Carry Trade Dynamics under Capital Controls: the Case of China

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The Big Picture

- Current Chinese financial markets leave significant asymmetries creating arbitrage opportunities
- The ongoing CNY/CNH spread on essentially identical asset has created arbitrage spread
- Despite the existence of explicit capital controls, firms know how to create implicit capital movement to arbitrage asset prices
- Take a micro-bottom up approach to studying macro-market moving processes

Copper Prices Fall as Traders Question Near-Record Data From China

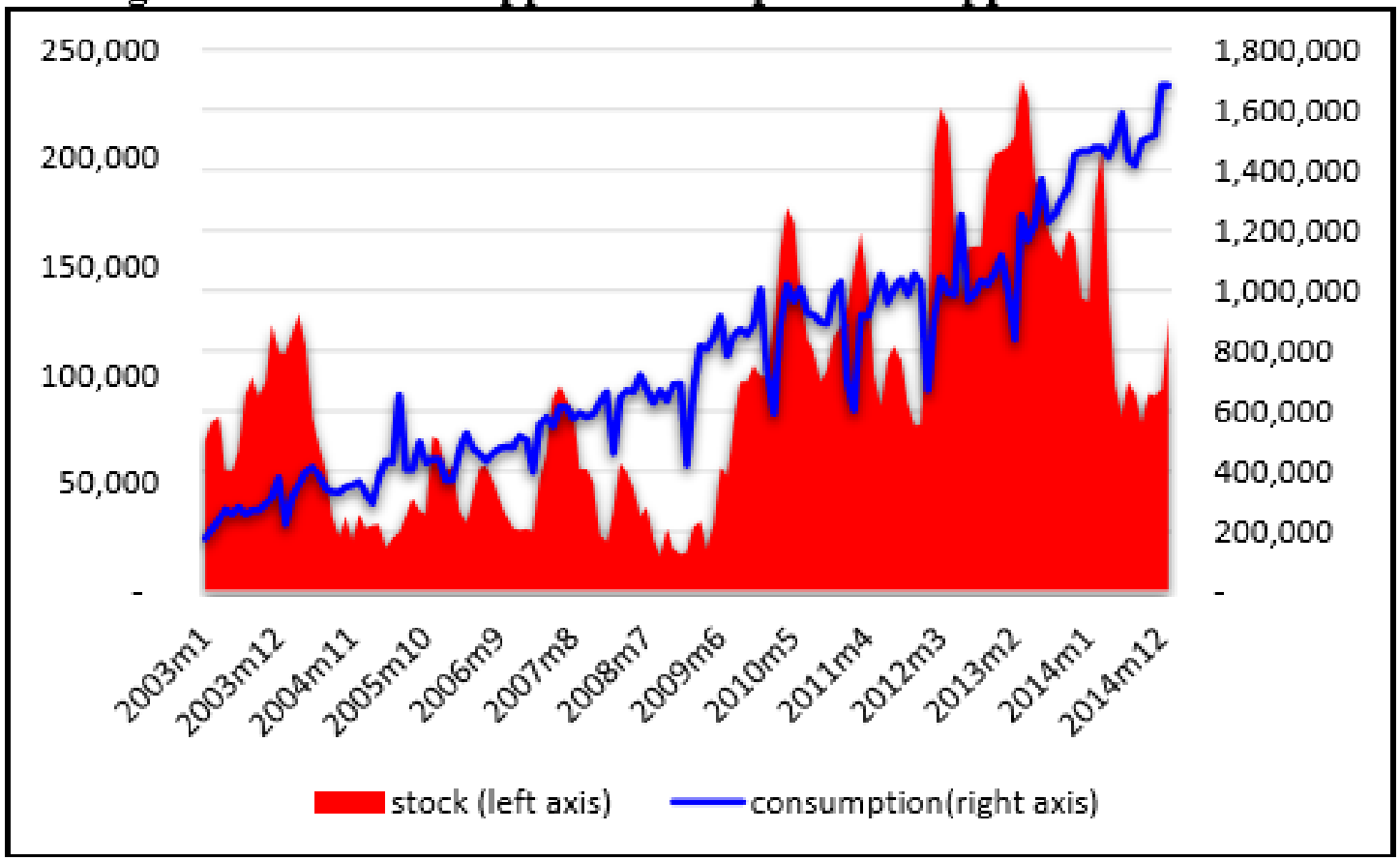
Copper futures fell Wednesday as more traders started to question data from China that had shown near-record imports…According to Chinese customs data Tuesday, 530,000 metric tons of unwrought copper and products were imported in December—a ***rise of 26% year-over-year*** and the second-highest monthly figure on record…But many also noticed the numbers showing a disproportionate amount of gold trade with Hong Kong and other clues that the increase may not be from increasing demand…It could be transactions simply designed to get cash out of China, he added.

China's Better-than-Expected Trade Numbers Raise Questions

China's better-than-expected trade figures in December have sparked questions over whether trade flows have been inflated by investors evading capital controls and the extent of incentives being offered by government agencies to prop up exports…Of particular note was a ***64.5% jump*** in China's imports from Hong Kong, the strongest pace in three years, analysts said. This compared with a 6.2% decline for the January-November period. "It really looks like capital flight,"

Copper consumption and copper stock

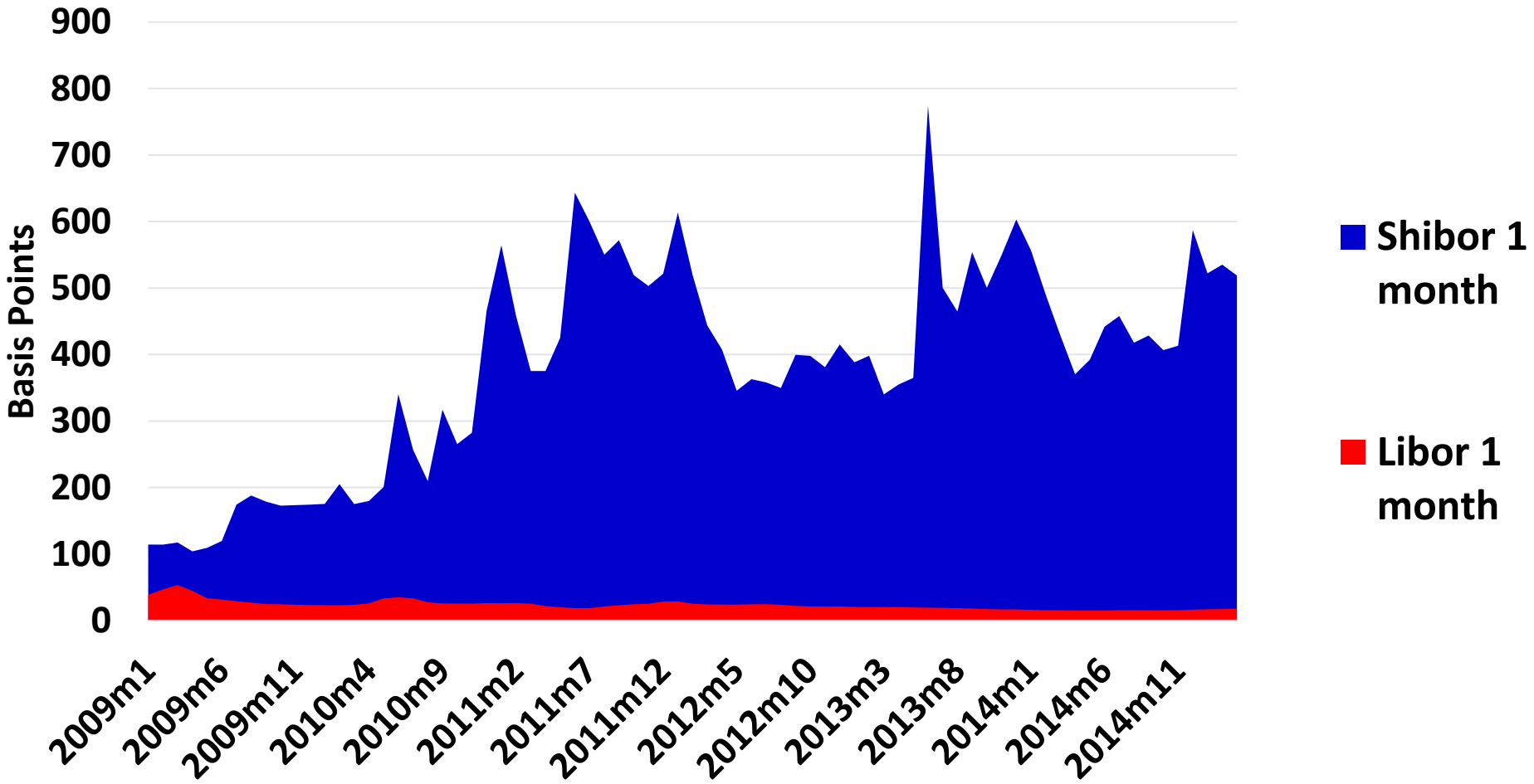
Figure 7 – Chinese Copper Consumption to Copper Stock in Tons



Source: Bloomberg and authors calculation

Background

It is profitable to borrow in USD and invest in CNY, why not?



What is copper trade finance?

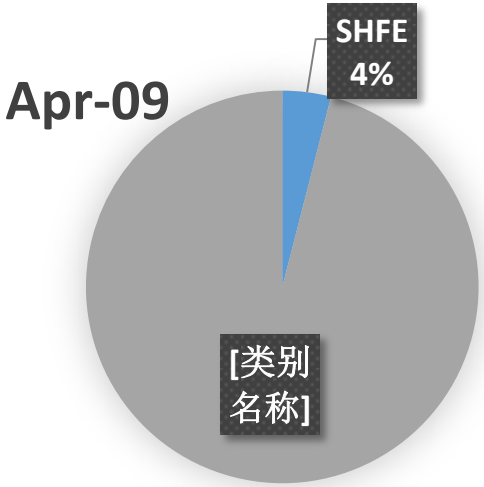
- It is an undercover capital inflow via importing copper.

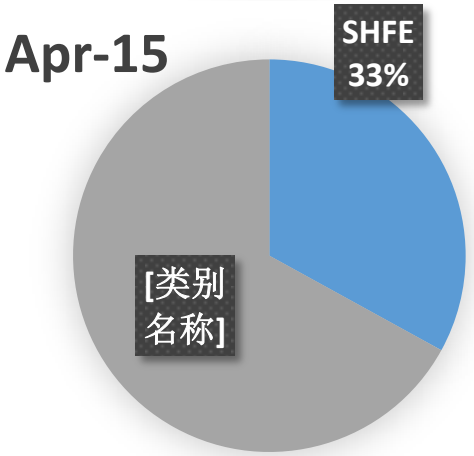
Step 1: China company ***A*** imports copper, apply for a letter of credit (L/C) to finance this trade

Step 2: Bank ***B*** agrees to issue L/C, paying ***A***'s trade counterparty in advance.

Step 3: ***A*** gets copper, and sells instantly for **cash. *This cash is a capital inflow unregulated by SAFE.***

This practice shifts global copper stock to Shanghai Futures Exchange -> measurable





Literature Review

1. Carry Trade	Chinn (2005) Burnside (2006) etc. on developed countries without capital control, not China.
2. Copper Trade Finance	Tang (2014) focused on commodity market equilibrium, not for purpose of studying carry trade.

