# ARE CHINESE STOCK PRICES REALLY THAT VOLATILE?

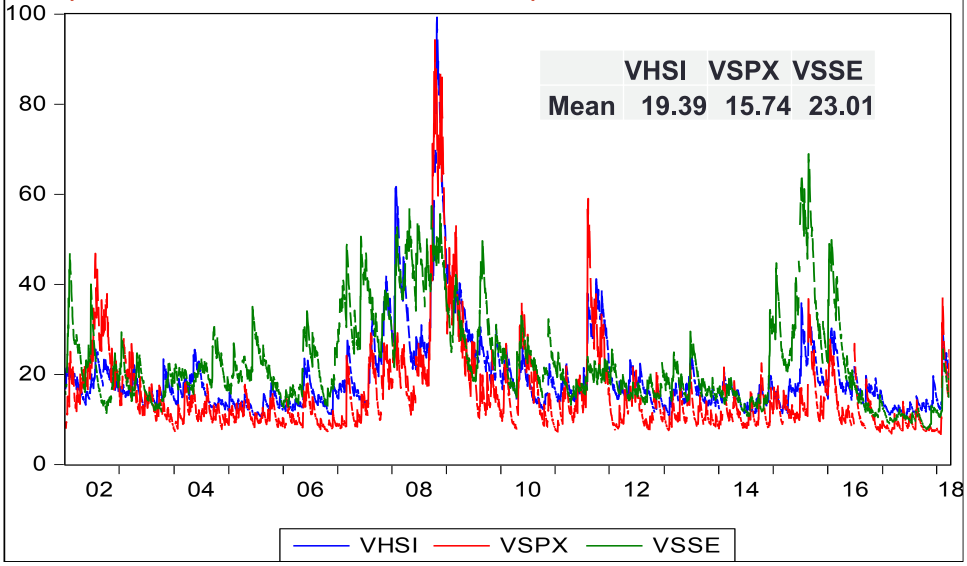
Robert Engle (NYU Stern), Matthew Richardson (NYU Stern) & Xin Zhou (NYU Shanghai)

## Casino Theory of Chinese Stock Market

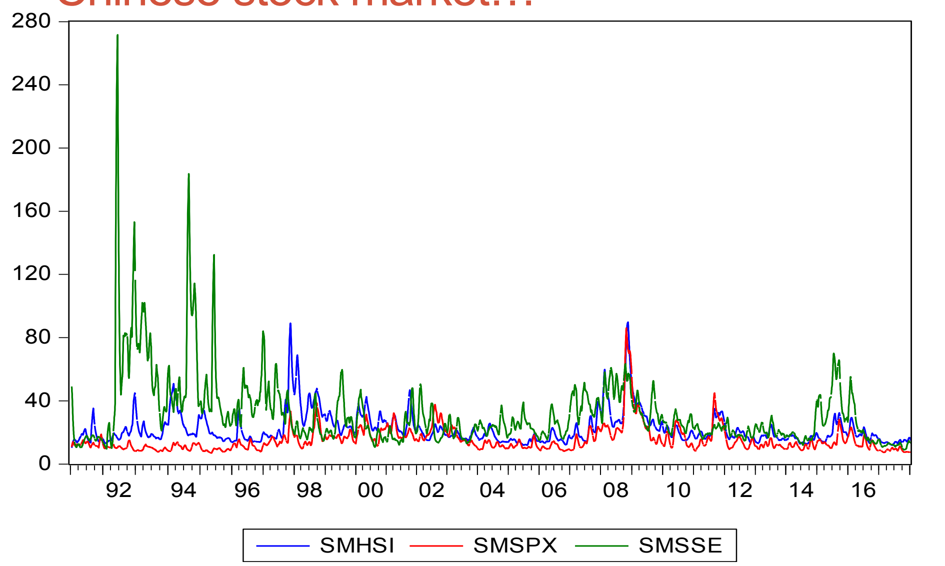
- "Casino Theory" of Chinese stock market by economist Wu Jinglian, February 2001, adding "There are rules in casinos such as you can't look at other people's cards. In our stock market, some people can take a peek at others' cards. And they get away with all sorts of tricks and chicanery."
- "Markets (like China) have a casino characteristic that has a lot of appeal to people, particularly when they see people getting rich around them," Warren Buffett, May 6, 2017

## Volatility of Chinese Market Is High (2002-2017, GJR-GARCH)

| | VHSI | VSPX | VSSE |
|---|---|---|---|
| Mean | 19.39 | 15.74 | 23.01 |




## And going back to the beginning of the Chinese stock market…



## Characteristics of China's Stock Market

- $2^{nd}$ largest in the world
  - A-shares: SSE - SHCOMP(1990, 1436 companies, $5.2 trn), SZE - SZCOMP (1990, 2126 companies, $3.7 trn), ChiNext Index(100 companies, $340 bn)
  - B-shares (Mainland open to foreign investors, 1991); H-shares (Hong Kong mainland, 1993; $761 bn); N-shares (NYSE, $734 bn, 1994); L-shares (LSE, 1997), S-shares (Singapore, 1997)
- Substantive state ownership
- Trading volume: A-shares is retail driven (approximately 85%), H-shares is institutional driven (approximately 65%)
- A-shares short-sale constrained, many H-shares are not
- Segmented from rest of world with gradual changes
  - QFII (2002), QDII (2006)
  - Hong Kong & Shenzhen Connect (2014/2016)

## Outline

- Theory
- Stylized facts on China's stock price volatility
- Case study: dual-listed A- and H- shares
- Cross-sectional analysis of China volatility

# I. Theory

Two assumptions:

- Assume segmented markets. (Hietala (1989) and Bailey (1994).)
- Chinese investors are less risk-averse than U.S and other countries' investors (Hsee & Weber (1998, 1999), Fan and Xiao (2006), Statman (2008), Arkes, Hirshleifer, Jiang and Lim (2010), and Rieger, Wang and Hens (2015))

What are the implications for asset pricing, and, in particular, volatility?

