Dynamics of dependence in international financial markets and their implications to international asset allocation

Tatsuyoshi Okimoto

Crawford School of Public Policy, Australian National University
GS of International Corporate Strategy, Hitotsubashi University
Research Institute of Economy, Trade and Industry (RIETI)

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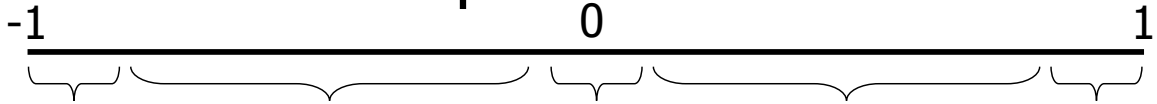
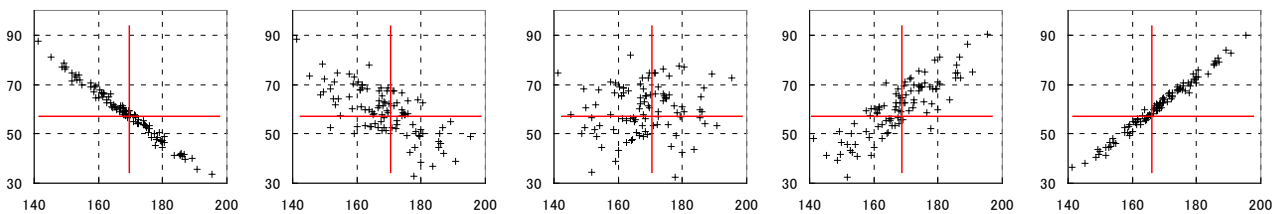
Motivations

1. Dependence in international financial markets has profound implications on asset allocation
2. One measure for dependence is correlation





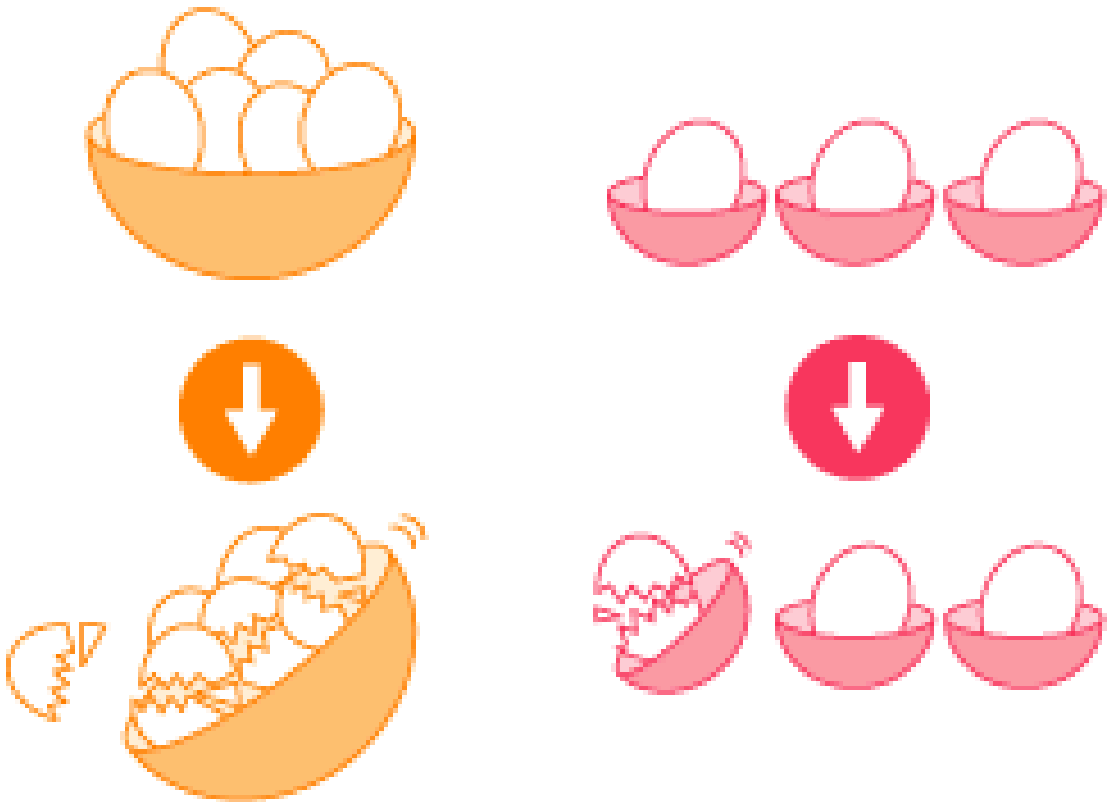
3. Correlation plays an important roll for asset allocation and risk management

