The Role of Financial Traders for Price Responses to Shocks in the Commodity Futures Markets

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What I Do

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- When do financial traders destabilise the commodity futures market?
- Use weekly trading position data of Commercial hedgers, Financial speculators and Index traders from Commodity Futures Trading Commission (CFTC)
- Step 1: Decompose the futures return for 13 agricultural commodities individually.
  - Disentangle the portions driven by fluctuations in the spot market and traders in the futures market.
  - Find that financial traders reduce volatility in 3 commodities during the GFC and in 8 commodities during the Russia-Ukraine war.
- Step 2: Run panel regressions to further investigate the drivers of these heterogeneous results.

Supplemental Info

Findings

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- Financial traders amplify price changes by 44.6% on average during the Global Financial Crises (GFC). (Cheng et al. (2014);Bonnier (2021))
- Financial traders dampen price changes by 28.3% on average during the Russia-Ukraine war.
- Yet, the mitigating effect decreases as the market share of the financial traders increases.

Contribution 1: Conditional Role of Financial Traders

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- Claim: When financial traders are unable to fulfil their role as liquidity providers, there is no inherent mechanism that forces them to support market stabilisation, which could imply a destabilizing effect.
- Confirm the claim by identifying two conditions:
  1. Financial shocks to limit the liquidity provision role of the financial traders.(Cheng et al. (2014); Bonnier (2021))
  2. High market share of the financial traders disrupts their liquidity-providing role.

Supplemental Info

Contribution 2: Structural Model Estimation

- Literature: Run regression of the futures return ($\Delta F_{c,t}$) on demands ($X^i_{c,t}$) for each trader group $i \in \{h, f, idx\}$ separately

$$\Delta X^i_{c,t} = \frac{netlong\_position^i_{c,t} - netlong\_position^i_{c,t-1}}{OI_{c,t-1}}$$
$$\Delta F_{c,t} = \beta_1 \Delta X^i_{c,t} + \epsilon_{c,t}$$

- What actually Hedging Pressure Theory says:

$$\Delta F_c(t,T) = E_t[\Delta S_{c,T}] - RP_{c,t} = RP_{c,t}(\Delta X^h_{c,t}, \Delta X^f_{c,t}, \Delta X^{idx}_{c,t})$$
$$\Delta X^i_{c,t} = \beta_1 \Delta F_c(t,T) + \gamma_1 E_t[\Delta S_{c,T}] + \epsilon_{c,t}$$

- My paper: Estimate a structural model representing the hedging pressure theory with selected abnormal spot price shocks by applying an identification methodology developed by Jarociński (2024).

Methodology: Two-step Procedure

1. Structural form estimation separately for 13 commodities
2. Panel regression

Methodology: Structural Form Estimation

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- SVAR decomposes reactions of financial variables to MP shocks into structural shocks.(Gourièroux et al. (2017);Maxand (2020);Lanne and Luoto (2021))
- Decomposed shocks are linear combinations of the original variables
- Factors in Factor Analysis are linear combinations of the original variables

5 original variables

1. Spot Price Difference
   - Net long Position Change
     2. Commercial Hedgers
     3. Financial Speculators
     4. Index Traders
5. Futures Return

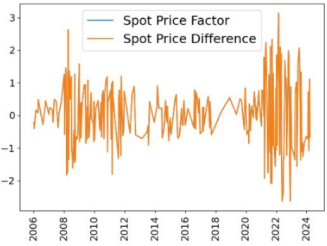
$\longrightarrow$

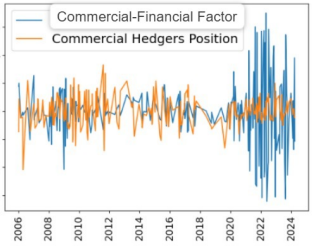
5 Factors

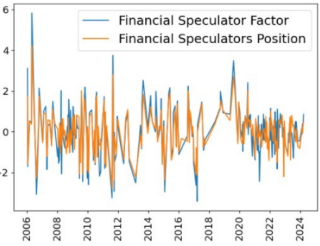
1. Spot price factor
2. Commercial-Financial factor
3. Financial speculator factor
4. Index trader Factor
5. Residual Factor

