The Financialization of Commodity Markets

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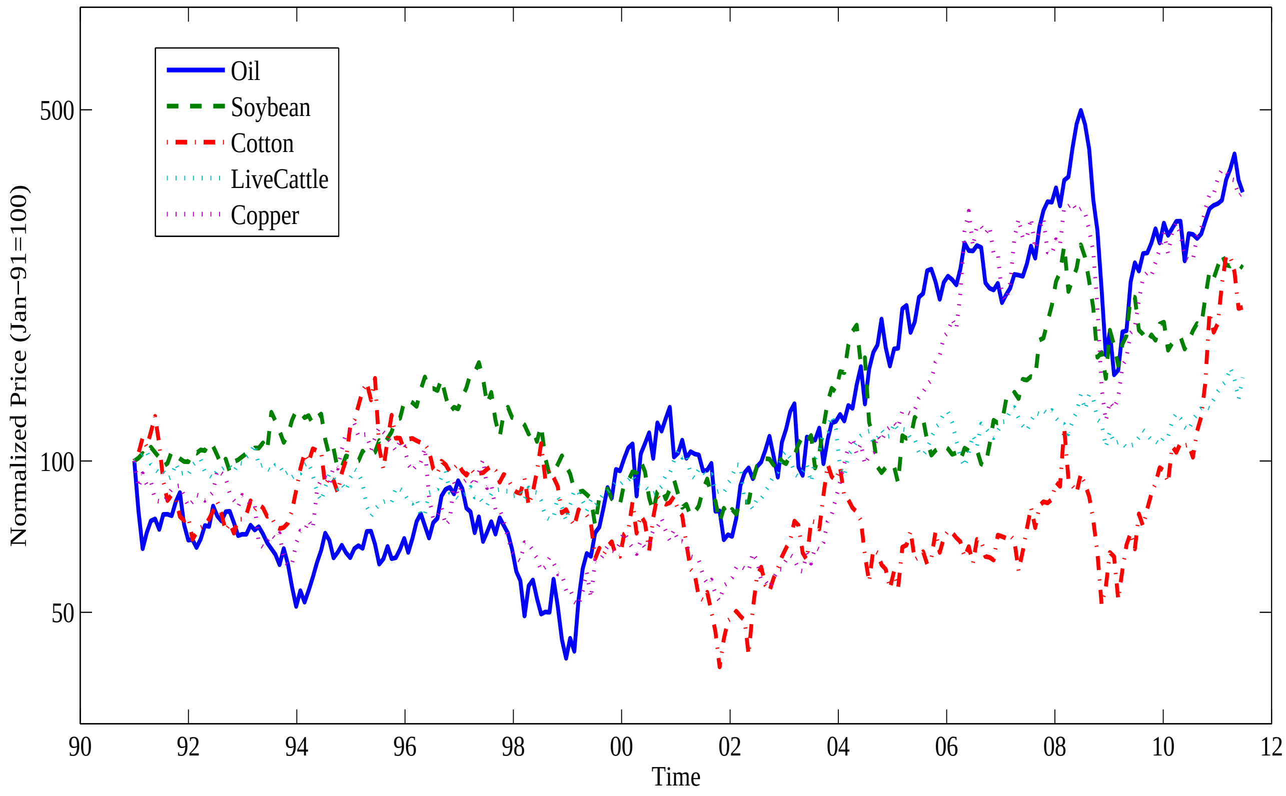
- This lecture builds on my recent review article with Ing-haw Cheng (Dartmouth)
  - Cheng and Xiong (2014): "The Financialization of Commodity Markets" in Annual Review of Financial Economics

- Large inflow of investment capital
  - according to CFTC Report (2008), commodity index investments in total $200B on June 30, 2008

- Commodity futures has become a new asset class for portfolio investors

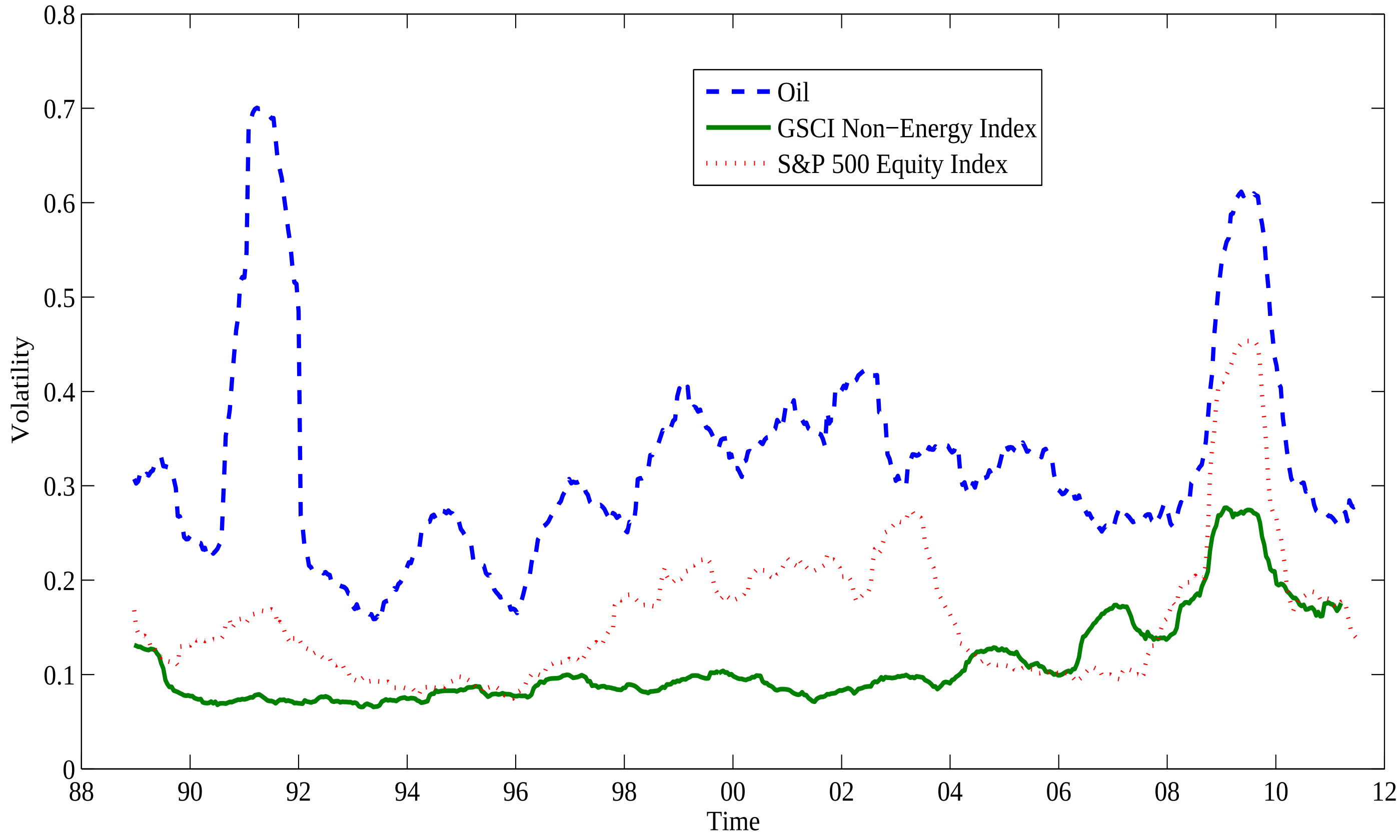
- Economic mechanisms that affect financial markets and financial investors may also be relevant for commodity markets

Synchronized Boom and Bust of Commodity Prices



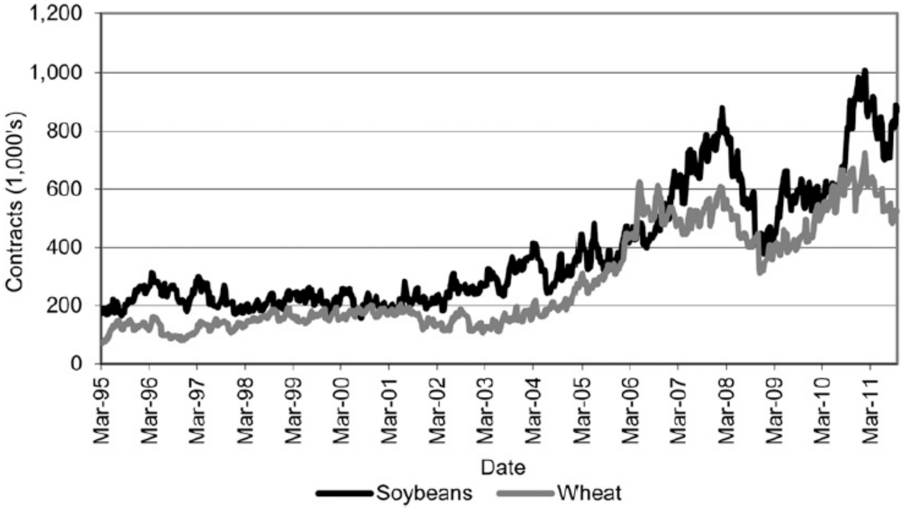
- Source: Tang and Xiong (2012)

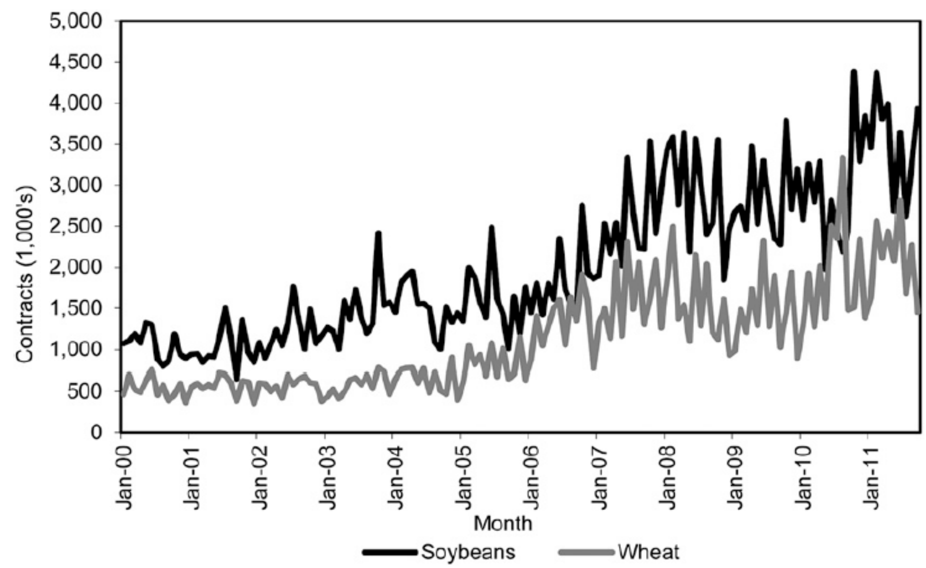
Commodity Price Volatility



Source: Tang and Xiong (2012)

Expansion of Open Interest and Volume

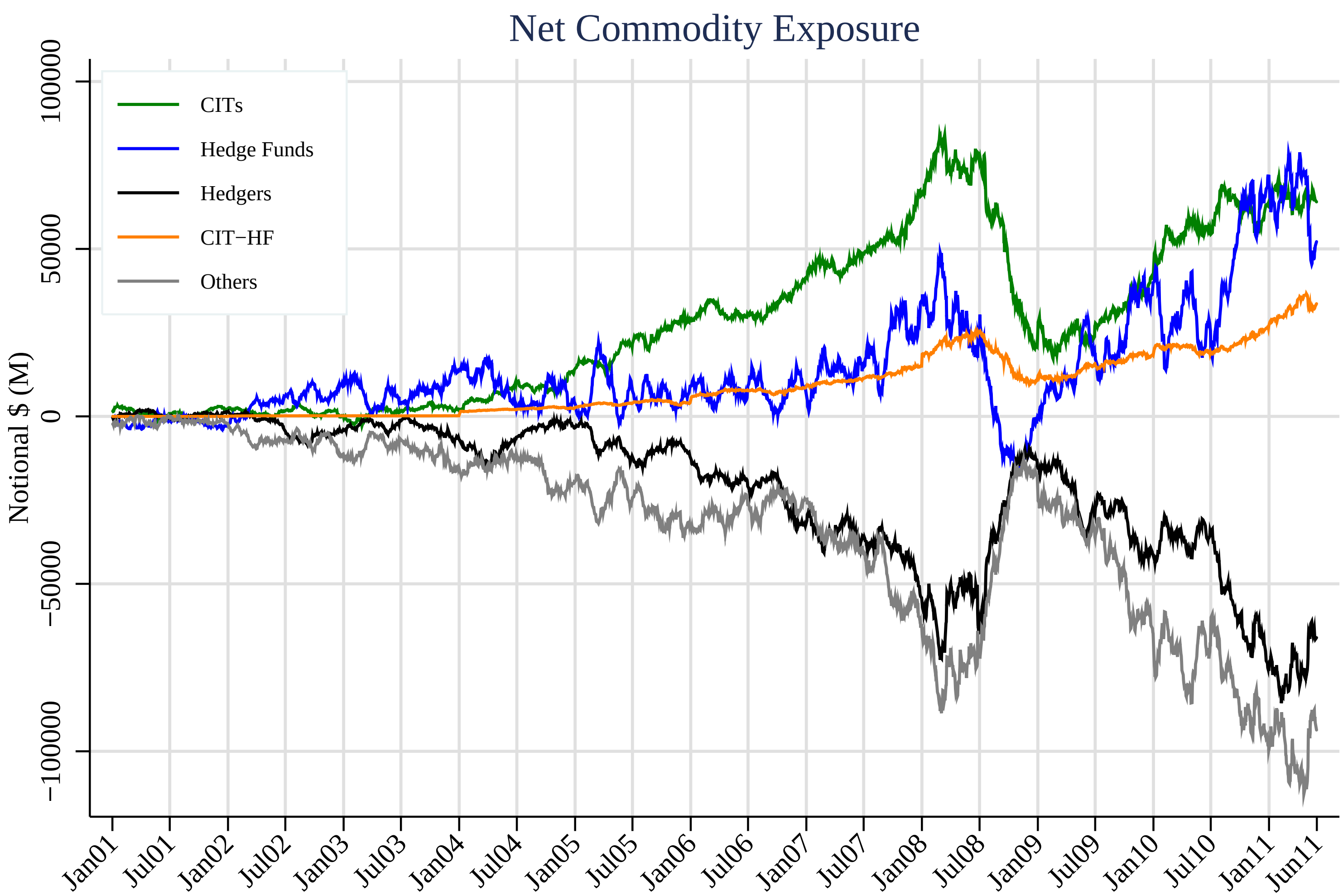




- Source: Irwin and Sanders (2012)

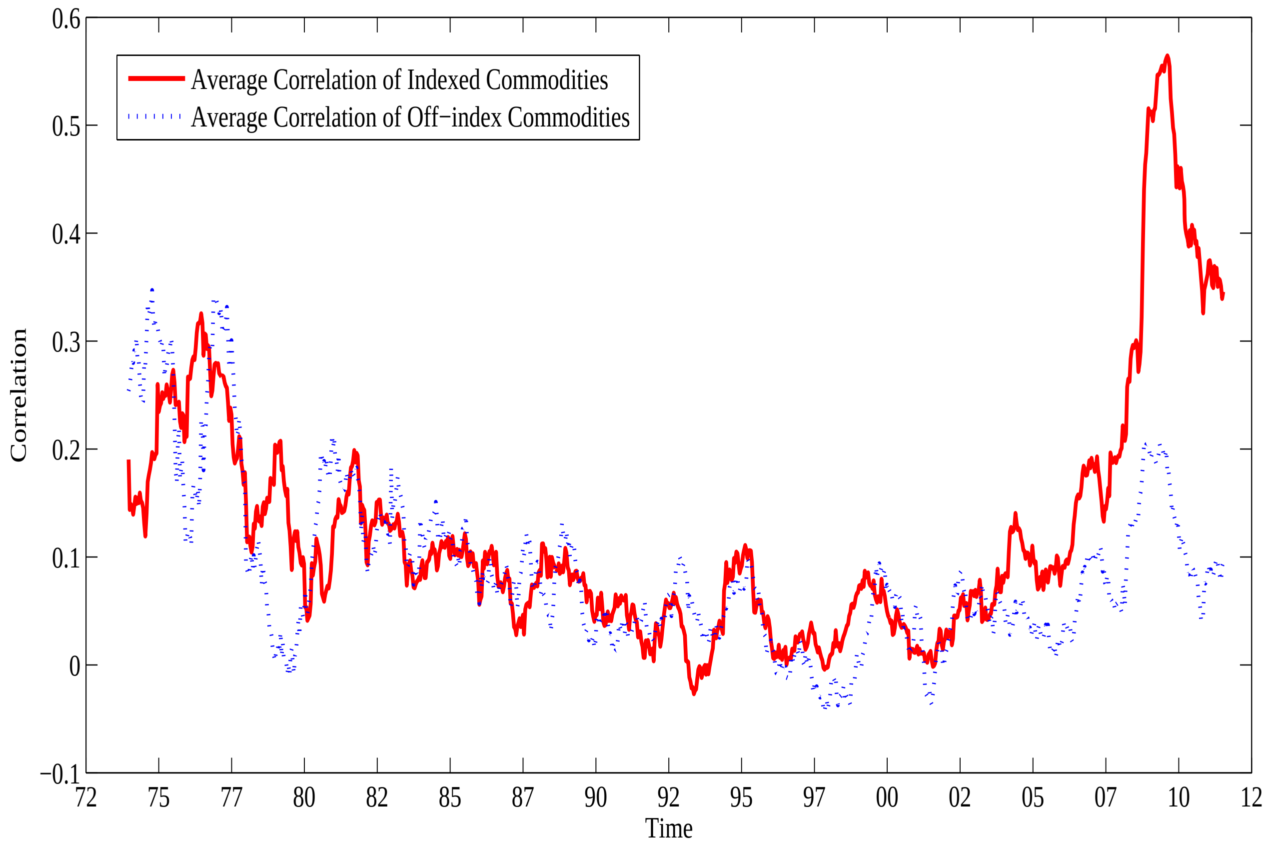
Evolution of Market Participation

Cheng, Kirilenko, and Xiong (2012)



Exposure defined as Net Position(t) x Front Month Price(t), Real Dec2006 $

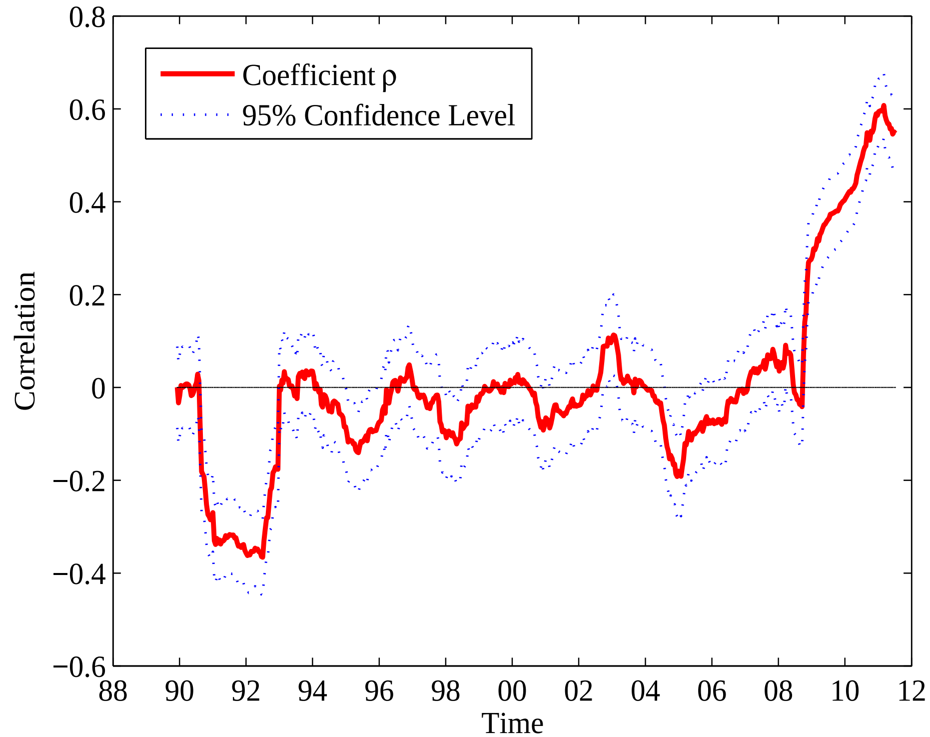
Comovement between Commodities



- Source: Tang and Xiong (2012)

Comovement between Commodities and Stocks

- Tang and Xiong (2012), Büyükşahin and Robe (2011, 2012), Silvennoinen and Thorp (2011)



- Source: Tang and Xiong (2012)

How does Financialization Affect Commodity Markets?

- Risk sharing
- Information discovery

- How do these basic economic mechanisms operate in commodity futures markets?
  - Hedging
    - Take a futures position to offset risk in one's commercial business
  - Speculation
    - Take advantage of one's information
    - Take advantage of other's mistake

Risk Sharing in Commodity Futures Markets

Hedging Pressure Theory

- Keynes (1930) and Hicks (1939)
  - Commercial hedgers, farmers and commodity producers, use commodity futures to hedge commodity price risk in their businesses.
  - Mostly on the short side of futures markets
  - To attract speculators to the long side, they have to offer premia in futures prices
  - An influential theory that highlights the importance of risk sharing, a key theme of having financial markets.