Asset allocation btw two stocks

1. Consider a portfolio consisting of two risky stocks
   - Stock 1: $E(r_1) = 4\%$, $\sigma_1 = 2\%$
   - Stock 2: $E(r_2) = 4\%$, $\sigma_2 = 4\%$
   - $\mathrm{Corr}(r_1, r_2) = 0$
2. If you invest \$10000 in each stock, you can earn \$400 on average
3. If you invest \$10000 in Stock 1, your earning will be between \$0 and \$800 with probability 95%
4. If you invest \$10000 in Stock 2, your earning will be between $\$-400$ and \$1200 with probability 95%
5. How to allocate your money to these two stocks?

Asset allocation btw two stocks

5. Invest all your money to Stock 1?
6. Don't put all your eggs in one basket



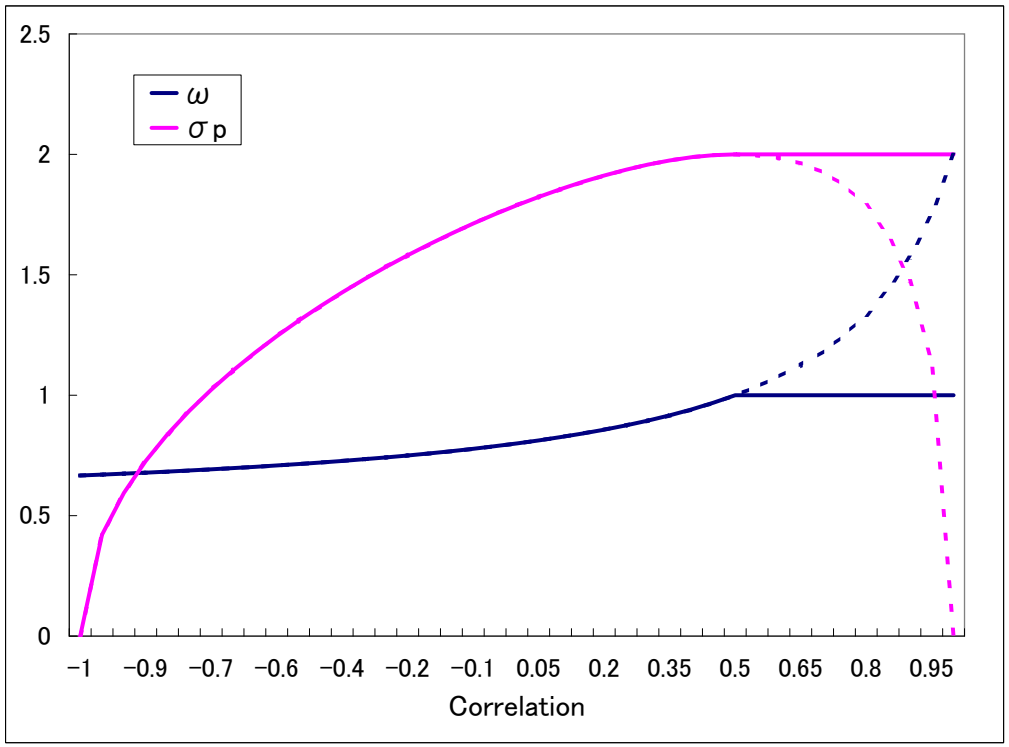
Source: Financial Services Agency

Asset allocation btw two stocks

7. Can reduce the risk of your portfolio by diversification
8. If you invest 80% of your money in Stock 1, σ_P^2 would be minimized
9. Your earning will be between \$42 and \$758 with probability 95%
10. Is diversification always beneficial?
11. What is an important factor to determine the effect of diversification and optimal weight?