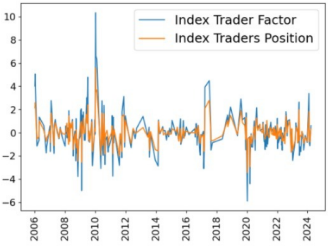
Quick Glance of the 5 factors

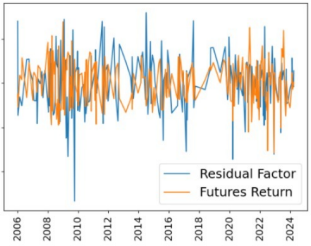
- Structural form estimation with 5 variables (in orange) outputs 5 factors (blue)











- Structural model follows Hedging Pressure Theory

$$
\begin{aligned}
\text{Spot price difference:} \quad & \Delta S_t = \epsilon_t^{spot} \\
\text{Demand of commercial hedgers:} \quad & \Delta X_t^h = \beta_h \Delta F_t + \gamma_h \Delta S_t + \epsilon_t^h \\
\text{Demand of financial speculators:} \quad & \Delta X_t^f = \beta_f \Delta F_t + \gamma_f \Delta S_t + \epsilon_t^f \\
\text{Demand of index traders:} \quad & \Delta X_t^{idx} = \beta_{idx} \Delta F_t + \gamma_{idx} \Delta S_t + \epsilon_t^{idx} \\
\text{Futures return:} \quad & \beta_f \Delta F_t = -\Delta X_t^h - \Delta x_t^f - \Delta x_t^{idx} - \gamma_o \Delta S_t - \epsilon_t^o,
\end{aligned}
$$

- Close the system by using the market clearing condition: $\sum_{i \in \{h,s,idx,\mathbf{o}\}} \Delta X_i = 0$

$$
\underbrace{\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ -\gamma_t^h & 1 & 0 & 0 & -\beta_t^h \\ -\gamma_t^f & 0 & 1 & 0 & -\beta_t^f \\ -\gamma_t^{idx} & 0 & 0 & 1 & -\beta_t^{idx} \\ \gamma_t^o & 1 & 1 & 1 & \beta_t^o \end{pmatrix}}_{:=\mathbf{W'}} \underbrace{\begin{pmatrix} \Delta S_t \\ \Delta X_t^h \\ \Delta X_t^f \\ \Delta X_t^{idx} \\ \Delta F_t \end{pmatrix}}_{:=\mathbf{y_t}} = \underbrace{\begin{pmatrix} \epsilon_t^{spot} \\ \epsilon_t^s \\ \epsilon_t^f \\ \epsilon_t^{idx} \\ \epsilon_t^o \end{pmatrix}}_{:=\boldsymbol{\epsilon_t}}.
$$

Estimation and Identification

1. Maximum likelihood estimation is used to statistically identify the optimal values for $\mathbf{W}$ and the degree of freedom

2. Identifying factors or transforming latent factors to (meaningful) factors
   - 2-1 Determining which factor(s) best explain the futures returns based on R^2.
   - 2-2 Only two factors are sufficient to explain the futures return on average 95%.
   - 2-3 Identifying the two factors: spot price and commercial-financial factors.
   - 2-4 Identifies the remaining three factors: financial speculator factor, the index trader factor, and residual factor.

