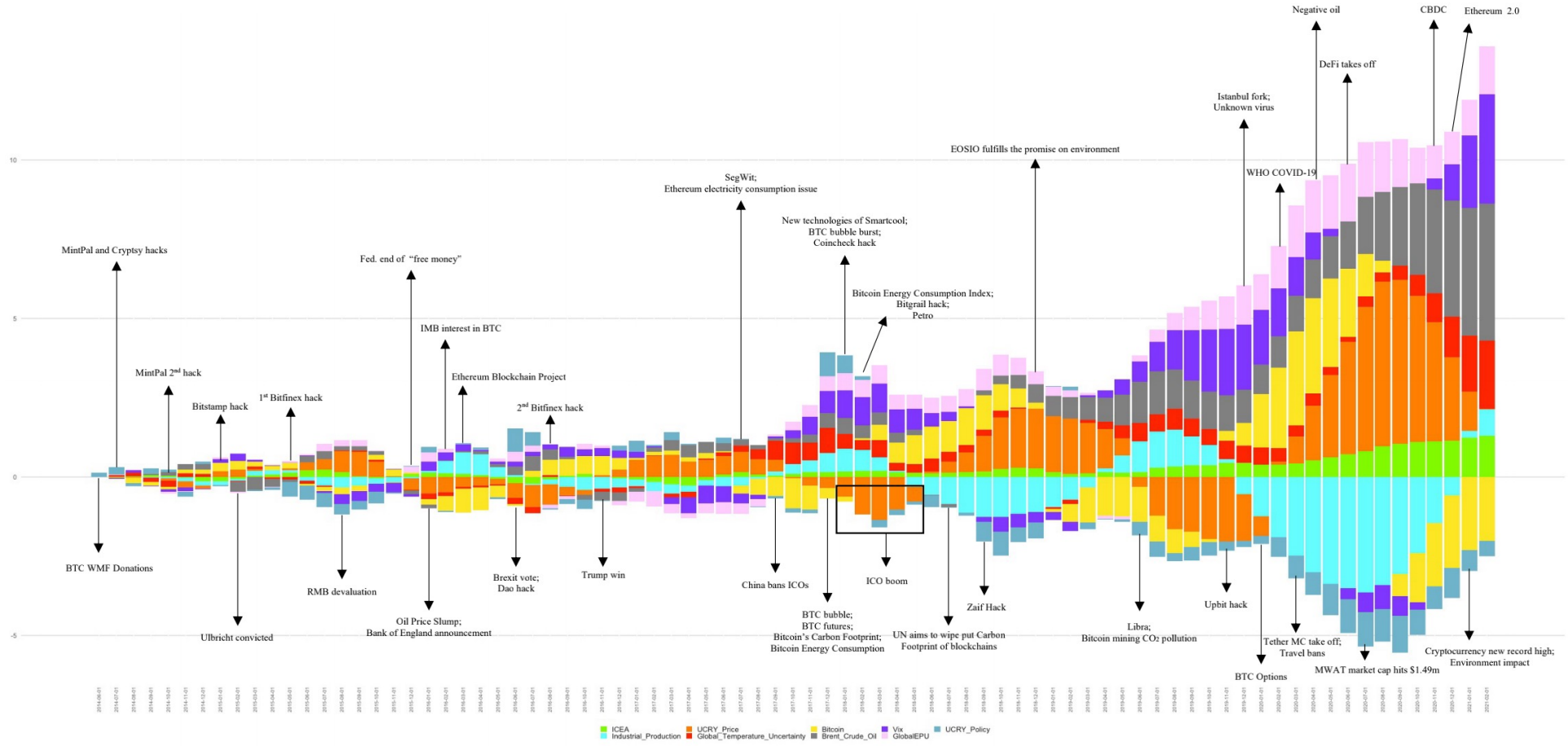
Main Empirical Results for ICEA (4)

- **FEVD analysis (2): FEVD findings**

1. In the first period, approximately 60% of the variation in ICEA is from shocks to ICEA itself.
2. The contribution of ICEA to the variations in the ICEA quickly dies after the first period and becomes stable after the sixth period.
3. The contribution of Bitcoin to variations in the ICEA changes fairly rapidly over the first period and eventually seems to converge at around 50%.
4. These findings are also comparable to results in Lucey et al, 2021 , which find that UCRY Policy and UCRY Price are more important in the short run, and the Bitcoin is more important in the long run.

Main Empirical Results for ICEA (5)

- ICEA historical decomposition analysis (1): HD results



Main Empirical Results for ICEA (6)

- **ICEA historical decomposition analysis (2): HD findings**

1. ICEA and UCRY Price have a significantly positive relationship. *The greater the media's attention to cryptocurrency's effects on the environment, the higher the cryptocurrency market value.*
2. Technology's type policy adjustment events positively correlated with the ICEA. *Smartcool.*
3. VIX and Bitcoin have a significantly positive relationship with the ICEA in general.
4. These empirical findings from the historical decomposition match the findings in the impulse response function analysis.

Main Empirical Results for ICEA (7)

Robustness tests

Does the ICEA really work ?

Lucey et al, 2021 proved the validities of the UCRY Policy and UCRY Price

Further find the relationship between UCRY Policy, UCRY Price, ICEA and Bitcoin

Pearson correlation to the raw data

Pearson correlation to the volatilities of data

Whether ICEA can actually impact the financial markets

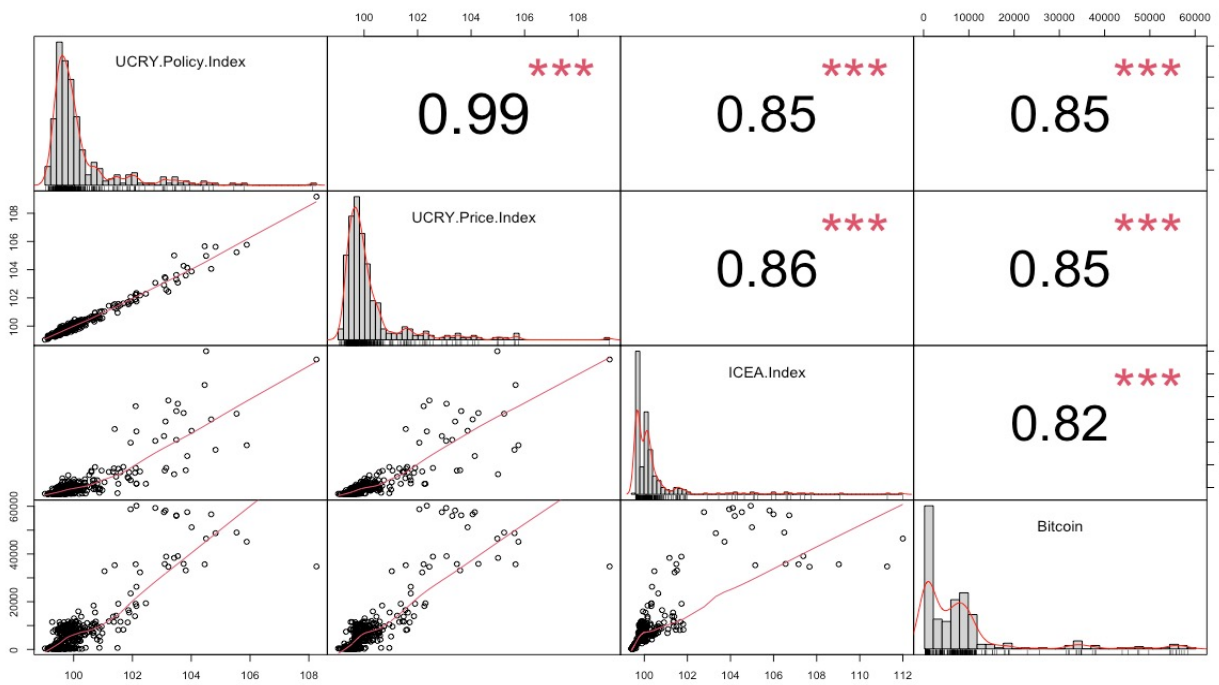
Lyu et al., 2021 applied a stronger IRF test