Asset allocation btw two stocks

12. Effect of diversification and optimal weight heavily depends on correlation



13. Important to examine the dynamics of dependence in international financial markets

Background

1. Understanding the dependence in international financial markets is not be easy due to the time variation
2. Focus on long-run trend in dependence
3. Possible factors to affect the dependence in the long-run
    1. Promotion of integration of financial markets
    2. Developments of financial market system
    3. Evolution in information technology
    4. Economic globalization

Previous literature

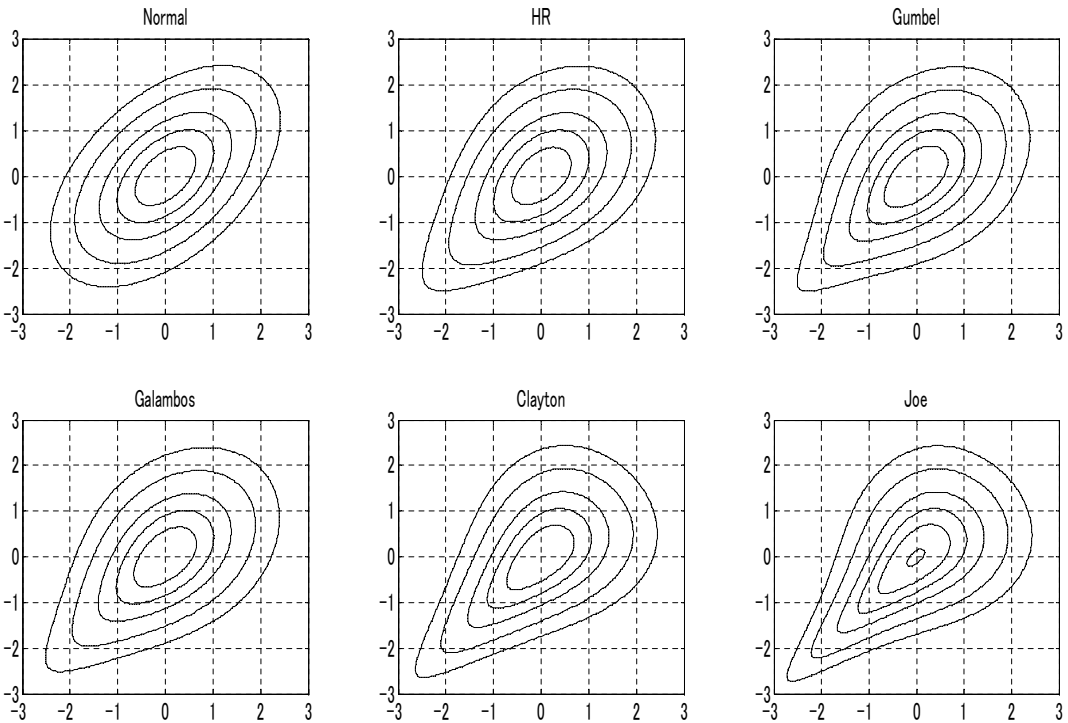
1. Longin and Solnik (1995, JIMF)
   1. Bivariate GARCH model with linear-trend correlation
   2. Correlations increase significantly for four out of six US and other G7 country pairs
2. Berben and Jansen (2005, JIMF)
   1. Smooth transition GARCH model
   2. Correlations among the German, UK, and US stock markets have doubled
3. Bekaert, Hodrick, and Zhang (2009, JF)
   1. Factor model with linear-trend correlation
   2. Find no evidence for an upward trend in international stock return correlations, except for the European stock markets

Previous literature

4. Christoffersen, Errunza, Jacobs and Langlois (2012, RFS),
   1. Analyze 16 advanced countries and 17 emerging economies
   2. Dependence in advance equity markets increased significantly
   3. Increase in dependence in emerging equity markets is limited
5. Few studies examine asymmetric dependence (Okimoto, 2014, JBF)
6. Few studies focus on the long-run trend in dependence in East Asian equity markets (Komatsubara, Okimoto, and Tatsumi, 2016)
7. Also instructive to investigate the dependence between stock and bond markets (Ohmi and Okimoto, 2016, AE)

Okimoto (2014, JBF)

1. Examine dependence in US, UK, FR, GE equity markets
2. Use a notion of copula to analyze dependence more comprehensively



Okimoto (2014, JBF)