- Does this theory work in practice?
  - Some evidence supporting it
  - The recent financial crisis offered a window to re-examine it.

Data

CFTC's Large Trader Reporting System (LTRS), 2000-2011.

- Provides detailed daily data on traders' long and short positions on individual futures contracts.
- Traders with positions in excess of a reportable level are reported to the CFTC by clearing members.
- Generally 70-90% of the open interest.
- Basis of weekly "Commitment of Traders" public reports.

Use this data to jointly look at reactions of all groups to the shock.

- Less likely to miss the effect of any one group because of excessive focus on other groups.
- Allows us to construct finer categorizations of traders than in the publicly available versions of the data.
- Other data from Bloomberg, FRB.

Table 1: Commodities

Sector	Commodity Name	Exchange	GSCI	DJ-UBS
Grains	Chicago Wheat	CME/CBT	X	X
	Corn	CME/CBT	X	X
	Kansas City Wheat	KBCT	X	
	Soybeans	CME/CBT	X	X
	Soybean Oil	CME/CBT		X
Livestock	Feeder Cattle	CME	X	
	Lean Hogs	CME	X	X
	Live Cattle	CME	X	X
Softs	Cocoa	ICE	X	
	Coffee	ICE	X	X
	Cotton #2	ICE	X	X
	Sugar #11	ICE	X	X
Energy	Crude Oil	CME/NYMEX	X	X
	Heating oil	CME/NYMEX	X	X
	Natural Gas	CME/NYMEX	X	X
	RBOB Gasoline	CME/NYMEX	X	X
Metals	Copper	CME/COMEX	X	X
	Gold	CME/COMEX	X	X
	Silver	CME/COMEX	X	X

Trader classifications

The LTRS contains information filed by traders as to their purposes of trade.

- Basis of classification in public COT reports.
- We extend this by combining information about their trading behavior in the previous year.

Commodity index traders

- Traders with who invested in 8 or more commodities in the previous year.
- Were long on average in the commodities in which they had exposure.
- Intersect this with the CFTC CIT classification, constructed through interviews with specific market participants.

Trader classifications

Hedge funds

- Traders registered as commodity pool operators (CPOs), commodity trading advisors (CTA), or managed money.

Commercial hedgers

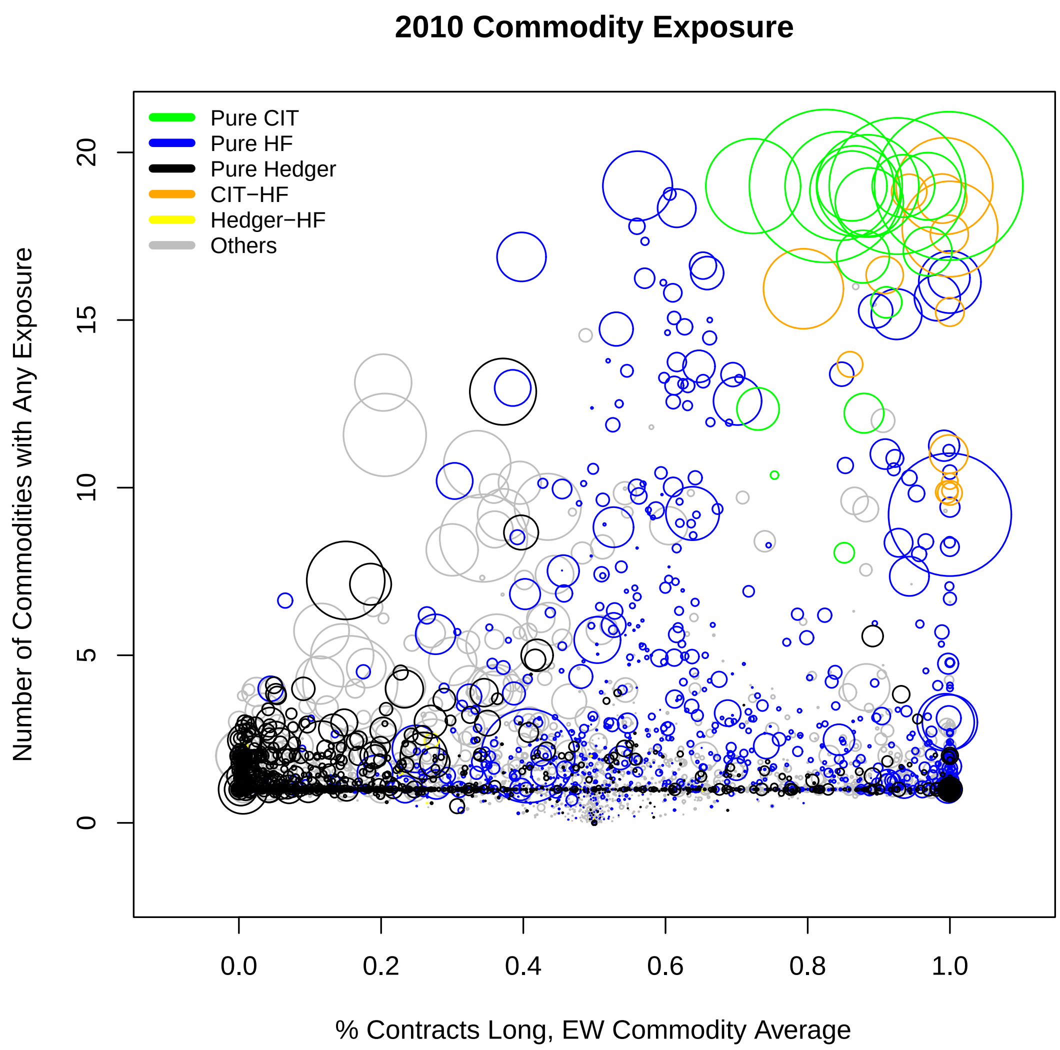
- Traders of types "Dealer/Merchant," "Agricultural," "Manufacturer," "Producer," or Livestock feeder/slaughterer.

Others

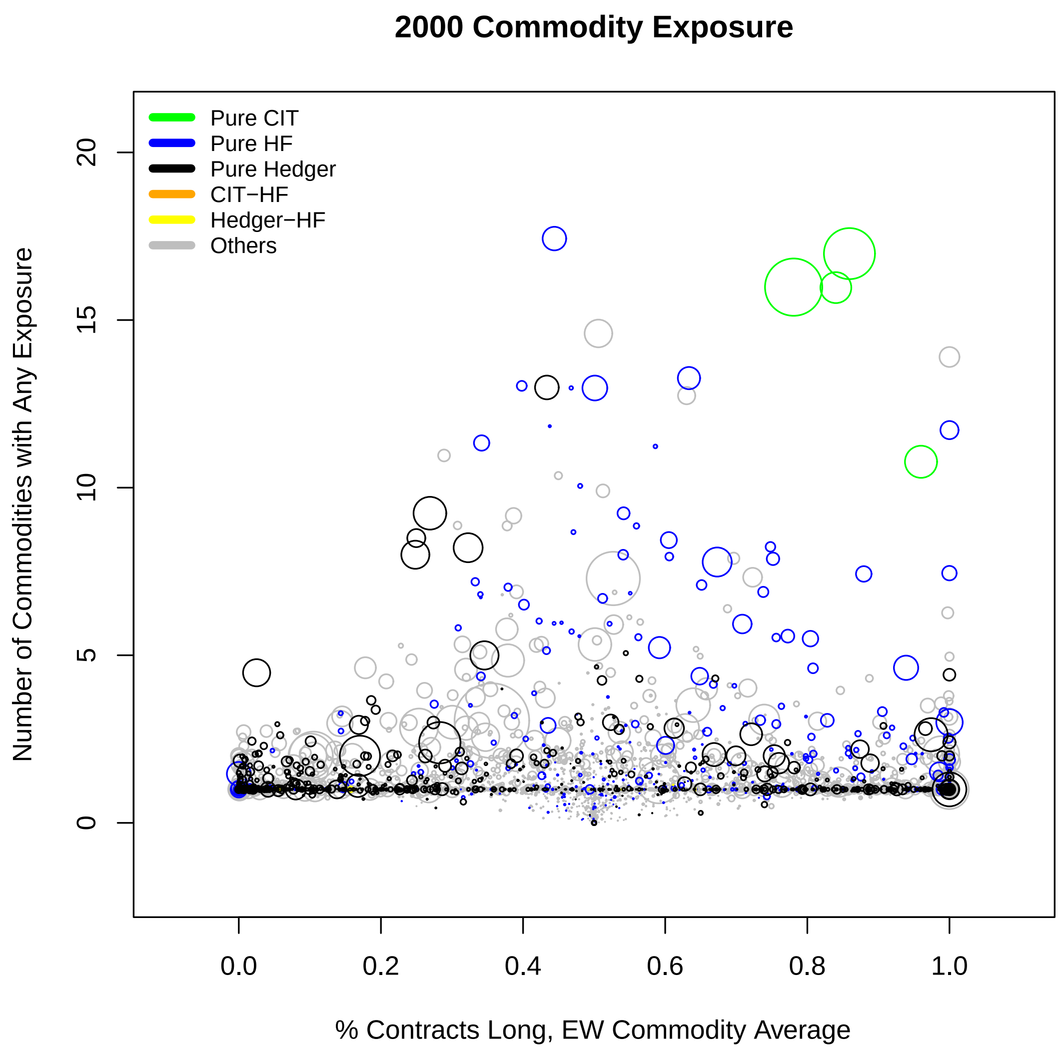
- Many traders may fall outside of our strict classification scheme. Leave the behavior of these traders as an empirical question.

One trader may have multiple classifications. Because we are interested in the time series properties of position responses, we separate these out.

Market participation in 2010



Evolution of market participation



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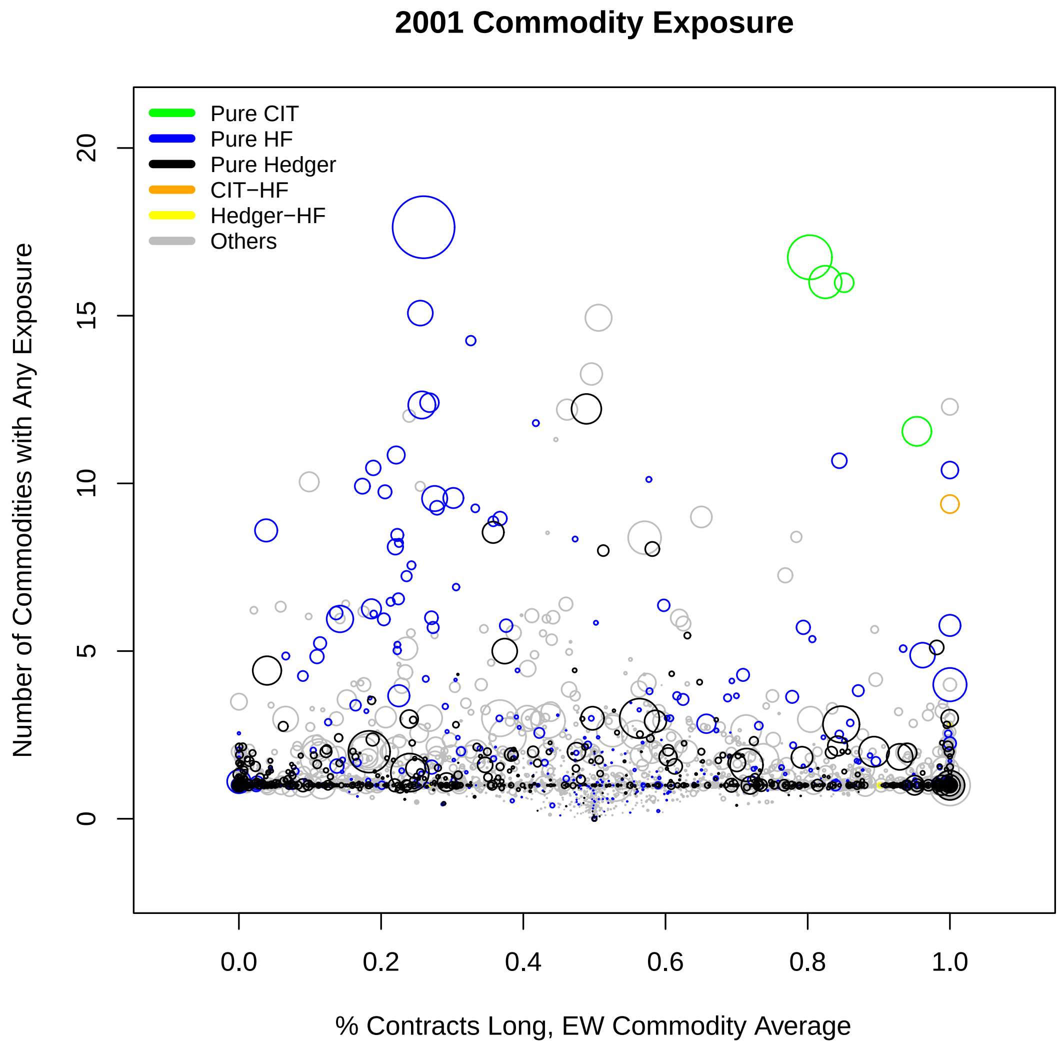

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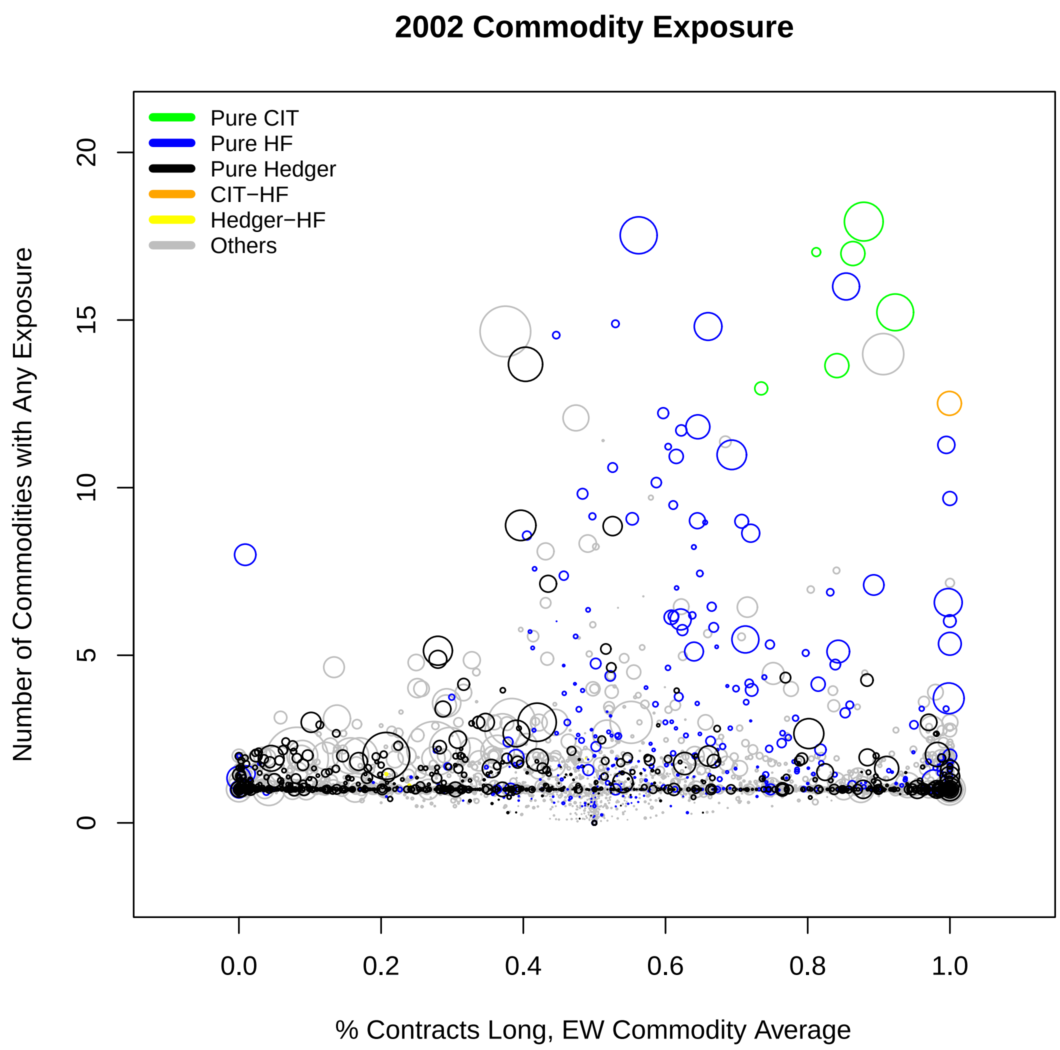

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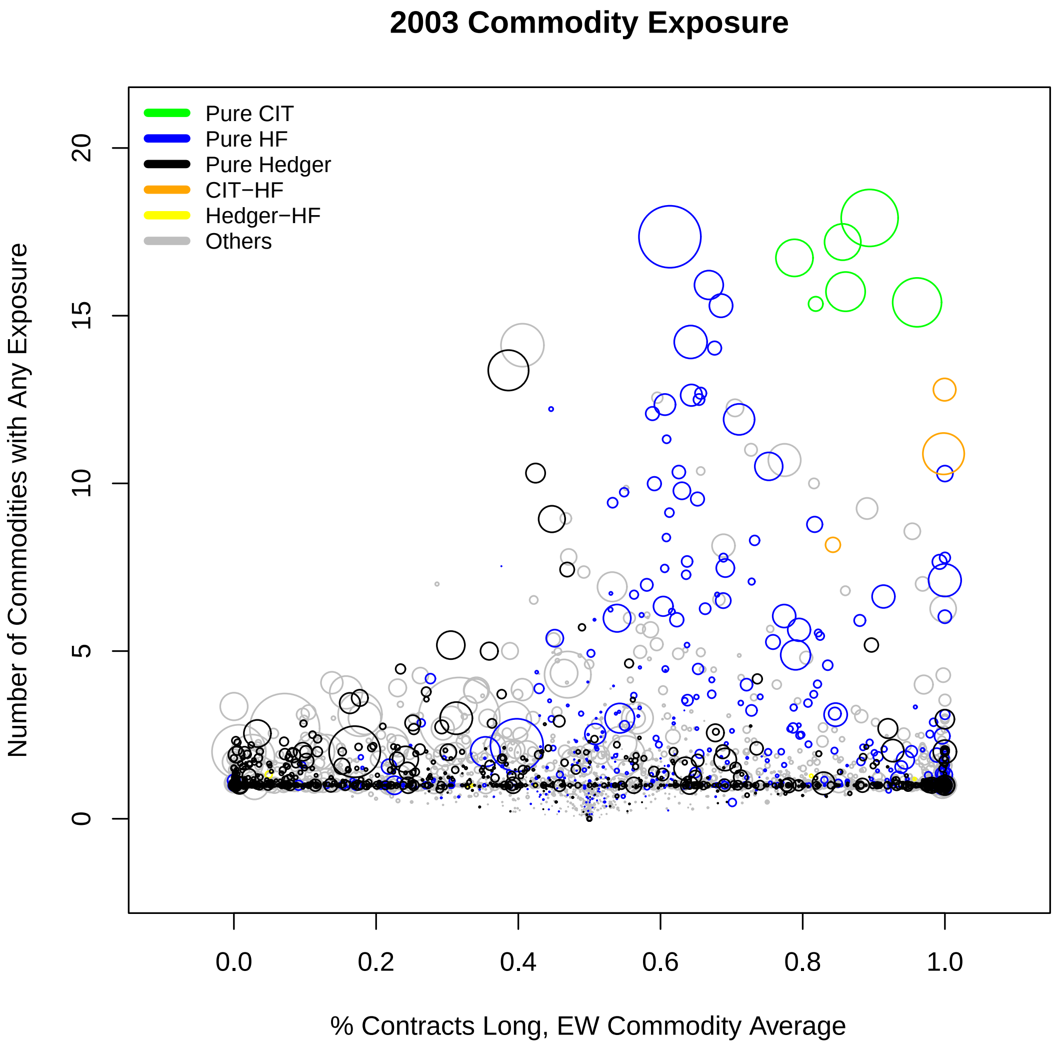