Supplemental Info

Visual Example of the Dimensional Reduction

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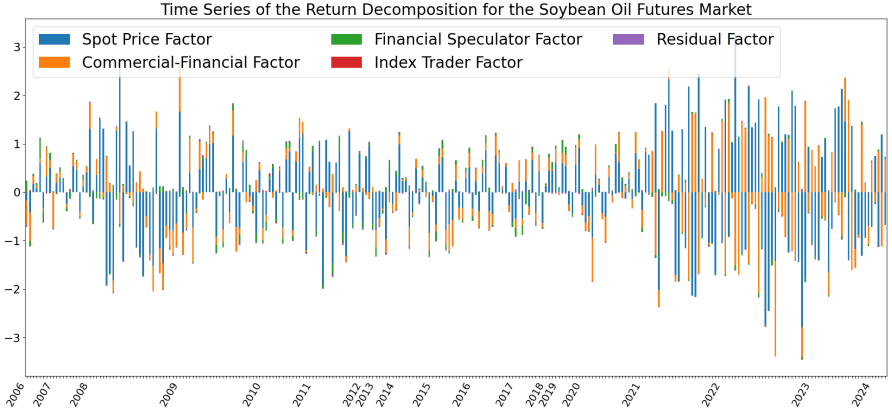
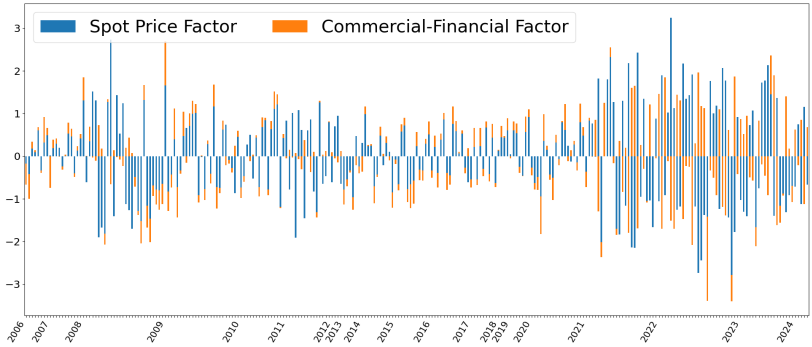
- Hedging Pressure Theory: $\Delta F_c(t,T) = E_t[\Delta S_{c,T}] - RP_{c,t} = RP_{c,t}(\Delta X^h_{c,t}, \Delta X^f_{c,t}, \Delta X^{idx}_{c,t})$
- **Neither financial traders nor index traders solely do have price impact.**
- It is combination of the all traders that do have price impact.



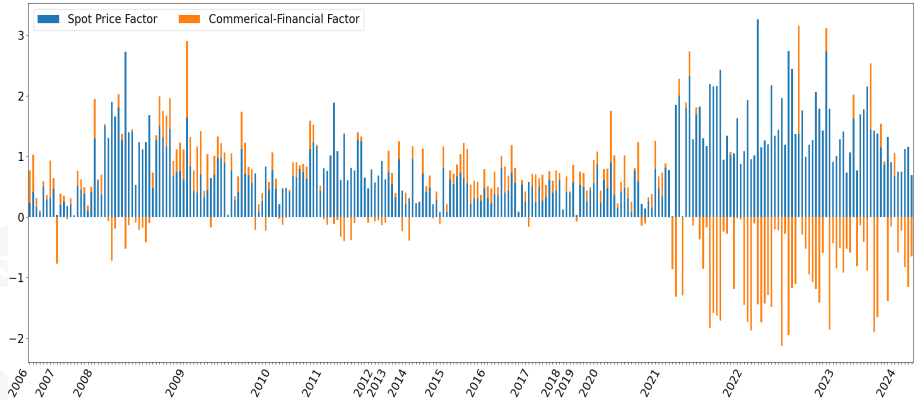
Commercial-Financial Factor Effects

- Dimensional reduction: Return $\approx$ Spot price factor + CF factor



- Spot Price Factor $\geq 0 \longrightarrow$ No change
- Spot Price Factor $< 0 \longrightarrow -$Spot Price Factor$\& -$ CF factor

Commercial-Financial Factor Effects



- GFC: mean of |Spot factor + CF factor| > mean of |the Spot Price Factor|
- RU war: mean of |Spot factor + CF factor| > mean of |the Spot Price Factor|

Results:

1. Structural form estimation
2. Panel regression

Answer 1: Clear Different Role Between GFC and RU war

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Commodity	GFC	RU war
Soybean oil	0.2894	-0.2746
Corn	0.2373	0.0957
Cocoa	0.0715	-0.4352
Cotton	-0.1456	0.1975
Feather cattle	3.8012	0.4972
Coffee	-0.0384	-0.0496
Hard Red wheat	0.1144	-0.1771
Live cattle	1.1958	-0.3963
Lean hogs	2.3317	0.7017
Soybean	0.1841	-0.3142
Sugar	-0.1818	-0.1495
Soybean meal		-0.1820
Wheat	0.2793	0.0042

- Calculate contribution of the Commercial-Financial factor to the volatility
- $$\frac{\text{vol(spot factor+CF factor)}-\text{vol(spot factor)}}{\text{vol(spot factor)}}$$
- Financial traders reduce volatility only in 3 markets during GFC
- During Russia-Ukraine war, this number rises to 8 out of the 13 markets.