CI: 90% to 95%; Threshold of runs: 1000 to 2000 runs

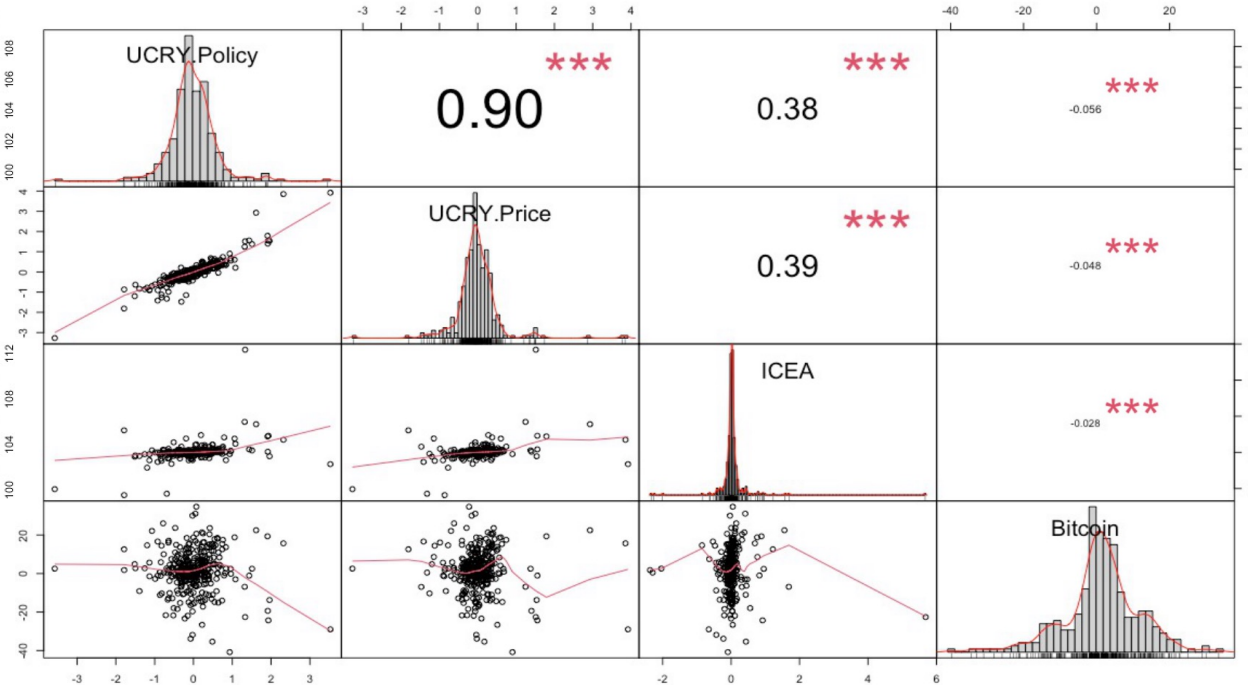
Re-process a stronger IRF test

Main Empirical Results for ICEA (8)

- Robustness test results: **Does the ICEA really work ? Yes!**



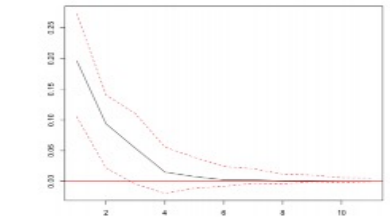
UCRY, ICEA, Bitcoin indices correlation



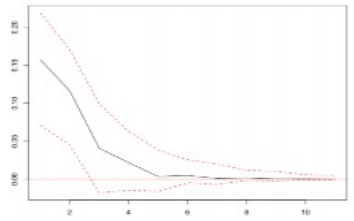
UCRY, ICEA, Bitcoin indices CCR correlation

Main Empirical Results for ICEA (9)

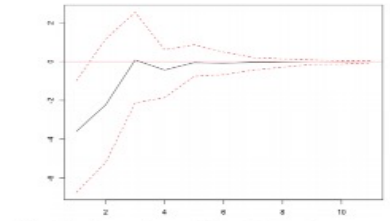
- **Robustness test results:** Whether ICEA can actually impact the financial markets? Yes!



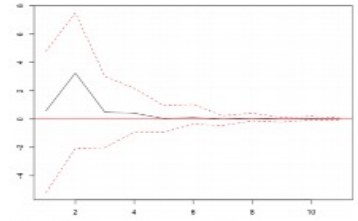
(a) εICEA impulse to UCRY Policy robustness test



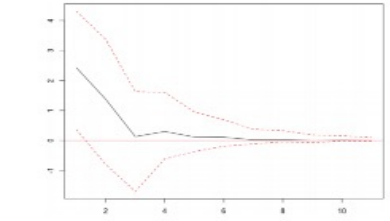
(b) εICEA impulse to UCRY Price robustness test



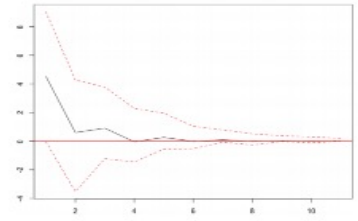
(c) εICEA impulse to GlobalEPU robustness test



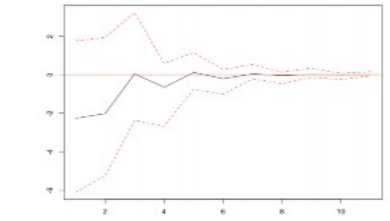
(d) εICEA impulse to VIX robustness test



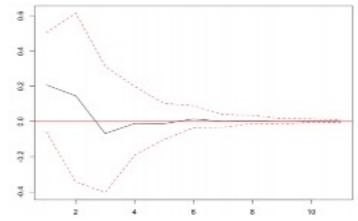
(e) εICEA impulse to BCO robustness test



(f) εICEA impulse to Bitcoin robustness test



(g) εICEA impulse to GTU robustness test



(h) εICEA impulse to IP robustness test

Main Empirical Results for ICEA (10): a brief conclusion

- ICEA has a significantly positive relationship with the UCRY Policy Index, the UCRY Price Index, VIX index, Brent Crude Oil price index, and Bitcoin price index. Besides, Bitcoin price index has the strongest reactions from the ICEA variation shocks.

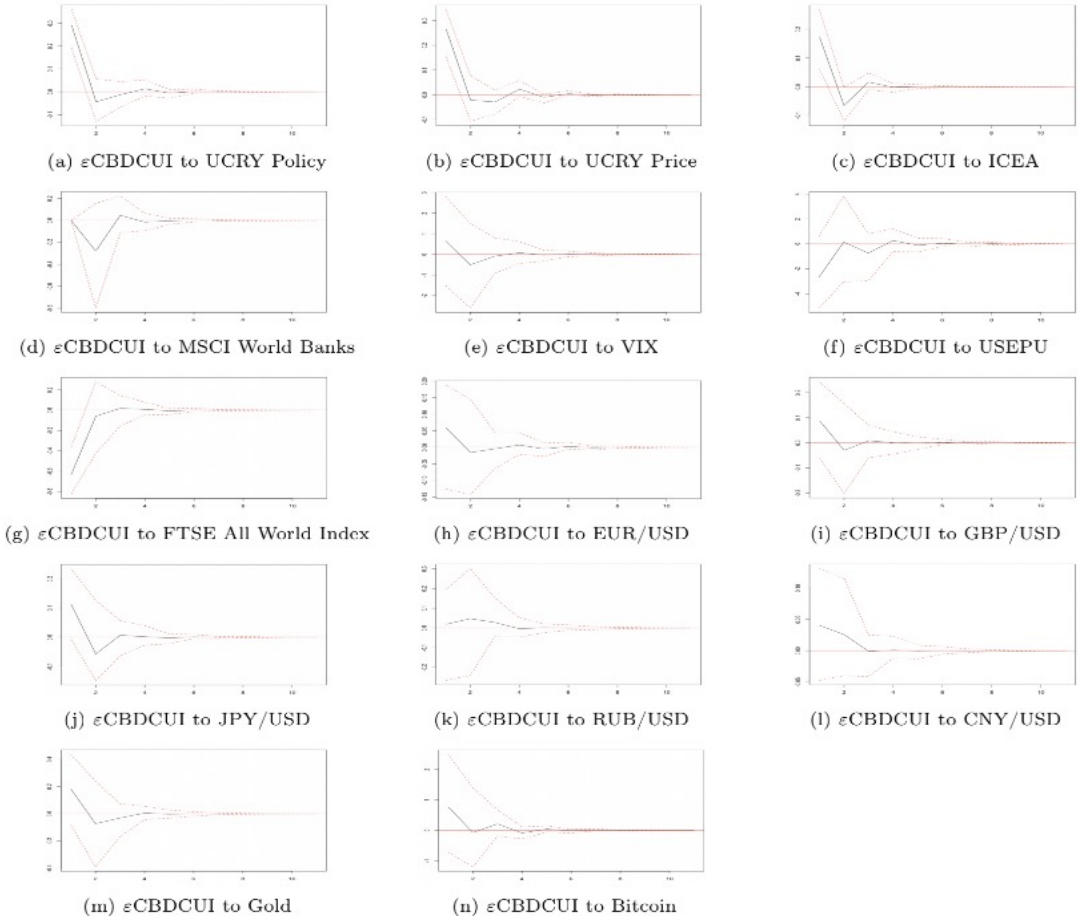
- ICEA has a significantly negative relationship with the Global Economic Policy Uncertainty Index and Global Temperature Uncertainty. Moreover, ICEA has a significantly positive relationship with the Industrial Production Index for OECD 37 members in the short-term, while having a significantly negative relationship in the long-term. Plus, the short-term positive relationship is leading.