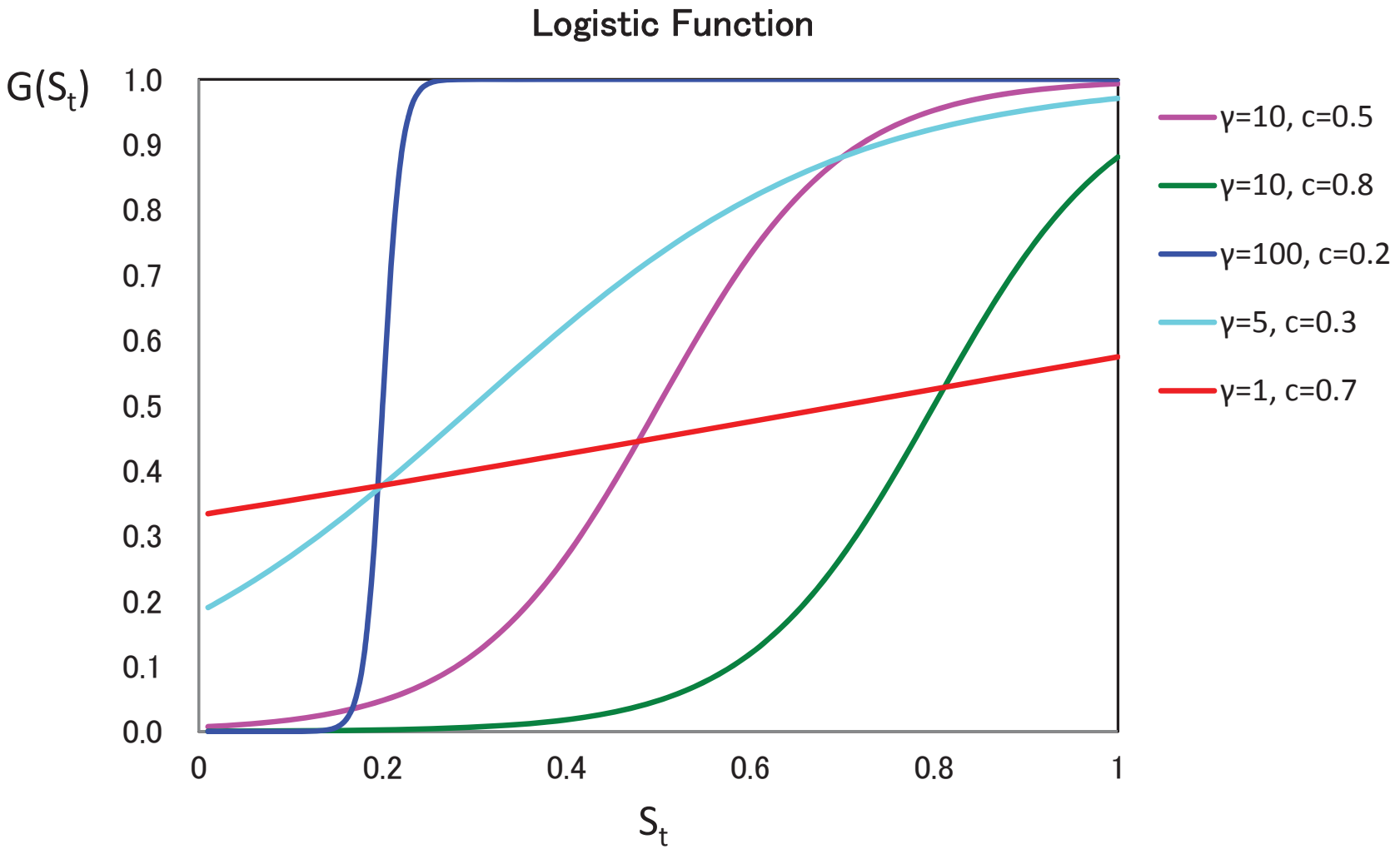
3. Three measures of dependence
   1. Spearman's ρ
   2. Upper-tail dependence
   3. Lower-tail dependence
4. Apply smooth-transition copula GARCH model to parameters of symmetrized Hüsler-Reiss copula
   - $C_{HR}(u,v;\delta) = 1-u-v+\exp\left\{\log u \cdot \Phi\left(\delta^{-1}+\frac{\delta}{2}\log\left(\frac{\log u}{\log v}\right)\right)\right.$
     $\left.+\log v \cdot \Phi\left(\delta^{-1}-\frac{\delta}{2}\log\left(\frac{\log u}{\log v}\right)\right)\right\}, \quad \delta \in (0,\infty)$
   - $C_{SHR}(u,v;\delta_1,\delta_2)$
     $= 0.5 \cdot \{C_{HR}(u,v;\delta_1) + C_{HR}(1-u,1-v;\delta_2) + u + v - 1\}$
5. δ_1 captures the upper tail dependence, while δ_2 characterize the lower tail dependence