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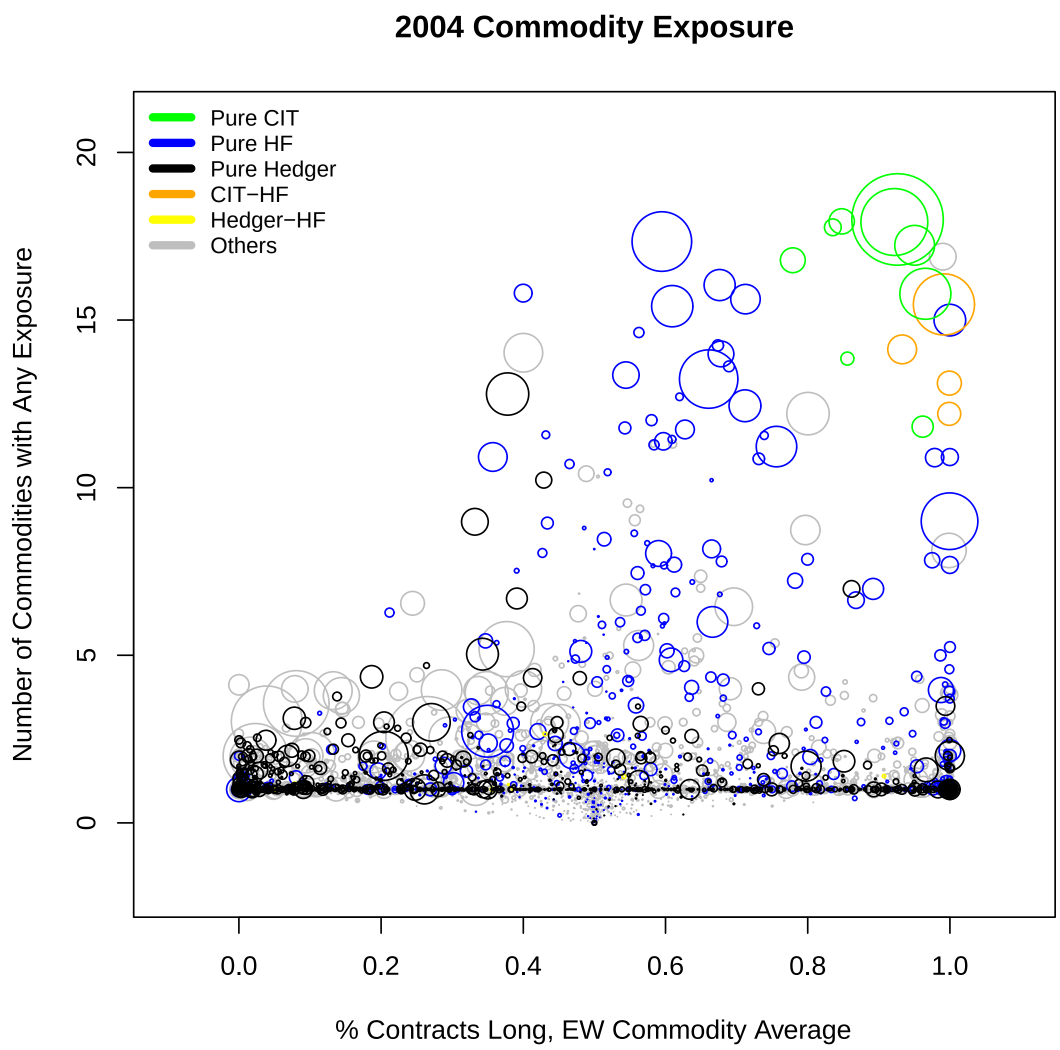

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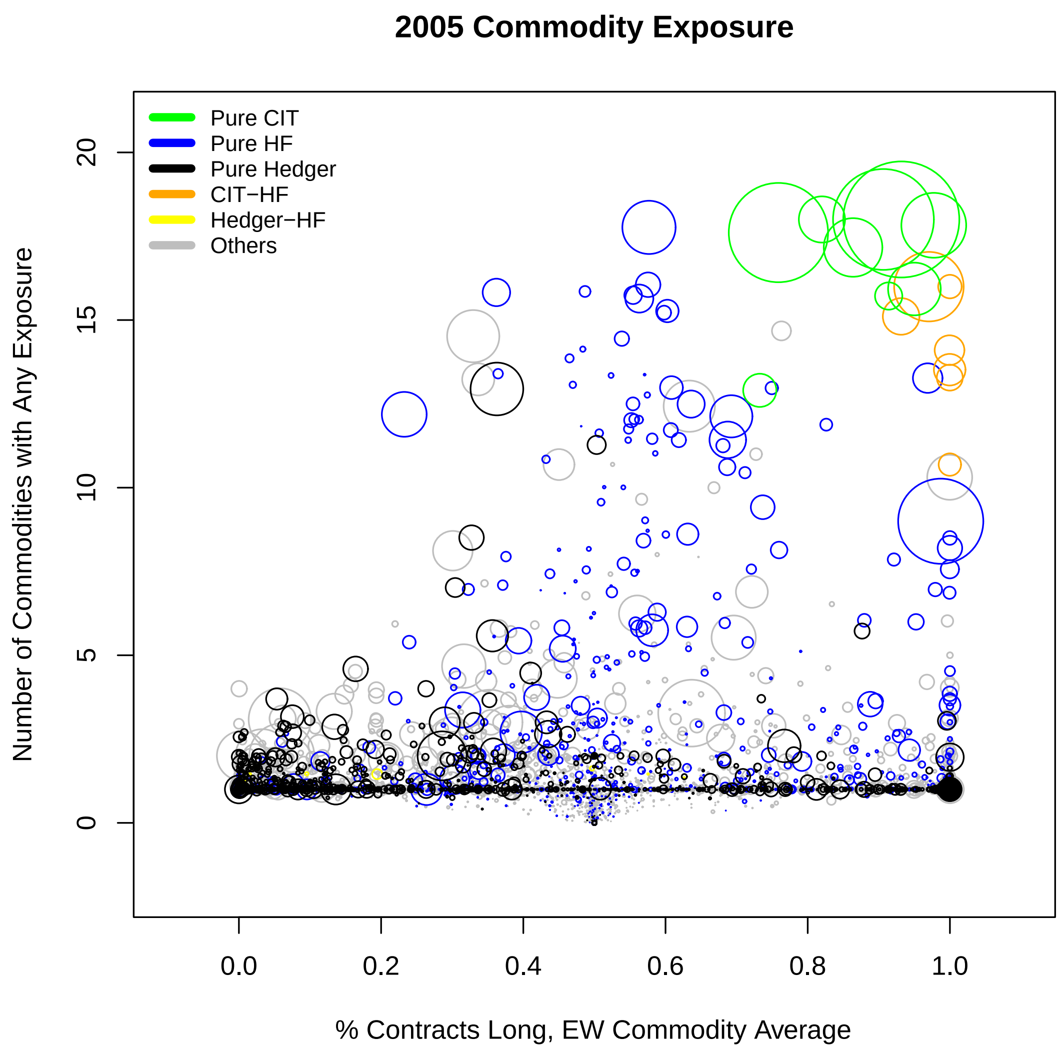

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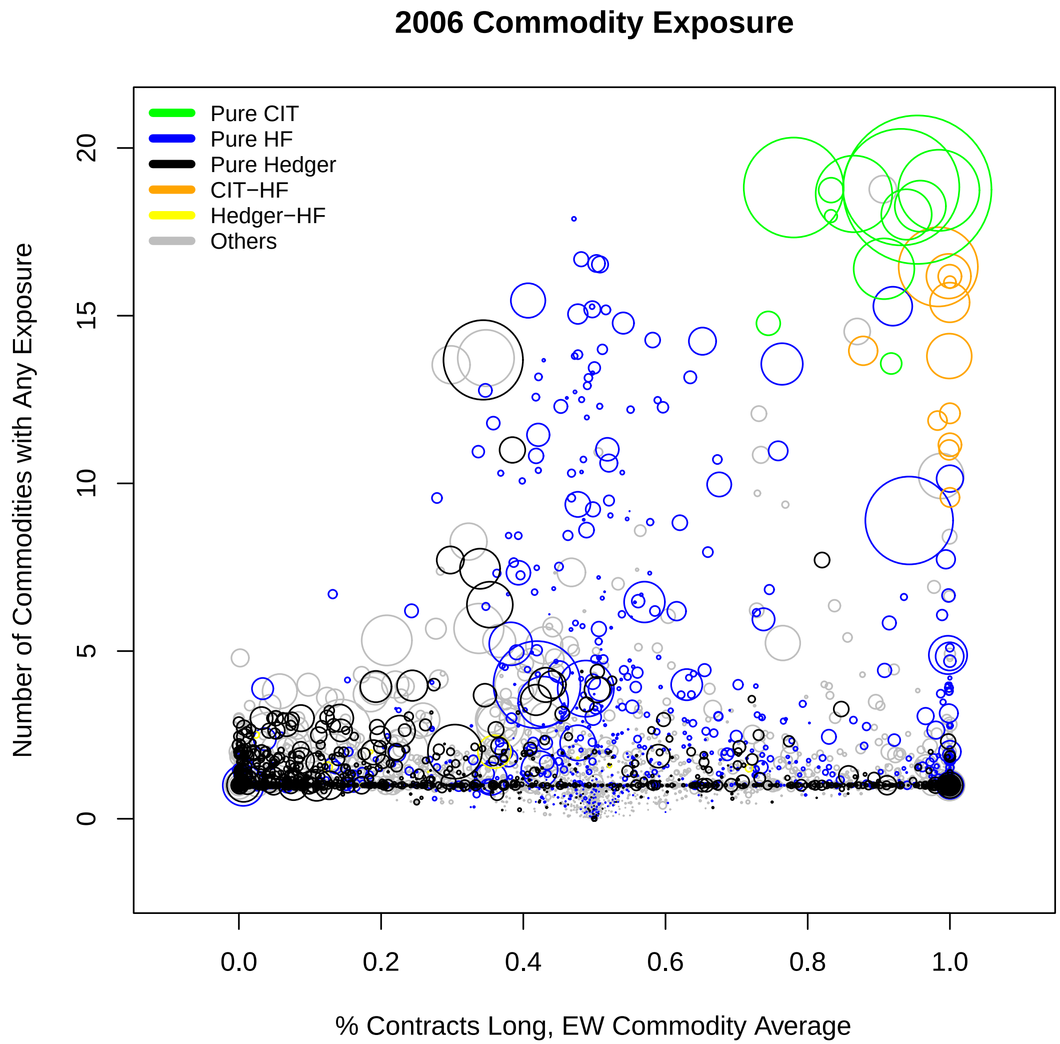

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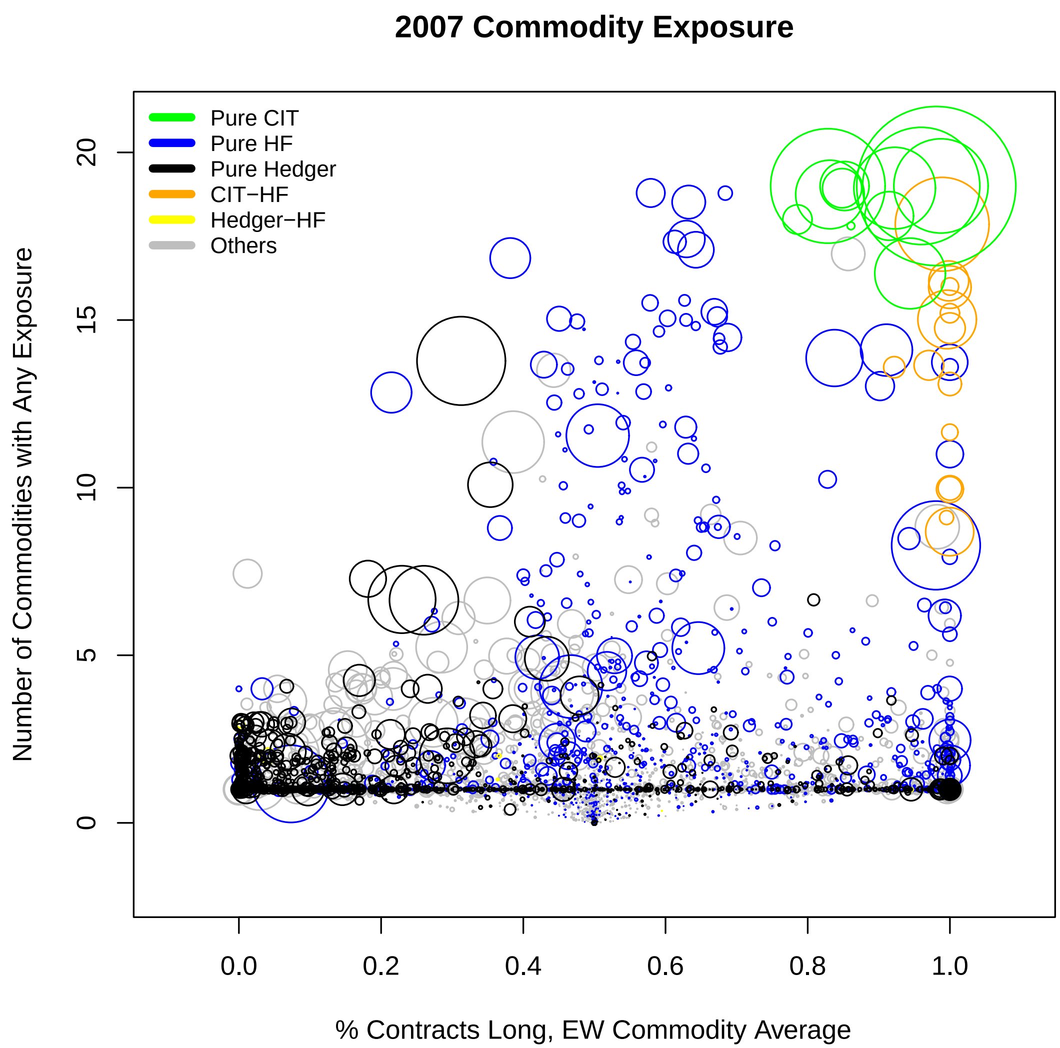

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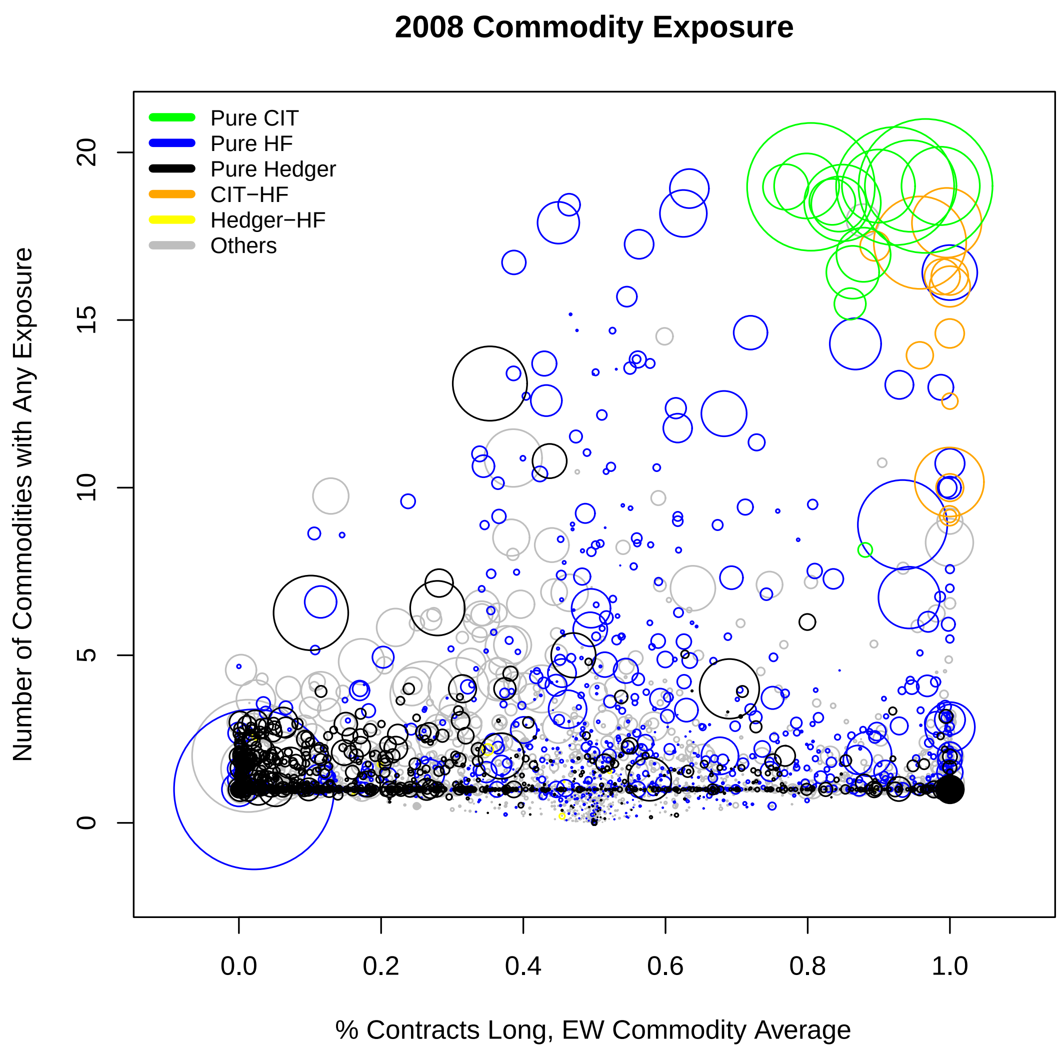

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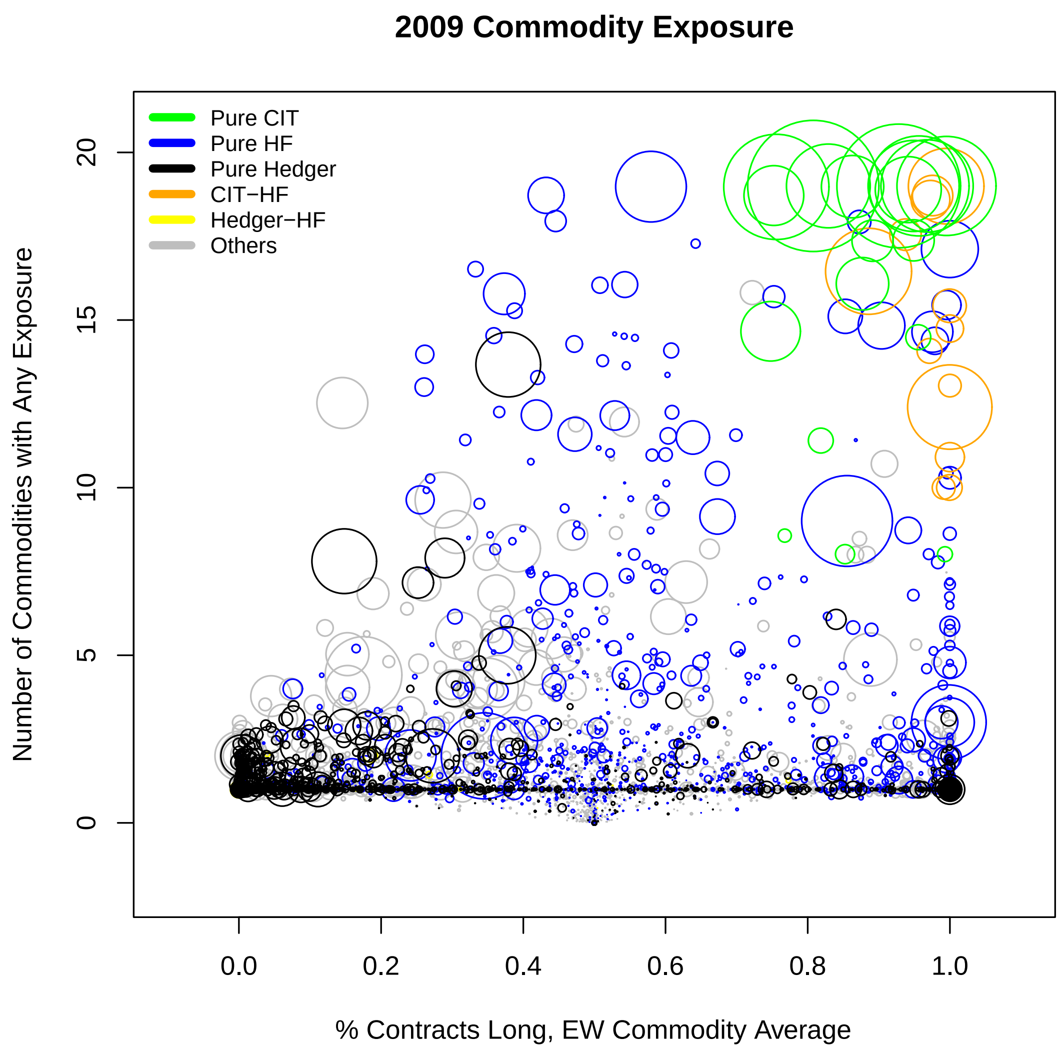