- The historical decomposition of the ICEA Index displays higher linkages between environmental attention, Bitcoin price, UCRY Policy Index and UCRY Price Index around key events that significantly changed prices of digital assets.

- We can conclude that overall attention to environmental issues of cryptocurrency will increase cryptocurrency price fluctuations. Besides, the public is growing more concerned with energy consumption of these innovative assets.

Main Empirical Results for CBDC indices (1)

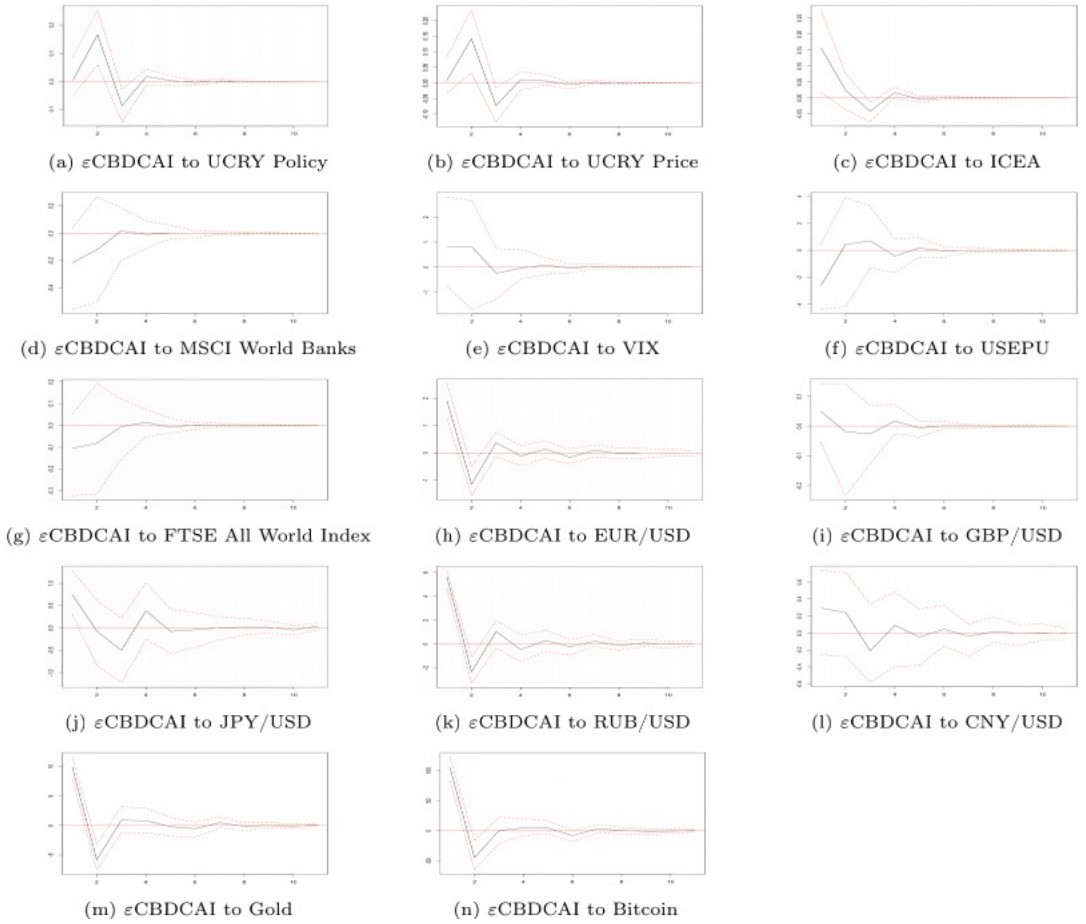
- CBDC shocks on the dynamics of financial variables volatility (1): CBDCUI IRF results



(a) εCBDCUI to UCRY Policy
(b) εCBDCUI to UCRY Price
(c) εCBDCUI to ICEA
(d) εCBDCUI to MSCI World Banks
(e) εCBDCUI to VIX
(f) εCBDCUI to USEPU
(g) εCBDCUI to FTSE All World Index
(h) εCBDCUI to EUR/USD
(i) εCBDCUI to GBP/USD
(j) εCBDCUI to JPY/USD
(k) εCBDCUI to RUB/USD
(l) εCBDCUI to CNY/USD
(m) εCBDCUI to Gold
(n) εCBDCUI to Bitcoin

Main Empirical Results for CBDC indices (2)

- CBDC shocks on the dynamics of financial variables volatility (2): CBDCAI IRF results



(a) εCBDCAI to UCRY Policy (b) εCBDCAI to UCRY Price (c) εCBDCAI to ICEA

(d) εCBDCAI to MSCI World Banks (e) εCBDCAI to VIX (f) εCBDCAI to USEPU

(g) εCBDCAI to FTSE All World Index (h) εCBDCAI to EUR/USD (i) εCBDCAI to GBP/USD