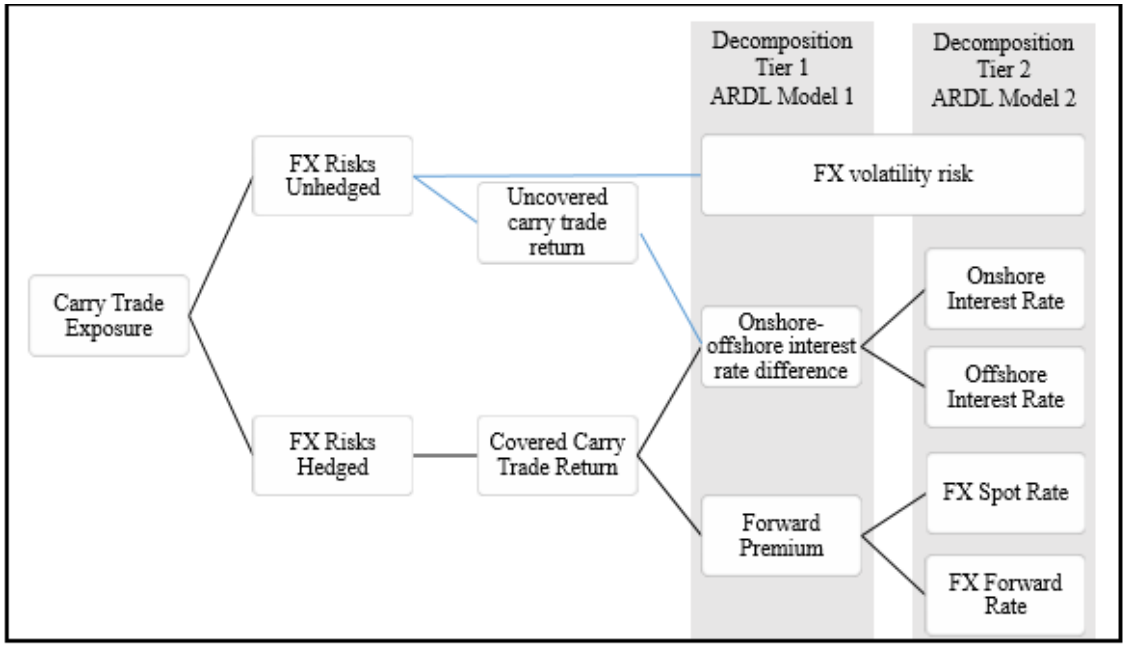
Hypothesis

- **Hypothesis 1**: SHFE copper stock value has long-run relationship with carry trade return
- **Hypothesis 2**: There is causality running from carry trade return and SHFE copper stock value, while there is no causality running from SHFE copper stock value to carry trade return.

Hypothesis

- **Hypothesis 3**: SHFE copper stock value is driven by onshore-offshore interest rate differential, USDCNY forward premium and USDCNY implied volatility.

- **Hypothesis 4**: SHFE copper stock value is positively affected by China onshore interest rate, USDCNY spot rate, but negatively affected by offshore interest rate and USDCNY forward rate.

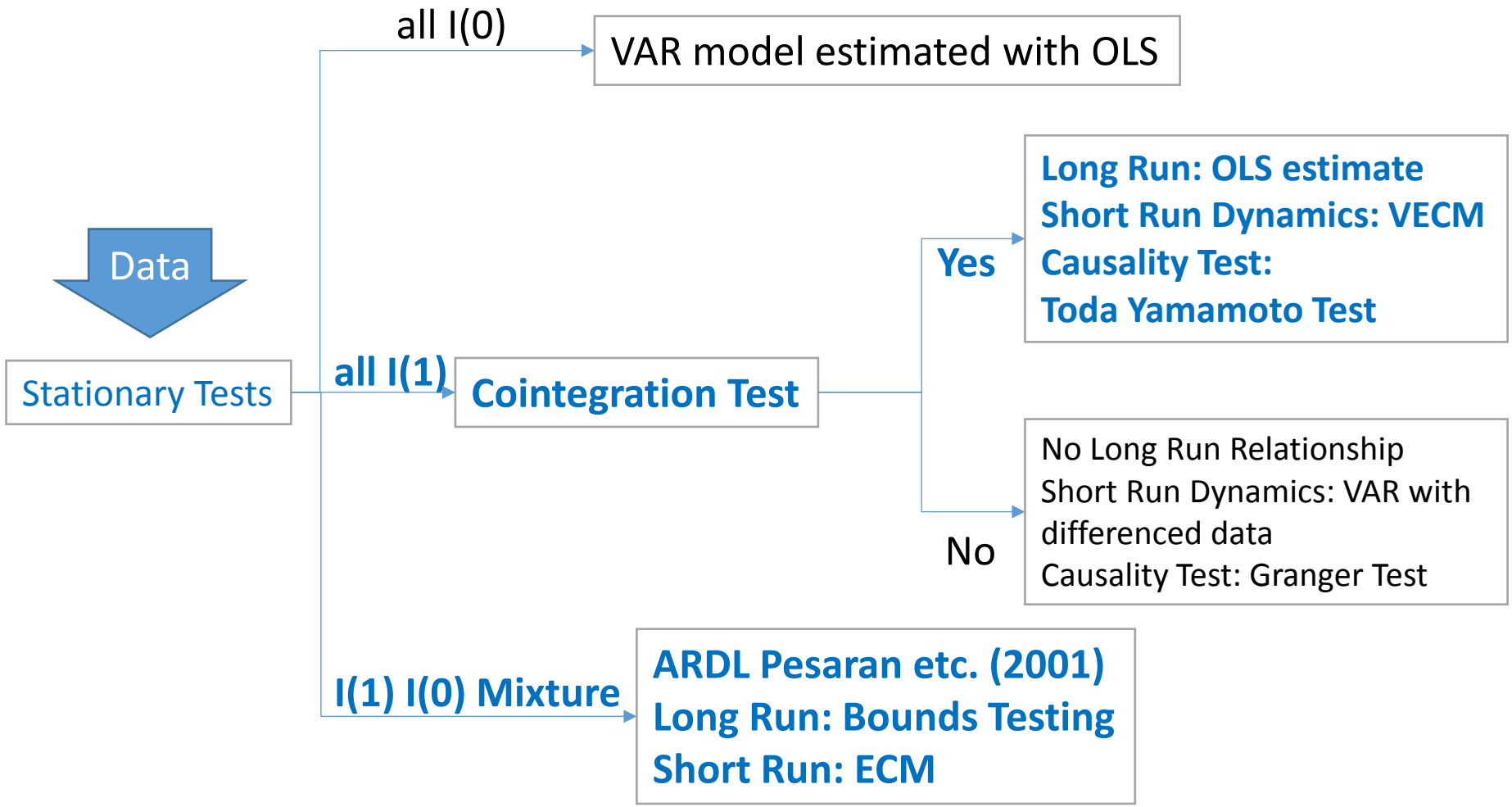


Data

Shanghai Copper Stock Value	USD value of copper stock stored and traded in Shanghai Futures Exchange. Source: Bloomberg and wind.
Foreign Exchange Rate	Spot: USD/CNY spot exchange rate. Source: Bloomberg
	Forward: USD/CNY forward Exchange rate. Source: Bloomberg
risk-free Interest rate	Onshore interest rate: Shibor after Oct 2006, weighted average interbank rate before Shibor. Source: Wind.
	Offshore Interest Rate: USD Libor. Source: Bloomberg

Methodology

Goal: to model the long-run relationship and short run dynamics between time series variables



Results:

Hypothesis 1: SHFE copper stock value has long-run relationship with carry trade return

YES, there's long-run relationship between 2 variables

Johansen Cointegration Test

No. of Cointegrating equation(s)	Trace Statistic	0.05 Critical Value	Prob.	Maximun Eigenvalue statistic	0.05 Critical Value	Prob.
None	17.99	15.49471	**0.02**	16.91	14.26	**0.02**
At most 1	1.078	3.841466	0.30	1.07	3.84	0.30

Both Trace test &Max-eigenvalue test indicate 1 cointegrating eqn at the 5% level between Copper stock Value and Carry Trade Return

Cointegrating coefficients

Copper Value	Covered Carry Trade Return
	-1718.59

For every 1 bp increase in return, copper value increase by 1.7 million USD

Results:

- **Hypothesis 2**: There is causality running from carry trade return and SHFE copper stock value, while there is no causality running from SHFE copper stock value to carry trade return.

- Carry trade return drives copper transit trade, while the transit trade flow is not significant enough to remove the arbitrage opportunity.

Toda Yamamoto Approach to Causality:

No-causality test from carry trade return to SHFE copper stock value – reject null

Null Hypothesis: First 4 lags Rc coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	3.27	(4, 612)	**0.01**
Chi-square	13.07	4	**0.01**

No-causality test from SHFE copper stock value to carry trade return – cannot reject null

Wald Test:

Null Hypothesis: First 4 lags CV coefficients are jointly

Test Statistic	Value	df	Probability
F-statistic	1.20	(4, 612)	**0.31**
Chi-square	4.80	4	**0.31**

Results:

Hypothesis 3: SHFE copper stock value is driven by onshore-offshore interest rate differential, USDCNY forward premium and USDCNY implied volatility.

We dropped implied volatility, and found there is a long-run relationship among copper stock value, onshore-offshore interest rate differential and USDCNY forward premium via ARDL bounds testing.

Dependent Variable: CV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FP	**-0.85**	3.76	-0.23	**0.82**
ID	**1,515.16**	449.80	3.37	**0.00**
C	417,456.81	135,188.90	3.09	0.00

We found in the long run, USDCNY forward premium is not significant.
Interest rate differential is significant, coefficient suggests for every 1 bps increase in interest rate differential, there will be 1.5 million dollar increase in SHFE copper stock value.

In the short run, there is causality running from forward premium to copper stock value.

Results:

Hypothesis 4: SHFE copper stock value is positively affected by China onshore interest rate, USDCNY spot rate, but negatively affected by offshore interest rate and USDCNY forward rate.

Long Run Coefficients Dependent Variable: CV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIBOR	**(1,187.57)**	610.44	-1.95	**0.05**
SHIBOR	**2,130.52**	625.61	3.41	**0.00**
SPOT	**-31.20**	334.94	-0.09	**0.93**
FWD	**32.64**	335.20	0.10	**0.92**

In the long run, interest rates are significant, FX rates are not.

Coefficents suggest how 1 bps change in libor/shibor will correlates to copper stock value in thousand dollar.

In the short run, error correction model suggests USDCNY spot and forward rates take 1 week to cause copper stock value to react in the theoretical direction: Lower cny spot value and higher cny forward value cause the entry of carry trade position.