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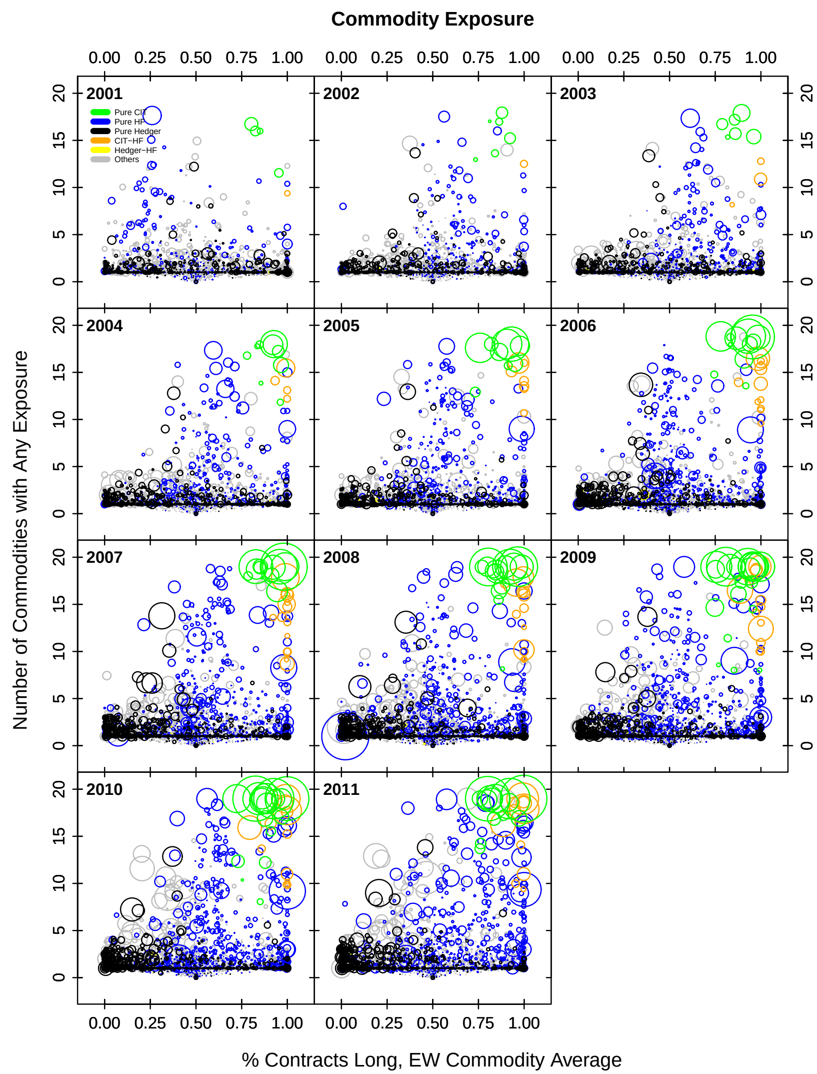
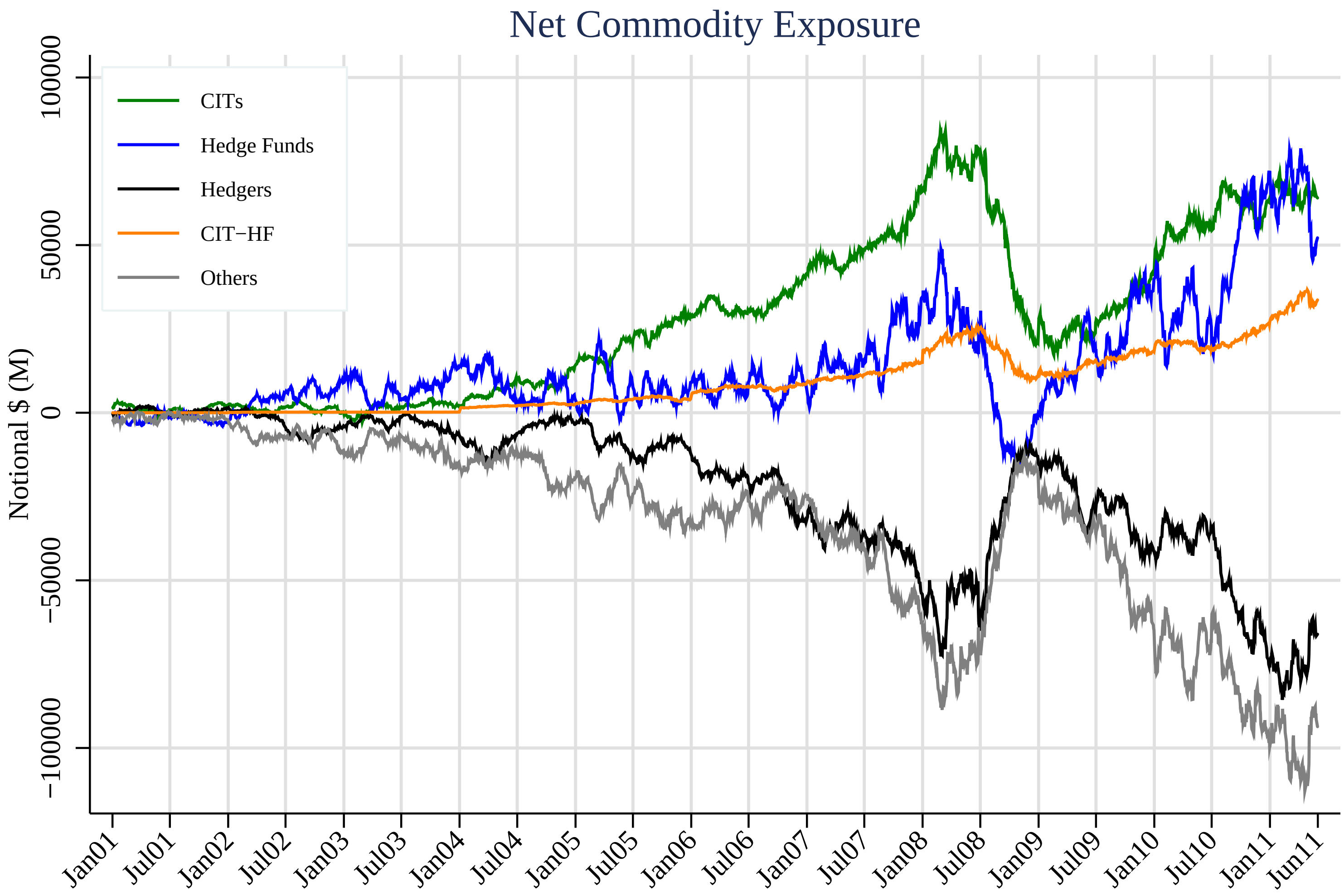


Table 2: Trader characteristics

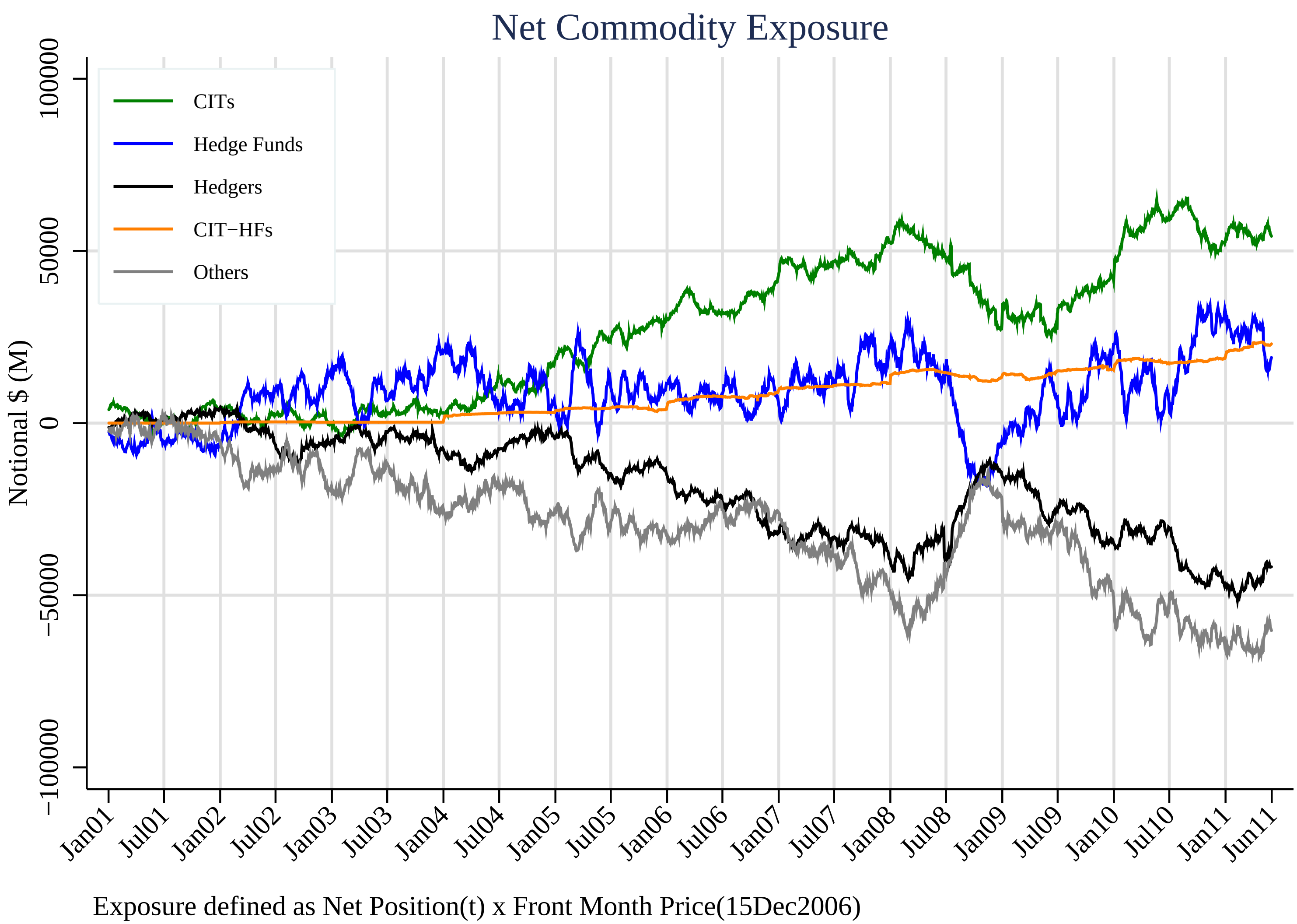
Panel A: Number of Traders							
Ranking Year	Population	CIT	C.Hedger	Hedge Fund	CIT-HF	Hedger-HF	Others
2000	4822	4	810	324			3672
2001	4576	4	857	334			3369
2002	4729	6	953	391			3363
2003	4990	6	1075	466			3424
2004	5376	9	1169	567			3610
2005	5197	9	1208	688			3267
2006	5664	12	1453	874			3293
2007	5629	12	1483	974			3123
2008	5667	15	1503	1089			3027
2009	5148	20	1332	1082			2686
2010	5699	18	1465	1116			3072

Commodity exposures



Exposure defined as Net Position(t) x Front Month Price(t), Real Dec2006 $

Commodity exposures



Trading by hedgers

Question: Do hedgers trade just to hedge?

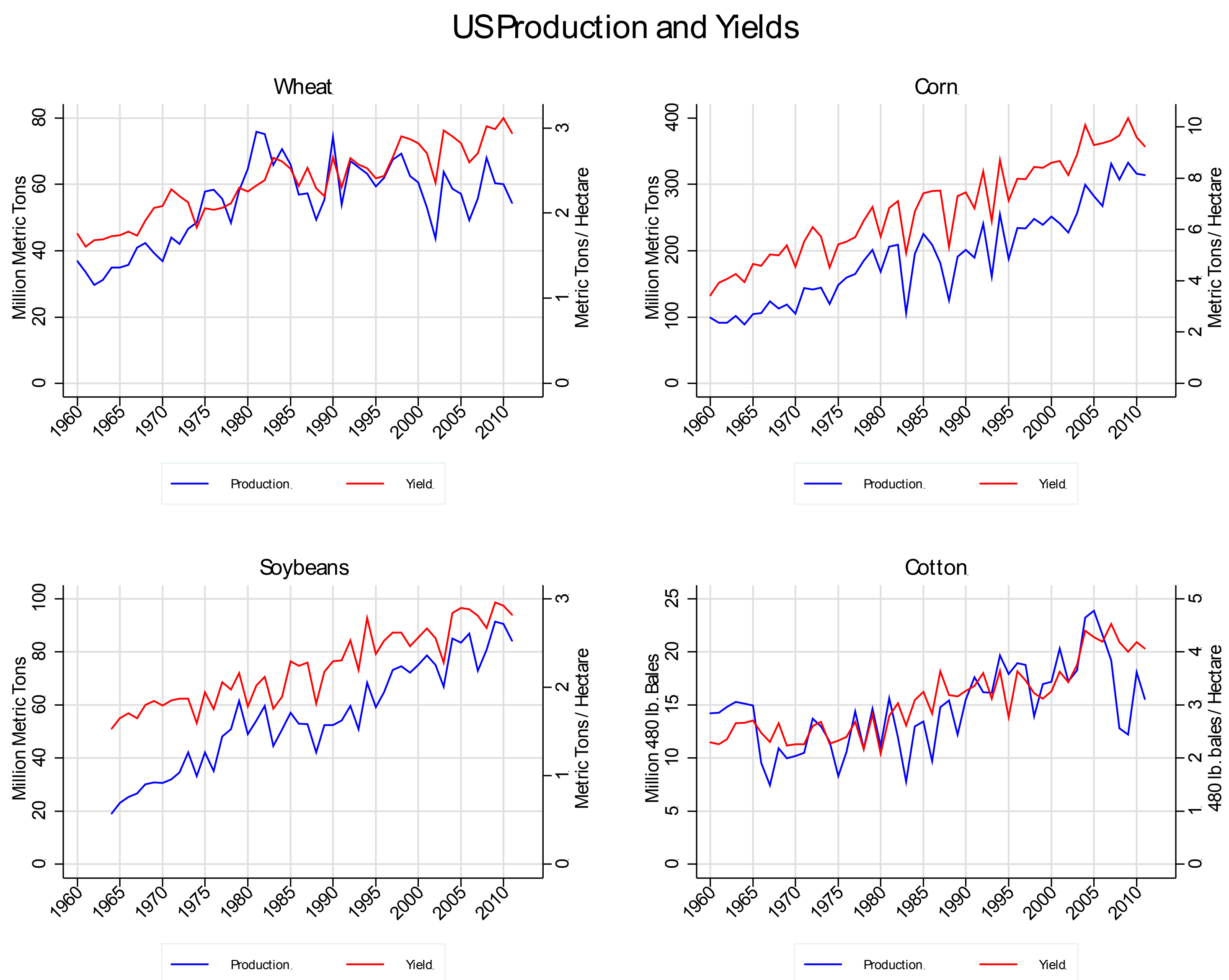
Existing models of hedging (Rolfo 1980, Hirshleifer 1991):

- w/o output uncertainty, a fixed hedging position perfectly hedges price uncertainty
- with output uncertainty, hedgers under-hedge as output is negatively correlated with price, and hedging position fluctuates with expected output

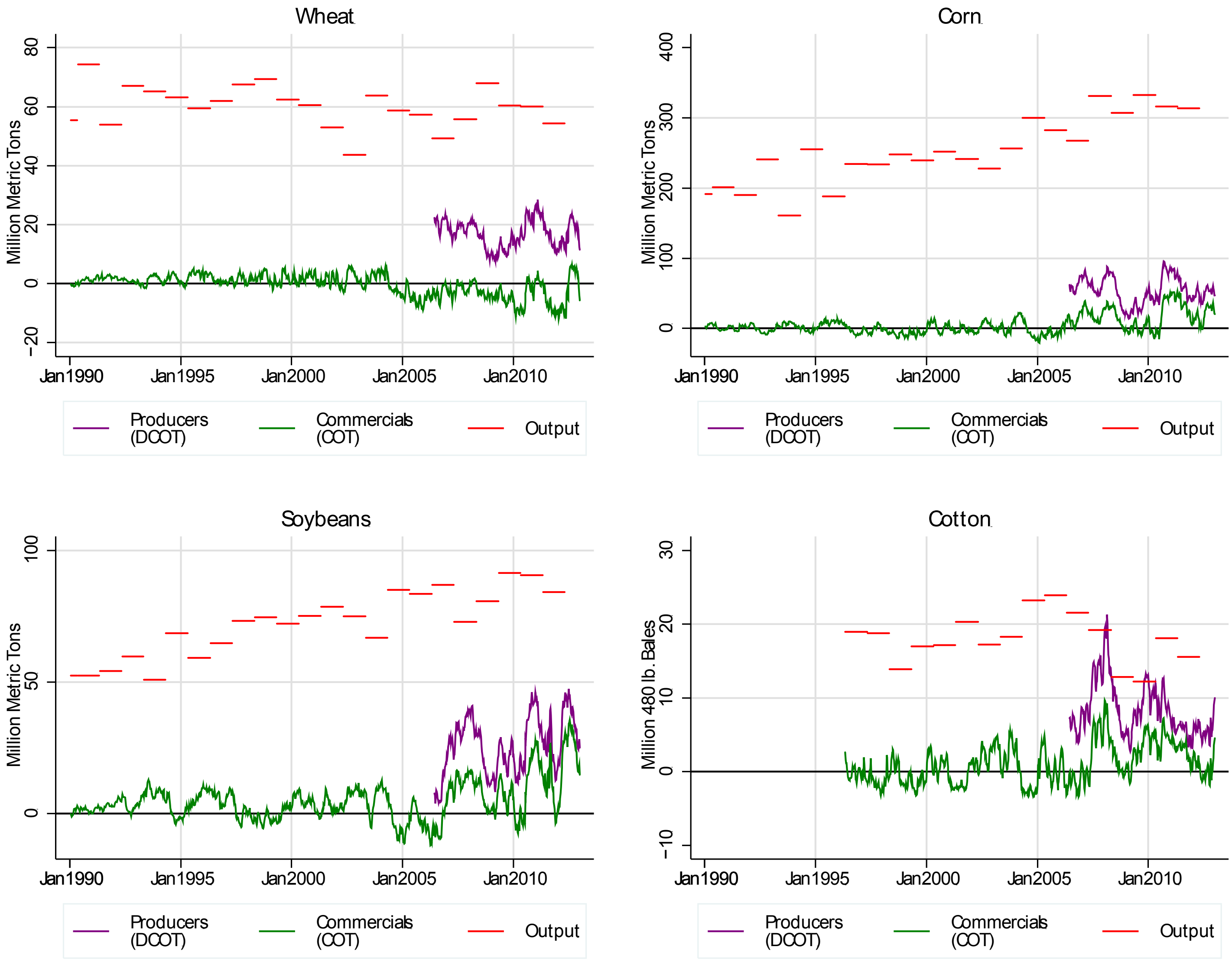
Empirical investigation:

1. How much does output volatility explain futures position volatility?
2. Do other factors explain futures position volatility?

How volatile is annual output?



How volatile are annual futures position changes?