(j) εCBDCAI to JPY/USD (k) εCBDCAI to RUB/USD (l) εCBDCAI to CNY/USD

(m) εCBDCAI to Gold (n) εCBDCAI to Bitcoin

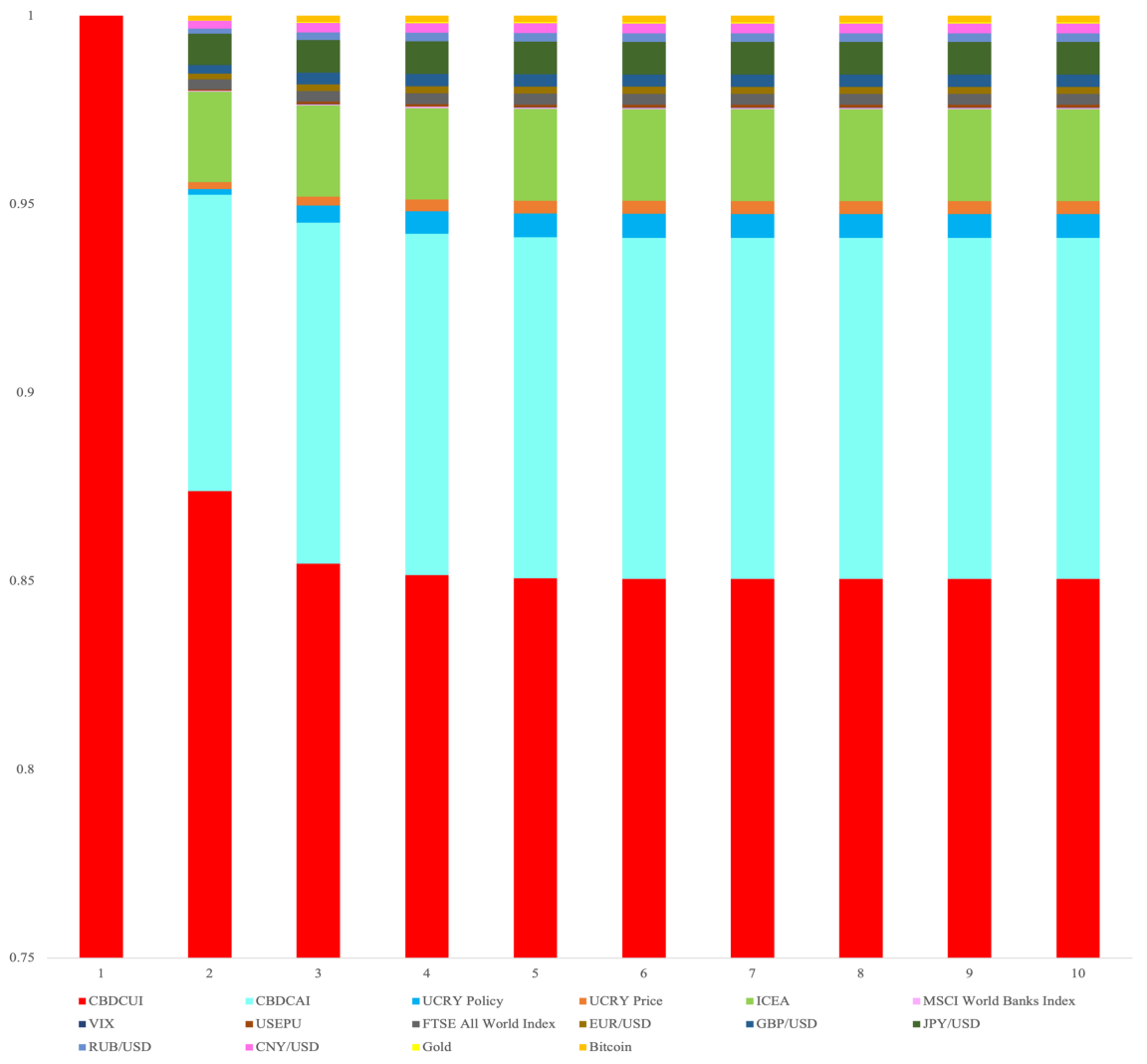
Main Empirical Results for CBDC indices (3)

- CBDC shocks on the dynamics of financial variables volatility (3): CBDC indices IRF findings

1. CBDCUI shocks can significantly increase the volatilities of UCRY Policy, UCRY Price, ICEA, VIX, EUR/USD, GBP/USD, JPY/USD, RUB/USD, CNY/USD, gold, and Bitcoin as a whole.
2. CBDCUI shocks can also significantly decrease the volatilities of the MSCI World Banks Index, USEPU, and the FTSE All-World Index overall.
3. The results of CBDCAI shocks on the dynamics of financial variables' volatility are the same as those relating to CBDCUI shocks.

Main Empirical Results for CBDC indices (4)

- Contributions of CBDC disturbances to the variation of financial variables volatility (1): CBDCUI FEVD results



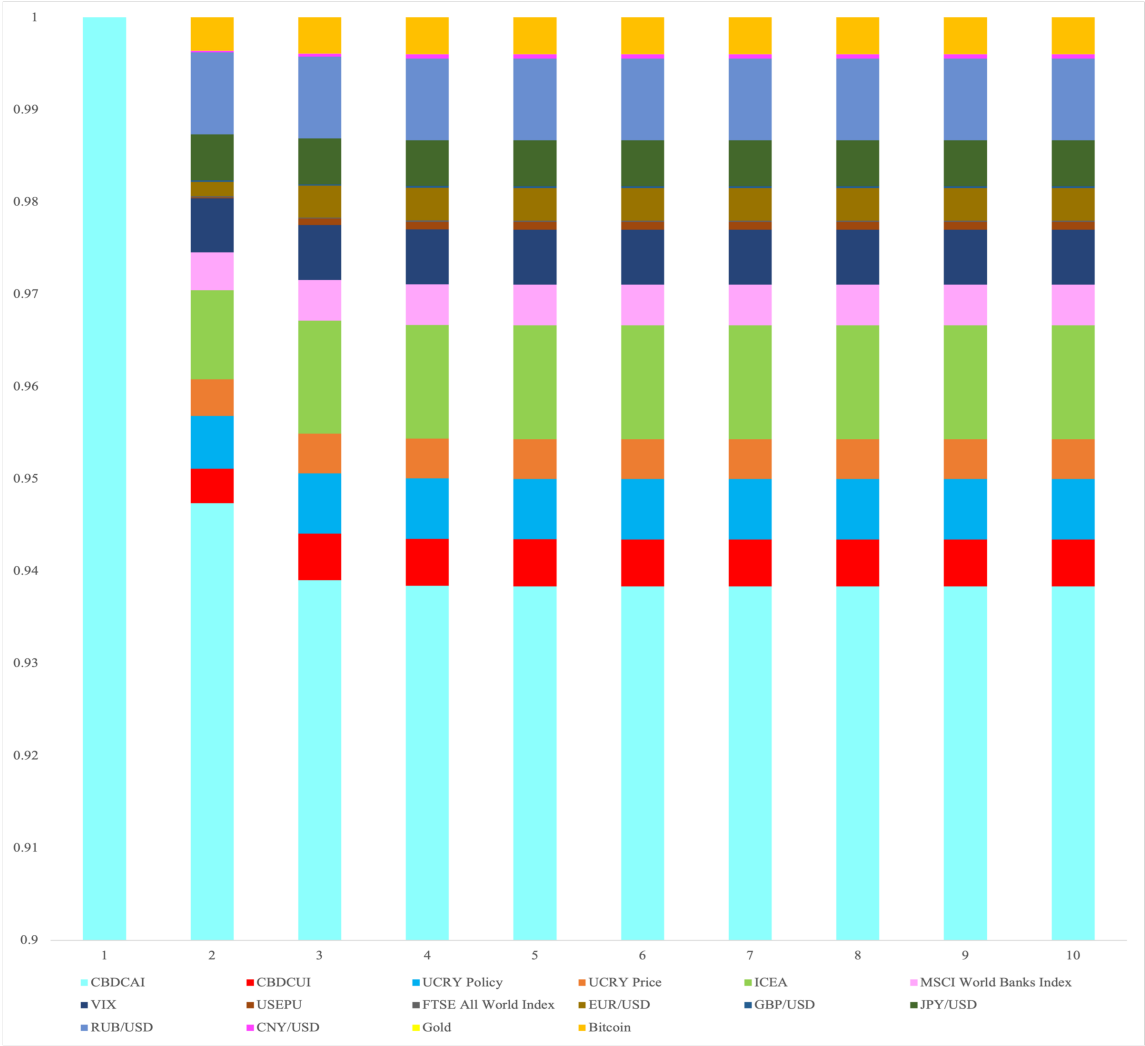
Main Empirical Results for CBDC indices (5)

- **Contributions of CBDC disturbances to the variation of financial variables volatility (2): CBDCUI FEVD findings**

1. A shock from the CBDCUI could play a non-trivial role in explaining variations in the CBDCUI FEVD.
2. CBDCAI was also a relatively significant variable in explaining variations in the CBDCUI FEVD.
3. Among three cryptocurrency indices, the ICEA had a greater contribution to the CBDCUI's fluctuations.
4. JPY/USD was the most important for CBDCUI variations in the five foreign exchange rate variables.