Confirm the first hypothetical condition where the financial traders destabilise the market Supplemental Info

Step 2: Panel Regression with Offset Value

- *Offset Value*: ln abs(*spot price factor* + *CF factor*) − ln abs(*spot price factor*)
  1. $\frac{abs(\textit{spot price factor}+\textit{Commercial-Financial factor})}{abs(\textit{spot price factor})} = \frac{\textit{large}}{\textit{small}} > 1 \longrightarrow$ Amplification effect
  2. $\frac{abs(\textit{spot price factor}+\textit{Commercial-Financial factor})}{abs(\textit{spot price factor})} = \frac{\textit{small}}{\textit{large}} < 1 \longrightarrow$ Mitigation effect
  3. To avoid overestimation (underestimation) of amplification (mitigation) effect, it turns into logarithm.
- Positive (Negative) coefficients represent increase (decrease) in the price changes.

Panel Regression with Offset Value

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- *Offset Value*: ln abs(*spot price factor* + *CF factor*) − ln abs(*spot price factor*)
  - $\frac{abs(\textit{spot price factor}+\textit{Commercial-Financial factor})}{abs(\textit{spot price factor})} = \frac{\textit{large}}{\textit{small}} > 1 \longrightarrow$ Amplification effect
  - $\frac{abs(\textit{spot price factor}+\textit{Commercial-Financial factor})}{abs(\textit{spot price factor})} = \frac{\textit{small}}{\textit{large}} < 1 \longrightarrow$ Mitigation effect
- Positive (Negative) coefficients represent increase (decrease) in the price changes.

	Offset Value			
GFC Dummy	0.0204	0.0439	0.3557***	0.3686***
	(0.4130)	(0.8881)	(3.7101)	(3.9374)
RU Dummy	-0.4470***	-0.4286***	-0.3402**	-0.3329**
	(-8.1720)	(-8.1554)	(-2.9631)	(-2.8562)
Constant	0.1750***	0.3022***	0.1845	0.1229
	(8.1720)	(5.6799)	(1.6358)	(0.8551)
Commodity FE	No	Yes	Yes	Yes
Year FE	No	No	Yes	Yes
Month FE	No	No	No	Yes
R-squared	0.0207	0.0443	0.0799	0.0828
Observations	2984	2984	2984	2984

- GFC: CF factor amplifies the price changes by 44.6% $(e^{0.369} - 1 \approx 0.4463)$
- RU : CF factor dampens the price changes by 28.3 % $(1 - e^{0.333} \approx 0.2832)$

Panel Regression: Market Share

- Positive (Negative) coefficients represent increase (decrease) in the price changes.

	Offset Value			
GFC Dummy	0.0557	0.0494	0.3558***	0.3706***
	(1.1087)	(0.9780)	(3.7115)	(3.9577)
RU Dummy	-0.4189***	-0.4362***	-0.3882**	-0.3823***
	(-6.4134)	(-6.5663)	(-2.4219)	(-2.6483)
Ratio of Financials	1.0003***	0.9584**	1.2463***	1.2629***
	(3.6088)	(2.3813)	(2.6641)	(2.6761)
Ratio of Index	-0.9740**	-0.0427	-0.5577	-0.6084
	(-2.0835)	(-0.0815)	(-0.8442)	(-0.8999)
Constant	-0.1933*	-0.1668	-0.3306	-0.3882
	(-1.6572)	(-0.8501)	(-1.4722)	(-1.6082)
Commodity FE	No	Yes	Yes	Yes
Year FE	No	No	Yes	Yes
Month FE	No	No	No	Yes
R-squared	0.0259	0.0462	0.0822	0.0852
Observations	2984	2984	2984	2984

- Given a same ratio of Non Commercials, still the CF factor dampens the price changes significantly during RU conflict, while amplifies during GFC.
- For the average ratio of financial traders (55%), the CF factor amplifies price fluctuations nearly twofold ($e^{0.55 \times 1.263} \approx 2.003$)

Panel Regression: Interaction with Market Share

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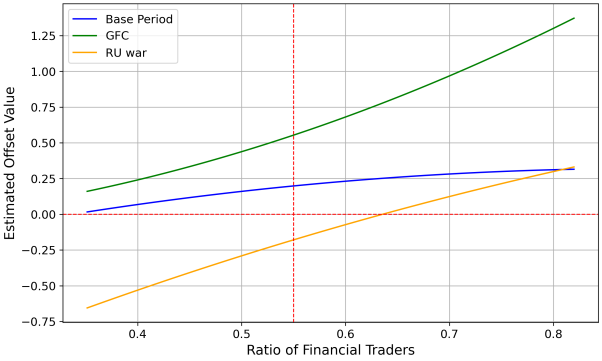
- Positive (Negative) coefficients represent increase (decrease) in the price changes.