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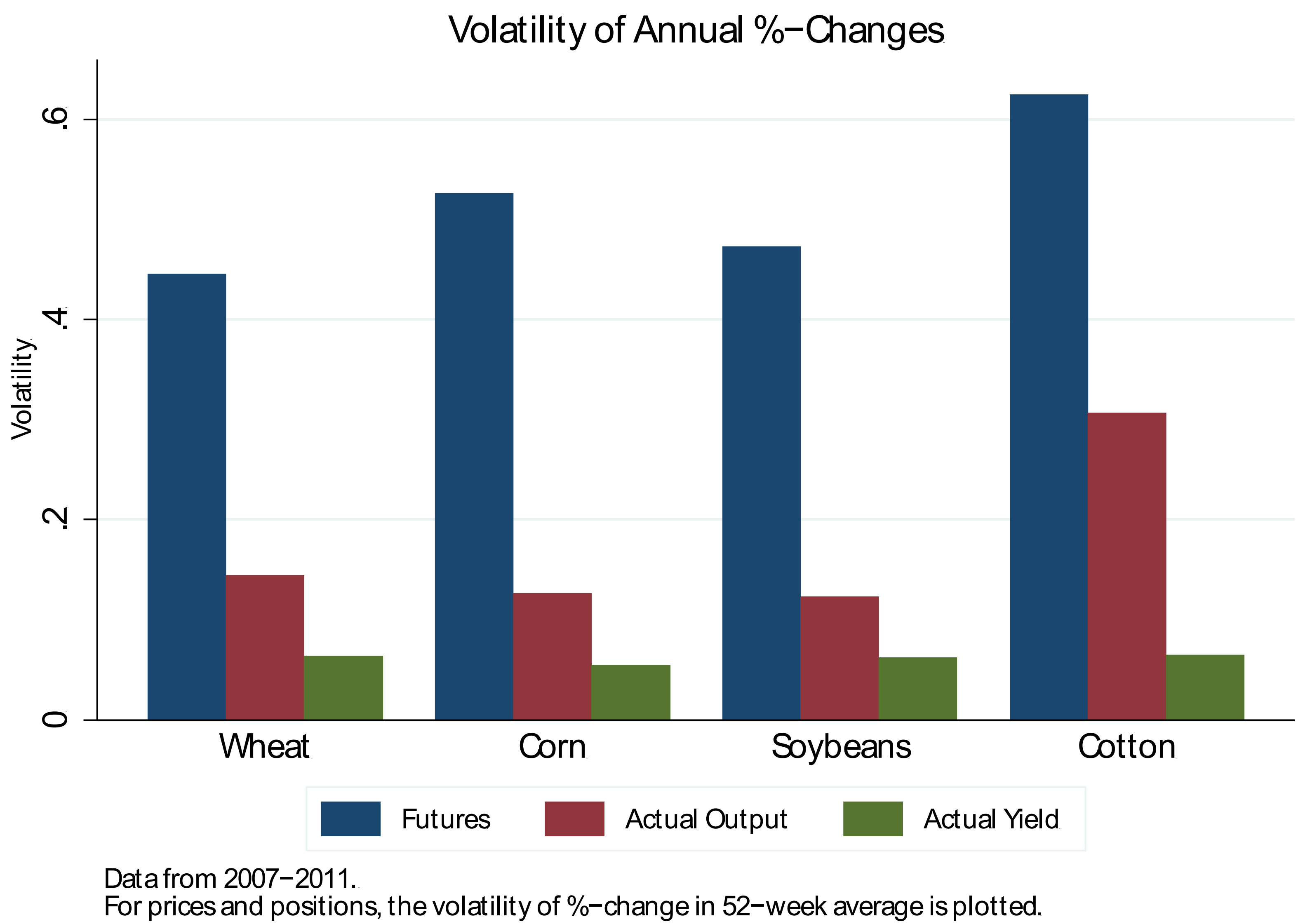
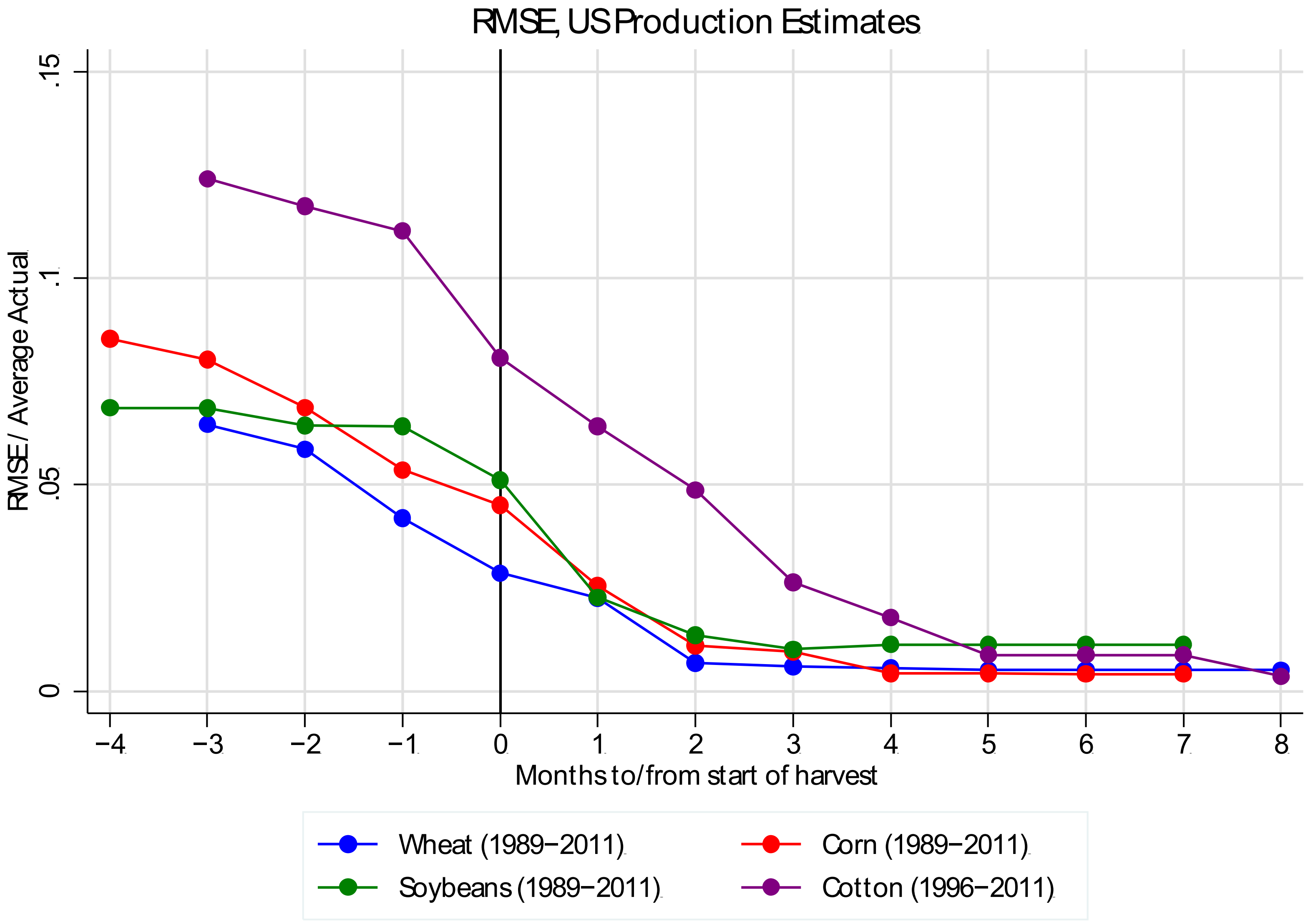
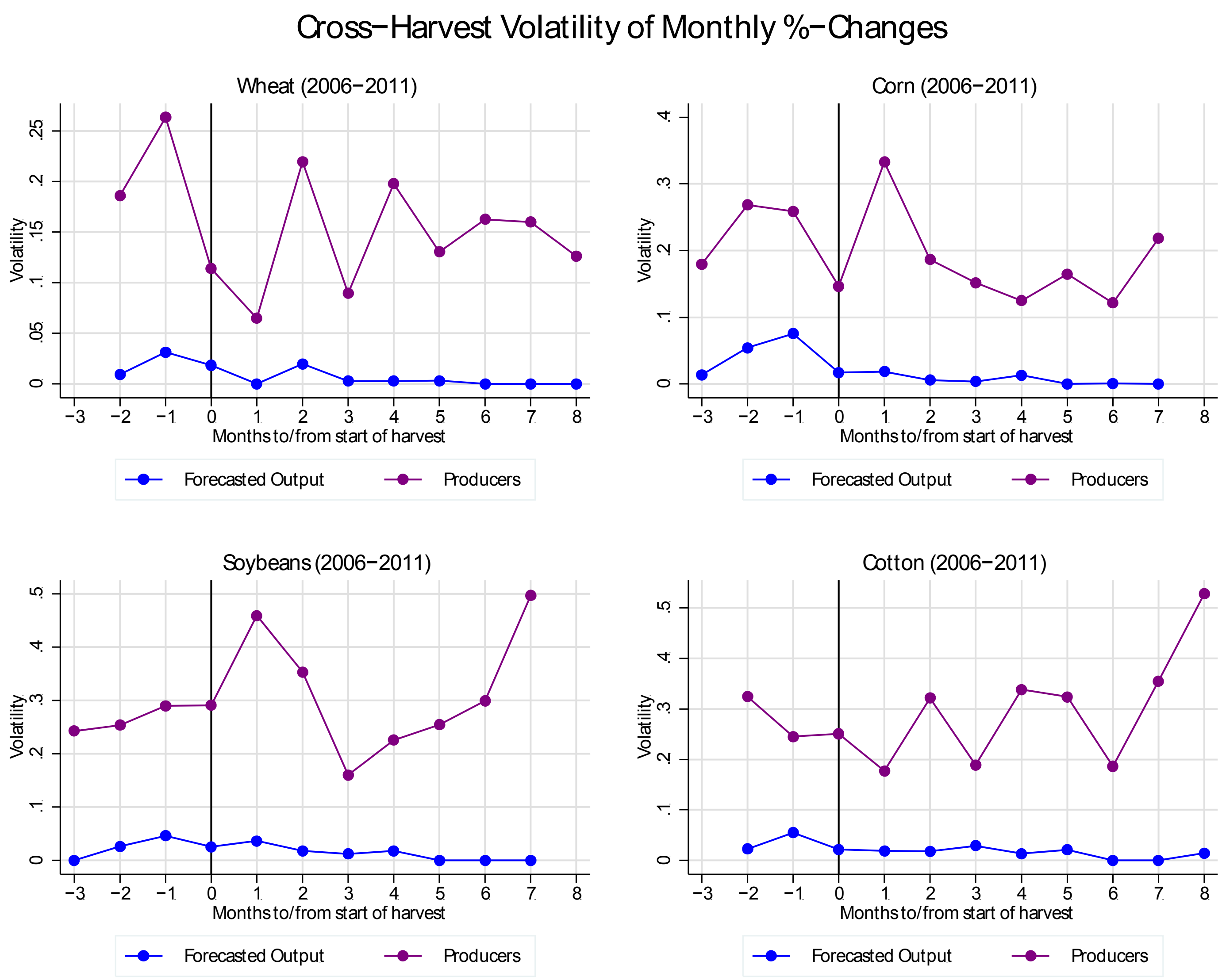


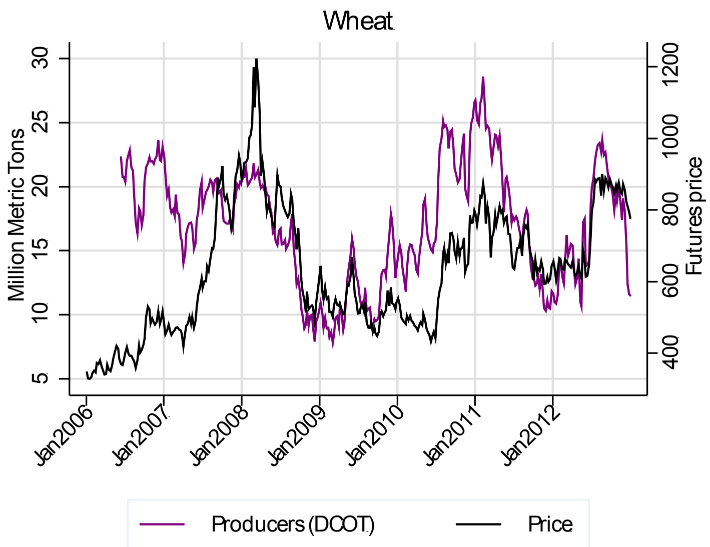
How accurate are monthly output forecasts?

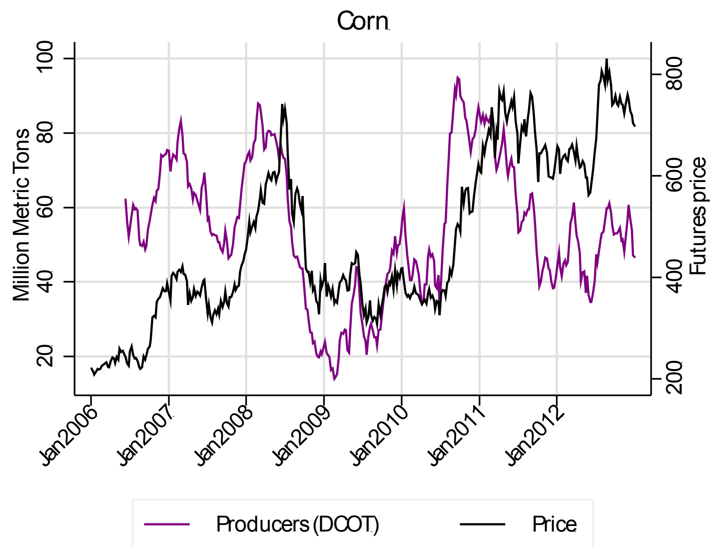


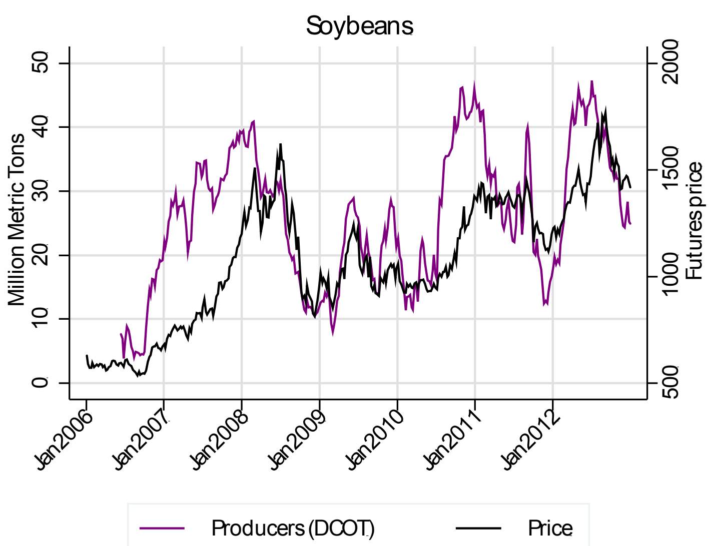
How volatile are monthly futures position changes relative to output expectations?

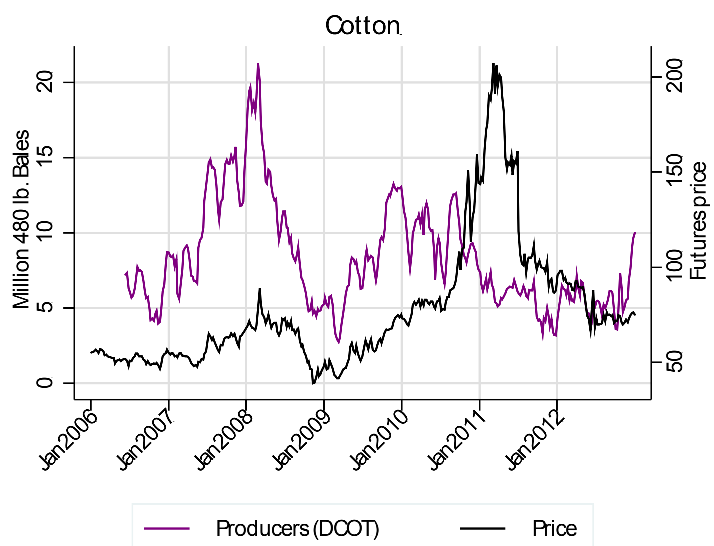


How do prices matter?









How are monthly futures position changes related to monthly price and output changes?

Dependent variable:	Wheat			Corn		
1-month % change in futures position	(1)	(2)	(3)	(4)	(5)	(6)
12-month % change in output forecast	0.014		-0.022	0.156		0.015
	[0.13]		[-0.29]	[1.61]		[0.20]
1-month % change in output forecast	0.312		0.262	-0.502		-0.011
	[0.54]		[0.78]	[-5.23]***		[-0.06]
1-month % change in futures price		0.530	0.529		0.628	0.624
		[4.39]***	[4.35]***		[6.49]***	[4.55]***
Constant	0.005	-0.055	-0.066	-0.005	-0.049	-0.052
	[0.05]	[-0.70]	[-0.77]	[-0.04]	[-0.63]	[-0.58]
Fully interacted turn-of-harvest effect	Y	Y	Y	Y	Y	Y
T	78	78	78	78	78	78
R-squared	0.041	0.370	0.379	0.144	0.418	0.423

How are monthly futures position changes related to monthly price and output changes?

Dependent variable:	Soybeans			Cotton		
1-month % change in futures position	(7)	(8)	(9)	(10)	(11)	(12)
12-month % change in output forecast	0.009		0.122	-0.054		-0.243
	[0.08]		[1.31]	[-0.53]		[-2.05]**
1-month % change in output forecast	0.205		0.384	-0.271		-0.056
	[1.22]		[3.19]***	[-1.17]		[-0.26]
1-month % change in futures price		0.632	0.701		0.461	0.549
		[5.22]***	[5.30]***		[2.53]**	[3.21]***
Constant	0.184	0.062	0.066	0.114	0.070	0.028
	[1.46]	[0.70]	[0.81]	[1.19]	[0.84]	[0.33]
Fully interacted turn-of-harvest effect	Y	Y	Y	Y	Y	Y
T	78	78	78	78	78	78
R-squared	0.023	0.412	0.491	0.019	0.185	0.241

How do prices matter?

Hedges increase in the data when prices increase

- Is this what is expected from hedging behavior?

Consider a representative hedger who observes a positive price shock

Two possibilities:

- Negative supply shock. Less output, larger hedge (?)
- Positive demand shock. Same output, larger hedge (?)

More complex theories of hedging can explain this, but less obvious and also do not explain high trading volatility

- More straightforward explanation: hedgers are taking a view on the price, selling more when prices rise

Implications

Categorical treatment of hedgers and speculators ignores that hedgers trade a lot, and for non-output-related reasons

- Trading volatility is much higher than output volatility
- Producer positions are much more related to price changes
  - In a manner that is inconsistent with basic risk-averse hedging

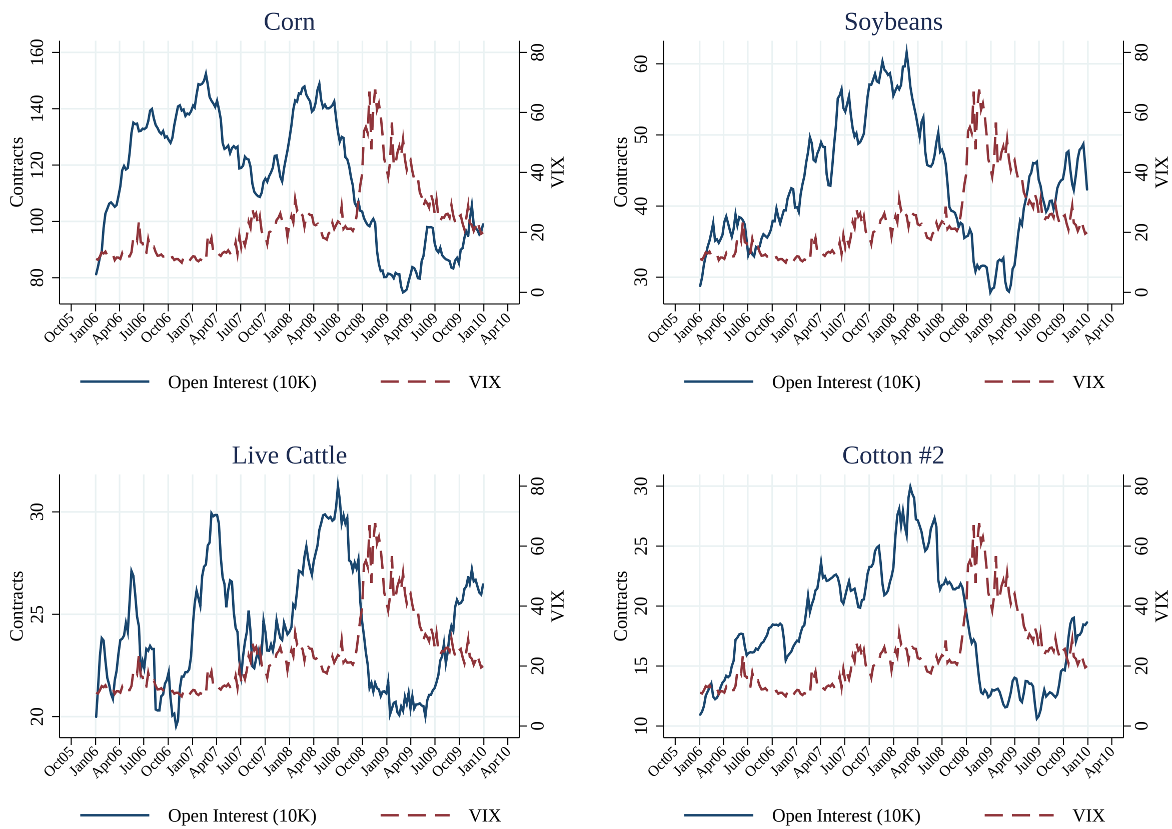
Blurs the distinction of hedging and speculation

- Identification of trades is needed, but may also be difficult to implement in practice

Academics should further study speculation by hedgers

- Hedgers may engage in sophisticated trading for informational advantages or market-making with others in supply chain, which is not a bad thing
- But they may also engage in “reckless” speculation

Commodities open interest



1. Collapse in open interest just as uncertainty spiked.
2. Concurrent with significant price drops.
3. Consistent across many markets- not substitution.

Re-thinking the Hedging Pressure Theory

- If hedgers used commodity futures to hedge risk, how could they cut positions when risk spiked?

- Who takes the other side of hedgers?
  - Financial traders
  - What happened to them in the crisis?

- When financial traders have to reduce their long positions (due to their financial distress), futures prices will fall and hedgers will cut their short positions to accommodate financial traders.
  - A risk convection generated by the differential distress of long and short sides of the futures market.
  - Cheng, Kirilenko, and Xiong (2012): "Convective Risk Flows in Commodity Futures Markets"

A Model of Risk Convection

- Consider a futures market with 2 groups of participants: a group of hedgers and another group of financial traders.
- Consider one period, during which random shocks cause the two groups of traders to change their positions:

$$dx_h = -\beta_h dF - \gamma_h z - u_h,$$
$$dx_f = -\beta_f dF - \gamma_f z,$$

  – dF is the futures price change., $\beta_h \geq 0$ and $\beta_f \geq 0$ are slopes of the two groups' demand curves, z is a shock with γ_f and γ_f as the exposures of the two groups.
  – Suppose that $\gamma_f > \gamma_h$, financial traders have greater exposure.
  – How does the market clear?

A Model of Risk Convection

- Market clearing imposes an add-up constraint on dx_h and dx_f:
$$dx_h + dx_f = 0,$$
  - which implies that
$$dF = -\frac{1}{\beta_h + \beta_f}\left[u_h + \left(\gamma_h + \gamma_f\right)z\right],$$

  and
$$dx_f = -dx_h = \frac{\beta_f}{\beta_h + \beta_f}u_h - \frac{\beta_h\gamma_f - \beta_f\gamma_h}{\beta_h + \beta_f}z.$$

- Consider the consequence of $\gamma_f \gg \gamma_h$.
  - dF decreasing with z
  - Financial traders selling to unwind and hedgers buying to accommodate financial traders---risk convection.

- Can we observe risk convection during the crisis?
  - We can use the increase of VIX (an index of implied volatility of S&P 500 index options.

Empirical strategy

Exploit the cross-section of traders and trader groups and the differential predictions of who should be selling.

Main analysis:

1. Look at which groups responded to the VIX before and after the crisis.

2. Examine financials at the micro level. Did distressed financials sell?

3. Examine hedgers. Can theories of hedging explain the pattern of position changes and prices?

Implications:

4. Examine the medium/long-run responses of trading. Was there a persistent re-allocation of risk?

Basic exercise

Idea: when the VIX changes, the price moves. Who is trading in the direction of the price movement and why?