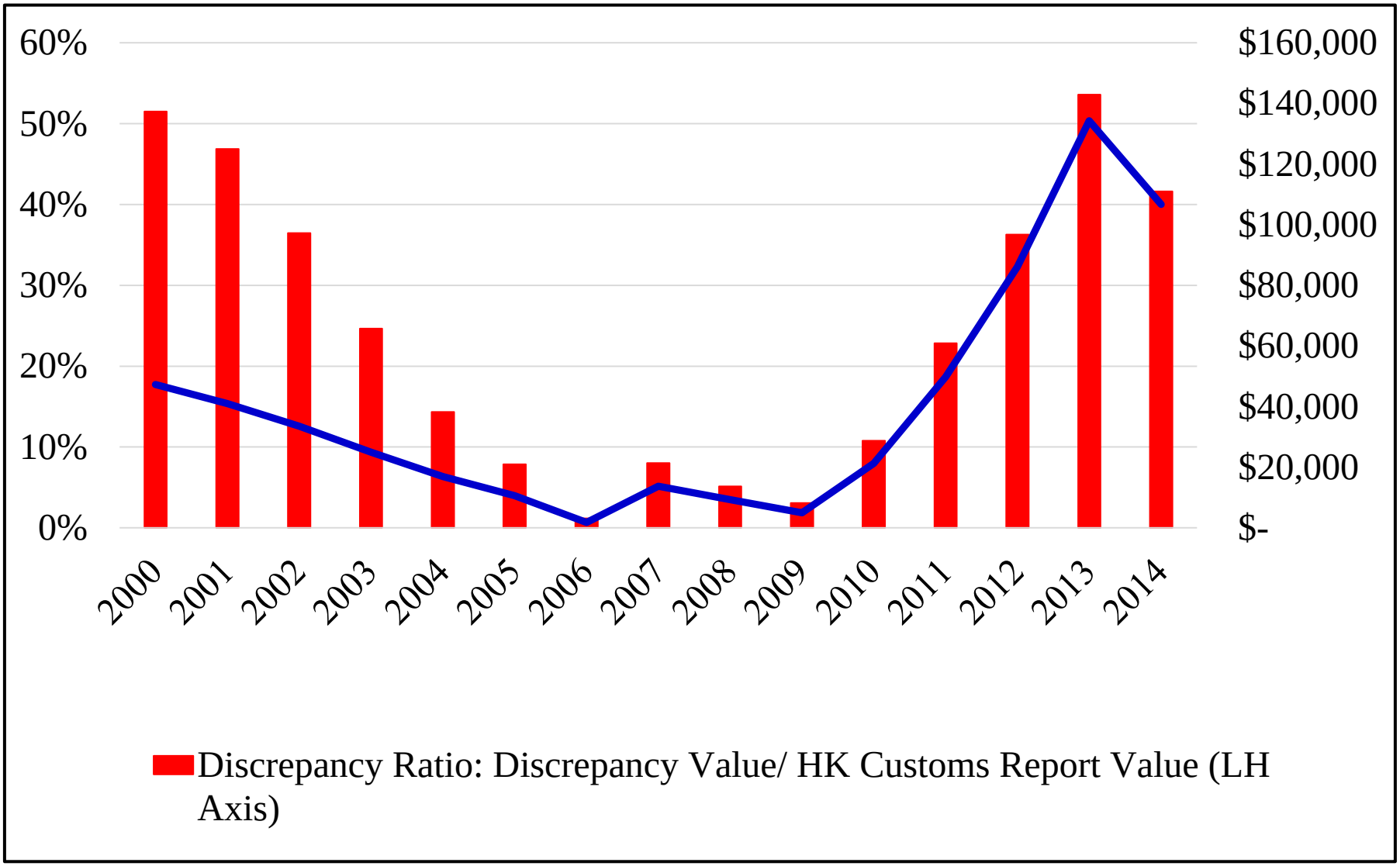
Recap

- Copper stock value in Shanghai is driven by carry trade return
- Carry trade opportunity emergence cause carry trade position to build up, carry trade flow no sufficient to remove arbitrage opportunity.
- Impied volatility is not significant in the model
- For every 1 bps increase in interest rate differential, there will be 1.5 million dollar increase in SHFE copper stock value

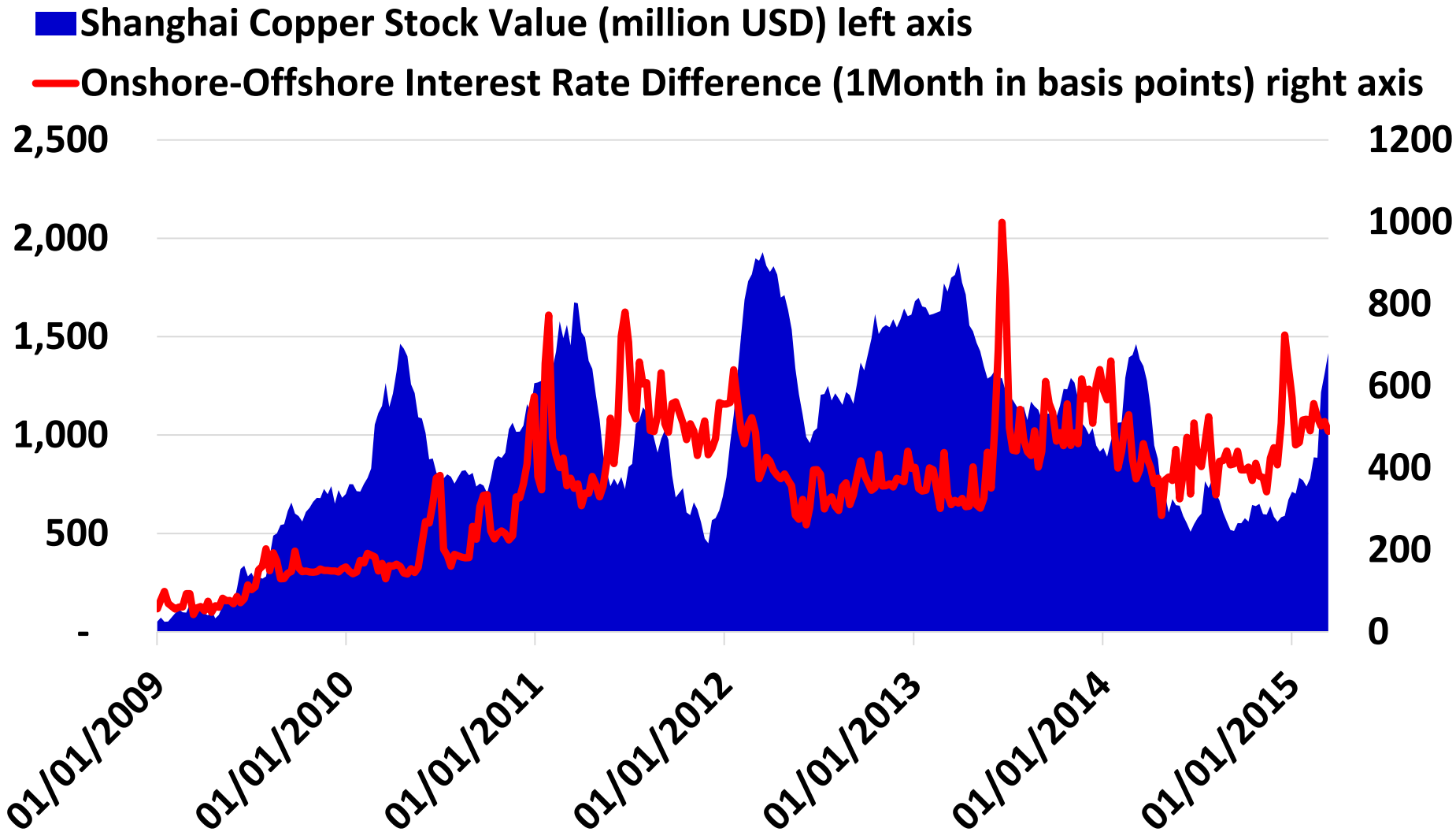
The End

Thank you very much for your kind attention

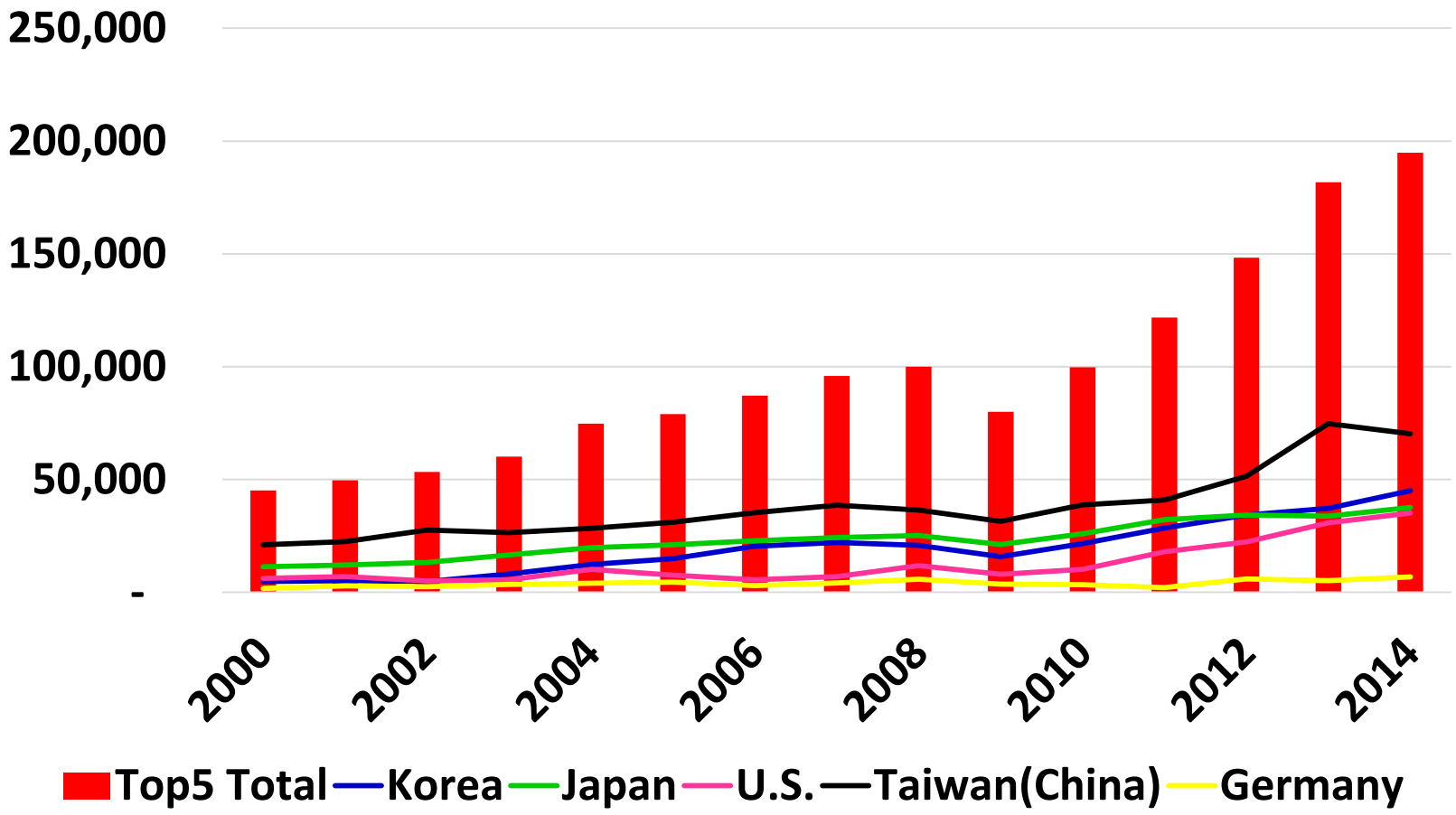
HK Over-invoicing



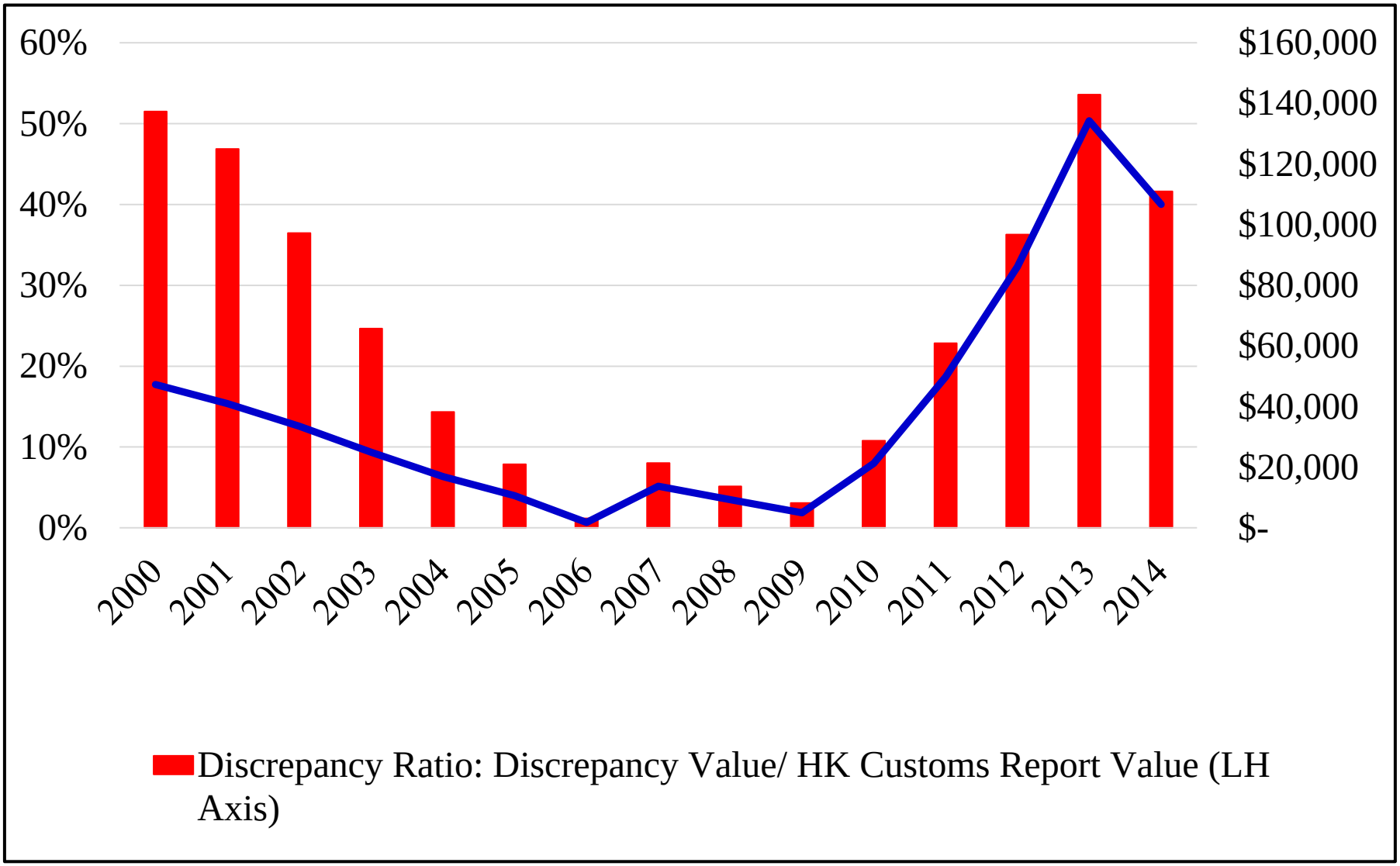
Copper stock value and interest rate difference