# Volatility & Risk Aversion

- Two views on volatility:
  - Campbell and Shiller (1988), De Long, Shleifer, Summers and Waldmann (1990) – noise trader & excess volatility
  - Barsky & De Long (1993), Cochrane (2009) – discount rates at aggregate level, Vuolteenaho (2002) – cash flows at individual level
- Volatility & Risk Aversion
  - LeRoy and LaCivita (1981) argue volatility is increasing in risk aversion – increases variation of discount rates which in turn lead to greater price volatility in representative agent models.
  - Barsky (1989) points out the affect on prices will be ambiguous (depending on whether CRRA is less than or greater than 1). Though equity premium goes up, expected stock returns (and thus prices) is ambiguous because riskless rate falls.
- Kandel and Stambaugh (1991), Tauchen (2011 ), and Wachter (2013), to name a few, argue more complex preferences are needed to fit asset pricing stylized facts.

## Tauchen's GE Model of Stochastic Volatility

Representative agent model;Epstein-Zin preferences; stochastic volatility of consumption growth w/ AR process in volatility with volatility of volatility also following an AR process.

Key parameter:

$\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$, where $\gamma$ is coeff of risk aversion, $\psi$ is intertemporal elasticity of substitution (IES)

Key results:

(1) RP increasing in $\gamma$ (standard result) and (1-$\theta$) (which is due to the VRP).

(2) VRP is positive if $\psi$>1 and $\gamma$>1 (or $\psi$<1 and 1/$\psi$>$\gamma$) . Thus, if $\gamma$ is small, more likely to see **small or negative VRPs**. $\gamma$ is small for China.

(3) GE Volatility decreasing in $\theta$, which means if $\psi$>1 then increasing in $\gamma$. Lower $\gamma$ (as in China) means **lower volatility**. If $\gamma$<1 (>1), then volatility increasing (decreasing) in $\psi$.

(4) Asymmetric volatility (leverage effect) depends on sign of $\theta$. If, for example, if $\psi$>1 , and $\gamma$>1 then standard negative value arises, but if $\gamma$<1 (**small $\gamma$ in China**) then counterfactual (**except in China**) positive value.

## Why Chinese volatility might be high?

- Dynamic version of dividend discount (Gordon growth) model

$$\sigma_R^2 \approx \text{var}[\Delta(\text{expectations of future cash flow})] + \text{var}[\Delta(\text{expectations of future discount rates})\text{-}2\text{cov}[\Delta_{CF}, \Delta_R]$$

- Timmerman (1993), David (1997), Brennan and Xia (2001), and Pastor and Veronesi (2003, 2006, 2009) have models with constant earnings growth but uncertainty about what this growth is, resulting, ceteris paribus, in (i) high P/E ratios and (ii) high volatility.

$$P = E\left[\frac{D}{r-g}\right] > \frac{D}{r-E[g]}$$

$$\sigma_R \approx \sigma_{D_G} \times [1 + f(\text{uncertainty})]$$

# Implications of Greater Integration

- Lintner (1969) model of heterogenous investors with CARA preferences: M China investors (lower RA coefficient, $\alpha_c$) and M Hong Kong investors ($\alpha_{hk}$) trading fixed number (say numeraire) of A- and H-shares separately
- Questions:
  - What do the prices/returns look like in these two markets?

$$\underline{p}_i = \tfrac{1}{r_0}\left(\sum_{j=1}^{m}\tfrac{1}{\alpha_{ij}}\Omega_{ij}^{-1}\right)^{-1}\left(\sum_{j=1}^{m}\tfrac{1}{\alpha_{ij}}\Omega_{ij}^{-1}\underline{\mu}_{ij} - \underline{1}\right)$$

where $\mu$ and $\Omega$ are the investor $j$'s mean and variance beliefs respectively in market $i$ (China and HK)

  - Assume homogenous beliefs in each and across markets.

Then

$$\underline{p}_i = \tfrac{1}{r_0}\left(\underline{\mu}_i - \left(\sum_{j=1}^{m}\tfrac{1}{\alpha_{ij}}\right)^{-1}\Omega\underline{1}\right);\ j\text{'s holdings of asset }(q_k),\ q_{kij} = \tfrac{1}{\alpha_{ij}}\left(\sum_{j=1}^{m}\tfrac{1}{\alpha_{ij}}\right)^{-1}$$

Investor $j$ in China & HK holds a linear share of the market portfolio in each Market (same % share of each risky asset). CAPM equation holds.

# Implications of Greater Integration

- A comparison of the prices in China and HK:
  Assume $\alpha_c$ and $\alpha_{hk}$ for China and HK investors. Then the price difference is:

$$p_C - p_{HK} = \left(\frac{\alpha_{HK} - \alpha_C}{m}\right)\Omega\underline{1}$$

Because single period model with same payoffs, both *ER* and *Vol* higher in HK than China.