	Offset Value			
GFC Dummy	-0.8814***	-0.9931***	-0.6113**	-0.6142*
	(-2.8492)	(-3.2283)	(-2.0900)	(-1.9433)
RU Dummy	-1.0512***	-1.1962***	-1.1653***	-1.1735***
	(-3.0347)	(-3.4254)	(-3.0995)	(-3.0870)
Ratio of Financial Traders	0.5705*	0.3568	0.6634	0.6730
	(1.8707)	(0.8274)	(1.3459)	(1.3519)
Interaction with GFC Dummy	1.7307***	1.9252***	1.7913***	1.8259***
	(2.8819)	(3.2388)	(3.4994)	(3.0924)
Interaction with RU Dummy	1.1640*	1.4058**	1.4165**	1.4428**
	(1.8243)	(2.1689)	(2.2936)	(2.2386)
Ratio of Index Traders	-1.1580**	-0.2323	-0.7397	-0.8007
	(-2.4645)	(-0.4390)	(-1.1128)	(-1.1775)
Constant	0.0805	0.1852	0.0103	-0.0476
	(0.5852)	(0.8649)	(0.0428)	(-0.1862)
Commodity FE	No	Yes	Yes	Yes
Year FE	No	No	Yes	Yes
Month FE	No	No	No	Yes
R-squared	0.0301	0.0516	0.0869	0.0901
Observations	2984	2984	2984	2984

- GFC: CF factor amplifies the price changes by 47.7% for the average financial traders ratio. $(e^{(-0.6142+0.55\times 1.8259)} - 1 \approx 0.4770)$
- RU: CF factor dampens the price changes by 31.6% for the average financial traders ratio. $(1 - e^{(-1.1735+0.55\times 1.4428)} \approx 0.3161)$

Predicted Offset Value Highlights the Two Findings



- Financial traders amplify price changes during the GFC,they dampen them % during the Russia-Ukraine war
- Yet, the mitigating effect decreases as the market share of financial traders increases.

Conclusion

- Claim: Inversely interpenetrating the hedging pressure theory, the liquidity provision role is a key to underpin financial traders to help the market stabilization.
- Confirm the claim by identifying two conditions:
  - Financial traders amplify price changes during the GFC,they dampen during the Russia-Ukraine war.
  - Yet, the mitigating effect decreases as the market share of the financial traders increases.

Policy Implication: Pay attention to the nature of the market disruption and the market share of financial traders.

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List of Acronyms

CFTC	Commodity Futures Trading Commission
SVAR	Structural VAR
PCA	Principal Component Analysis
PC	Principal Component
GFC	Global Financial Crises
OI	Open Interest
LICs	Low Income Countries

Appendix

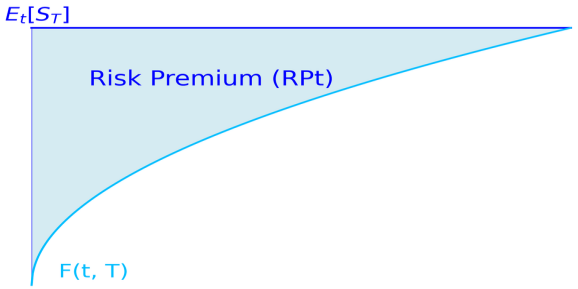
Financial Traders in the Commodity Futures Market

- CFTC definition:
  - **Commercials**:= *...classified as commercial if the trader uses futures contracts in that particular commodity for* ***hedging****....*
  - **Non Commercials**:= *...noncommercial positions in futures contracts mainly represent* ***speculative activity in pursuit of financial profits****.*
  - **Index Traders** := *are generally* ***replicating a commodity index*** *by establishing long futures positions in the component markets.*
- In my paper:

CFTC	My Paper	
Commercials	Commercial Hedgers (Farmers, Mitsubishi company)	Commercial Hedgers
Non Commercials	Financial Speculators (Hedge funds, Pension funds)	**Financial Traders**
Index Traders	Index Traders	