Okimoto (2014, JBF)

6. Model copula parameters using multiple-regime smooth-transition model
   1. $\delta_{it} = (1 - G(s_t; c, \gamma))\delta_i^{(1)} + G(s_t; c, \gamma)\delta_i^{(2)}$
   2. G: logistic transition function
   $$G(s_t; c, \gamma) = \frac{1}{1 + \exp(-\gamma(s_t - c))}, \quad \gamma > 0$$
   3. s_t : Transition variable
   4. c: Location parameter
   5. γ: Smoothness parameter
7. Can capture dominant long-run trends by setting $s_t = t/T$ (Lin and Teräsvirta, 1994, JoE)

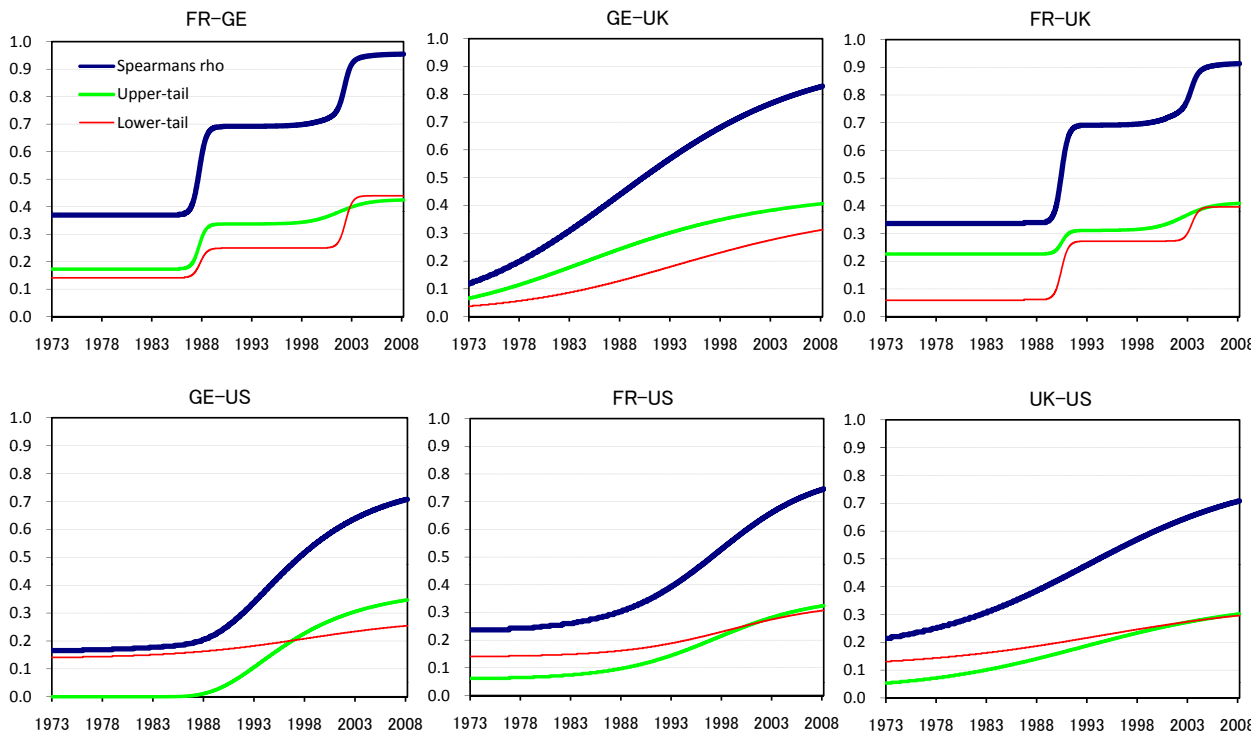
Okimoto (2014, JBF)