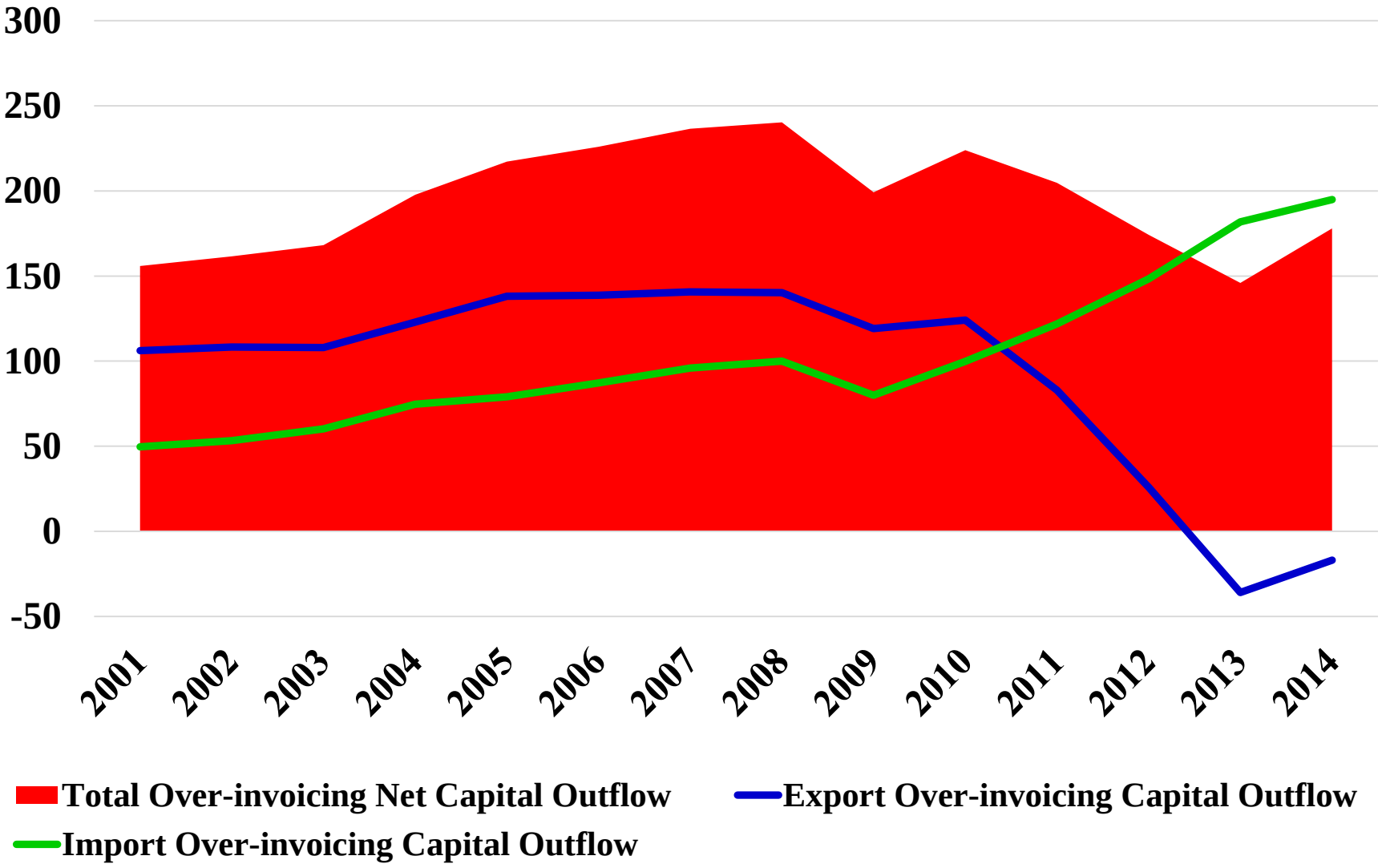
Export Under-Invoicing



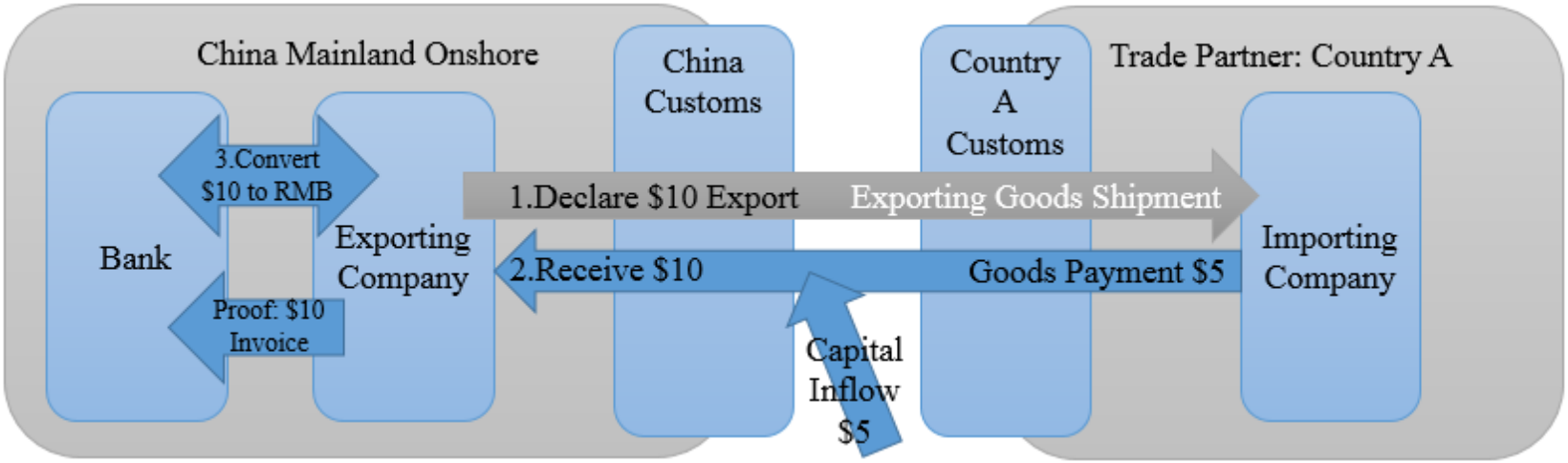
HK Over-invoicing

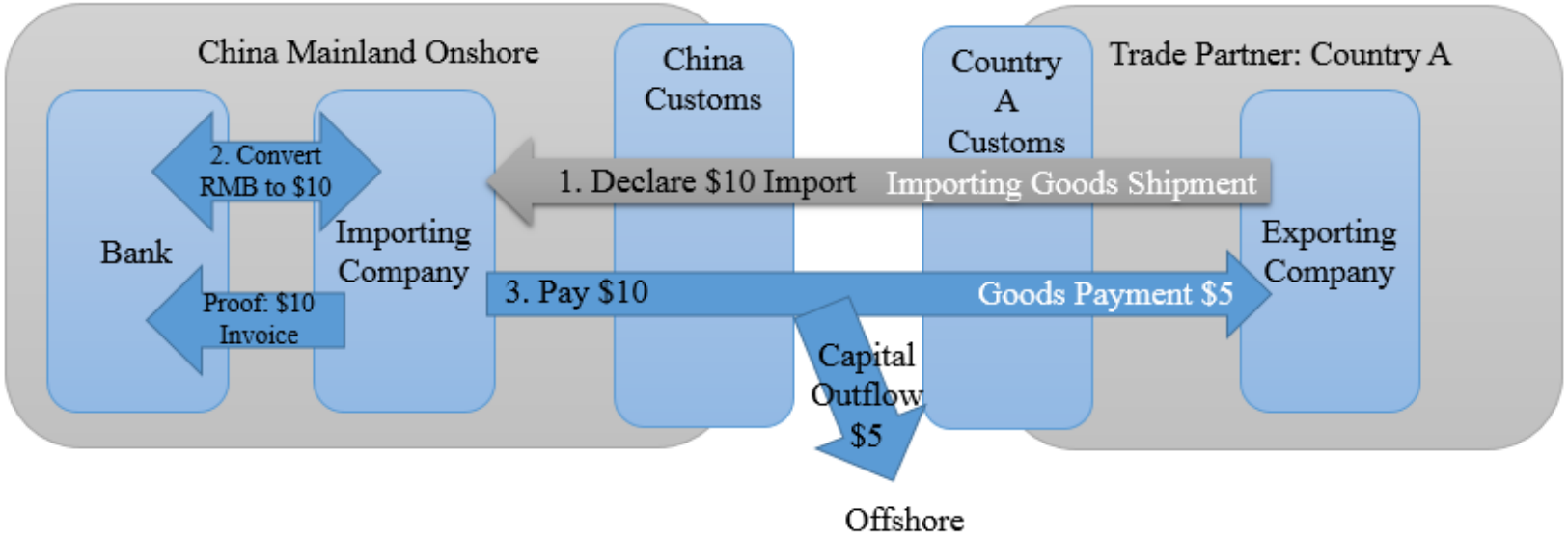


Net capital outflow

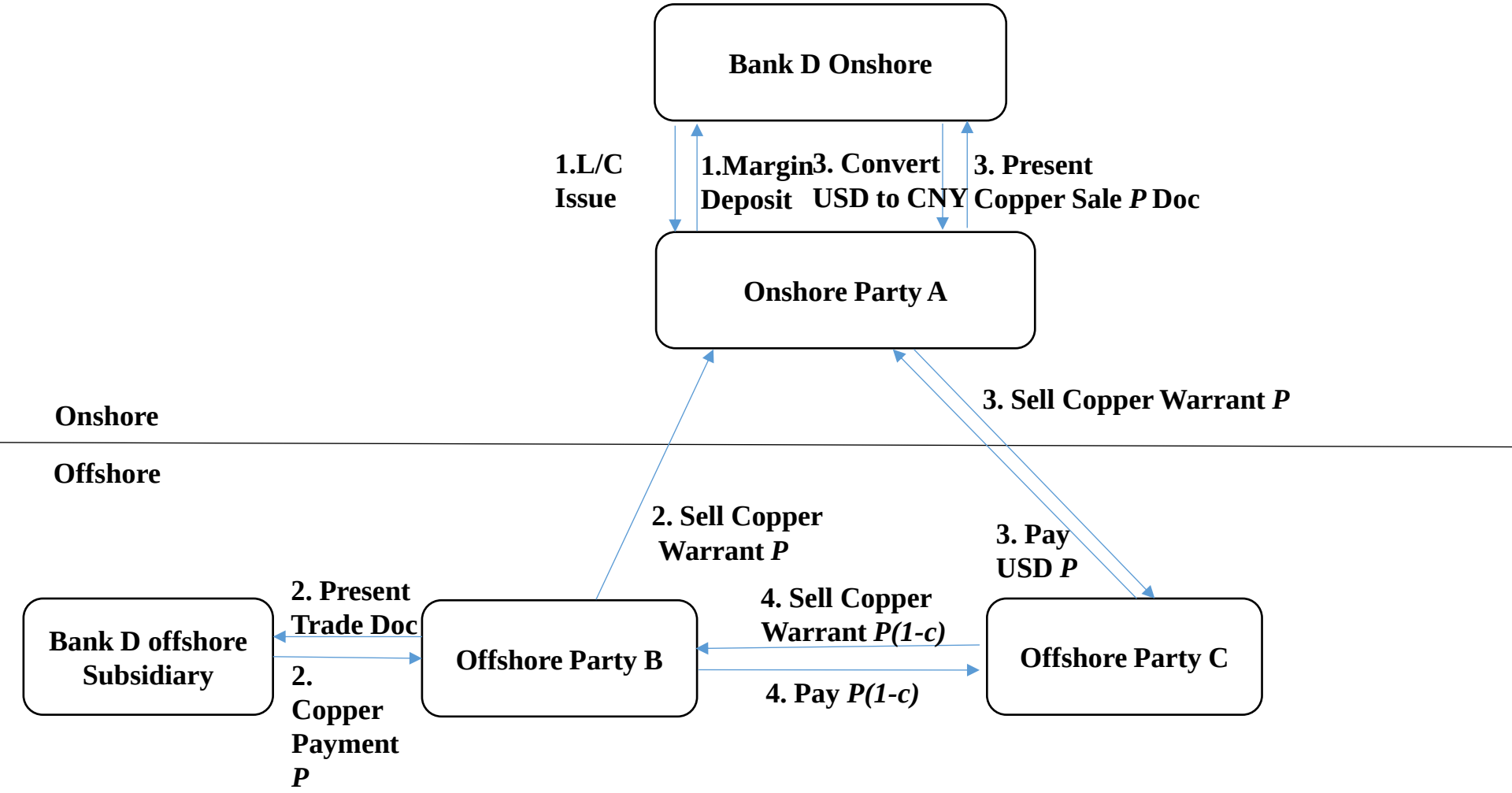


Over-invoicing





Copper Trade Finance



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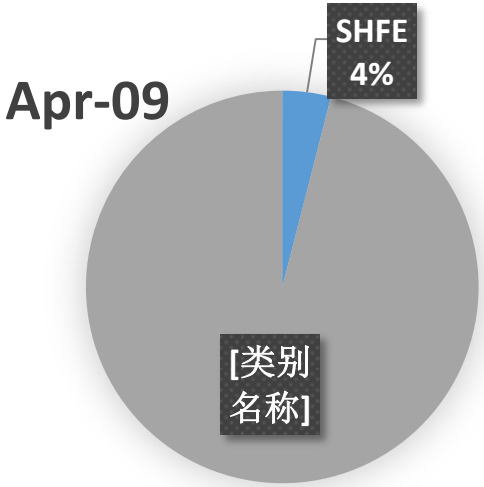
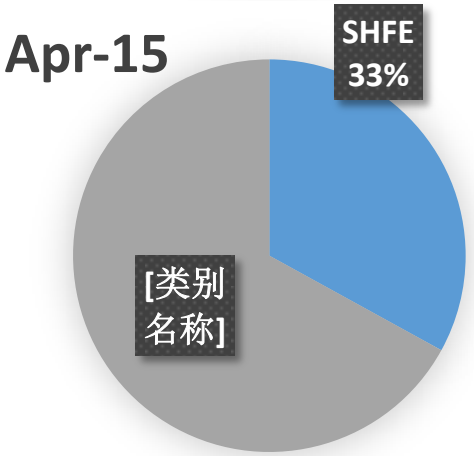
This practice shifts global copper stock to Shanghai Futures Exchange -> measurable

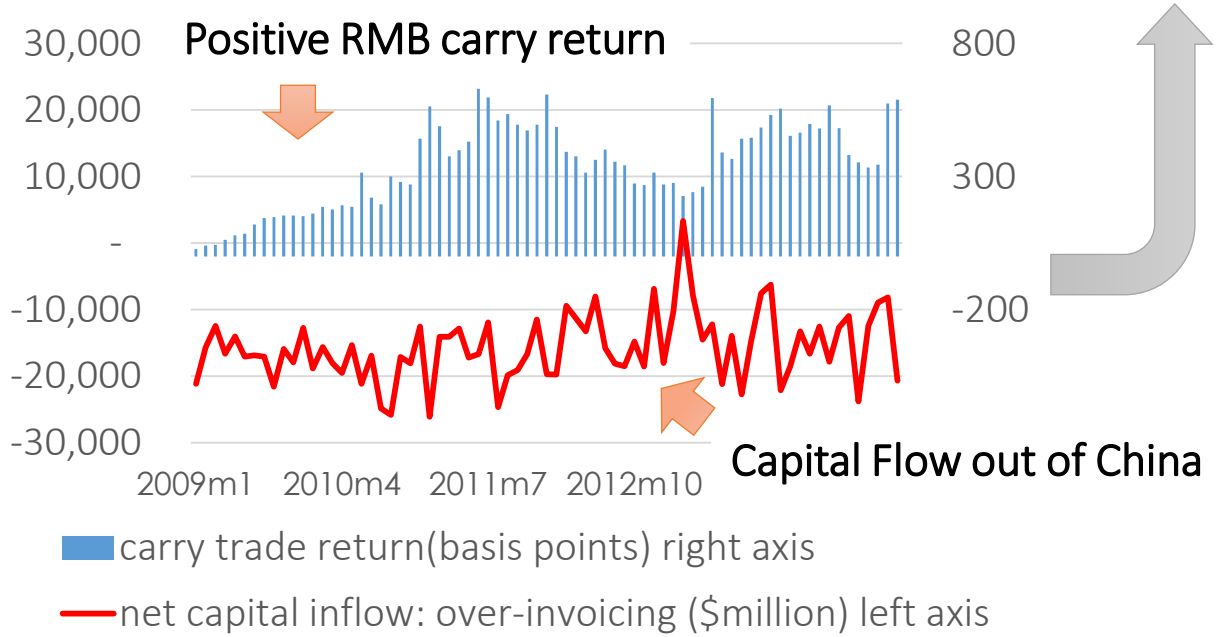




Q2-2 Over-invoicing is Driven by Capital Flight

Over-invoicing Capital Flow not affected by carry trade return → means it is not a carry trade tool

Evidence 1: Pesaran (2001) ARDL Bounds Testing suggest Long Run relationship between Carry Trade Return and Over-invoicing net capital inflow **Evidence 2**: Constant outflow despite high-profit carry trade → <u>A capital flight tool</u>



<u>Supported</u> Gunter (2001) Capital flight from China: 1984–2001 China Economic Review, 2004

(App. ARDL4)

Appendix

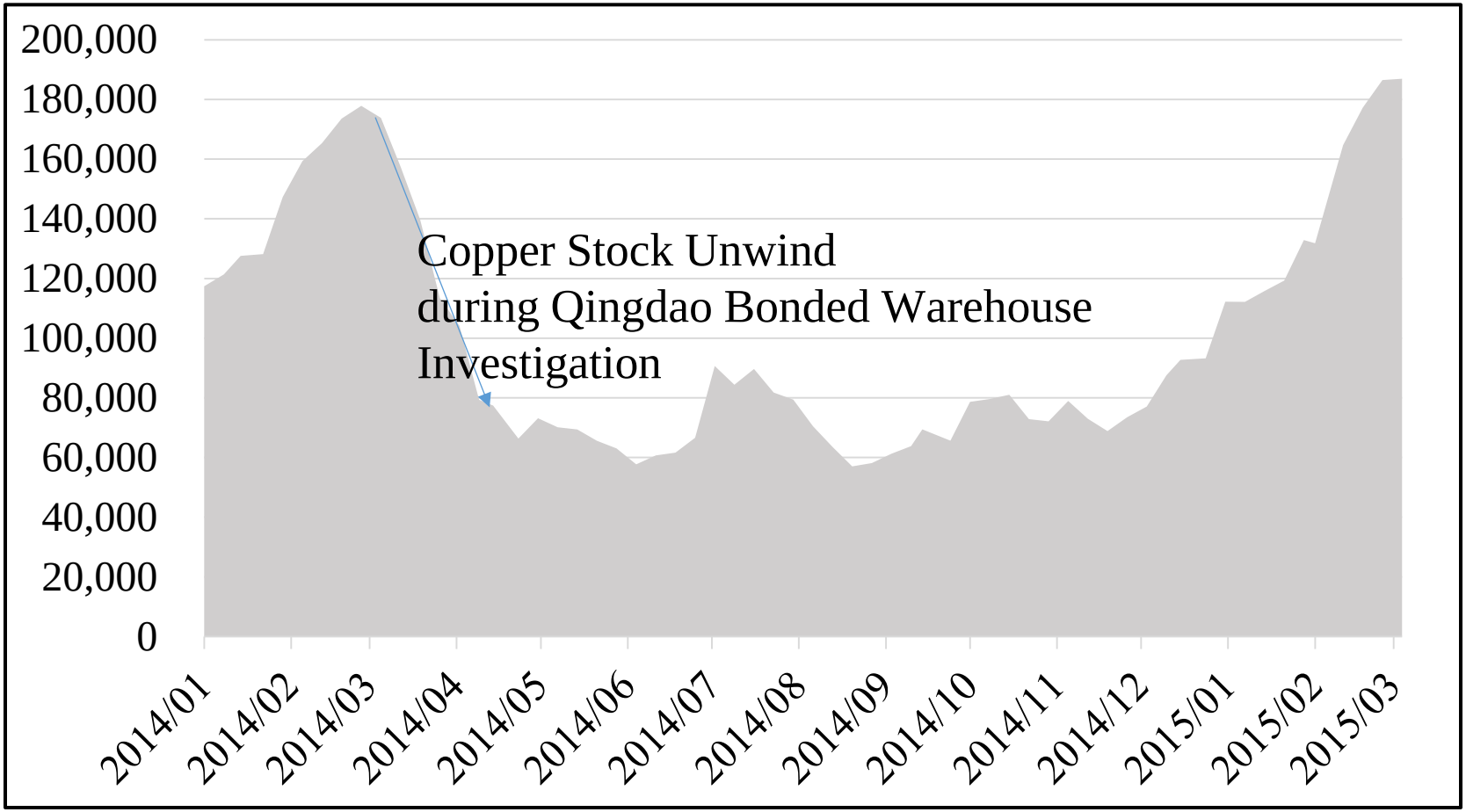
Variables Notation I (please skip, for your references later)

- ***CV***: Copper stock value, calculated as "total copper stock in Shanghai×Copper price" in thousand U.S. dollar. I(1)
- ***Ion***: 1 month Onshore risk-free interest rate, proxied by 1 month interbank lending rate in basis points. I(1)
- ***Ioff***: 1 month offshore risk-free interest rate, proxy as 1 month USD LIBOR in basis points. I(0)
- ***ID***: onshore-offshore interest rate difference (1 month), calculated as "Ion - Ioff" in basis points. I(1)
- ***SPOT***: USD/CNY spot exchange rate in basis points. I(1)
- ***FWD***: USD/CNY 1 month forward exchange rate in basis points. I(1)
- ***FP***: forward premium, calculated as "FWD - SPOT", is the forward market expectation of Renminbi depreciation (note: the fact that forward premium implies Renminbi depreciation subject to the quoting norm of using USD as base currency) in basis points. I(0)
- ***IMV***: expected implied volatility over the carry trade period, proxied by 1 month FX option implie volatility in percentage points. I(0)

Variables Notation 2 (please skip, for your references later)