Main Empirical Results for CBDC indices (6)

- Contributions of CBDC disturbances to the variation of financial variables volatility (3): CBDCAI FEVD results



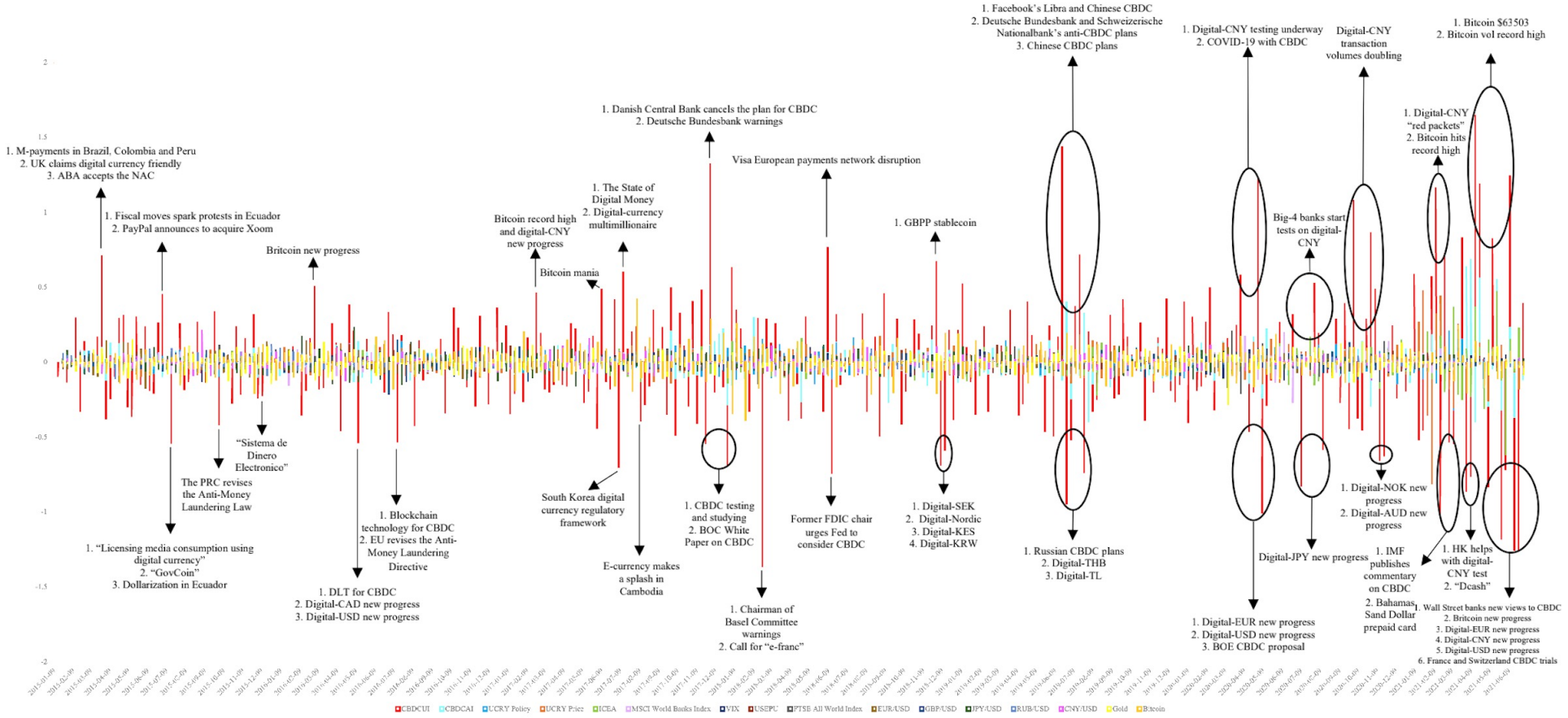
Main Empirical Results for CBDC indices (7)

- Contributions of CBDC disturbances to the variation of financial variables volatility (4): CBDCAI FEVD findings

1. The dominant role that a shock from the CBDCAI could play in explaining variations in the CBDCAI FEVD.
2. However, the CBDCUI's explanation power in the FEVD of CBDCAI was significantly lower than that of the CBDCAI.
3. In CBDCAI FEVD, the contributions from the other variables become more significant on the percentage level.
4. The RUB/USD had the greatest contribution to the CBDCAI's variations.
5. **Surprisingly, although China is leading the CBDC revolution, CNY/USD was relatively less important in explaining the variations in the both CBDCUI and CBDCAI FEVD.**

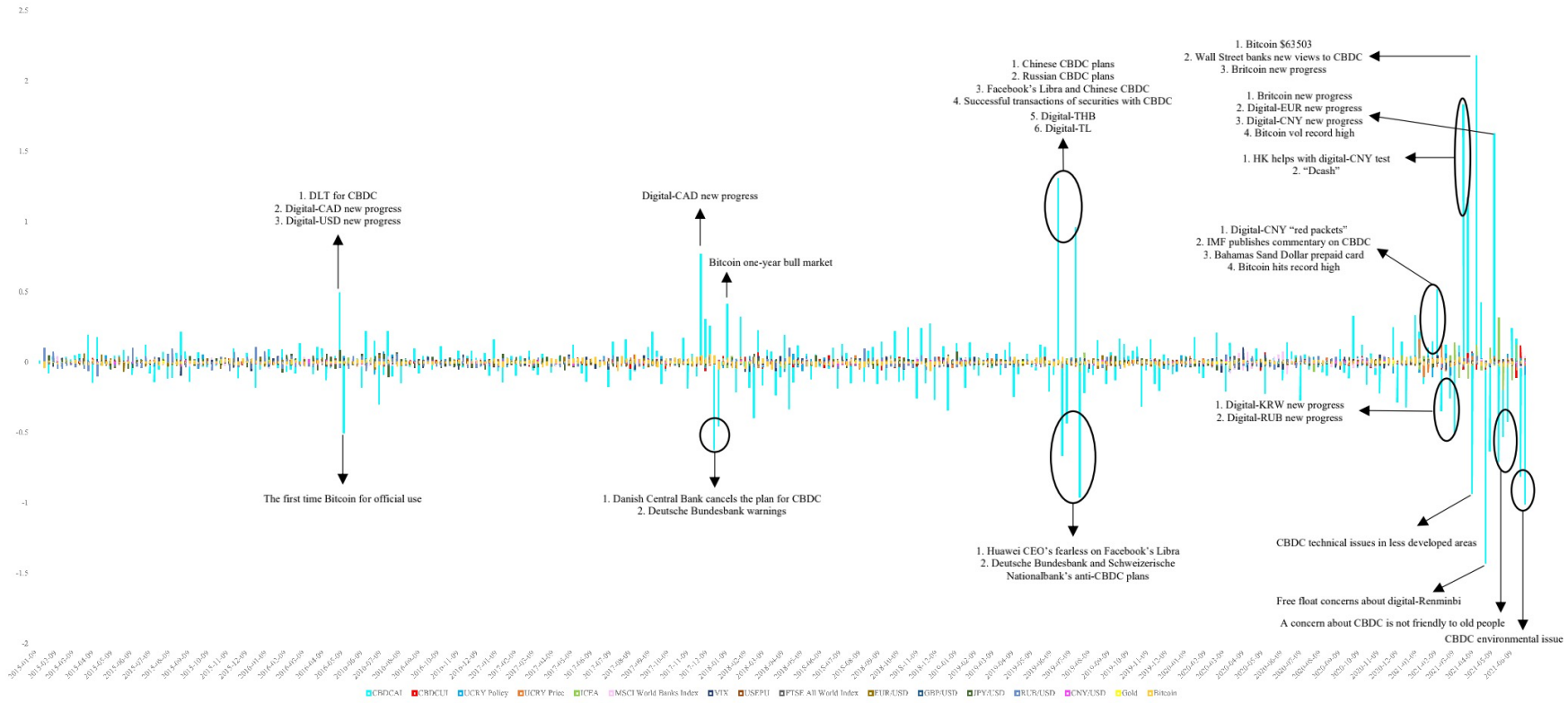
Main Empirical Results for CBDC indices (8)

- Cumulative contributions of CBDC disturbances to the financial variables volatility (1): CBDCUI HD results



Main Empirical Results for CBDC indices (9)

- Cumulative contributions of CBDC disturbances to the financial variables volatility (2): CBDCAI HD results



Main Empirical Results for CBDC indices (10)

- Cumulative contributions of CBDC disturbances to the financial variables' volatility (3): CBDC indices HD findings

1. Both the cumulative positive and negative effects of CBDCUI disturbances on financial variables were larger than those of the CBDCAI.
2. Secondly, the contributions of the estimated CBDCUI and CBDCAI shocks to the evolution of the financial variables' volatilities changed over time.
3. Generally speaking, these positive or negative shocks appear perfectly reasonable.