Price correlation

$$dF_t = \tilde{a} + \tilde{b}_1 z_t + \tilde{b}_2\, z_{t-1} + \tilde{c}\, dF_{t-1} + \tilde{d}\, Controls_t$$

Position change response

$$dx_t = a + b_1 z_t + b_2\, z_{t-1} + c\, dF_{t-1} + d\, Controls_t$$

where z(t) is the change in the VIX, and *dF* is the fully collateralized return to a rolling position in the front month futures price, and controls are weekly changes in BDI, Baa credit spread, and inflation compensation.

Focus on weekly regressions- comparability, less interested in extremely short-run effects.

Table 4: Price correlation

OLS: $dF_t = \tilde{a} + \tilde{b}_1 z_t + \tilde{b}_2\, z_{t-1} + \tilde{c}\; dF_{t-1} + \tilde{d}\; Controls_t.$ Reported $\tilde{b}_1$:

Coefficient on Contemporaneous ΔVIX, with Controls									
		Post-Crisis				Pre-Crisis			
		15Sep2008-01Jun2011		01Jan2010-01Jun2011		01Jan2006-15Sep2008		01Jan2001-01Jan2006	
		T=142 Weeks		T=74 Weeks		T=141 Weeks		T=262 Weeks	
		Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic
Grains	Chi W	-0.6174	[-6.8105]***	-0.9345	[-3.8257]***	0.0068	[0.0303]	0.0747	[0.8290]
	Corn	-0.4551	[-3.8024]***	-0.7121	[-4.8204]***	-0.1429	[-0.8316]	-0.0166	[-0.1937]
	KC W	-0.5688	[-6.9442]***	-0.8676	[-3.9568]***	-0.0354	[-0.1510]	0.113	[1.2397]
	Soybeans	-0.3718	[-4.6336]***	-0.4896	[-3.4953]***	-0.0344	[-0.2206]	0.0203	[0.2320]
	Soyb Oil	-0.4115	[-4.9881]***	-0.4951	[-4.1131]***	-0.0384	[-0.2652]	-0.0587	[-0.6628]
Livestock	F Cattle	-0.2252	[-3.9118]***	0.0065	[0.1067]	0.0524	[0.5151]	0.0477	[0.9251]
	L Hogs	-0.0919	[-1.1710]	-0.3613	[-2.3938]**	0.0143	[0.1208]	-0.1337	[-1.3270]
	L Cattle	-0.1963	[-4.9440]***	-0.0775	[-1.1357]	-0.042	[-0.4006]	0.0666	[1.3047]
Softs	Cocoa	-0.2134	[-2.3469]**	-0.1228	[-0.7663]	-0.3467	[-1.7125]*	-0.0691	[-0.5049]
	Coffee	-0.2914	[-4.0742]***	-0.4263	[-2.2689]**	-0.2348	[-1.7615]*	0.0336	[0.2606]
	Cotton	-0.371	[-6.4895]***	-0.3929	[-1.9713]*	-0.0891	[-0.5968]	-0.1032	[-0.8861]
	Sugar	-0.2701	[-2.0996]**	-0.5985	[-2.1881]**	-0.0577	[-0.3413]	0.2296	[1.7985]*

Table 5: Position response

Post-Crisis, 15Sep2008-01Jun2011 (T=142)

OLS: $dx_t = a + b_1 z_t + b_2\, z_{t-1} + c\, dF_{t-1} + d\; Controls_t$. Reported b_1:

		Post-Crisis, 15Sep2008-01Jun2011 (T=142 Weeks)							
		CITs		**Hedge Funds**		**Comm. Hedgers**		**Other Unclassified**	
		Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic
Grains	Chi W	-0.0406	[-2.0679]**	-0.0992	[-2.6972]***	0.0983	[3.9693]***	0.0537	[1.6003]
	Corn	-0.0718	[-1.8418]*	-0.1729	[-1.7389]*	0.1217	[1.6063]	0.0901	[2.5066]**
	KC W	-0.0127	[-2.3353]**	-0.0242	[-1.6728]*	0.0477	[2.7001]***	0.0004	[0.0600]
	Soybeans	-0.0613	[-2.2734]**	-0.1772	[-1.8907]*	0.1703	[2.3964]**	0.1277	[2.5582]**
	Soyb Oil	-0.0115	[-1.0703]	-0.0437	[-1.3787]	0.05	[1.5339]	0.0368	[2.3800]**
Livestock	F Cattle	-0.0034	[-1.3905]	-0.0089	[-0.8355]	0.0119	[2.3098]**	-0.003	[-0.5542]
	L Hogs	-0.0208	[-1.0839]	-0.0144	[-1.0220]	-0.0004	[-0.0404]	0.0546	[2.2974]**
	L Cattle	-0.0705	[-2.7050]***	-0.026	[-0.6738]	0.0481	[2.4147]**	0.0519	[2.3585]**
Softs	Cocoa	-0.0045	[-1.0804]	0.0004	[0.0404]	0.0036	[0.7471]	0.006	[0.5533]
	Coffee	-0.0609	[-3.6880]***	-0.0647	[-1.6287]	0.0834	[2.7330]***	0.0506	[2.4617]**
	Cotton	-0.0299	[-2.0970]**	-0.0544	[-2.3864]**	0.0352	[2.7333]***	0.0818	[2.7030]***
	Sugar	-0.0644	[-2.3465]**	-0.0477	[-1.7686]*	0.0533	[2.2771]**	0.089	[2.7478]***
Average R-Squared		9.45%		15.99%		15.76%		9.77%	

Average economic significance: -0.21 for CITs, -0.12 for HFs, +0.16 for Comm. Hedgers, +0.15 for Others.

Table 5: Position response

Pre-Crisis, 01Jan2006-15Sep2008 (T=141)

OLS: $dx_t = a + b_1 z_t + b_2\, z_{t-1} + c\, dF_{t-1} + d\; Controls_t$. Reported b_1:

Panel B: Pre-Crisis, 01Jan2006-15Sep2008 (T=141 Weeks)									
		Coefficient on Contemporaneous ΔVIX							
		CITs		**Hedge Funds**		**Comm. Hedgers**		**Other Unclassified**	
		Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic
Grains	Chi W	0.0489	[1.4619]	0.1694	[2.3234]**	-0.0813	[-1.4291]	-0.128	[-2.7704]***
	Corn	0.0242	[0.3914]	-0.0223	[-0.1528]	0.104	[0.7782]	-0.0722	[-1.0279]
	KC W	0.0114	[1.6206]	0.0254	[0.6491]	-0.0397	[-0.8581]	0.0015	[0.0640]
	Soybeans	0.0481	[1.0047]	0.0375	[0.2697]	-0.0594	[-0.5393]	-0.1231	[-1.2378]
	Soyb Oil	0.0143	[1.1623]	-0.0233	[-0.4291]	0.0316	[0.7071]	-0.0158	[-0.4083]
Livestock	F Cattle	0.0102	[1.1226]	-0.0245	[-1.6905]*	0.001	[0.1283]	0.0106	[0.7442]
	L Hogs	-0.0429	[-1.7085]*	-0.0459	[-1.4848]	-0.0206	[-1.0118]	0.1103	[2.2984]**
	L Cattle	-0.0031	[-0.1626]	-0.0044	[-0.0608]	0.0444	[1.2345]	-0.021	[-0.4048]
Softs	Cocoa	0.0045	[0.7035]	-0.0737	[-2.0659]**	0.0362	[1.3269]	0.0273	[1.3053]
	Coffee	-0.0116	[-0.6407]	0.0006	[0.0076]	0.0177	[0.3468]	0.0064	[0.1122]
	Cotton	-0.0014	[-0.0431]	0.026	[0.3804]	-0.0216	[-0.7584]	0.0185	[0.2223]
	Sugar	-0.0647	[-1.7767]*	-0.0454	[-0.6309]	0.0735	[0.5311]	0.0798	[0.7674]

Table 6: Distress of CITs

- Sort CIT trader accounts (~15) every week into high/low (above/below median) CDS spreads.
- Account-level panel regression of position changes on changes in VIX with interaction, post-Lehman.

OLS: $dx_{i,t} = a + b_1 CDSHI_{i,t} + b_2 z_t + b_3 (CDSHI_{i,t} \times z_t) + c\, dF_{t-1} + d\, Controls_t$

		CDS Hi/Lo		Change in VIX		Interaction		R-Squared
		Coef.	t-statistic	Coef.	t-statistic	Coef.	t-statistic	
Grains	Chi W	-2.4707	[-1.4571]	0.0006	[0.3021]	-0.0063	[-2.3222]**	0.0083
	Corn	1.2416	[0.4841]	0.0015	[0.4648]	-0.0124	[-2.3353]**	0.0124
	KC W	0.7686	[1.5370]	-0.0007	[-0.9089]	-0.0012	[-1.3178]	0.0126
	Soybeans	0.1508	[0.0711]	-0.0033	[-1.1243]	0.0003	[0.0611]	0.0099
	Soyb Oil	-0.4106	[-0.4452]	-0.0006	[-0.5533]	0.0001	[0.0752]	0.0074
Livestock	F Cattle	-0.2099	[-0.5660]	0	[-0.0119]	-0.0006	[-0.7565]	0.0069
	L Hogs	-1.1912	[-1.3219]	-0.0007	[-0.7136]	-0.0008	[-0.3948]	0.0189
	L Cattle	-1.4333	[-1.0355]	-0.0049	[-2.4045]**	-0.002	[-0.5185]	0.0202
Softs	Cocoa	-0.3576	[-0.7369]	0.0001	[0.1206]	-0.0009	[-0.4630]	0.0034
	Coffee	-1.5446	[-1.6353]	-0.0007	[-0.4404]	-0.0066	[-3.0605]***	0.0316
	Cotton	-0.7968	[-0.8265]	0.001	[0.7768]	-0.0053	[-1.9560]*	0.0234
	Sugar	-1.6204	[-1.1252]	0.0006	[0.2197]	-0.0079	[-2.0602]**	0.0155

Table 6: Distress of CITs

- Consistent with distressed financial institution hypothesis that vulnerable financial institutions are selling. Suggests convection was *towards* commercials.

- Instead of exploiting relative ranking of CDS spreads, could have interacted absolute level – same.

- Effect could be due to selling of own proprietary positions co-mingled with the account. Or clients may withdraw their investment as the institution is under distress.

Table 7: Hedging pressure

- Alternative story: hedgers wanted to reduce hedges. Convection was towards financials.

- Commercials would want to reduce their hedges when the VIX rises if…
  - Commodity price volatility was dropping. (It wasn't.)
  - Risk of financial distress was declining (Smith and Stulz 1985) – unlikely.
  - Cost of external financing declined (FSS 1993) – unlikely.
  - Investment opportunity set declined (FSS 1993) – possibly. Although, this is open to interpretation, since hedgers are short; they would make money when price falls and need less cash.

- Suggests a test: classify long hedgers and short hedgers and look for differential response (reductions in hedges).

Table 7: Hedging pressure

Examine whether long hedgers reduced positions:

OLS: $dx_t = a + b_1 z_t + b_2\, z_{t-1} + c\; dF_{t-1} + d\; Controls_t$. Reported b_1:

		Comm. Hedgers, Long		Comm. Hedgers, Short	
CIT Position Changes		Coef.	t-statistic	Coef.	t-statistic
Grains	Chi W	0.0065	[1.9214]*	0.0918	[3.9348]***
	Corn	-0.0011	[-0.0612]	0.1168	[1.7359]*
	KC W	0.0008	[0.1143]	0.0445	[3.2131]***
	Soybeans	0.0007	[0.0456]	0.1507	[2.2548]**
	Soyb Oil	0.0193	[1.3809]	0.0338	[1.4093]
Livestock	F Cattle	0.0019	[1.0432]	0.0068	[2.0401]**
	L Hogs	0.0031	[1.3733]	0.0011	[0.1688]
	L Cattle	-0.0051	[-1.4066]	0.0578	[3.0390]***
Softs	Cocoa	0.0006	[0.2442]	0.0032	[0.7040]
	Coffee	0.0121	[1.7131]*	0.0787	[2.7089]***
	Cotton	-0.003	[-1.8002]*	0.0346	[2.7801]***
	Sugar	-0.0088	[-2.2474]**	0.0551	[2.4479]**
Average R-Squared		7.85%		13.51%	

Little evidence of reductions in hedges by long hedgers.

Table 7: Hedging pressure

Several theories would actually suggest that hedgers would want to increase their hedges as the VIX increased, rather than decrease.

- Short hedgers would have been making money as prices fell; why reduce the futures position?

Expectations for demand could have fallen, but data on production in corn and wheat suggest quantities did not decline very much through the crisis.

Story of hedging must fit all these facts.

Implications and Discussion

We think of financials as providing liquidity, and commercial hedgers as using futures markets to offload risk.

Evidence suggests there was a *convective flow* of risk away from distressed financials towards commercial hedgers after the crisis and an amplifying role for financial traders.

CITs tended to reduced their long positions as the VIX rose, while commercial hedgers decreased short positions, inconsistent with hedging pressure

- Reduced net cash commitments as well

Crisis led to a potentially inefficient allocation of risk in the real economy due to financial institutions consuming liquidity

Informational Frictions in Commodity Markets

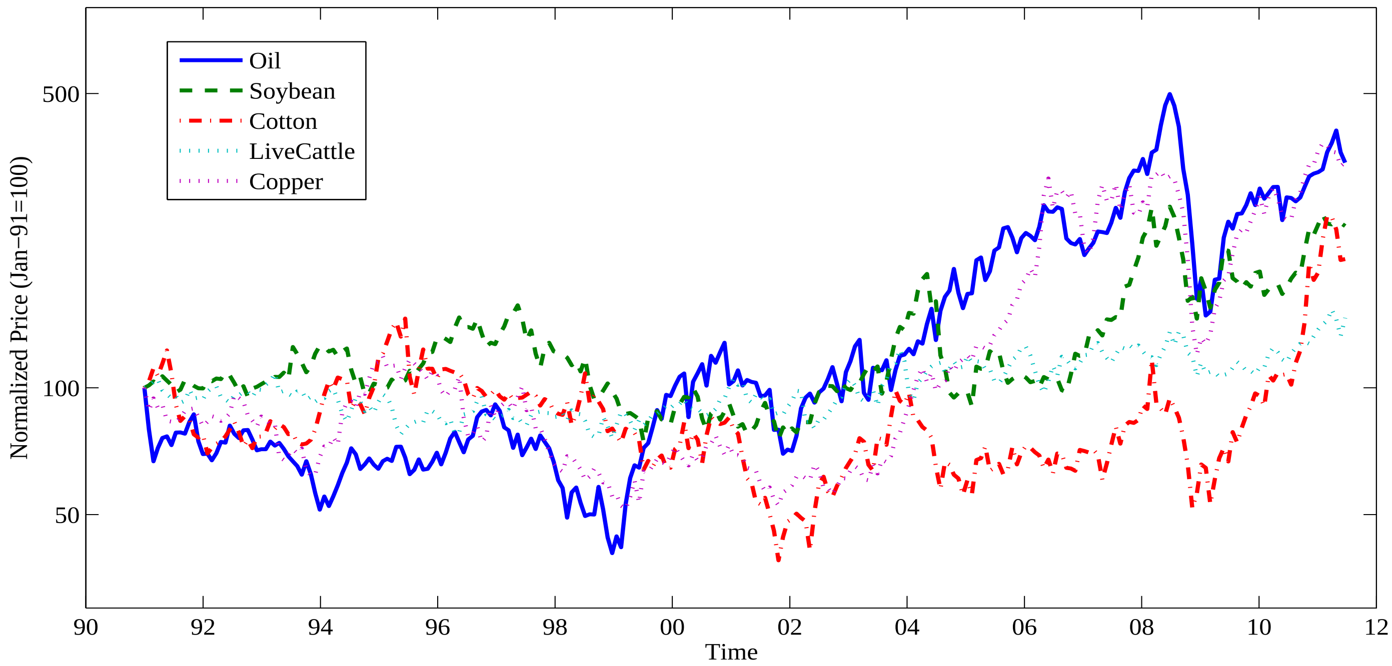
Commodity Price Fluctuations

- What do commodity price fluctuations represent?

- Supply shocks
  - Hamilton (1983):
    - all major oil price increases in history were caused by oil supply shortfalls in Middle East.
    - (Almost) all U.S. recessions have been preceded by major oil price increases.
  - Bernanke and Yellen:
    - Price increases of oil and other commodities represent higher costs for US consumers and thus greater inflation risk.

- Demand shocks
  - Kilian (2009):
    - Commodity prices may fluctuate due to changes in demands, which ultimately reflect strength of US and world economies.
    - Global economic activity measured by an index of global shipping cost explains a significant fraction of oil price fluctuations.

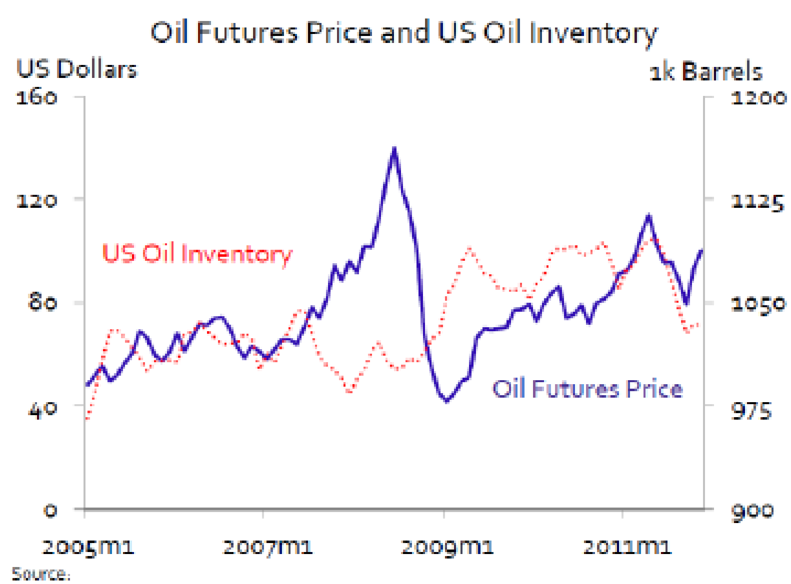
Synchronized Boom and Bust of Commodity Prices



- Supply shocks, demand shocks, or speculative shocks?
  - No supply interruption
  - Hard to explain the large price increases in 2008 with the clear weakness in U.S. and developed economies

Commodity Price Boom/Bust in 2007-2008

- Difficulty to explain the boom/bust purely based on economic fundamentals
  - Financial crisis started in US in 2007, Europe was not going strong, no sign of China growing faster than before.
- Many worried about financialization/speculation distorting prices.
  - If so, economists (Krugman, Hamilton) argued that demand would fall and inventory would spike. There was no evidence of this.
  - This argument ignores potentially important informational feedback effects of commodity prices.