- $\boldsymbol{R^c}$: Covered carry trade return, calculated as "((spot USD/CNY rate) ×(1+ China onshore interbank rate) / (NDF USD/CNY rate)) – Libor−1" in basis points. I(1)
- ***EXO***: China export over-invoicing to top 5 importing countries from China, which is a capital inflow, in million U.S dollar. I(1)
- ***IMO***: China export over-invoicing to top 5 exporting countries to China, which is a capital outflow, in million U.S dollar. I(1)
- ***Capin***: Capital inflow via legal channels. China onshore banks report FX purchases/sales under capital account inflow, including foreign direct investment and portfolio investment, in million dollars. I(1)
- ***Capout***: Capital outflow via legal channels. China onshore banks report FX purchases/sales under capital account outflow, including foreign direct investment and portfolio investment, in million dollars. I(1)
- $\boldsymbol{\Delta M2}$: China's monetary supply expansion, calculated as the first difference of M2, reported by People's Bank of China. I(1)

Qingdao Case



VECM CV Rc

Unrestricted Cointegration Rank Test(Trace & Maximum Eigenvalue)

No. of Cointegrating equation(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Maximun Eigenvalue statistic	0.05Critical Value	Prob.
None	0.02	17.99	15.49471	**0.02**	16.91	14.26	**0.02**
At most 1	0.00	1.078	3.841466	0.30	1.07	3.84	0.30

Trace test indicates 1 cointegrating eqn at the 5% level

Max-eigenvalue test indicates 1 cointegrating eqn at the 5% level

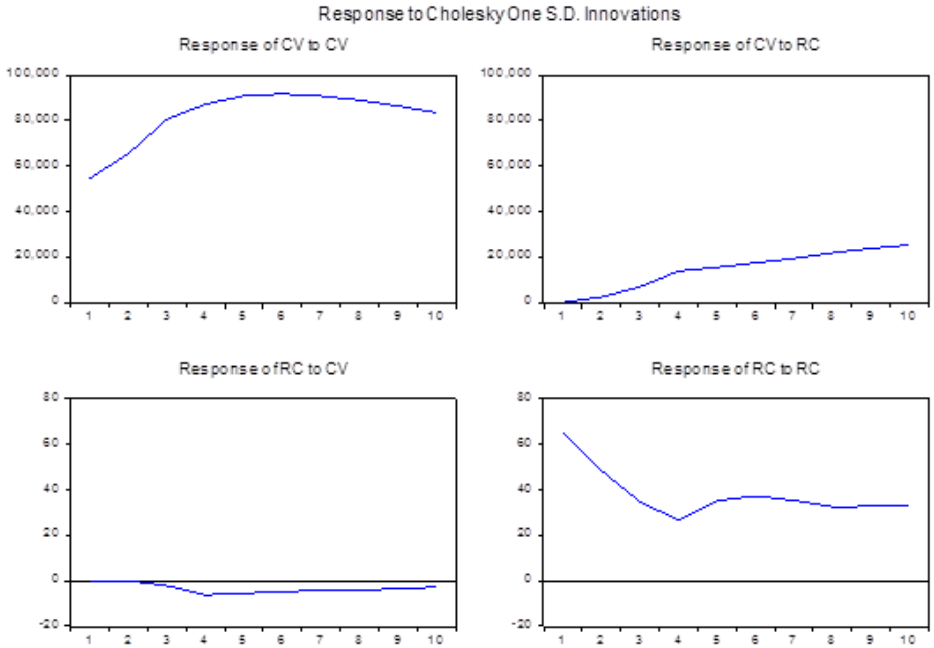
Normalized cointegrating coefficients
(standard error in parentheses)

Copper Value	Covered Carry Trade Return
1.000000	**-1718.59**
	(406.14)

VECM short-run coefficient, irf

VECM Result Summary (Partial)
Dependent Variable CV

		Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
	Error Correction Term	**-0.02**	0.01	-3.85	**0.00**	-0.03	-0.01
CV	lag 1	0.22	0.04	5.56	0.00	0.14	0.30
	lag 2	0.26	0.04	6.50	0.00	0.18	0.33
	lag 3	0.04	0.04	1.05	0.29	-0.04	0.12
Rc	lag1	0.98	33.45	0.03	0.98	-64.58	66.54
	lag2	34.48	33.05	1.04	0.30	-30.30	99.25
	lag3	**74.65**	33.01	2.26	**0.02**	9.95	139.35
	Constant	0.00	2206.02	0.00	1.00	-4323.71	4323.71



Vecm CV Rc Causality

- Copper Carry Trade Cannot Remove Arbitrage Opportunity
- Toda Yamamoto Approach to Causality:
  1) Causality Running From Carry Trade Return to Copper Stock Value
  2) **No** causality running from Copper Stock Value to Carry Trade Return

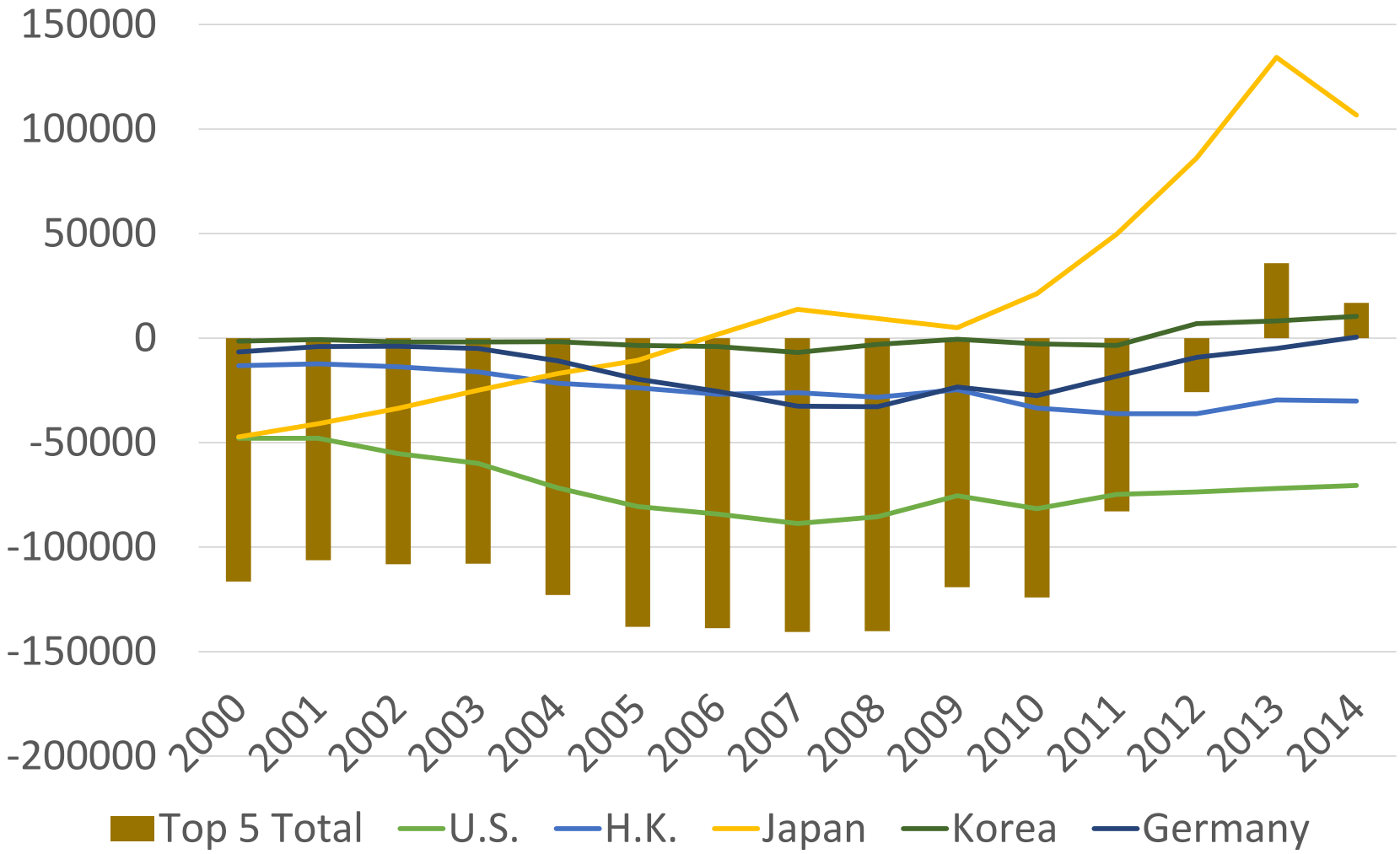
Wald Test:
Null Hypothesis: First 4 lags Rc coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	3.268225	(4, 612)	**0.01**
Chi-square	13.07290	4	**0.01**

Wald Test:
Null Hypothesis: First 4 lags CV coefficients are jointly

Test Statistic	Value	df	Probability
F-statistic	1.200379	(4, 612)	**0.31**
Chi-square	4.801517	4	**0.31**

Import Over-invoicing



Cv-fp id

- $CV_t = \alpha_0 + \sum \beta_i CV_{t-i} + \sum \gamma_J FP_{t-j} + \sum \delta_k ID_{t-k} + \sum \theta_l IMV_{t-l} + \epsilon_t$
- $\Delta CV_t = \alpha + \sum \beta_i \Delta CV_{t-i} + \sum \gamma_J \Delta FP_{t-j} + \sum \delta_k \Delta ID_{t-k} + \mu_0 CV_{t-1} + \mu_1 FP_{t-1} + \mu_2 ID_{t-1} + \epsilon$
- $\Delta CV_t = \alpha + \sum \beta_i \Delta CV_{t-i} + \sum \gamma_J \Delta FP_{t-j} + \sum \delta_k \Delta ID_{t-k} + \varphi Z_{t-1} + \epsilon_t$
- $z_{t-1} = CV_{t-1} - (a_0 + a_1 FP_{t-1} + a_2 ID_{t-1})$

Table 2-6 ARDL1 Bounds Testing Result

ARDL Bounds Test

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	**4.98**	2

Critical Value Bounds

Significance	Lower Bound	Upper Bound
10%	3.17	4.14
5%	3.79	**4.85**
2.50%	4.41	5.52
1%	5.15	6.36

Cv-fp id

Table 2-7 ARDL1 Unrestricted Error Correction Model Results

Dependent Variable: D(CV)

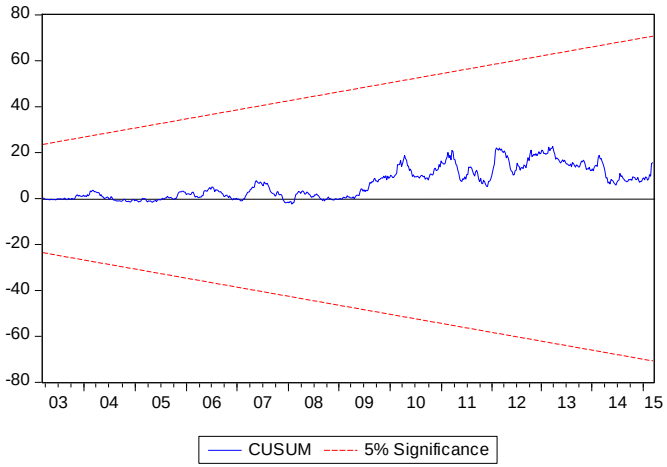
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CV(-1))	0.23	0.04	6.04	0.00
D(CV(-2))	0.27	0.04	6.91	0.00
D(FP)	-0.26	0.19	-1.38	0.17
D(FP(-1))	-0.59	0.19	-3.10	0.00
D(ID)	-31.98	32.57	-0.98	0.33
C	8946.55	3980.62	2.25	0.03
FP(-1)	**-0.02**	0.08	-0.23	**0.82**
ID(-1)	**32.47**	11.12	2.92	**0.00**
CV(-1)	**-0.02**	0.01	-3.67	**0.00**

Table 2-8 ARDL1 Long Run Coefficients

Dependent Variable: CV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FP	**-0.85**	3.76	-0.23	**0.82**
ID	**1515.16**	449.80	3.37	**0.00**
C	417456.81	135188.90	3.09	0.00