Main Empirical Results for CBDC indices (11)

- Dynamic conditional correlations (1): CBDCUI bivariate AR (1)-GJR-GARCH(1,1)-DCC model results

Panel A (1): estimates of AR(1)-GARCH(1,1) model														
	CBDCUI	UCRY Policy	CBDCUI	UCRY Price	CBDCUI	ICEA	CBDCUI	MSCI World Banks Index	CBDCUI	VIX	CBDCUI	US	CBDCUI	FTSE All World Index
Const.(v)	0.0048*	0.0094*	0.0027*	0.0054**	0.0042*	0.0016**	−0.0030*	−0.9474***	0.0031*	21.2874***	−0.0233*	−3.4476***	−0.0041*	−0.3035**
	(0.8677)	(1.9222)	(0.9759)	(1.923)	(0.7985)	(0.7124)	(−0.8779)	(−2.3587)	(0.9243)	(6.5871)	(−0.2637)	(−3.0515)	(−0.9847)	(−2.0948)
ARCH(1)	0.1852***	0.1755***	0.2065***	0.2177***	0.1693***	0.4502***	−0.2033***	−0.0171*	0.2076***	0.000092*	−0.0582*	−0.0272*	−0.2012***	−0.0689**
	(2.9619)	(3.9854)	(3.6433)	(2.8688)	(3.0564)	(2.7573)	(−3.0502)	(−0.3867)	(3.3069)	(0.0288)	(−0.2764)	(−0.3032)	(−3.2419)	(−0.9216)
GARCH(1)	0.7899***	0.8420***	0.8221***	0.8768***	0.8065***	0.7643***	−0.8212***	−0.7078***	0.8190***	0.9592***	−0.9782***	−0.7743***	−0.7922***	−0.6856***
	(7.3271)	(15.6031)	(11.9939)	(12.0024)	(8.1141)	(4.7883)	(−10.0654)	(−7.3188)	(10.4843)	(2113.9894)	(−14.7319)	(−2.7395)	(−9.0582)	(−11.5944)
GJR	0.0477*	−0.1237***	−0.0590**	−0.3015***	0.0464*	−0.4310***	−0.0511*	0.3539**	−0.0552*	−0.1345***	0.2923*	0.2626*	0.0113*	0.3890**
	(0.2631)	(−0.8861)	(−0.4398)	(−2.3607)	(0.2397)	(−3.0971)	(−0.3541)	(1.9956)	(−0.3857)	(−4.5559)	(0.6655)	(1.7554)	(0.0722)	(2.1039)
Panel B (1): DCC estimates														
a	0.1409*		0.0581*		0.0205*		0.0135*		0.000001*		−0.000001*		0.000001*	
	(1.7584)		(0.2856)		(0.4701)		(0.6689)		(1.3003)		(0.000002)		(0.000002)	
b	0.4720***		0.8457*		0.6829*		−0.9566***		0.3009*		−0.9078***		−0.9495***	
	(2.9921)		(0.6339)		(0.5171)		(10.54563)		(0.3059)		(8.7714)		(9.0846)	
Panel A (2): estimates of AR(1)-GARCH(1,1) model														
	CBDCUI	EUR/USD	CBDCUI	GBP/USD	CBDCUI	JPY/USD	CBDCUI	RUB/USD	CBDCUI	CNY/USD	CBDCUI	Gold	CBDCUI	Bitcoin
Const.(v)	0.0033**	0.0638*	0.0277*	0.3203***	0.0044*	0.0395*	0.0042*	0.1507*	0.0035*	0.0187***	0.0045*	0.3254*	0.0042*	0.8772***
	(0.8943)	(1.1504)	(0.3692)	(2.5007)	(0.8349)	(1.4056)	(0.8676)	(1.6818)	(0.9418)	(8.2973)	(0.8976)	(1.0609)	(7.7588×10^{-1})	(4.2911×10^{2})
ARCH(1)	0.1973***	0.0764**	0.0305*	0.0986*	0.1836***	0.1018***	0.1878***	0.0061*	0.1893***	0.000001*	0.1914***	0.1959*	0.1753***	0.0671***
	(3.3401)	(1.2547)	(0.1998)	(0.6922)	(3.0963)	(2.6788)	(2.8232)	(0.1549)	(3.1339)	(0.0081)	(2.9448)	(1.8621)	(2.5477)	(7.0613×10^{2})
GARCH(1)	0.8195***	0.8466***	0.9742***	0.4535***	0.7891***	0.8585***	0.7969***	0.8592***	0.8149***	0.9635***	0.7916***	0.7989***	0.8069***	0.9816***
	(10.1700)	(9.5910)	(20.7864)	(2.6901)	(7.4884)	(17.5126)	(7.5917)	(14.4046)	(9.5409)	(4508.0829)	(7.5012)	(6.9123)	(7.4144)	(1.6031×10^{5})
GJR	−0.0356*	0.0426*	0.3234*	0.5766***	0.0526*	0.0218*	0.0287*	0.1657*	−0.0106*	−0.0363**	0.0321*	−0.1466*	0.0337*	−0.0993***
	(−0.2468)	(0.7341)	(1.1818)	(2.8659)	(0.3128)	(0.3181)	(0.1861)	(1.7291)	(−0.0814)	(−2.0156)	(0.1921)	(−1.2593)	(2.1941×10^{-1})	(-5.9355×10^{2})
Panel B (2): DCC estimates														
a	0.000001*		0.0082*		0.0193*		0.000001*		0.000001*		0.000001*		0.0146*	
	(0.000001)		(0.5754)		(0.4099)		(0.000003)		(0.000002)		(0.000002)		(3.6812×10^{-1})	
b	0.9305***		0.9907***		0.8528**		0.9284***		0.9449***		0.9208***		0.7588***	
	(13.2015)		(25.2558)		(2.3202)		(20.9329)		(7.7331)		(8.1857)		(2.4951)	

Note:*p<0.1; **p<0.05; ***p<0.01

Main Empirical Results for CBDC indices (12)

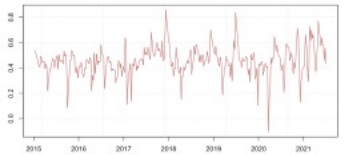
- Dynamic conditional correlations (2): CBDCAI bivariate AR (1)-GJR-GARCH(1,1)-DCC model results