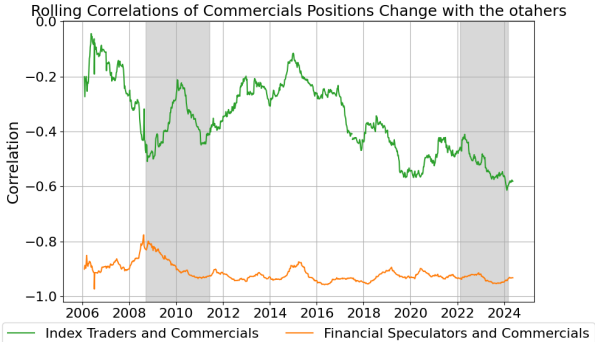
How do Financial Traders Trade with Commercial Traders ?

- Hedging pressure theory (Keynes (1923); Hicks (1939);Hirshleifer (1988);Hirshleifer (1990))
  1. Farmers want to hedge the price uncertainty by locking in a price
  2. Farmers sell futures contract (take a short position): $HP_t \Uparrow$
  3. The future price goes down as the supply increase: $F(t,T) \Downarrow$
  4. Generating positive risk premium: $RP_t (:= E_t[S_T] - F(t,T)) \Uparrow$
  5. Financial traders earn the risk premium by going long: $LP_t \Uparrow$



$$F(t,T) = E_t[S_T] - RP_t = E_t[S_T] - RP_t(HP_t, LP_t)$$

Financial Traders Are the Counterparts of the Commercials



- Claim: When financial traders are unable to fulfil their role as liquidity providers, there is no inherent mechanism that forces them to support market stabilisation, which could imply a destabilizing effect.

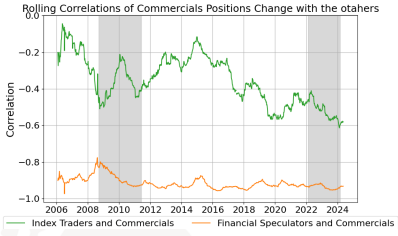
Back

Estimation: Maximum Likelihood

- The system estimation follows the approach in Jarociński (2024):
  - Probability density, $i.i.d.p(\epsilon_t)$ may follow Student-t distribution. Detail
  - Optimal values for $\mathbf{W}$ and the degree of freedom that maximize the log-likelihood of sample $\mathbf{Y}(=\mathcal{E}\mathbf{C})$

$$\mathbf{W} = \begin{pmatrix} \alpha_1 & -\gamma^h & -\gamma^f & -\gamma^{idx} & -\gamma^o \\ 0 & \alpha_2 & 0 & 0 & \alpha_5 \\ 0 & 0 & \alpha_3 & 0 & \alpha_6 \\ 0 & 0 & 0 & \alpha_4 & \alpha_7 \\ -\beta^{vix} & -\beta^h & -\beta^f & -\beta^{idx} & \beta^o \end{pmatrix}$$

- Solving issues of simultaneity & Spurious Correlation



Data and Variables

- Weekly frequency from Tuesday to Tuesday between 2006 and 2024
- Price data from Barchart and Bloomburg, and Trade data from CFTC
- 13 Agricultural commodities: Soybean oil, Corn, Cocoa, Cotton, Feeder cattle, Hard Red wheat, Coffee, Live cattle, Lean hogs, Soybean, Sugar, Soybean, meal Wheat
- Endogeneous Variables
  1. Futures Return: $\Delta F_t = lnF(t,T) - lnF(t-1,T)$
  2. Spot price difference: $\Delta S_t = S_t - S_{t-1}$
  3. Change in net long position : $\mathbf{x_{it}} = \frac{netlong\_position_{i,t} - netlong\_position_{i,t-1}}{OI_{i,t-1}}$

  $i \in \{\text{Commercial Hedgers}, \text{Noncommerical Speculators}, \text{Index Traders}\}$
- Exogenous Spot Price Shocks: The sample includes weeks where the spot price change on Mondays is greater than or equal to 1 standard deviation.