Cv-fp id



ARDL1 RECM Wald Test against No Short-Run Effect from FP

Wald Test:

Null Hypothesis: FP lags coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	5.354703	(2, 619)	**0.0049**
Chi-square	10.70941	2	**0.0047**

ARDL1 Restricted ECM Estimation Results

Dependent Variable: CV

Selected Model: ARDL(3, 2, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CV(-1))	0.2317	0.0384	6.0414	0.0000
D(CV(-2))	0.2668	0.0386	6.9114	0.0000
D(FP)	-0.2607	0.1889	-1.3801	0.1681
D(FP(-1))	**-0.5915**	0.1906	-3.1037	**0.0020**
D(ID)	-31.9836	32.5671	-0.9821	0.3264
CointEq(-1)	**-0.0214**	0.0058	-3.6727	**0.0003**

Cointeq = CV - (-0.8486*FP + 1515.1647*ID + 417456.8061)

CV-SPOT FWD ION OFF

- $\mathrm{CV} = \alpha_0 + \alpha_1 ION + \alpha_2 IOFF + \alpha_3 SPOT + \alpha_4 FWD + \epsilon$

ARDL2 Bounds Testing

ARDL Bounds Test

Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	**3.59**	4

:al Value Bounds

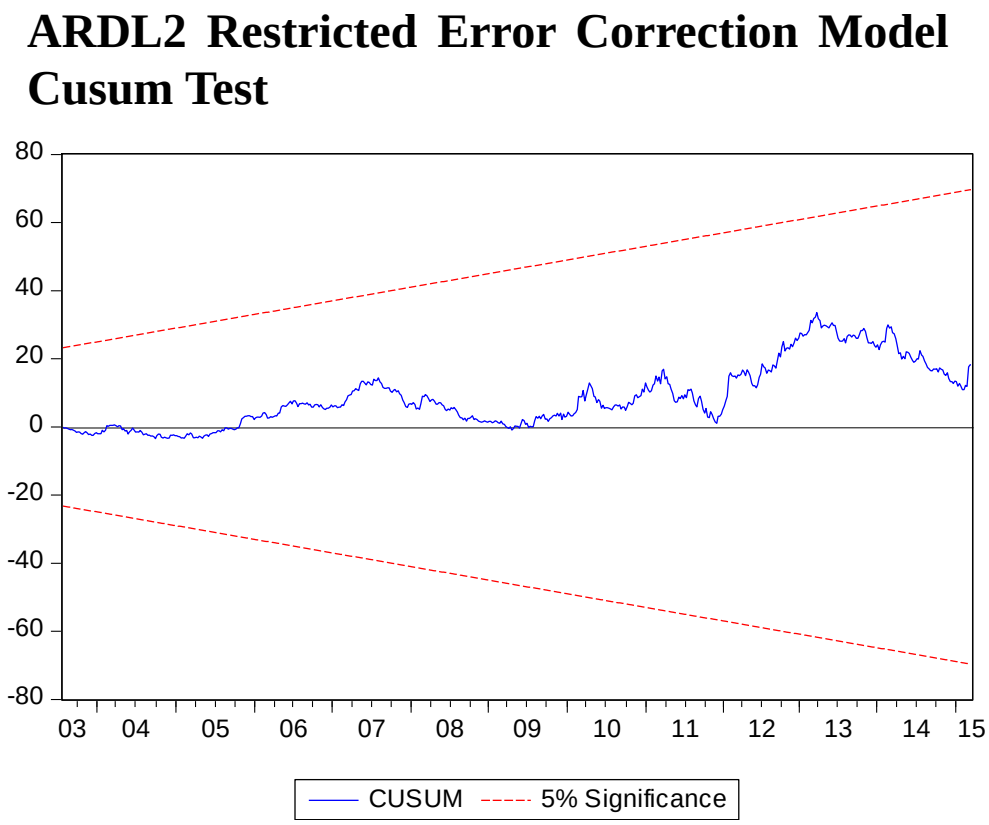
Significance	Lower Bound	Upper Bound
10%	1.9	3.01
5%	2.26	**3.48**
2.50%	2.62	3.9
1%	3.07	4.44

ARDL2 Long Run Cointegration Coefficients

Long Run Coefficients Dependent Variable: CV

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIBOR	**-1187.57**	610.44	-1.95	**0.05**
SHIBOR	**2130.52**	625.61	3.41	**0.00**
SPOT	**-31.20**	334.94	-0.09	**0.93**
FWD	**32.64**	335.20	0.10	**0.92**

CV-SPOT FWD ION OFF



CV-SPOT FWD ION OFF

ARDL2 Restricted Error Correction Model Estimation Results

Dependent Variable: CV
Selected Model: ARDL(5, 0, 4, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(CV(-1))	0.21	0.04	5.41	0.00
D(CV(-2))	0.25	0.04	6.15	0.00
D(CV(-3))	0.03	0.04	0.77	0.44
D(CV(-4))	0.09	0.04	2.24	0.03
D(Ioff)	**-28.64**	15.15	-1.89	**0.06**
D(Ion)	7.57	35.75	0.21	0.83
D(Ion(-1))	-65.42	42.32	-1.55	0.12
D(Ion(-2))	-31.25	42.56	-0.73	0.46
D(Ion(-3))	**81.79**	36.01	2.27	**0.02**
D(SPOT)	2.25	23.04	0.10	0.92
D(SPOT(-1))	**53.01**	22.36	2.37	**0.02**
D(FWD)	-29.04	19.45	-1.49	0.14
D(FWD(-1))	**-61.25**	19.51	-3.14	**0.00**
CointEq(-1)	**-0.02**	**0.01**	-4.06	**0.00**

Cointeq = CV - (-1187.5667*LIBOR + 2130.5174*SHIBOR -31.2044*SPOT + 32.6437*FWD)

CV-SPOT FWD ION OFF

Wald Test:
Null Hypothesis: Ion lags coefficients are jointly zero

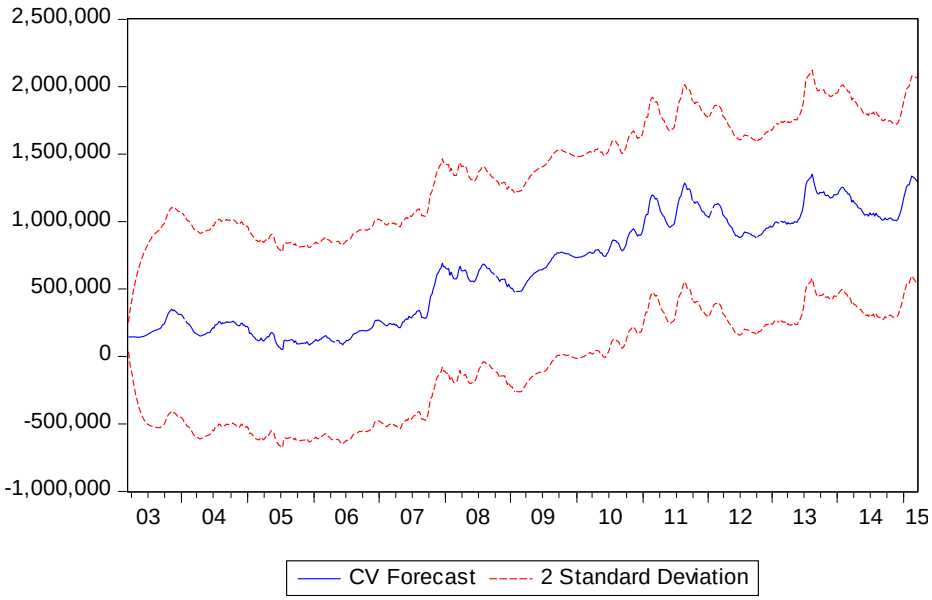
Test Statistic	Value	df	Probability
F-statistic	1.85	(4, 612)	**0.12**
Chi-square	7.41	4	**0.12**

Wald Test:
Null Hypothesis: SPOT lags coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	3.17	(2, 609)	**0.04**
Chi-square	6.34	2	**0.04**

Wald Test:
Null Hypothesis: FWD lags coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	5.87	(2, 609)	**0.00**
Chi-square	11.74	2	**0.00**



Exo and Rc

ARDL3 Bounds Testing for No Long-Run Relationship between EXO and R_c

ARDL Bounds Test
Null Hypothesis: No long-run relationships between EXO and Rc

Test Statistic	Value	k
F-statistic	**4.76**	1

Critical Value Bounds		
Significance	Lower Bound	Upper Bound
10%	4.04	**4.78**
5%	4.94	**5.73**
2.50%	5.77	6.68
1%	6.84	7.84

ARDL3 Bounds Testing for No Long-Run Relationship between IMO and R_c

ARDL Bounds Test
Null Hypothesis: No long-run relationships between IMO and Rc

Test Statistic	Value	k
F-statistic	**1.14**	1

Critical Value Bounds		
Significance	Lower Bound	Upper Bound
10%	4.04	**4.78**
5%	4.94	**5.73**
2.50%	5.77	6.68
1%	6.84	7.84

Capital inflow affect domestic supply

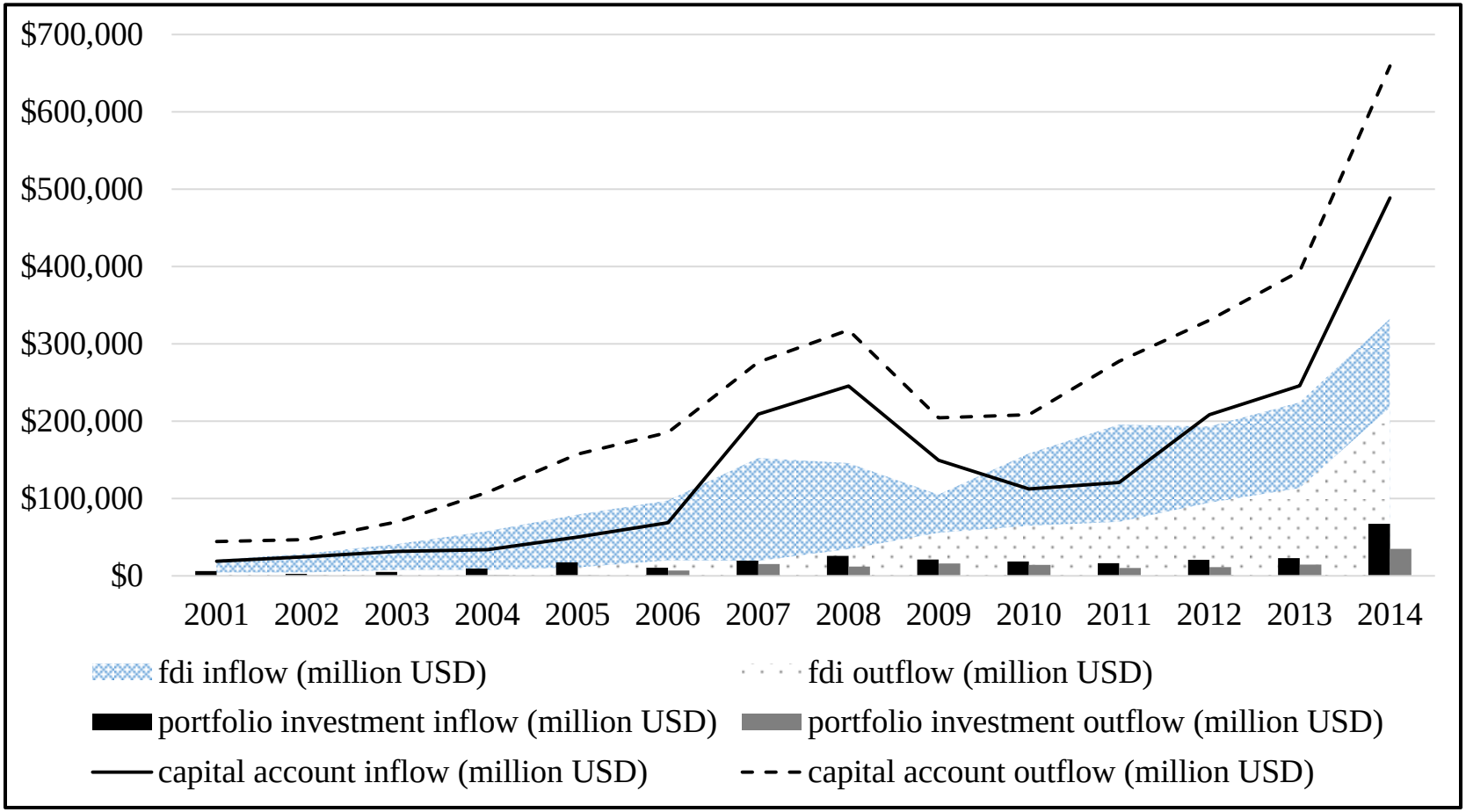
- Monetory supply

$$\mathrm{M} = \mathrm{MB}_t \times \mathrm{m}_t$$

Capital inflow -> fx sale-> SAFE intervene -> FX reserve down -> MB down -> M down