- What do the prices/returns look like in these two markets when they integrate?
  Integration leads to price convergence ($p^*$) and a decrease (increase) in Chinese (Hong Kong) stock prices and higher (lower) volatility

$$p_C - p^* = \left(\frac{\alpha_C(\alpha_{HK} - \alpha_C)}{m(\alpha_{HK} + \alpha_C)}\right)\Omega\underline{1}$$

$$q_C = \left(\frac{\alpha_{HK}}{m(\alpha_{HK} + \alpha_C)}\right); q_{HK} = \left(\frac{\alpha_C}{m(\alpha_{HK} + \alpha_C)}\right)$$

# II. Stylized Facts

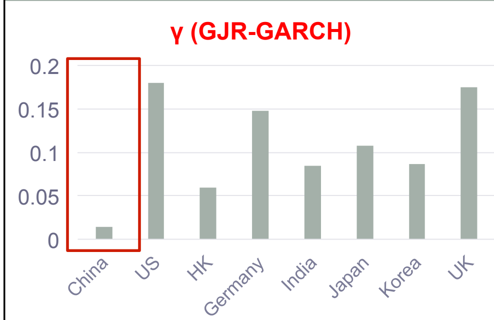
- Return Volatility & Other Measures
  - Aggregate Markets
  - Case Study: Dual-listed A- versus H-shares
    - Description
    - Individual results
    - Portfolio results
  - Cash Flow Volatility

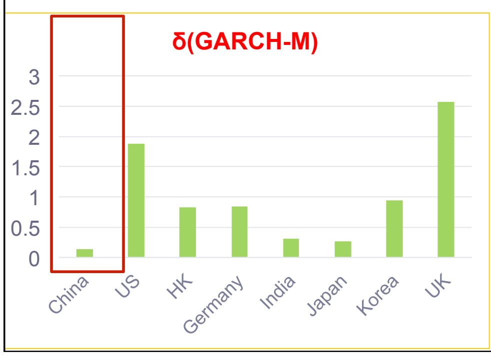
# A. Aggregate Markets

- Summary table or figure of average volatility across aggregate markets
- Measure of asymmetry (GJR GARCH) and risk aversion (M-GARCH)
- Correlation of conditional volatilities (US, China, HK)
- Volatility risk premium
- Pairwise conditional correlations

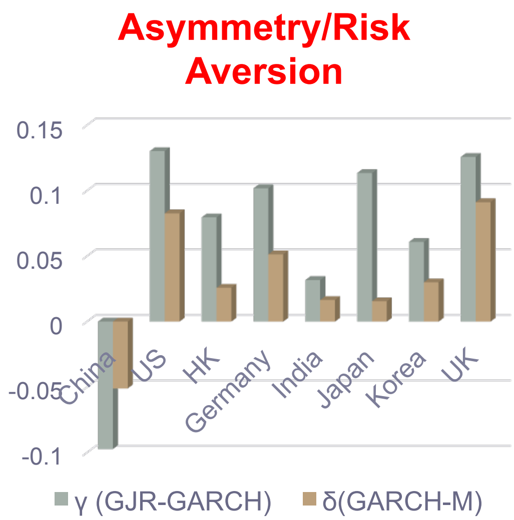
# Aggregate volatility across markets (2002-2017)

| | VSSE | VSPX | VNIKKEI | VNIFTY | VKOSPI | VHSI | VDAX | VFTSE |
|---|---|---|---|---|---|---|---|---|
| Mean | 22.99 | 15.74 | 21.28 | 19.55 | 18.69 | 19.39 | 20.46 | 15.88 |
| Median | 20.05 | 12.52 | 19.10 | 16.40 | 15.48 | 16.61 | 17.48 | 12.90 |
| Maximum | 68.95 | 94.25 | 107.62 | 94.31 | 94.30 | 99.29 | 78.24 | 96.06 |
| Minimum | 7.70 | 6.57 | 11.02 | 9.33 | 8.38 | 10.17 | 8.68 | 6.83 |
| Skewness | 1.30 | 3.33 | 3.64 | 2.61 | 2.39 | 3.38 | 1.95 | 3.06 |
| Kurtosis | 4.41 | 18.39 | 24.48 | 12.28 | 12.39 | 19.80 | 7.37 | 17.54 |