Identification of the 5 factors

- Identification: transform latent factors to (meaningful) factors
- How? Two evaluation tools: based on statistics, R^2 and economic intuitions
  1. Identify factors based R^2: how much a factor a variable
     $\longrightarrow$ Identify the spot, the financial speculator and the index factors
  2. Economic intuition based on the estimated $\mathbf{C}$ matrix.
     $\longrightarrow$ Identify the commercial financial factor:
  3. The last latent factor $\longrightarrow$ Residual as it does not have high R^2 for any variables.

Validity of the Dimensional Reduction Based R^2

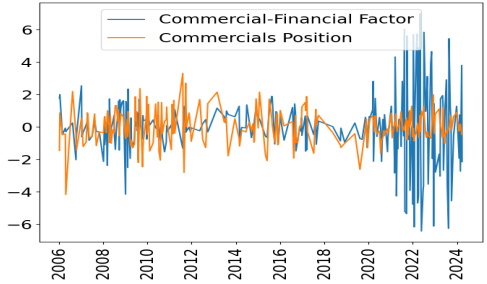
- Run 10 regressions of the futures return on a different combination of two latent factors
- Choose the combination that yield highest R^2 the spot price factor and the commercial financial factors

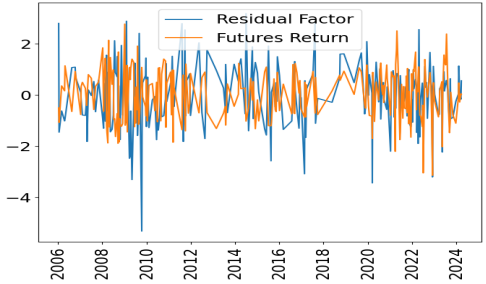
Commodity	R^2
Soybean oil	0.99
Corn	0.98
Cocoa	0.79
Cotton	0.98
Feather cattle	0.94
Coffee	0.94
Hard Red wheat	1.00
Live cattle	0.83
Lean hogs	0.94
Soybean	0.99
Sugar	1.00
Soybean meal	1.00
Wheat	0.97

Economic Intuition for the Commercial-Financial Factor

- Use the estimated $\mathbf{C}$ matrix in $\mathbf{Y} = \mathcal{E}\mathbf{C}$

Spot Spot Price Difference	Commercial Hedgers Position	Financial Speculators Position	Index Traders Position	Futures Return	
-1.000	1.242	-0.690	-0.538	-1.225	Spot price Factor
-0.000	**-0.293**	**0.153**	**0.111**	**0.358**	**Latent Factor 2**
-0.001	-1.231	0.834	0.032	0.103	Financial Speculator Factor
-0.000	-0.195	0.007	0.963	0.016	Index Trader Factor
0.000	0.312	-0.011	-0.008	-0.026	Latent Factor 5





Identification Using R^2

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- Spot Price factor

Commodity	R^2
Soybean oil	1.00
Corn	1.00
Cocoa	1.00
Cotton	1.00
Feather cattle	1.00
Coffee	1.00
Hard Red wheat	1.00
Live cattle	1.00
Lean hogs	1.00
Soybean	1.00
Sugar	1.00
Soybean meal	1.00
Wheat	1.00

- Financial Speculator factor

Commodity	R^2
Soybean oil	0.7210
Corn	0.6609
Cocoa	0.2369
Cotton	0.7931
Feather cattle	0.8940
Coffee	0.4646
Hard Red wheat	0.7345
Live cattle	0.6247
Lean hogs	0.4854
Soybean	0.5896
Sugar	0.5761
Soybean meal	0.3196
Wheat	0.8281

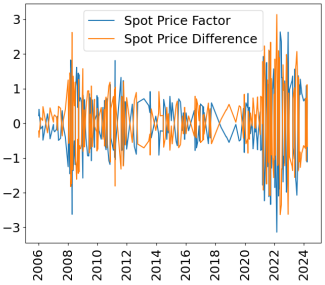
- Index trader factor

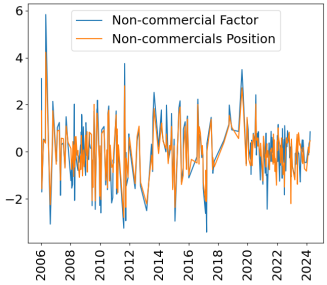
Commodity	R^2
Soybean oil	0.90
Corn	0.91
Cocoa	0.90
Cotton	0.98
Feather cattle	1.00
Coffee	0.93
Hard Red wheat	0.92
Live cattle	0.96
Lean hogs	0.95
Soybean	0.91
Sugar	1.00
Soybean meal	0.92
Wheat	0.96