- Sterilization coefficient
  - $\mathrm{I}_t = \frac{\Delta CC_t}{\Delta FR_T}$

Legal Capital Flow



- $\Delta M2 = \alpha_0 + \alpha_1 CAPIN + \alpha_2 CAPOUT + \alpha_3 EXO + \alpha_4 IMO + \alpha_5 CV + \varepsilon$
- **Hypothesis 7: Capital movement significantly affect domestic money supply (M2) in the short-run and long-run.**

ARDL Bounds Test

Null Hypothesis: No long-run relationships

Test Statistic	Value	k
F-statistic	**5.51**	5

Critical Value Bounds

Significance	Lower Bound	Upper Bound
10%	2.26	**3.35**
5%	2.62	**3.79**
2.50%	2.96	4.18
1%	3.41	4.68

ARDL4 Bounds Testing against No Long-Run Relationship

ARDL4 short run coefficients

ARDL4 Unrestricted Error Correction Model
Long Run Coefficients

Dependent Variable: CV

Selected Model: ARDL(3, 1, 0, 4, 4, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(M2(-1), 2)	-0.32	0.11	-2.92	0.00
D(M2(-2), 2)	-0.24	0.08	-3.13	0.00
D(CAPIN)	7.47	2.02	3.71	0.00
D(CAPOUT)	-0.15	1.26	-0.12	0.91
D(EXO)	-2.93	2.49	-1.18	0.24
D(EXO(-1))	5.40	2.40	2.25	0.03
D(EXO(-2))	-5.29	2.40	-2.21	0.03
D(EXO(-3))	12.96	2.59	5.01	0.00
D(IMO)	4.44	3.41	1.30	0.20
D(IMO(-1))	-2.47	3.15	-0.78	0.43
D(IMO(-2))	1.92	3.67	0.52	0.60
D(IMO(-3))	-11.87	3.91	-3.03	0.00
D(CV)	38.97	26.43	1.47	0.14
CointEq(-1)	-0.60	0.14	-4.40	0.00

Cointeq = D(M2) - (-0.2309*CAPIN -0.2477*CAPOUT -17.3038*EXO + 28.3508*IMO + 64.6988*CV -303398.9094)

ARDL 4 short run wald test

ARDL4 RECM Wald Test against No Short-Run Effect from EXO

Wald Test:

Null Hypothesis: EXO lags coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	11.48	(4, 130)	**0.00**
Chi-square	45.95	4	**0.00**

ARDL4 RECM Wald Test against No Short-Run Effect from imo

Wald Test:

Null Hypothesis: IMO lags coefficients are jointly zero

Test Statistic	Value	df	Probability
F-statistic	8.37	(4, 130)	**0.00**
Chi-square	33.48	4	**0.00**

Copper consumption and copper stock value

Unrestricted Cointegration Rank Test(Trace & Maximum

No. of Cointegrating equation(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Maximun Eigenvalue statistic	0.05Critical Vlue	Prob.
None	0.069	10.35985	15.49471	**0.2541**	10.29544	14.2646	**0.1932**
At most 1	0.000447	0.064406	3.841466	0.7996	0.064406	3.841466	0.7996

Trace test indicates 0 cointegrating eqn(s) at the 5% level

Max-eigenvalue test indicates 0 cointegrating eqn(s) at the 5% level

robustness

Unrestricted Cointegration Rank Test(Trace & Maximum Eigenvalue)

No. of Cointegrating equation(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Maximun Eigenvalue statistic	0.05Critical Vlue	Prob.
None	0.030676	13.40257	12.3209	**0.0328**	13.39723	11.2248	**0.0204**
At most 1	1.24E-05	0.005343	4.129906	0.952	0.005343	4.129906	0.952

1 year

Trace test indicates 1 cointegrating eqn at the 5% level

Max-eigenvalue test indicates 1 cointegrating eqn at the 5% level

Unrestricted Cointegration Rank Test(Trace & Maximum Eigenvalue)

No. of Cointegrating equation(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Maximun Eigenvalue statistic	0.05Critical Vlue	Prob.
None	0.03101	13.55322	12.3209	**0.0309**	13.5456	11.2248	**0.0192**
At most 1	1.77E-05	0.007619	4.129906	0.9433	0.007619	4.129906	0.9433

6 month

Trace test indicates 1 cointegrating eqn at the 5% level

Max-eigenvalue test indicates 1 cointegrating eqn at the 5% level

Unrestricted Cointegration Rank Test(Trace & Maximum Eigenvalue)

No. of Cointegrating equation(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.	Maximun Eigenvalue statistic	0.05Critical Vlue	Prob.
None	0.030965	13.54022	12.3209	**0.0311**	13.52564	11.2248	**0.0194**
At most 1	3.39E-05	0.014575	4.129906	0.9214	0.014575	4.129906	0.9214

3 month

Trace test indicates 1 cointegrating eqn at the 5% level

Max-eigenvalue test indicates 1 cointegrating eqn at the 5% level

Appendix. Method Choice:

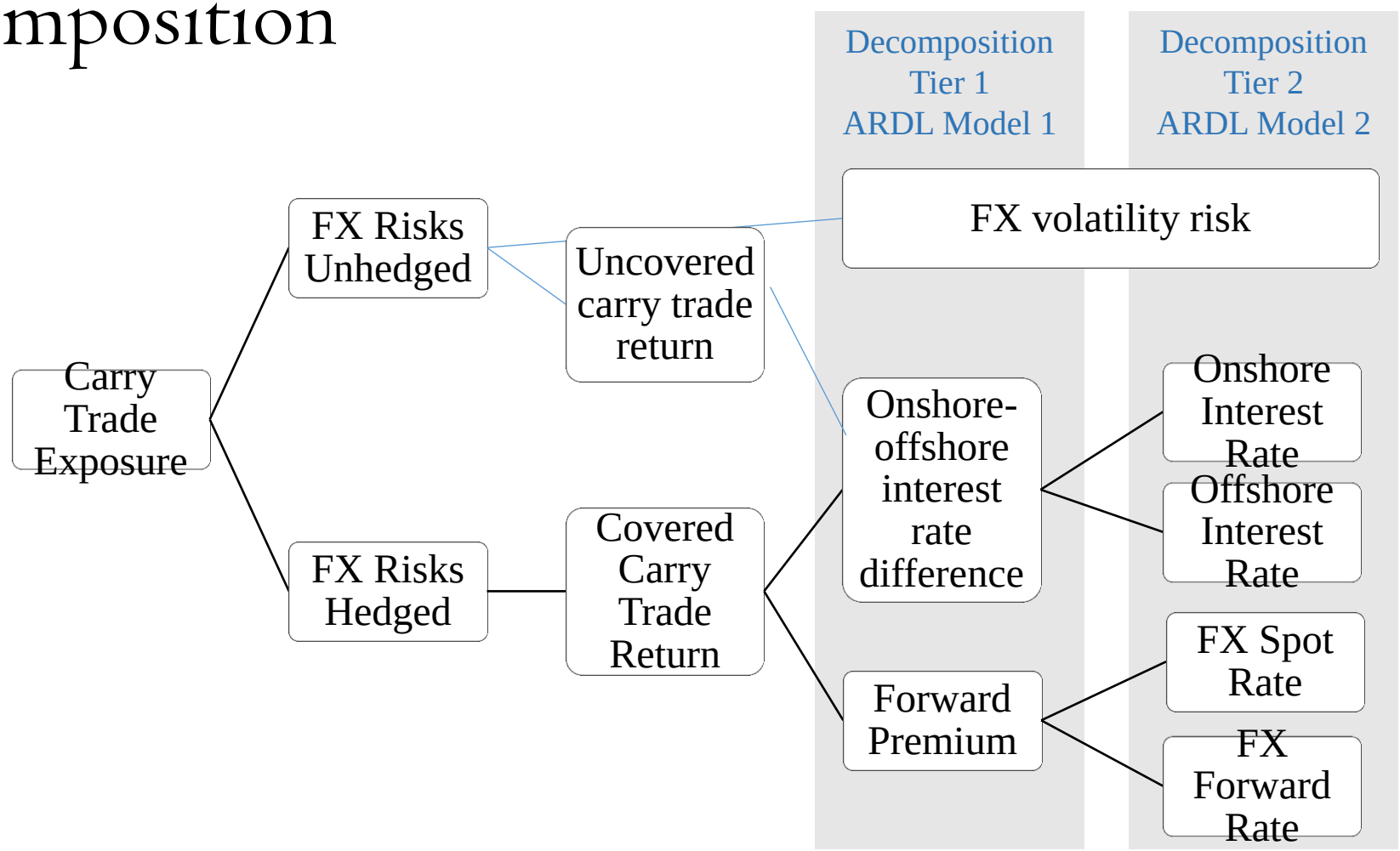
Autoregressive Distributed Lags Error Correction Model & Vector Error Correction Model

- Use ARDL-ECM Pesaran & etc (2001) because
  - a mixture if I(1) and I(0) and no I(2) variables(VECM/VAR requires all I(1) or I(0))
  - one single equation set-up, simple to interpret the main model (eg. SPOT FWD SHIBOR LIBOR effect on COPPER VALUE)
  - different variable lag-length to include in this model (VECM/VAR requires all same lag-length)
  - present both the long-run co-integration and short-run dynamics
  - Relatively small sample size: 628 and 144 respectively in two estimations (back to dropping imv)
- Use VECM as a cross-check, and for
  - impulse response function
  - Better Forecast with feedback effects included
- Use Toda Yamamoto (1995) Approach to Causality because
  - There is nonstandard asymptotic properties in wald tests of Granger Causality with the existence of co-integration

Appendix. Carry Trade Return

- Covered Carry Trade Return: $R_t^c = \frac{S_t \times (1+i_t^{on})}{F_t} - i_t^{off} - 1$
  - R_t^c: Covered Carry Trade Return at time t
  - S_t: USD/CNY spot exchange rate at time t
  - F_t: USD/CNY 1 Month Forward Rate at time t
  - i_t^{on}: Onshore 1-month risk-free interest rate at time t
  - i_t^{off}: Offshore 1-month risk-free interest rate at time t
- Uncovered Carry Trade Return: $R_t^c = \frac{S_t \times (1+i_t^{on})}{F_t} - i_t^{off} - 1$
  - R_t^u: Covered Carry Trade Return at time t
  - S_t/S_{t+1}: USD/CNY spot exchange rate at time t/(t+1)
  - i_t^{on}: Onshore 1-month risk-free interest rate at time t
  - i_t^{off}: Offshore 1-month risk-free interest rate at time t

Appendix. Carry Trade Exposure Decomposition



Appendix. Over-invoicing capital flight

- There are some attempts to estimate capital flight over-invoicing in previous research. Claessen (1993) found countries with smaller GDP have more capital flight than one would expect if it were distributed over countries proportionately to GDP. During the period 1998–2001, cumulative capital flight of approximately $920 billion for the PRC and about $60 billion for Hong Kong are estimated by Gunter (2001). Rishi (1990) estimated that the total India capital flight via trade invoice manipulation in this sixteen-year period amounted to $ 21.1 billion in 1986 between 1971 and 1986.