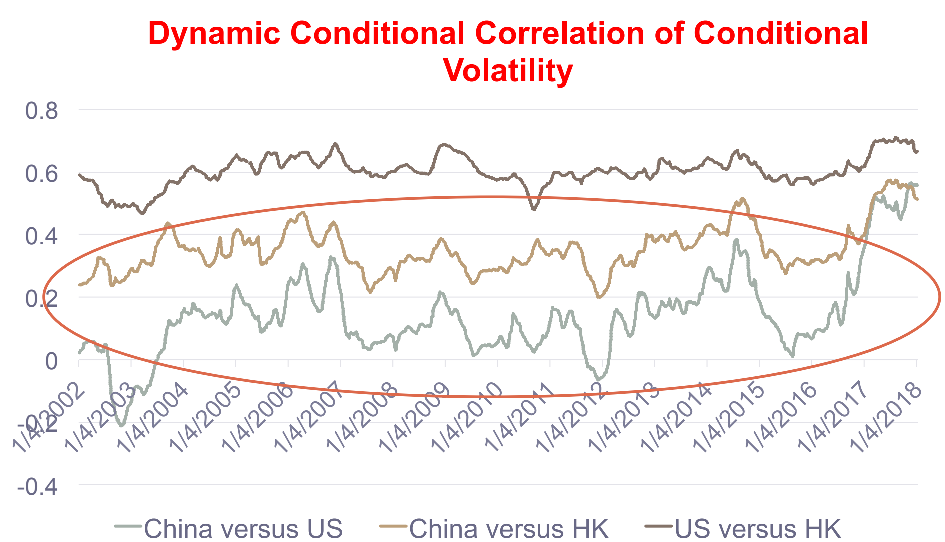


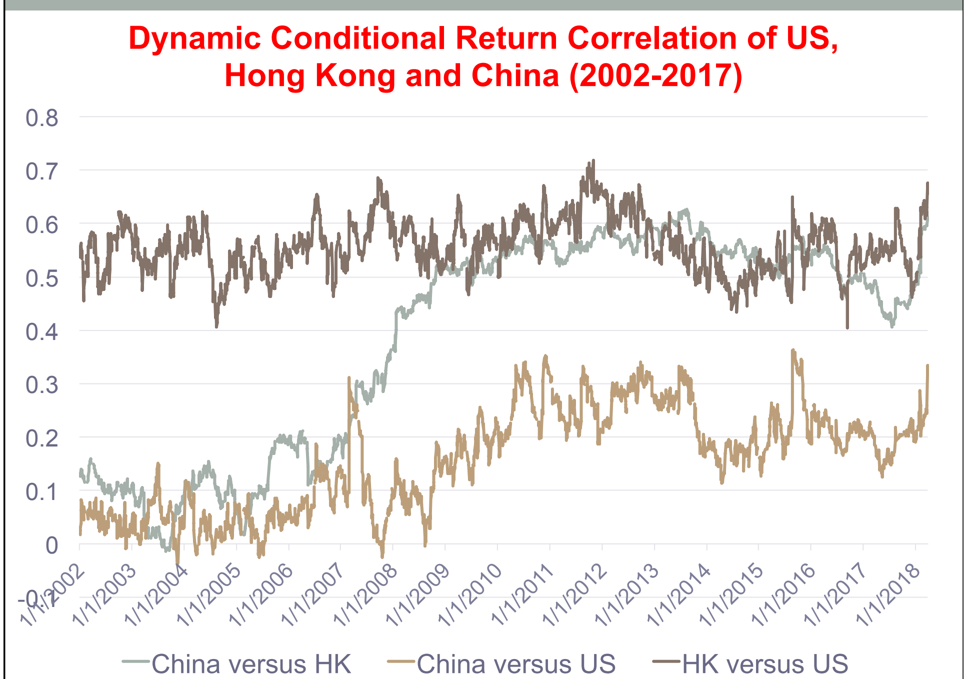

| 2002-2016 | γ (GJR-GARCH) | δ(GARCH-M) |
|---|---|---|
| China | 0.014 (2.806) | 0.138 (0.103) |
| US | 0.180 (15.888) | 1.883 (1.395) |
| HK | 0.059 (8.900) | 0.826 (0.538) |
| Germany | 0.148 (14.622) | 0.849 (0.726) |
| India | 0.085 (10.109) | 0.306 (0.192) |
| Japan | 0.108 (13.650) | 0.271 (0.163) |
| Korea | 0.087 (10.620) | 0.945 (0.589) |
| UK | 0.175 (15.965) | 2.575 (1.833) |