Informational Frictions in Commodity Markets

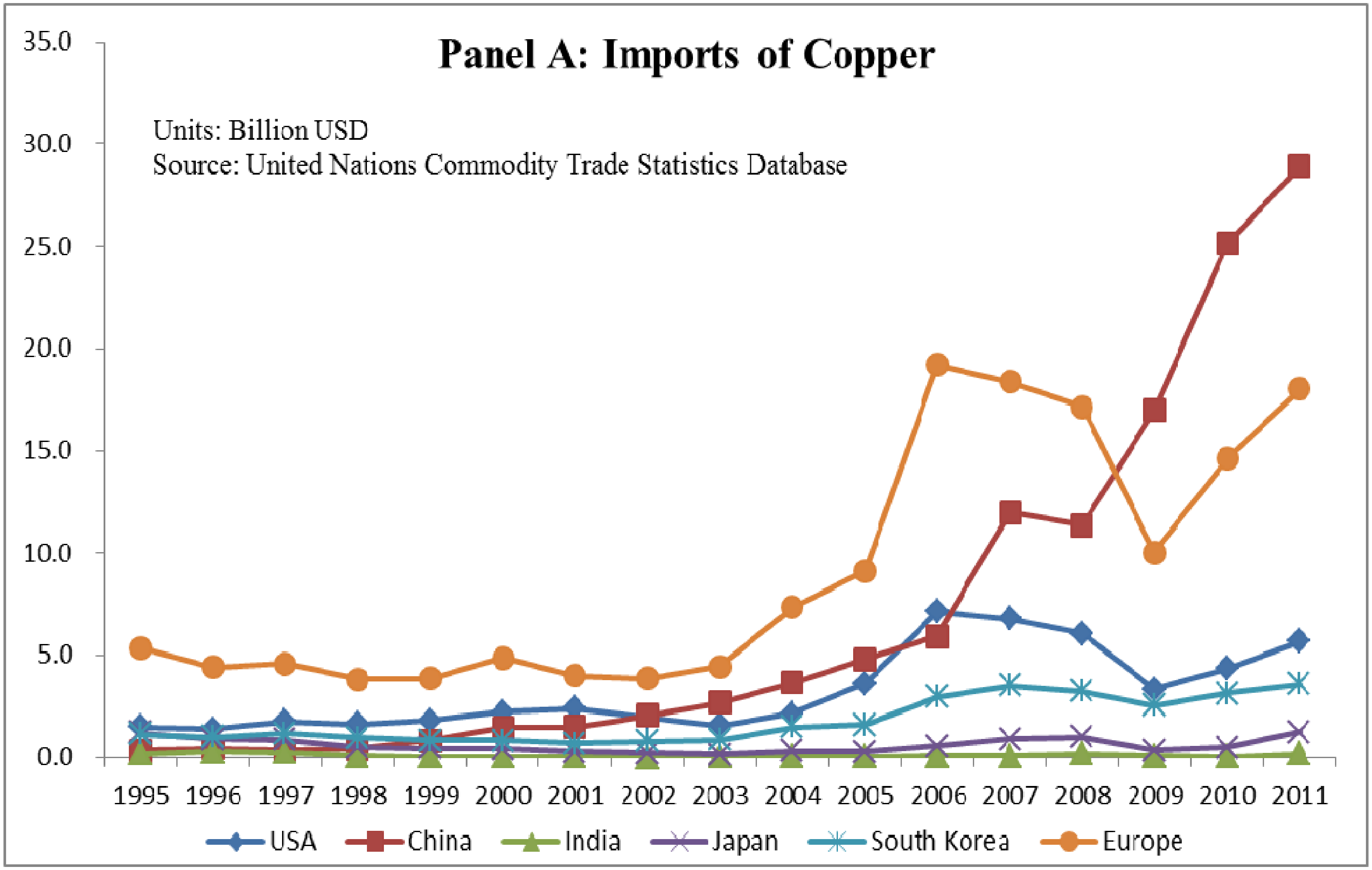
Participants face severe information frictions

- supply and demand from all over the world
- scant data from emerging economies
- recent concerns about manipulated information on inventory

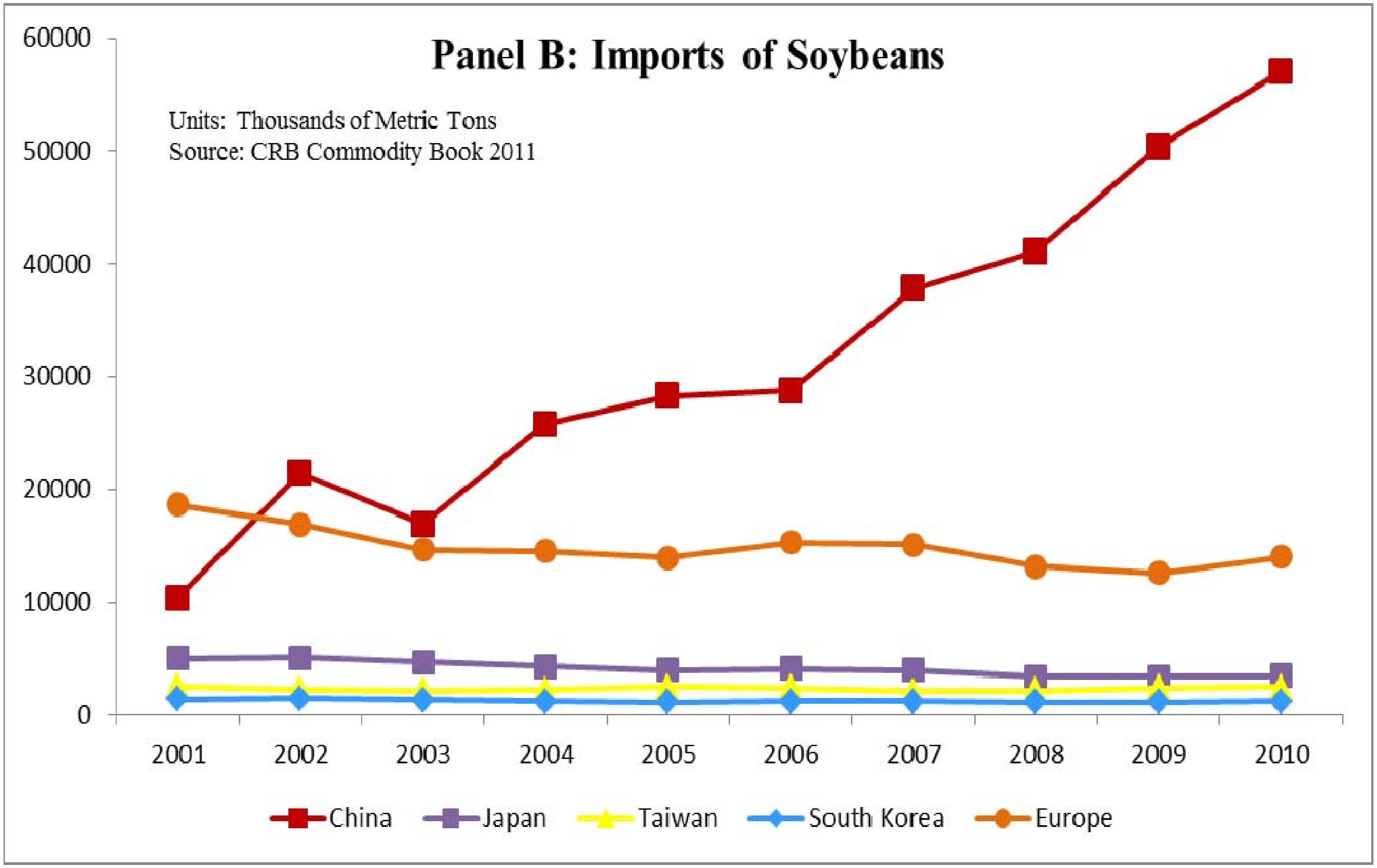
Informational role of commodity futures prices, a la Hu and Xiong (2012)

- Commodity futures prices are often regarded as barometers of the global economy

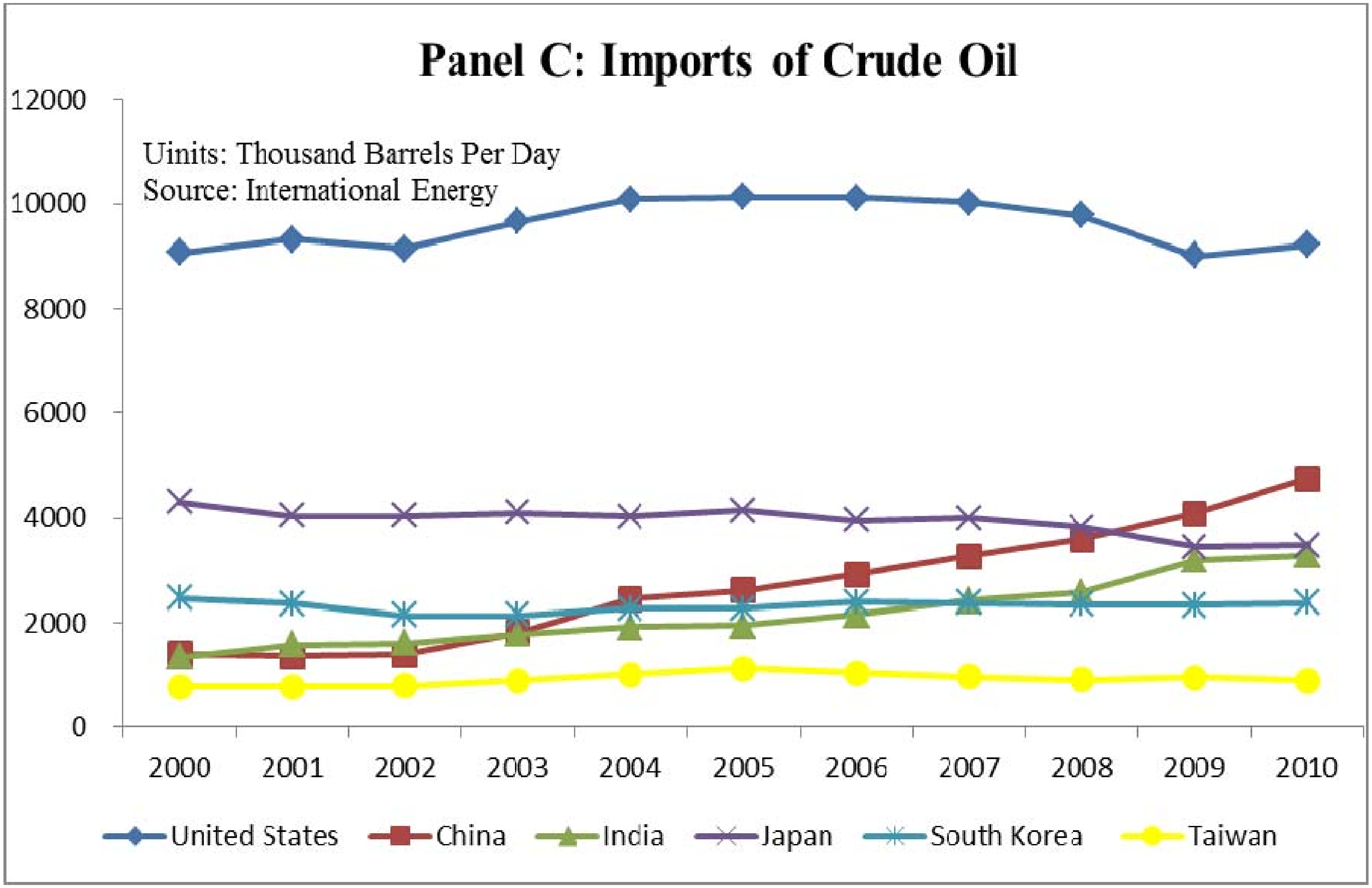
Copper Imports across Regions



Soybean Import across Regions



Crude Oil Imports across Regions



Summary of Results

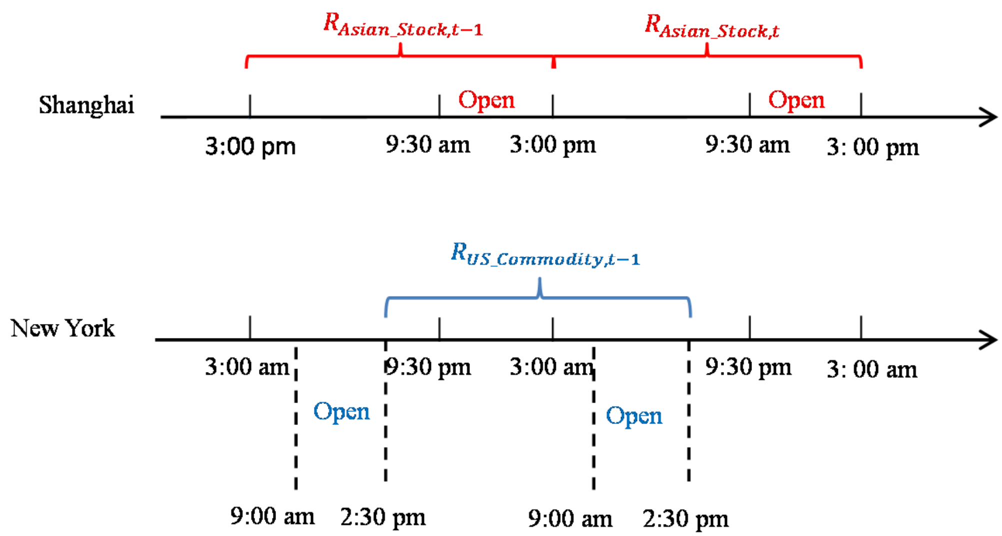
- Little reactions of East Asian stock prices to lagged overnight futures returns before mid-2000s

- Significant and **positive** reactions to lagged overnight futures returns after mid-2000s
  - The reactions to **copper** and **soybeans** are robust even after controlling for lagged overnight futures return of S&P 500 index & spot return
  - The reactions to **crude oil** become insignificant after controlling for overnight futures return of S&P 500 index

- Evidence of commodity futures prices as barometers of the global economy
  - The informational content of copper and soybeans is cleaner
  - Crude oil prices potentially contaminated by supply shocks

Empirical Design without Overnight Trading

- Daytime in the U.S. is nighttime in East Asia
  - Time zone difference 12-14 hours
  - Overnight trading in US futures markets not popular until mid-2000s

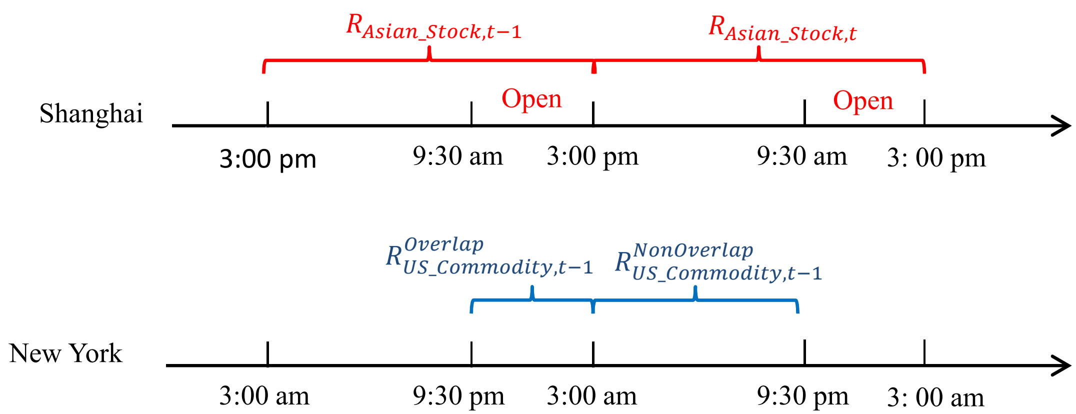


- Information flow identified by lead-lag in returns across markets
  - $R_{Asian\_Stock,t} = b_0 + b_1 R_{US\_Commodity,t-1} + b_2 R_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$
    - *We control for both lagged S&P futures return and spot return to show information in commodity futures is special*

Empirical Design with Overnight Trading

- Overnight trading in U.S. futures markets complicates analysis
  - Introduced by GLOBEX in 1994, made convenient by electronic trading systems
  - Overnight volume became heavy after mid-2000s

- Tick-by-tick data after 2005 for futures returns in overlapping and non-overlapping hours



- Info flow from lagged futures return to East Asia stock prices
  - $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

Interpret Information Content

If East Asian stock prices react to lagged commodity futures returns, what type of information do they reveal?

Type of shocks

- Supply shocks
  - Bad news for East Asian stocks except those in supply industries
- Idiosyncratic U.S. demand shocks
  - Bad news for East Asian stocks, except those in supply industries
- Global demand shocks
  - Good news for all stocks
- Financial market shocks
  - Tend to induce positive correlations bw stock returns and futures returns, not valid for Chinese stocks due to China's capital controls

We don't isolate each type of stocks in driving commodity futures prices, but measure average stock price reactions to commodity futures returns.

- Reactions might vary over periods due to changes in composition of shocks

Data

- Daily index returns of each East Asian stock market
  - Tokyo Price Index
  - Hang Seng Index
  - Korea Composite Stock Price Index
  - Shanghai Market Index
  - Taiwan Market Index

- Daily returns for a set of industries in Tokyo, Shanghai, and Hong Kong

- Futures of copper, soybeans, crude oil, and S&P 500 Index
  - Daily returns before 2005
  - Tick-by-tick prices in Jan. 2005-Sep. 2012

- Daily spot prices of copper, soybeans, and crude oil

East Asian Market Reactions to Copper Return before 2005

$$R_{Asian\_Stock,t} = b_0 + b_1 R_{US\_Commodity,t-1} + b_2 R_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
					Panel A: Copper					
b_1	0.0119*	0.000170	0.0274**	0.00308	0.0159	0.00553	0.0162*	0.00749	0.00829	0.00653
	(1.80)	(0.03)	(2.16)	(0.26)	(1.58)	(0.55)	(1.91)	(0.88)	(0.31)	(0.24)
b_2		0.268***		0.458***		0.205***		0.181***		0.0262
		(10.08)		(14.25)		(9.89)		(7.05)		(0.78)
b_3	0.0836***	0.0615***	0.0100	-0.0127	0.0726***	0.0684***	0.0890***	0.0859***	0.0427	0.0428
	(3.69)	(3.01)	(0.41)	(-0.49)	(4.59)	(4.39)	(2.90)	(2.78)	(1.60)	(1.60)
Obs	9,999	9,976	6,980	6,979	8,770	8,748	9,849	9,830	3,092	3,091
Adj R^2	0.008	0.082	0.001	0.068	0.006	0.023	0.009	0.017	0.002	0.002

East Asian Market Reactions to Soybean Return before 2005

$$R_{Asian\_Stock,t} = b_0 + b_1 R_{US\_Commodity,t-1} + b_2 R_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
	Panel B: Soybeans									
b_1	0.00447	-0.00142	0.0293*	0.0189	0.0144	0.0110	0.00144	-0.00188	0.0340	0.0339
	(0.73)	(-0.25)	(1.93)	(1.26)	(1.48)	(1.14)	(0.14)	(-0.18)	(1.01)	(1.00)
b_2		0.266***		0.454***		0.204***		0.179***		0.0270
		(10.06)		(14.27)		(9.92)		(7.06)		(0.82)
b_3	0.0912***	0.0682***	0.0110	-0.0123	0.0718***	0.0661***	0.0909***	0.0875***	0.0434	0.0435
	(3.96)	(3.24)	(0.45)	(-0.48)	(4.54)	(4.24)	(2.98)	(2.83)	(1.63)	(1.63)
Obs	10,060	10,027	7,012	7,007	8,812	8,784	9,913	9,884	3,107	3,103
Adj R^2	0.009	0.081	0.001	0.067	0.006	0.023	0.009	0.017	0.002	0.002

East Asian Market Reactions to Crude Oil Return before 2005

$$R_{Asian\_Stock,t} = b_0 + b_1 R_{US\_Commodity,t-1} + b_2 R_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	Japan		Hong Kong		Taiwan		South Korea		Shanghai	
	Panel C: Crude Oil									
b_1	-0.0268***	-0.0168**	-0.00439	0.00938	-0.0442***	-0.0361***	-0.0229**	-0.0140	0.0117	0.0132
	(-3.56)	(-2.44)	(-0.46)	(1.03)	(-3.14)	(-2.70)	(-2.09)	(-1.33)	(0.73)	(0.83)
b_2		0.372***		0.500***		0.272***		0.296***		0.0315
		(10.23)		(13.09)		(9.95)		(10.18)		(0.96)
b_3	0.0649**	0.0280	-0.0383	-0.0728**	0.0922***	0.0873***	0.0587***	0.0469**	0.0443*	0.0444*
	(2.13)	(1.07)	(-1.21)	(-2.18)	(4.69)	(4.51)	(3.04)	(2.52)	(1.66)	(1.66)
Obs	4,591	4,590	4,507	4,506	5,089	5,089	5,078	5,077	3,094	3,093
Adj R^2	0.008	0.128	0.002	0.108	0.013	0.040	0.005	0.044	0.002	0.002

East Asian Market Reactions to Copper Return in 2005-2012

- $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
	Panel A: Copper									
b_1	0.265***	0.0919***	0.280***	0.0675**	0.169***	0.0185	0.202***	0.059**	0.155***	0.083***
	(10.53)	(3.99)	(8.28)	(2.18)	(6.71)	(0.81)	(6.24)	(2.20)	(6.09)	(2.85)
b_2		0.613***		0.702***		0.505***		0.466***		0.234***
		(17.54)		(15.66)		(13.33)		(9.60)		(4.43)
b_3	0.018	0.0304	-0.052	-0.070	0.028	0.043	0.086*	0.088**	-0.0005	0.004
	(0.45)	(0.80)	(-1.09)	(-1.43)	(0.98)	(1.53)	(1.86)	(1.97)	(-0.02)	(0.15)
Obs	1,692	1,690	1,715	1,715	1,731	1,728	1,711	1,709	1,720	1,718
Adj R^2	0.123	0.377	0.095	0.323	0.057	0.243	0.069	0.196	0.023	0.044

East Asian Market Reactions to Soybean Return in 2005-2012

- $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
	Panel B: Soybeans									
b_1	0.180***	0.0502*	0.240***	0.0832**	0.147***	0.0489**	0.157***	0.0546*	0.186***	0.134***
	(4.98)	(1.89)	(5.39)	(2.07)	(5.59)	(1.98)	(4.42)	(1.67)	(5.46)	(3.61)
b_2		0.655***		0.719***		0.504***		0.487***		0.249***
		(19.18)		(16.41)		(14.03)		(10.18)		(5.09)
b_3	0.00909	0.0285	-0.0383	-0.0666	0.0345	0.0465*	0.0941**	0.0911**	0.00944	0.0125
	(0.20)	(0.73)	(-0.78)	(-1.40)	(1.22)	(1.65)	(2.02)	(2.04)	(0.32)	(0.43)
Obs	1,688	1,688	1,714	1,714	1,727	1,727	1,707	1,707	1,716	1,716
Adj R^2	0.037	0.368	0.048	0.325	0.028	0.246	0.033	0.195	0.022	0.050

East Asian Market Reactions to Crude Oil Return in 2005-2012

- $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
	Panel C: Crude Oil									
b_1	0.165***	0.0216	0.180***	0.00392	0.120***	0.00754	0.116***	-0.00289	0.0609**	-0.00527
	(7.47)	(1.23)	(6.72)	(0.18)	(6.03)	(0.43)	(4.64)	(-0.14)	(2.50)	(-0.20)
b_2		0.656***		0.741***		0.512***		0.504***		0.290***
		(19.34)		(16.55)		(14.22)		(10.61)		(5.56)
b_3	0.00177	0.0261	-0.0601	-0.0701	0.0191	0.0427	0.0818*	0.0887**	-0.00345	0.00492
	(0.04)	(0.67)	(-1.18)	(-1.42)	(0.68)	(1.52)	(1.76)	(1.99)	(-0.12)	(0.17)
Obs	1,692	1,690	1,715	1,715	1,731	1,728	1,711	1,709	1,720	1,718
Adj R^2	0.061	0.366	0.052	0.319	0.038	0.243	0.035	0.192	0.005	0.038