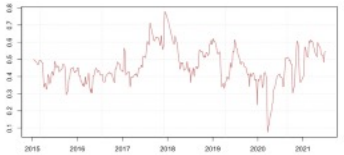
Panel A (1): estimates of AR(1)-GARCH(1,1) model														
	CBDCAI	UCRY Policy	CBDCAI	UCRY Price	CBDCAI	ICEA	CBDCAI	MSCI World Banks Index	CBDCAI	VIX	CBDCAI	USEPU	CBDCAI	FTSE All World Index
Const.(v)	0.0013*	0.0093*	0.0013*	0.0055*	0.0029*	0.0014*	−0.0017*	−0.7918**	0.0048*	3.2251***	−0.0163*	−3.2242***	−0.0016*	−0.3176*
	(1.9087)	(1.8120)	(1.5935)	(1.7201)	(1.0917)	(0.1321)	(−1.3207)	(−2.3191)	(0.0234)	(4.0131)	(−0.0859)	(−3.0266)	(−1.3712)	(−1.7539)
ARCH(1)	0.5288***	0.1548***	0.5231**	0.2113***	0.3094***	0.3906***	−0.5238***	−0.00059*	0.3263*	0.4947***	−0.4152*	−0.0231*	−0.4676***	−0.0886*
	(20.3448)	(3.7060)	(2.2679)	(3.3912)	(3.0216)	(3.0702)	(−2.8854)	(−0.0147)	(1.2392)	(3.4608)	(−1.4535)	(−0.2666)	(−2.6122)	(−0.9773)
GARCH(1)	0.7670***	0.8643***	0.7584***	0.8603***	0.5801***	0.7951*	−0.7433***	−0.7392***	0.9412***	0.4112***	−0.9329***	−0.5106***	−0.7488***	−0.6892***
	(20.0939)	(15.6031)	(20.6359)	(20.4433)	(5.2085)	(1.3843)	(−19.9631)	(−9.4292)	(27.2468)	(2.9420)	(−30.0175)	(−3.1421)	(−14.3742)	(−11.8936)
GJR	−0.5936***	−0.1434*	−0.5649**	−0.2231*	0.2189*	−0.3733*	−0.5361*	0.3787**	0.8831***	−0.1739*	1.0704***	0.2437*	−0.4348*	0.3278*
	(−25.0153)	(−1.7349)	(−2.2012)	(−1.6833)	(0.5515)	(−1.6126)	(−1.9006)	(2.2753)	(3.4623)	(−1.1930)	(3.4552)	(1.6828)	(−1.3385)	(1.7767)
Panel B (1): DCC estimates														
a	0.0467*		0.0732**		0.2322*		−0.000001*		0.000001*		−0.000001*		−0.000001*	
	(1.1837)		(2.2918)		(1.247532)		(0.0071)		(0.0285)		(0.0188)		(0.000006)	
b	0.8325***		0.8452***		0.000001*		−0.9042***		0.8930***		−0.8805***		−0.9217***	
	(4.0646)		(12.9301)		(0.0661)		(8.037396)		(3.6646)		(4.4211)		(10.1536)	
Panel A (2): estimates of AR(1)-GARCH(1,1) model														
	CBDCAI	EUR/USD	CBDCAI	GBP/USD	CBDCAI	JPY/USD	CBDCAI	RUB/USD	CBDCAI	CNY/USD	CBDCAI	Gold	CBDCAI	Bitcoin
Const.(v)	0.0014*	0.0583*	0.0391*	0.3431**	0.0026*	0.0453*	0.0025*	0.1532*	0.0702*	0.0862***	0.0024*	0.2289*	0.0026*	0.9453***
	(1.2329)	(1.1390)	(0.2276)	(2.4791)	(0.9869)	(1.3657)	(0.9726)	(1.6683)	(3.9045×10^{-1})	(1.9338×10^{1})	(0.7893)	(0.7083)	(9.8787×10^{-1})	(1.0553×10^{2})
ARCH(1)	0.5119**	0.0757*	0.2789*	0.1084*	0.2883**	0.1014***	0.2829***	0.0074*	0.2608*	0.0216*	0.3085*	0.1719*	0.2891***	0.0555***
	(2.0227)	(1.4179)	(1.3574)	(0.7446)	(2.3987)	(2.6579)	(2.8084)	(0.1718)	(1.2410)	(9.7291×10^{-1})	(1.7366)	(1.3358)	(2.9371)	(2.9794×10^{2})
GARCH(1)	0.7551***	0.8549***	0.9393***	0.4265**	0.6581***	0.8581***	0.6490***	0.8516***	0.9295***	0.9259***	0.6657***	0.8331***	0.6658***	0.9903***
	(19.3449)	(10.7939)	(28.3969)	(2.3780)	(5.2388)	(15.0118)	(6.0123)	(13.2041)	(2.5945×10^{1})	(8.6684×10^{4})	(3.7912)	(6.1930)	(6.8731)	(1.4925×10^{4})
GJR	−0.5359*	0.0391*	0.8743***	0.5663***	0.1051*	0.0125*	0.1341*	0.1782*	0.8785***	−0.0861***	0.0496*	−0.1145*	0.0881*	−0.0935***
	(−1.9671)	(0.6952)	(4.1450)	(2.8378)	(0.2088)	(0.1796)	(0.3082)	(1.7084)	(4.0370)	(-2.7836×10^{1})	(0.0744)	(−0.8677)	(1.9239×10^{-1})	(-2.8211×10^{2})
Panel B (2): DCC estimates														
a	−0.000001*		0.000001*		−0.0095*		−0.0053*		−0.000002*		−0.000001*		−0.000001*	
	(0.000005)		(0.0359)		(0.8089)		(0.3851)		(9.1802×10^{-1})		(0.0178)		(0.0017)	
b	0.9244***		0.9369***		0.9799***		0.9062***		0.0808*		0.9058***		0.8068*	
	(9.5477)		(15.2649)		(27.4912)		(6.4818)		(5.0000×10^{-6})		(14.5571)		(0.2973)	

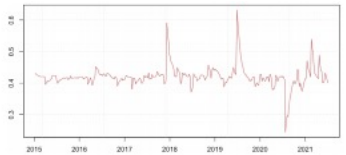
Note:*p<0.1; **p<0.05; ***p<0.01

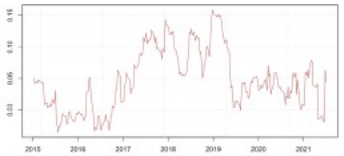
Main Empirical Results for CBDC indices (13)

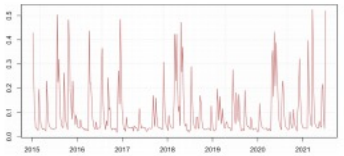
- Dynamic conditional correlations (3): CBDCUI dynamic conditional correlations results

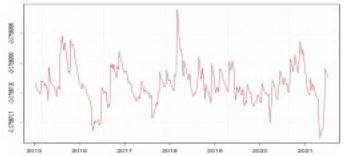

(a) UCRY Policy

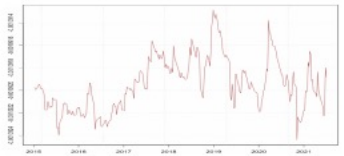

(b) UCRY Price

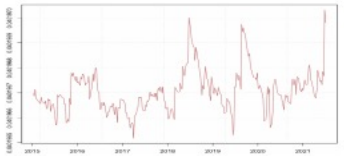

(c) ICEA


(d) MSCI World Banks Index


(e) VIX

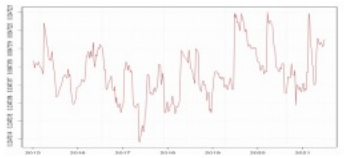

(f) USEPU

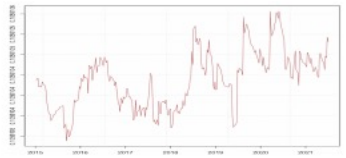

(g) FTSE All World Index

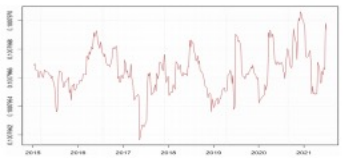

(h) EUR/USD


(i) GBP/USD


(j) JPY/USD


(k) RUB/USD

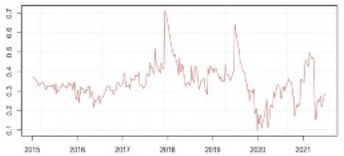

(l) CNY/USD


(m) Gold

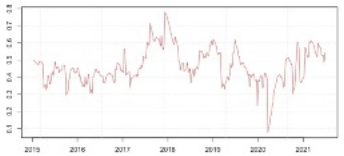

(n) Bitcoin

Main Empirical Results for CBDC indices (14)

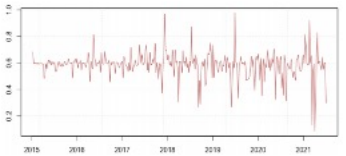
- Dynamic conditional correlations (4): CBDCAI dynamic conditional correlations results



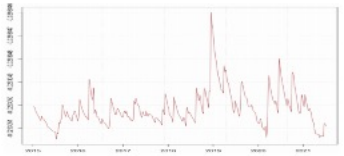
(a) UCRY Policy



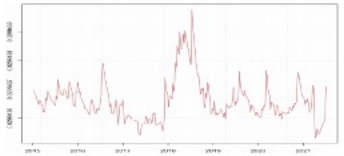
(b) UCRY Price



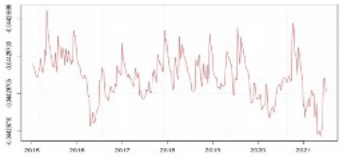
(c) ICEA



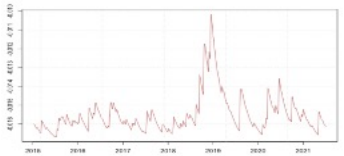
(d) MSCI World Banks Index



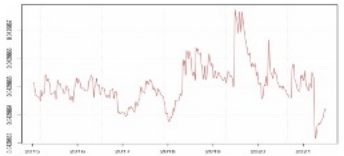
(e) VIX



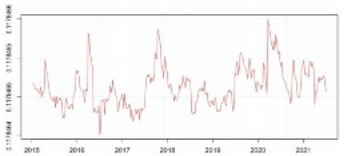
(f) USEPU



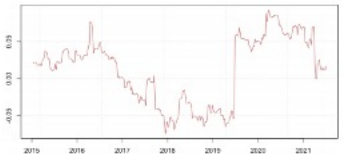
(g) FTSE All World Index



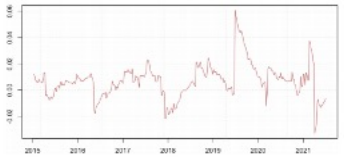
(h) EUR/USD



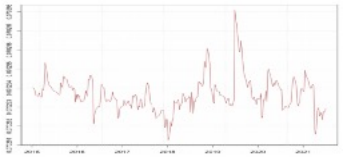
(i) GBP/USD



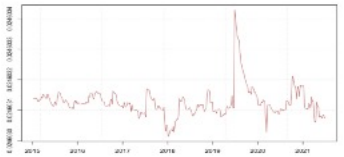
(j) JPY/USD



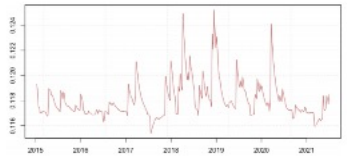
(k) RUB/USD



(l) CNY/USD



(m) Gold



(n) Bitcoin

Main Empirical Results for CBDC indices (15)