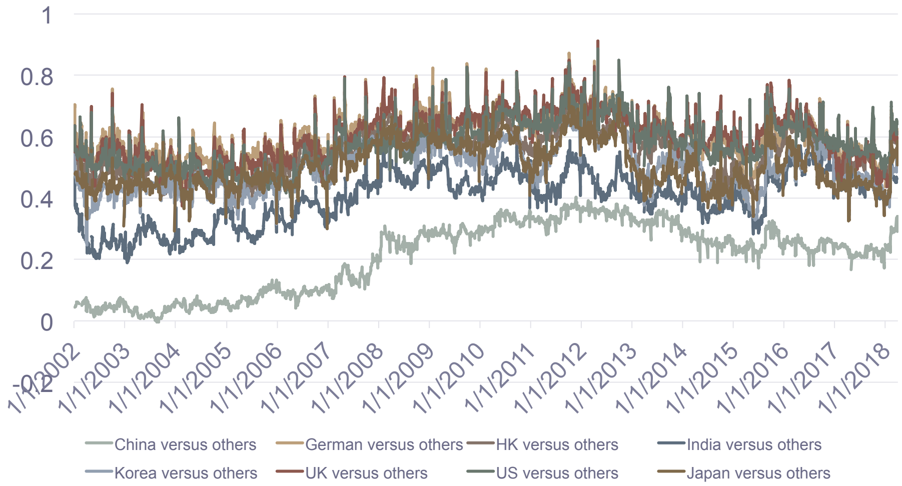

Extending back to 1991




| | | IV-E[V] |
|---|---|---|
| SZ50ETF China | Mean | **-0.005** |
| | t-statistic | -0.086 |
| | Starting date | 2/9/2015 |
| Ishare China Large Cap | Mean | 0.188 |
| | t-statistic | 4.517 |
| | Starting date | 3/16/2011 |
| US | Mean | 0.079 |
| | t-statistic | 1.956 |
| | Starting date | 1/2/1990 |
| HK | Mean | 0.071 |
| | t-statistic | 1.942 |
| | Starting date | 7/16/2010 |
| UK | Mean | 0.074 |
| | t-statistic | 1.566 |
| | Starting date | 1/4/2000 |
| Germany | Mean | 0.082 |
| | t-statistic | 1.710 |
| | Starting date | 1/2/1992 |
| India | Mean | 0.080 |
| | t-statistic | 1.790 |
| | Starting date | 3/3/2008 |
| Japan | Mean | 0.087 |
| | t-statistic | 1.863 |
| | Starting date | 1/4/1990 |
| Korea | Mean | 0.064 |
| | t-statistic | 2.192 |
| | Starting date | 4/13/2009 |



## Average Pairwise Dynamic Conditional Return Correlation



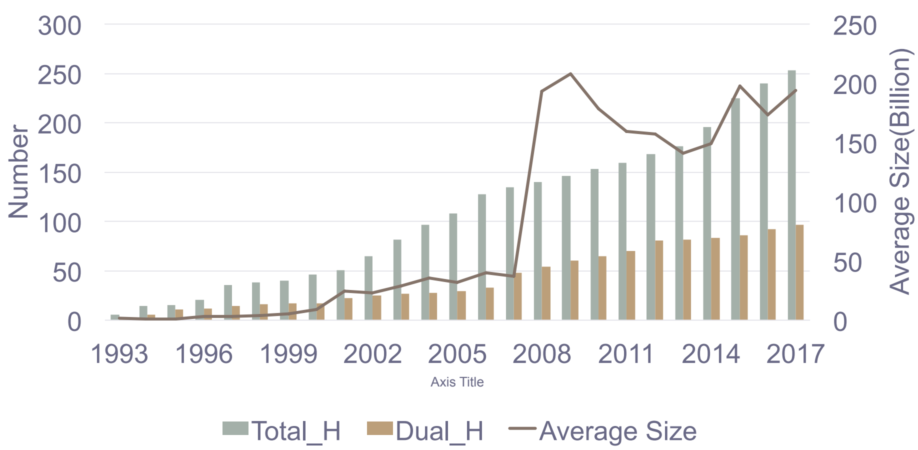

## Summary Stats of Average Pairwise Dynamic Conditional Return Correlation

| | CHINA | GERMANY | HK | INDIA | JAPAN | KOREA | UK | US |
|---|---|---|---|---|---|---|---|---|
| Mean | 0.208 | 0.606 | 0.544 | 0.397 | 0.505 | 0.499 | 0.604 | 0.577 |
| Median | 0.242 | 0.607 | 0.548 | 0.409 | 0.490 | 0.495 | 0.607 | 0.573 |
| Maximum | 0.403 | 0.871 | 0.767 | 0.588 | 0.758 | 0.723 | 0.911 | 0.886 |
| Minimum | -0.005 | 0.396 | 0.369 | 0.189 | 0.292 | 0.247 | 0.373 | 0.341 |
| Std. Dev. | 0.113 | 0.070 | 0.071 | 0.085 | 0.073 | 0.076 | 0.077 | 0.074 |
| Skewness | -0.344 | 0.085 | -0.022 | -0.362 | 0.335 | 0.137 | 0.017 | 0.220 |
| Kurtosis | 1.685 | 2.763 | 2.205 | 2.230 | 2.236 | 2.232 | 2.439 | 2.704 |

# B. Dual listed A- and H-shares Case Study

- Extensive literature on A- versus B-shares (Chen, Menkveld and Yang (2008), Mei, Sheinkman and Xiong (2005), etc…)
- Approximately 100 firms are dual listed on SSE/SZE (A-shares) and HKSE (H-shares) – same cash flows & voting rights.
  - Stylized Facts
    - A-H share premiums (e.g., Carpenter, Whitelaw and Zhou (2017) study determinants. (See also Seasholes and Liu (2011).)
    - A-H share premiums partially tied to short-sale constraints (e.g., Chan, Kot and Yang (2010))
    - A-H share premiums due to model uncertainty (Chung, Li and Hui (2013))
    - Liquidity (Chan and Kwok (2005))
    - Asymmetric information (Chakravarty, Sarkar and Wu (1998), Kim, Kim, Park and Min (2015))
    - Ng and Wu (2007) behavior of Chinese investors

# A-H Dual Listings

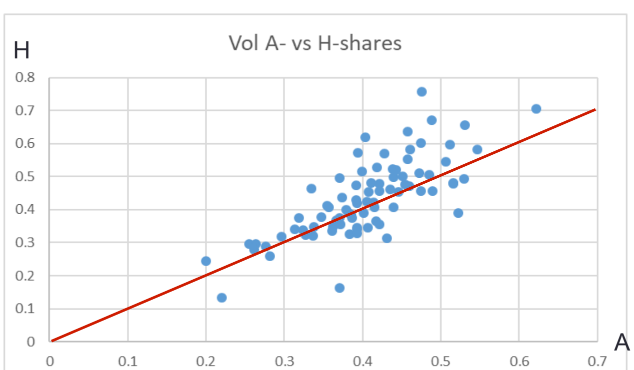


# i. Cross-sectional analysis

- Firm by firm GJR-GARCH analysis.
  - Document average conditional vol: mean, range, #A-shares < #H-shares
  - Document cross-sectional asymmetric coefficients across dual listed firms: mean, range, #A-shares < #H-shares
- Pooled regression of spread between conditional volatility of dual listed A-shares and H-shares on
  - A-H premium, H-shortable or not, retail vs institutional measures, liquidity measure (like Amihud), asymmetry coefficient spread, aggregate risk measure, controls like size, …