East Asian Market Reactions to Copper Return in 2005-2012, Controlling for Spot Return

$$R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R_{US\_spot,t-1} + b_3 R^{NonOverlap}_{S\&P500,t-1} + b_4 R_{Asian\_Stock,t-1} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
	Panel A: Copper									
b_1		0.107***		0.0926*		0.0421		0.0470		0.126***
		(2.76)		(1.88)		(1.47)		(1.17)		(2.70)
b_2	0.0871**	0.0273	0.0641	0.0484	0.0738**	0.0408*	0.0526	0.0336	-0.00600	-0.0237
	(2.32)	(1.35)	(1.27)	(1.02)	(2.38)	(1.76)	(1.25)	(0.82)	(-0.17)	(-0.67)
b_3	0.639***	0.641***	0.691***	0.632***	0.458***	0.460***	0.459***	0.438***	0.296***	0.216***
	(17.40)	(17.26)	(15.14)	(11.75)	(11.75)	(10.02)	(8.41)	(7.46)	(6.23)	(3.47)
b_4	-0.0289	-0.0274	-0.0958	-0.0843	0.0159	0.0157	0.0581	0.0620	0.0257	0.0288
	(-0.55)	(-0.52)	(-1.41)	(-1.30)	(0.46)	(0.46)	(0.94)	(1.02)	(0.64)	(0.72)
Obs	1,028	1,023	1,052	1,052	1,071	1,071	1,055	1,055	1,047	1,047
Adj R^2	0.413	0.414	0.307	0.313	0.240	0.240	0.192	0.193	0.053	0.063

East Asian Market Reactions to Soybean Return in 2005-2012, Controlling for Spot Return

$$R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity\ ,t-1} + b_2 R_{US\_spot,t-1} + b_3 R^{NonOverlap}_{S\&P500,t-1} + b_4 R_{Asian\_Stock,t-1} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
					Panel B: Soybeans					
***b*₁**		0.0490*		0.0964**		0.0638**		0.0804**		0.134***
		(1.70)		(2.46)		(2.30)		(2.34)		(3.37)
***b*₂**	0.0145	-0.00444	0.00707	-0.0293	-0.00810	-0.0316	-0.0235	-0.0527*	0.0395	-0.00999
	(0.79)	(-0.23)	(0.22)	(-0.96)	(-0.44)	(-1.54)	(-0.89)	(-1.95)	(1.29)	(-0.32)
***b*₃**	0.669***	0.658***	0.736***	0.713***	0.508***	0.495***	0.508***	0.489***	0.273***	0.243***
	(19.81)	(19.12)	(17.03)	(16.51)	(14.34)	(13.99)	(10.61)	(10.08)	(5.79)	(4.97)
***B*₄**	0.0217	0.0272	-0.0749	-0.0660	0.0439	0.0510*	0.0883*	0.0958**	-0.00159	0.00723
	(0.54)	(0.67)	(-1.50)	(-1.41)	(1.57)	(1.82)	(1.96)	(2.14)	(-0.05)	(0.25)
Obs	1,664	1,660	1,684	1,683	1,698	1,695	1,683	1,679	1,689	1,685
Adj R^2	0.367	0.370	0.317	0.324	0.238	0.243	0.194	0.198	0.038	0.047

East Asian Market Reactions to Crude Oil Return in 2005-2012, Controlling for Spot Return

$$R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R_{US\_spot,t-1} + b_3 R^{NonOverlap}_{S\&P500,t-1} + b_4 R_{Asian\_Stock,t-1} + \varepsilon_t$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VAR	**Japan**		**Hong Kong**		**Taiwan**		**South Korea**		**Shanghai**	
	Panel C: Crude Oil									
b_1		0.00438		0.00418		-0.00826		0.0722**		0.0278
		(0.16)		(0.10)		(-0.29)		(2.00)		(0.69)
b_2	0.0196	0.0166	0.00447	0.00155	0.0109	0.0165	-0.0290	-0.0772**	-0.0123	-0.0304
	(1.33)	(0.73)	(0.20)	(0.04)	(0.71)	(0.66)	(-1.51)	(-2.31)	(-0.58)	(-0.97)
b_3	0.656***	0.655***	0.731***	0.729***	0.501***	0.504***	0.508***	0.484***	0.282***	0.273***
	(19.25)	(19.33)	(16.45)	(16.92)	(14.17)	(14.13)	(10.54)	(10.19)	(5.85)	(5.26)
B_4	0.0190	0.0197	-0.0786	-0.0778	0.0366	0.0352	0.0860*	0.0971**	-0.00323	-0.00108
	(0.48)	(0.50)	(-1.59)	(-1.56)	(1.29)	(1.24)	(1.89)	(2.10)	(-0.11)	(-0.04)
Obs	1,647	1,647	1,676	1,676	1,685	1,685	1,669	1,669	1,675	1,675
Adj R^2	0.366	0.366	0.318	0.318	0.240	0.240	0.192	0.195	0.037	0.037

Industry Reactions to Copper Return in 2005-2012

- $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

	Japan		Hong Kong		Shanghai	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
Panel A: Copper						
Supply Industries						
Diversified Metals & Mining	0.113***	(4.58)	0.119***	(3.10)	0.402***	(8.54)
Consumer Industries						
Electrical Components & Equipment	0.105***	(4.68)	0.109***	(2.82)	0.0903**	(2.49)
Consumer Electronics	0.0523**	(2.23)	0.0450	(1.18)	0.0394	(1.18)
Semiconductors	0.0758***	(3.53)	0.0797***	(2.65)	0.0696*	(1.82)
Other Unrelated Industries						
Construction Materials	0.0929***	(4.03)	0.131***	(2.63)	0.0944***	(2.72)
Steel	0.167***	(5.55)	0.0984***	(2.72)	0.0650*	(1.80)
Industrial Machinery	0.101***	(4.24)	0.0490*	(1.73)	0.0855**	(2.35)
Auto Parts & Equipment	0.101***	(4.42)	0.0843***	(3.02)	0.0773**	(2.12)
Real Estate Activities	0.0587**	(2.47)	0.0656***	(2.69)	0.0473	(1.22)
Food and Beverage	0.0554***	(3.29)	0.0835**	(2.55)	0.0811**	(2.15)
Health Care	0.0432***	(2.65)	0.0664***	(2.77)	0.0554*	(1.66)
Software and IT Services	0.0429**	(2.16)	0.0500	(1.62)	0.0545*	(1.69)

Industry Reactions to Soybean Return in 2005-2012

- $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

	Japan		Hong Kong		Shanghai	
	Coef	t-stat	Coef	t-stat	Coef	t-stat
Panel B: Soybeans						
Supply Industries						
Farming	-0.0157	(-0.86)	0.0994***	(3.35)	0.217***	(3.60)
Consumer Industries						
Beverage	0.000881	(0.04)	0.0658	(1.58)	0.136***	(3.42)
Food Processing	-0.00632	(-0.35)	0.0988***	(4.24)	0.209***	(3.41)
Other Unrelated Industries						
Construction Materials	0.0389	(1.23)	0.0721	(1.23)	0.151***	(3.68)
Steel	0.0746**	(1.97)	0.0888**	(2.16)	0.138***	(3.00)
Industrial Machinery	0.0460	(1.48)	0.0661**	(2.16)	0.182***	(3.71)
Auto Parts & Equipment	0.0525*	(1.74)	0.0771***	(2.73)	0.151***	(3.26)
Real Estate Activities	0.0167	(0.54)	0.0824***	(3.30)	0.117**	(2.45)
Health Care	0.0236	(1.13)	0.0750***	(2.83)	0.153***	(3.42)
Software and IT Services	0.0259	(1.08)	0.0786***	(2.62)	0.133***	(3.19)

Industry Reactions to Crude Oil Return in 2005-2012

- $R_{Asian\_Stock,t} = b_0 + b_1 R^{NonOverlap}_{US\_Commodity,t-1} + b_2 R^{NonOverlap}_{S\&P500,t-1} + b_3 R_{Asian\_Stock,t-1} + \varepsilon_t$

	Japan		Hong Kong		Shanghai	
	Coef	**t-stat**	**Coef**	**t-stat**	**Coef**	**t-stat**
Panel C: Crude Oil						
Supply Industries						
Oil Production Related Industries	0.0709***	(4.39)	0.0669***	(3.16)	0.116***	(2.63)
Consumer Industries						
Chemicals	0.0265	(1.54)	0.0159	(0.86)	0.00506	(0.16)
Transportation	0.0114	(0.79)	0.0225	(1.07)	-0.0463	(-1.55)
Other Industries						
Construction Materials	0.0176	(1.00)	0.0525	(1.32)	-0.00263	(-0.27)
Steel	0.0632***	(2.82)	0.0506	(1.54)	-0.0214	(-0.59)
Industrial Machinery	0.0337*	(1.79)	0.0280	(1.32)	-0.0164	(-0.50)
Auto Parts & Equipment	0.0239	(1.32)	0.0248	(1.10)	-0.0466	(-1.45)
Real Estate Activities	0.0176	(0.90)	-0.0129	(-0.62)	-0.0363	(-1.10)
Food and Beverage	0.0172	(1.17)	-0.0241	(-1.09)	-0.00994	(-1.38)
Health Care	0.0100	(0.73)	0.0213	(1.14)	-0.0276	(-0.96)
Software and IT Services	0.00584	(0.36)	0.0364	(1.33)	-0.0264	(-0.94)

Informational Frictions and Commodity Markets

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A Theoretical Framework

Key ingredients:

- centralized trading with dispersed information
  - a la Grossman and Stiglitz (1980) and Hellwig (1980)
  - price aggregates information
- a global economy with a continuum of specialized goods producers
  - a la Ageletos and La'O (2013)
  - producers demand a commodity as common production input
  - complementarity in production due to the need to trade produced goods for consumption

Two Versions

- Baseline model
  - a spot market for commodity
  - decentralized markets for produced goods
- Extended model
  - an additional round of futures market trading before physical delivery in spot market

Key Insights

Without informational frictions:

- A higher price leads to lower demand
- A supply shock reduces price and boosts demand
- Futures price is a shadow of spot price

With informational frictions about global economic strength:

- A higher price leads to two offsetting effects:
  - a usual cost effect and an informational effect: a higher price signals a stronger economy and thus higher demand
    - complementarity in production magnifies the informational effect
  - in net, price elasticity of demand is reduced and can be even positive
- Through the informational channel, supply shock has an amplified price effect and an undetermined effect on demand
- Futures price provides a price signal even if spot price is observed
  - noise from futures market can boost demand and spot price

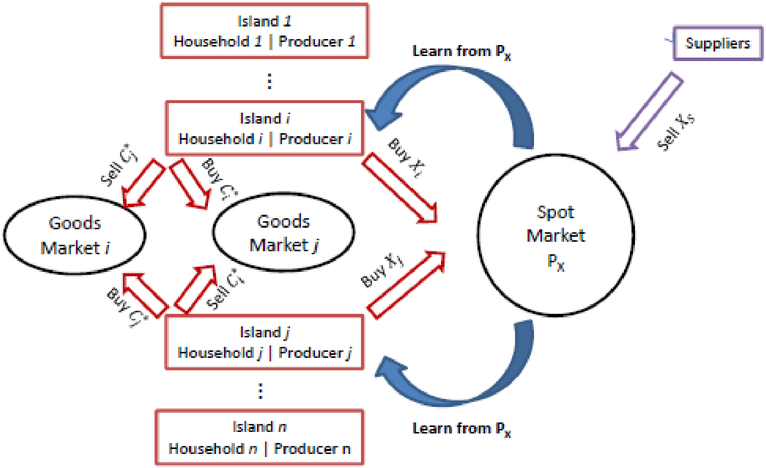
Related Literature

- Growing literature on interactions between financial markets and commodity markets
  - Tang and Xiong (2010), Singleton (2011), Cheng, Kirilenko, and Xiong (2012), Hamilton and Wu (2012), Kilian and Murphy (2012), and Henderson, Pearson, and Wang (2012)
  - Our model gives a conceptual framework, which can help design sharper tests
- Informational frictions in affecting macroeconomy
  - Lorenzoni (2009) and Angeletos and La'O (2013), which do not consider centralized asset market trading to aggregate information
- Feedback effects of financial prices
  - without complementarity: Bray (1981) and Subrahmanyam and Titman (2001)
  - with complementarity: Morris and Shin (2002), Angeletos, Lorenzoni and Pavan (2010), Goldstein, Ozdenoren, and Yuan (2011, 2012)
  - Our model derives a tractable log-linear equilibrium

Baseline Model

- Two dates $t = 1, 2$.
- A commodity (oil or copper, a key input for goods production)
- A group of commodity suppliers with a random supply shock
- A continuum of islands (a la, Angeletos and La'O (2013))
  - Each island specializes in producing a single good
  - Island producers purchase commodity at $t = 1$, produce and trade goods at $t = 2$.
  - Dispersed information about unobservable global economic strength
- Two markets:
  - a centralized commodity market at $t = 1$
  - decentralized markets for produced goods at $t = 2$

The Model Structure



Island Households

- Each island has a representative household.
- Following Angeletos and La'O (2013), a particular structure for goods trading between different islands.
  - Each island is randomly paired with another island at $t = 2$.
  - The households on the two islands trade their goods and consume both goods.
  - A bundle (C_i, C_i^*): C_i—consumption of "home" good, C_i^*—consumption of "away" good
  - Cobb-Douglas utility:

$$U(C_i, C_i^*) = \left(\frac{C_i}{1-\eta}\right)^{1-\eta} \left(\frac{C_i^*}{\eta}\right)^{\eta}$$

    - $\eta \in [0, 1]$—degree of production complementarity
    - this utility treats all away goods as perfect substitutes

Goods Producers

- Each island has a locally-owned representative firm (a producer).
- The production uses the commodity as an input: $Y_i = AX_i^{\phi}$
  - X_i—commodity input
  - A—**unobservable**, common productivity of all islands with a lognormal distribution: $\log A \backsim \mathcal{N}\left(\overline{A}, \tau_A^{-1}\right)$
- At $t = 1$, the producer on each island observes a private signal:

$$s_i = \log A + \varepsilon_i, \quad \varepsilon_i \backsim \mathcal{N}\left(0, \tau_s^{-1}\right)$$

  - Commodity trading serves to aggregate the private signals.
- At $t = 1$, the producer on island i maximizes his expected profit:

$$\max_{X_i} \; E\left[P_i Y_i \middle| \mathcal{I}_i\right] - P_X X_i$$

where his information set $\mathcal{I}_i = \{s_i, P_X\}$.

  - P_X acts as a key information channel.

Commodity Suppliers

- A group of commodity suppliers face the following optimization problem:

$$\max_{X_S}\; P_X X_S - \frac{k}{1+k} e^{-\xi/k} \left(X_S\right)^{\frac{1+k}{k}} .$$

- The supply curve:

$$X_S = e^{\xi} P_X^k,$$

  - $\xi \backsim \mathcal{N}\left(\bar{\xi}, \tau_{\xi}^{-1}\right)$ is supply noise
  - $k \in (0,1)$ measures price elasticity of commodity supply
  - we ignore feedback effects to suppliers

Joint Equilibrium of Different Markets

- At $t = 2$, households of each pair of randomly matched islands $\{i, j\}$ trade produced goods and clear market of each goods:

$$\begin{aligned} C_i + C_j^* &= AX_i^{\phi}, \\ C_i^* + C_j &= AX_j^{\phi}. \end{aligned}$$

- At $t = 1$, commodity market clears

$$\int_{-\infty}^{\infty} X_i\left(s_i, P_X\right) d\Phi\left(\varepsilon_i\right) = X_S\left(P_X\right)$$

Goods Market Equilibrium

- For a pair of randomly matched islands, i and j, their representative households' optimal consumptions of the two goods are

$$C_i = (1-\eta)\, Y_i,\;\; C_i^* = \eta Y_j,\;\; C_j = (1-\eta)\, Y_j,\;\; C_j^* = \eta Y_i.$$

- The price of the goods produced by island i is

$$P_i = \left(\frac{Y_j}{Y_i}\right)^{\eta}.$$

  - common in international macro literature
- Complementarity in goods productions: one island's good is more valuable when the other island produces more.
  - η determines the complementarity.

Producers' Production Decision

- Expected profit of the goods producer on island i:

$$\max_{X_i} \; E\left[A P_i X_i^{\phi} \,\middle|\, s_i, P_X \right] - P_X X_i$$

- Optimal production decision:

$$X_i = \left\{ \frac{\phi E\left[A X_j^{\phi\eta} \,\middle|\, s_i, P_X \right]}{P_X} \right\}^{1/(1-\phi(1-\eta))}$$

  - The information channel through P_X
  - The producer is concerned by both A and $X_j^{\phi\eta}$.

A Unique Log-Linear Equilibrium with Frictions

- Commodity price

$$\log P_X = h_A \log A + h_\xi \xi + h_0,$$

  with $h_A > 0$, $h_\xi < 0$.

  - $\log P_X$ aggregates producers' signals on $\log A$, a la Hellwig (1980)
  - $h_A > 0$ and $h_\xi < 0$ are both lower than their values in a perfect-information benchmark
  - as $\tau_s \to \infty$, the price converges to this benchmark

- Commodity demand of goods producer on island i is

$$\log X_i = l_s s_i + l_P \log P_X + l_0$$

  with $l_s > 0$ and l_P undetermined sign.

- Law of large number ensures log-linearity after aggregating producers' commodity demand.

Price Informativeness

- Equilibrium commodity price

$$\log P_X = h_A \log A + h_\xi \xi + h_0$$

serves as a signal on $\log A$

- A measure of price informativeness

$$\pi = \frac{h_A^2 / \tau_A}{h_\xi^2 / \tau_\xi}$$

- π is increasing in τ_s and τ_ξ and decreasing in η.

Price Elasticity

Each producer's demand $\log X_i = l_s s_i + l_P \log P_X + l_0$

- Two offsetting effects:
  - a usual cost effect
  - an informational effect
- Two necessary and sufficient conditions ensures that $l_P > 0$:
  1. $\tau_\xi / \tau_A > 4k^{-1}\left(1 - \phi + k^{-1}\right)$;
  2. parameter η within a range

$$1 - \frac{1}{\phi} + \frac{k\tau_\xi\tau_s}{4\phi\tau_A^2}(1-\rho)^2 < \eta \ < 1 - \frac{1}{\phi} + \frac{k\tau_\xi\tau_s}{4\phi\tau_A^2}(1+\rho)^2,$$

where $\rho = \tau_A^{1/2}\tau_\xi^{-1/2}\sqrt{\tau_\xi/\tau_A - 4k^{-1}\left(1-\phi+k^{-1}\right)}$.

- When $\eta = 0$, $l_P < 0$.
  - demand elasticity is negative without complementarity

Feedback Effect of Supply Shock

In a perfect-information benchmark where A and ξ are observable:

- supply shock reduces price and boosts demand

In the presence of informational frictions:

- commodity price $\log P_X = h_A \log A + h_\xi \xi + h_0$
  - h_ξ more negative—an amplified price impact
- producers' aggregate commodity demand is

$$\log\left[\int_{-\infty}^{\infty} X_i\left(s_i, P\right) d\Phi\left(\varepsilon_i\right)\right] = l_P h_\xi \xi + \left(l_s + l_P h_A\right)\log A + l_0 + l_P h_0 + \frac{1}{2} l_s^2 \tau_s^{-1}.$$

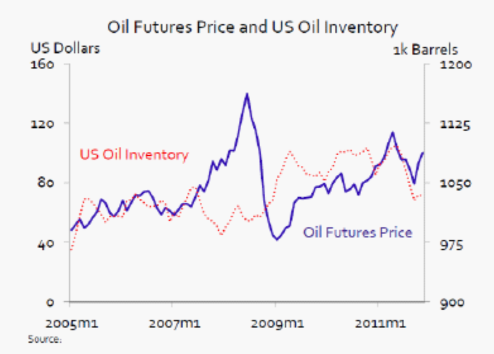
- undetermined effect on demand
  - If $l_P < 0$: supply shock boosts demand
  - If $l_P > 0$: supply shock reduces demand

Extended Model with Futures

- In practice, spot markets of commodities are typically decentralized, while centralized trading occurs in futures markets.
- We can extend the model to incorporate an intermediate futures market with financial traders who do not take delivery and two rounds of information aggregation
- Futures and spot prices do not subsume each other
  - builds on timing of informational flow
- Noise in futures market from financial trader positions can have a positive effect on both spot price and aggregate demand
  - despite not taking any delivery, trading in futures market can still affect price and demand!

Expaining Commodity Boom in 2007-2008

- Hamilton (2009): rapidly growing demand from emerging economies and stagnant supply were key drivers
- Difficult to explain the continued commodity price increases in early 2008 despite many signs of weakness in developed economies
  - Oil prices rose over 40% in the first half of 2008 to peak at $147 per barrel only in July 2008



Conclusion

- A model of information aggregation in commodity markets
- Both spot and futures prices can serve as price signals
  - informational effect can make demand elasticity positive;
  - amplify price impact of supply shock and make its impact on demand undetermined;
  - allow noise in futures market to drive up both spot price and demand