- **Dynamic conditional correlations (1): CBDC indices DCCs findings**

1. The CBDC indices have a positive and statistically significant DCCs with the volatility of UCRY Policy, UCRY Price, ICEA, VIX, EUR/USD, GBP/USD, JPY/USD, RUB/USD, CNY/USD, gold, and Bitcoin.
2. The CBDC indices have a negative and statistically significant DCCs with the volatility of the MSCI World Bank Index, the FTSE All-World Index, and the USEPU.

Main Empirical Results for CBDC indices (16)

Robustness tests

Core heart: the relationships between the CBDC indices and the financial variables

Method one: the relationship between CBDC indices risk and financial variables' volatility (Pástor and Veronesi, 2013; Demir et al., 2018 and Al Mamun et al., 2020)

H_0: CBDC indices risk increases, financial variables' volatility also increases.

Or

H_0: CBDC indices risk increases, financial variables' volatility decreases.

$$FV_t = \beta_1 + \beta_2 CBDC_t + \beta_3 FV_{t-1} + \varepsilon_t$$

Method two: the absolute rate of CBDC indices' changes (Whaley, 2009).

Negative relationship: the changes in $CBDC_t$ rise at a higher absolute rate when the FV_t falls than when it increases.

Or

Positive relationship: the changes in $CBDC_t$ rise at a higher absolute rate when the FV_t rises than when it falls.

$$CBDC_t = \beta_1 + \beta_2 FV_t + \beta_3 FV_t^- + \varepsilon_t$$

Main Empirical Results for CBDC indices (17)

- Robustness test results: rigorous? Yes!

	CBDC risk (CCR)		*CBDC risk (RV)*		*CBDC risk (R)*	
	CBDCUI	CBDCAI	CBDCUI	CBDCAI	CBDCUI	CBDCAI
	(1)	(2)	(3)	(4)	(5)	(6)
UCRY Policy	0.7003***	0.6334***	0.6094***	0.7315***	0.4520***	0.1773***
	(0.0529)	(0.0995)	(0.1293)	(0.1524)	0.0056***	−0.0073***
UCRY Price	0.6555***	0.6366***	0.5949***	0.6594***	0.4483***	0.1788***
	(0.0526)	(0.0963)	(0.1495)	(0.1837)	0.0316***	0.0096***
ICEA	0.3969***	0.7964***	0.7685***	0.7884***	0.4022***	3.747e-01***
	(0.0461)	(0.0681)	(0.1187)	(0.1384)	0.1423***	−4.096e-02***
MSCI World Banks Index	−0.0985*	−0.5429*	−0.1455*	−0.6099*	−0.0132*	−0.0112*
	(0.3749)	(0.6023)	(0.6335)	(0.7801)	−0.0206*	−0.0130*
VIX	0.1592**	0.1531**	0.0473*	0.0943*	0.0004*	0.0004*
	(0.0538)	(0.0543)	(0.1177)	(0.1159)	0.0055*	0.0022*
USEPU	−0.2394**	−0.2406***	−3.2239*	−0.2895*	−0.0002*	−0.0011*
	(0.0528)	(0.0522)	(0.675)	(0.1164)	−0.0025*	−0.0012*
FTSE All World Index	−0.0995**	−0.2132*	−0.0649*	−0.2601*	−0.0048*	−0.0031*
	(0.2567)	(0.4129)	(0.4390)	(0.5405)	−0.0005*	−0.0019*
EUR/USD	0.1238*	0.0216*	0.4218*	0.4018***	0.0423*	0.0018*
	(0.1323)	(0.2124)	(0.1013)	(0.1022)	0.0425*	0.0040*
GBP/USD	0.1800*	0.3351*	0.5098*	0.7419*	0.0201*	0.0121*
	(0.1607)	(0.2573)	(0.2653)	(0.3295)	−0.0021*	0.0042*
JPY/USD	0.2524*	0.1240*	0.2555*	0.2731*	0.0203*	0.0044*
	(0.1316)	(0.2120)	(0.1116)	(0.1115)	0.0503*	0.0080*
RUB/USD	0.0281*	0.1526*	0.3585*	0.3608*	0.0196*	0.00682*
	(0.2429)	(0.3894)	(0.1012)	(0.1007)	0.0312*	−0.00665*
CNY/USD	0.0411*	0.0305*	0.0291*	0.1519*	0.0830*	0.0022*
	(0.0664)	(0.1064)	(0.1002)	(0.1229)	0.2111*	0.0187*
Gold	0.3893*	0.0704*	0.1704*	0.2555*	0.0022*	0.0028*
	(0.2329)	(0.3747)	(0.3618)	(0.1133)	0.0488*	0.0087*
Bitcoin	0.4789*	0.6257*	5.6714**	5.428*	0.0141***	0.0041*
	(1.2138)	(1.9506)	(1.8814)	(2.334)	0.0259***	0.0069*
Observations	338	338	78	78	339	339

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Main Empirical Results for CBDC indices (18): a brief conclusion

- CBDC indices have a significantly negative relationship with the volatilities of the MSCI World Banks Index, USEPU, and FTSE All-World Index.
- However, CBDC indices have a significantly positive relationship with the volatilities of UCRY Policy, UCRY Price, ICEA, and Bitcoin (cryptocurrency markets), EUR/USD, GBP/USD, RUB/USD, JPY/USD, and CNY/USD (foreign exchange markets), as well as VIX and gold.
- Furthermore, the volatilities of financial variables are more sensitive to CBDCUI when compared with reactions from CBDCAI shocks, highlighting the importance of CBDC uncertainty in this interconnected system.
- The historical decomposition results for both the CBDCUI and CBDCAI show significant spikes near key CBDC innovations and important digital currency events. Both cumulative positive and negative effects of CBDCUI's disturbances on financial variables are larger than those of CBDCAI disturbances.

Potential implications and extensions

1. Theory development

- **A new methodology for a new index construction (Uncertainty index, attention index).**

This methodology can provide a new channel to more comprehensively understand broad financial developments by systematic online empirical inquiries.

2. Applied finance and economics

- **Impact of UCRY indices, ICEA and CBDC indices on the patterns of interconnection between financial markets.**

For example: Exploring the hedge and safe haven properties of financial assets by using these indices.

- **Analysing UCRY indices, ICEA and CBDC indices with firm-level data.**

For example: The relationship between CBDC indices and stock price volatility of specific companies.

Indices papers and latest data download

UCRY indices paper:

Lucey, B. M., Vigne, S. A., Yarovaya, L., & Wang, Y. (2021). The cryptocurrency uncertainty index. *Finance Research Letters*, 102147.
https://www.sciencedirect.com/science/article/pii/S1544612321002282

ICEA paper:

Wang, Y. and Lucey, B. M. and Vigne, S.A and Yarovaya, L. (2021). An Index of Cryptocurrency Environmental Attention (ICEA). *China Finance Review International.* (R & R).
https://ssrn.com/abstract=3866535

CBDC indices paper:

Wang, Y., Lucey, B. M., Vigne, S. A., & Yarovaya, L. (2021). The Effects of Central Bank Digital Currencies News on Financial Markets. *Technological Forecasting and Social Change.* (Under review).
https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3952729

UCRY indices, ICEA and CBDC indices latest data can be downloaded from our website:

https://sites.google.com/view/cryptocurrency-indices/home?authuser=0

Thanks for Listening!