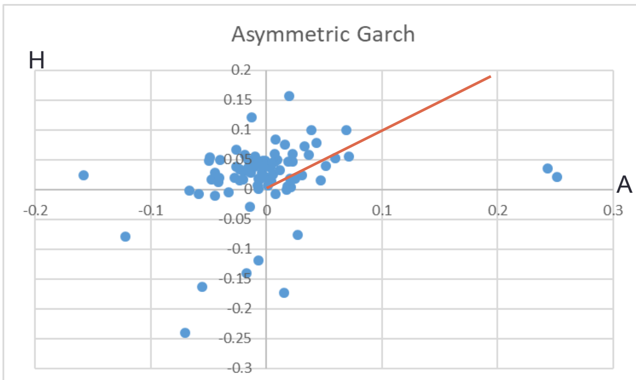
# Comparison of A- and H-share Vol (back to 1993)

Mean (median) $\sigma_A$ 37.95% (33.51%) vs $\sigma_{HK}$=40.09% (36.40%)



## Comparison of A- and H-share Asymmetric Vol Coefficient (back to 1993)

Mean $\gamma_A$ = -0.0186 vs $\gamma_{HK}$=0.0258




## Pooled Regression of A- vs H-share Vol Spread

| | | a_h_vol_diff | a_h_vol_diff2 |
|---|---|---|---|
| Standard controls | pe | 0.00148 | -0.00755 |
| | debt_ratio | -0.00014 | -0.00342 |
| | inst_holder_ratio | 0.0100** | 0.00670* |
| | logsize | 0.0172*** | 0.0186*** |
| | age | 0.0122** | 0.00778* |
| | eg_vol | 0.00491 | 0.00415 |
| Theory | a_premium | 0.0169** | 0.0140** |
| | soe | 0.0357*** | 0.0260** |
| | amihud_diff | 0.0521*** | 0.0426*** |
| | gamma_diff | -0.00947** | -0.00959** |
| | h_short | -0.00404 | 0.00181 |
| | beta_a | 0.0913*** | 0.0778*** |
| | Constant | -0.144*** | -0.133*** |
| | R-squared | 0.226 | 0.237 |

## ii. Summary Stats: Portfolios

- Form portfolios of (i) dual-listed A-shares ; (ii) dual-listed H-shares; (iii) SSE; (iv) HSI; (v) S&P500
- Mean, vol, asymmetric parameter (from GJR-GARCH), RA estimates from GARCHM, for each portfolio
- Graph of conditional vol of dual-listed A versus H share portfolio
- Correlation matrix of returns
- Correlation matrix of vols

## Portfolio Return Summary Stats

| | DUAL_A | DUAL_H | HSHARES | HSI | SPX | SSE |
|---|---|---|---|---|---|---|
| Mean | 0.04 | 0.07 | 0.09 | 0.06 | 0.05 | 0.04 |
| Median | 0.21 | 0.14 | 0.25 | 0.00 | 0.07 | 0.00 |
| Maximum | 23.62 | 38.37 | 39.32 | 33.79 | 27.61 | 22.77 |
| Minimum | -25.66 | -39.93 | -36.54 | -34.23 | -23.86 | -23.33 |
| Std. Dev. | 0.28 | 0.29 | 0.26 | 0.22 | 0.18 | 0.24 |
| Skewness | -0.53 | -0.08 | -0.35 | 0.01 | -0.24 | -0.44 |
| Kurtosis | 7.64 | 10.53 | 12.86 | 13.49 | 13.71 | 8.17 |

# Portfolio Volatility Summary Stats

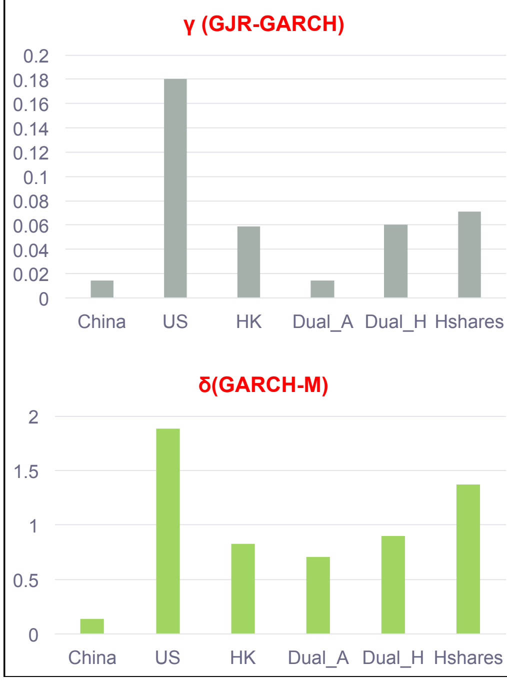
| | VDUAL_A | VDUAL_H | VHSHARES | VHSI | VSPX | VSSE |
|---|---|---|---|---|---|---|
| Mean | 26.09 | 26.22 | 22.67 | 19.38 | 15.69 | 23.06 |
| Median | 22.72 | 22.33 | 19.20 | 16.59 | 12.49 | 20.09 |
| Maximum | 82.38 | 123.71 | 124.05 | 99.29 | 94.25 | 68.95 |
| Minimum | 10.37 | 14.15 | 11.44 | 10.17 | 6.80 | 7.70 |

| | |
|---|---|
| Average vol of individual firm in Dual_A: | 38.74% |
| Average vol of individual firm in Dual_H: | 44.14% |
| | |
| Average pairwise correlation in Dual_A: | 0.375 |
| Average pairwise correlation in Dual_H: | 0.359 |