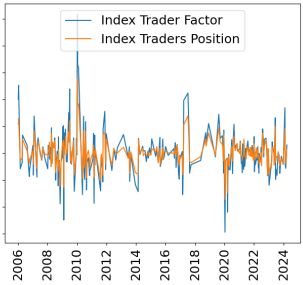
Economic Intuition for the Other Factors

- Use the estimated $\mathbf{C}$ matrix in $\mathbf{Y} = \mathcal{E}\mathbf{C}$

Spot Spot Price Difference	Commercial Hedgers Position	Financial Speculators Position	Index Traders Position	Futures Return	
-1.000	1.242	-0.690	-0.538	-1.225	Spot price Factor
-0.000	-0.293	0.153	0.111	0.358	CF Factor
-0.001	-1.231	**0.834**	0.032	0.103	Speculator Factor
-0.000	-0.195	0.007	**0.963**	0.016	Index Trader Factor
0.000	0.312	-0.011	-0.008	-0.026	Residual factor







Financial Traders Position and Financial Market

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- Claim: Speculation motive is weakened during the GFC
- Financial traders prioritizes in responding the financial turmoil
- Check if the demand of traders is elastic to VIX

(Cheng et al. (2014);Kang et al. (2020);Bonnier (2021))

	GFC			RU War		
	Commercials ΔX_t^h	Financials ΔX_t^f	Index Traders ΔX_t^{idx}	Commercials ΔX_t^h	Financials ΔX_t^f	Index Traders ΔX_t^{idx}
ΔVIX_t	0.0554***	-0.0400***	-0.0487***	0.0181	-0.0178	0.0006
	(6.381)	(-4.828)	(-4.643)	(0.989)	(-0.997)	(0.978)
ΔF_{t-1}	-0.0052	0.0389	-0.0826	-0.1149	0.1197**	0.0317
	(-0.123)	(0.954)	(-1.600)	(-2.372)	(2.547)	(0.556)
$\Delta VIX_t - 1$	0.0053	0.0022	-0.0290 **	-3.005e-05	0.0034	0.0009
	(0.558)	(0.249)	(-2.546)	(-0.002)	(0.202)	(0.963)
Commodity FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
N	573	573	573	396	396	396
R^2	0.110	0.067	0.068	0.068	0.056	0.062

Back

Location of My Paper 2/ Research Question

- Literature: Do financial traders amplify price changes in the commoditydity futures market?
  1. Support their stabilizing role assuming they provide liquidity to hedgers
     - Old theories suggest their systematic contribution as a liquidity provider (Keynes (1923); Hicks (1939); Hirshleifer (1988),Hirshleifer (1990)) Detail
     - Empirical studies find little evidence for its destabilization effect. (Haase et al. (2016) and Boyd et al. (2018))
  2. Financial Speculators can be liquidity consumers instead of providers.
     - Recent studies suggest this, as evidenced during the GFC and possibly in the periods that followed. (Cheng et al. (2014);Kang et al. (2020);Bonnier (2021))
     -
- My paper: **When** do financial traders amplify price changes?
  1. Their role as liquidity providers dampens the price changes.
  2. When they dominate the market, they can no longer simply meet the demands of commercial traders.
  3. H_0: Dominance of Financial Speculators do not have impacts on price changes in the commodity futures markets.

Related Literature

- Financialization in commodity futures market
  - Empirical:Kang et al. (2020)(JF);Cheng et al. (2014)(RF);Haase et al. (2016), Boyd et al. (2018);Tang and Xiong (2012);Da et al. (2024);Bonnier (2021);Kang et al. (2023);Bosch and Pradkhan (2015);Brunetti et al. (2016);Büyükşahin and Harris (2011);Bierbaumer et al. (2021)
  - Theoretical: Keynes (1923); Hicks (1939); Hirshleifer (1988);Basak and Pavlova (2016);Kondor and Vayanos (2019);Sockin and Xiong (2015)
- SVAR in MP: Jarociński (2024)(JME);Gourièroux et al. (2017);Maxand (2020); Lanne and Luoto (2020);Lanne and Luoto (2021);
- Lead-Lag:Pradhan et al. (2021);Shao et al. (2019);Zhang et al. (2022)