# Time-Series Properties of Spread Between Vol of A- and H-shares Portfolio

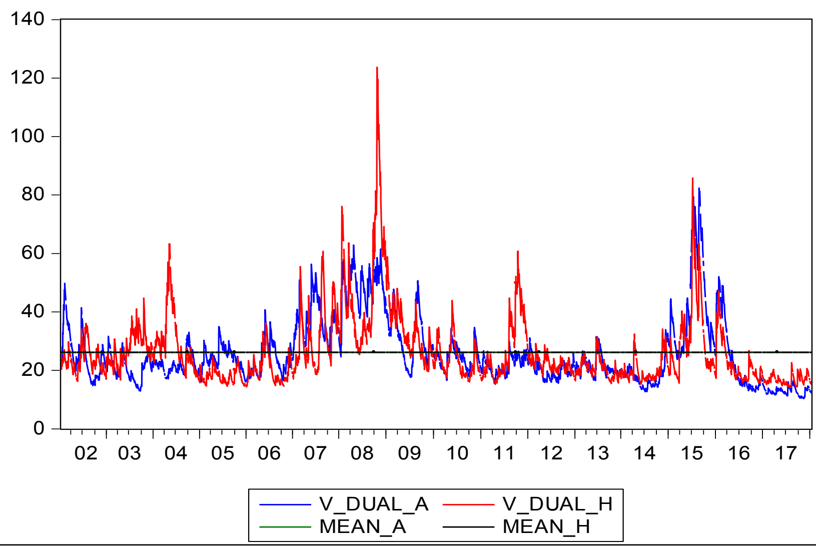
| | A_PREMIUM | RET_A_H | VOL_A_H |
|---|---|---|---|
| Mean | 112.97 | -2.39 | -0.14 |
| Maximum | 523.98 | 2266.34 | 34.78 |
| Minimum | 18.53 | -3248.28 | -65.09 |
| Std. Dev. | 85.47 | 27.68 | 9.88 |

| | A_PREMIUM | | RET_A_H | | VOL_A_H | |
|---|---|---|---|---|---|---|
| | AC | PAC | AC | PAC | AC | PAC |
| 1 | 0.996 | 0.996 | 0.051 | 0.051 | 0.978 | 0.978 |
| 2 | 0.993 | 0.143 | -0.036 | -0.039 | 0.957 | 0.007 |
| 3 | 0.99 | 0.006 | -0.02 | -0.016 | 0.936 | -0.031 |
| 4 | 0.988 | 0.004 | 0.012 | 0.013 | 0.912 | -0.053 |
| 5 | 0.985 | 0.043 | -0.006 | -0.008 | 0.888 | -0.018 |




| | γ (GJR-GARCH) | δ(GARCH-M) |
|---|---|---|
| China | 0.014 (2.806) | 0.138 (0.103) |
| US | 0.180 (15.888) | 1.883 (1.395) |
| HK | 0.059 (8.900) | 0.826 (0.538) |
| Dual_A | 0.014 (2.268) | 0.710 (0.540) |
| Dual_H | 0.060 (7.066) | 0.896 (0.690) |
| Hshares | 0.071 (6.887) | 1.369 (0.957) |

## Conditional Vol of A Shares V.S. H Shares (2002-2016, JGR-GARCH)



## Portfolio Return Correlation Matrix

| | DUAL_A | DUAL_H | HSHARES | HSI | SPX | SSE |
|---|---|---|---|---|---|---|
| DUAL_A | 1.000 | 0.538 | 0.529 | 0.401 | 0.206 | 0.949 |
| DUAL_H | 0.538 | 1.000 | 0.963 | 0.807 | 0.525 | 0.527 |
| HSHARES | 0.529 | 0.963 | 1.000 | 0.804 | 0.517 | 0.523 |
| HSI | 0.401 | 0.807 | 0.804 | 1.000 | 0.613 | 0.423 |
| SPX | 0.206 | 0.525 | 0.517 | 0.613 | 1.000 | 0.207 |
| SSE | 0.949 | 0.527 | 0.523 | 0.423 | 0.207 | 1.000 |

## Portfolio Vol Correlation Matrix

| | DUAL_A | DUAL_H | HSHARES | HSI | SPX | SSE |
|---|---|---|---|---|---|---|
| DUAL_A | 1.000 | 0.590 | 0.607 | 0.476 | 0.360 | 0.971 |
| DUAL_H | 0.590 | 1.000 | 0.946 | 0.911 | 0.706 | 0.592 |
| HSHARES | 0.607 | 0.946 | 1.000 | 0.800 | 0.595 | 0.582 |
| HSI | 0.476 | 0.911 | 0.800 | 1.000 | 0.816 | 0.516 |
| SPX | 0.360 | 0.706 | 0.595 | 0.816 | 1.000 | 0.402 |
| SSE | 0.971 | 0.592 | 0.582 | 0.516 | 0.402 | 1.000 |

## C. Volatility of Cash Flows & Other Uncertainty

- Dynamic Gordon growth model
- Policy uncertainty

## Variance Decomposition: Cash Flow News V.S. Discount Rate News

| | China | |
|---|---|---|
| | Ncf | Nr |
| Ncf | 0.0882 | |
| Nr | -0.0240 | 0.0119 |

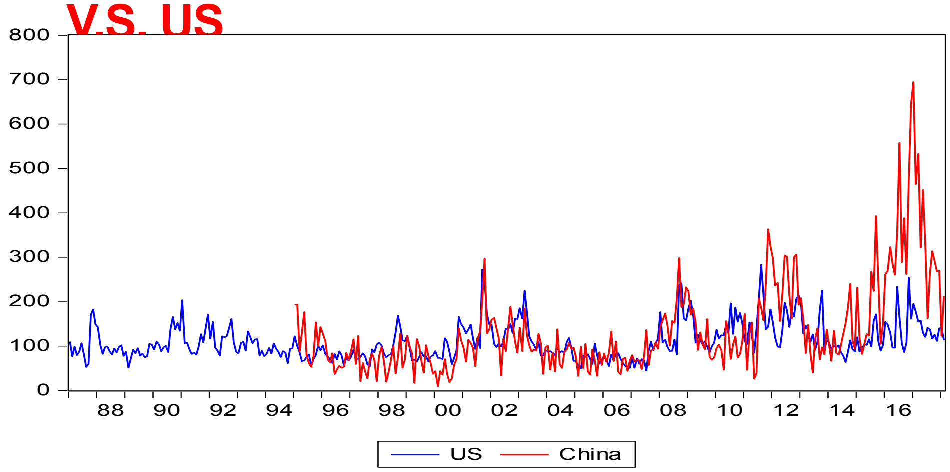
| | US | |
|---|---|---|
| | Ncf | Nr |
| Ncf | 0.0801 | |
| Nr | 0.0147 | 0.0161 |

**China's higher vol driven by negative covariance of cash flow news and discount rate news. Volatility of discount rate news higher in U.S.**

## Economic Policy Uncertainty (Baker, Bloom and Davis(2016))

| | CHINA | EUROPEAN | GERMANY | INDIA | JAPAN | KOREA | UK | US |
|---|---|---|---|---|---|---|---|---|
| Mean | 134.67 | 122.84 | 120.38 | 96.08 | 101.23 | 106.59 | 170.72 | 110.53 |
| Median | 102.87 | 105.24 | 106.24 | 83.00 | 94.67 | 92.47 | 124.71 | 100.69 |
| Maximum | 694.85 | 433.28 | 454.01 | 283.69 | 237.32 | 409.51 | 1141.80 | 283.67 |
| Minimum | 9.07 | 33.79 | 28.43 | 24.94 | 45.99 | 22.50 | 25.34 | 44.78 |
| Std. Dev. | 103.15 | 60.53 | 60.06 | 52.66 | 34.16 | 61.13 | 147.91 | 41.05 |
| Skewness | 2.19 | 1.55 | 1.69 | 1.20 | 1.53 | 1.58 | 2.45 | 1.30 |
| Kurtosis | 9.48 | 6.77 | 7.63 | 4.34 | 5.92 | 6.80 | 12.25 | 4.91 |
| Observations | 278 | 374 | 302 | 182 | 374 | 329 | 254 | 374 |

## Economic Policy Uncertainty : China V.S. US



# III. Cross-sectional volatility (TBD)

- Many papers:
  - Campbell, Lettau, Malkiel and Xu (2001) (idiosyncratic volatility increased); Ang, Hodrick, Xing and Zhang (2004) (idiosyncratic vol is priced); Wu (2001) and Bekaert and Wu (2000) (volatility negatively correlated with equity returns); Institutional ownership Xu and Malkiel (2003) (Institutional ownership, firm "focus"); Irvine and Pontiff (2009) (leverage, earnings vol and product market competition); Chun, Kim, Morck and Yeung (2008) (technology); Brown and Kapadia (2007) (new listings); Bennett, Sias and Starks (2003) (Institutional investor preferences ; and Herskovic, Kelly, Lustig and Van Nieuwerburgh (2016) (Common factors, income risk); Duarte, Kamara, Siegel and Sun (2014) (Unaccounted systematic risk); Jurado, Ludvigson and Ng (2015) (Common undertainty).
  - See typical pooled regression of vol regression determinants (table 3 of Brandt, Brav, Graham and Kumar (2009), price, size, lagged, institutional versus retail ownership measures, book-to-mkt, leverage, past returns, skewness, firm age, volume).
- The idea would be to run cross-sectional volatility analysis in China (perhaps, comparing the results to US and Hong Kong), including China-specific determinants such as region, SOE (maybe industry).

# Conclusion

- Evidence (and facts) to support segmented markets and lower risk aversion for Chinese investors – existing theory
- Consistent with a number of new stylized facts
  - Controlling for cash flow, lower (not higher) volatility in China
  - Smaller VRP, RP and asymmetry coefficient
  - True at individual and aggregate level
- Need to still work on
  - Understanding idiosyncratic risk
  - Cash flow volatility
  - Convergence parameters over past 25 years