8 Can describe a wide variety of patterns of change



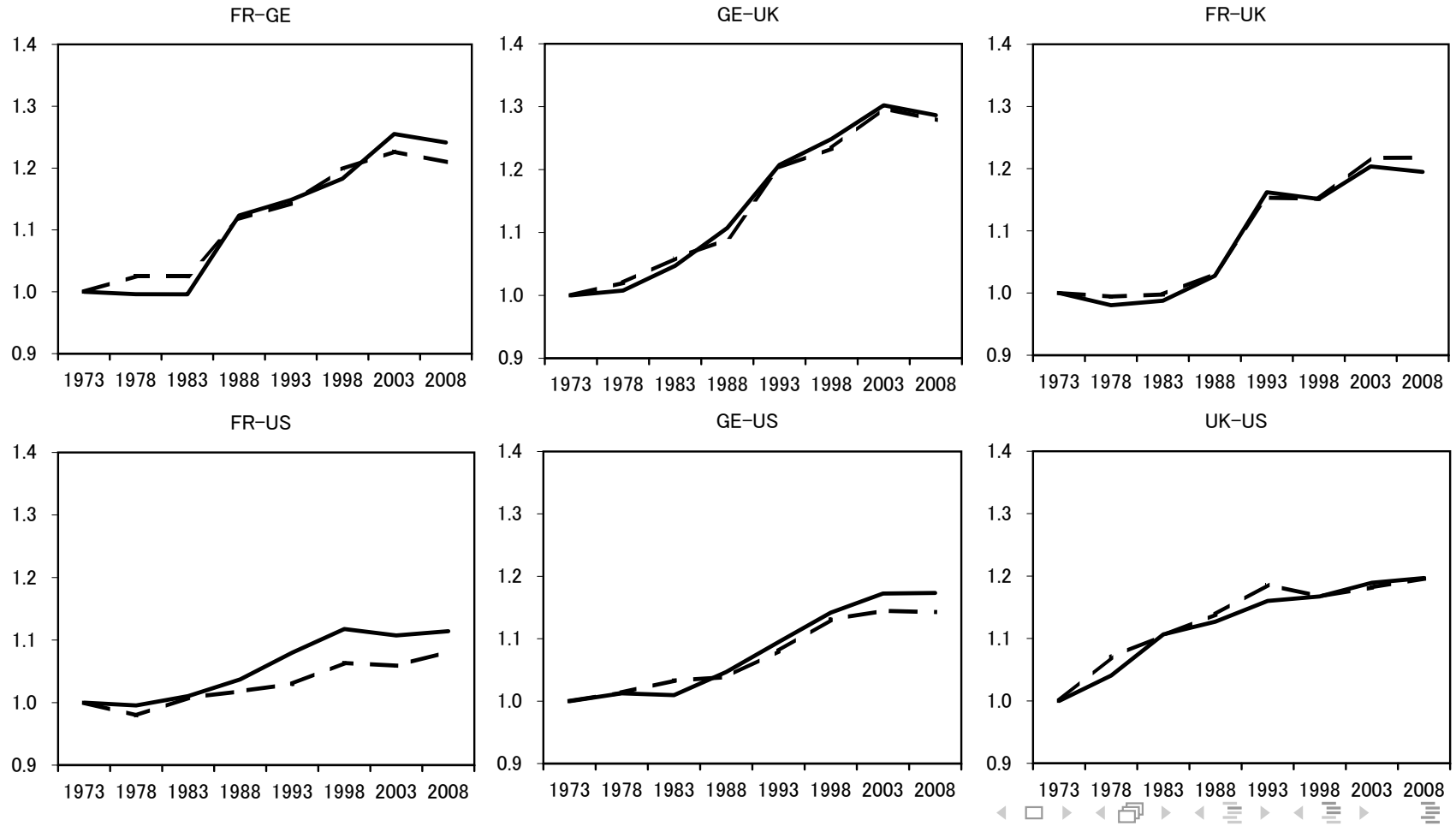
Okimoto (2014, JBF)

9. Sample period: 1973.1 to 2008.6 (weekly data)
10. Upper- and lower-tail dependences increased significantly and asymmetrically



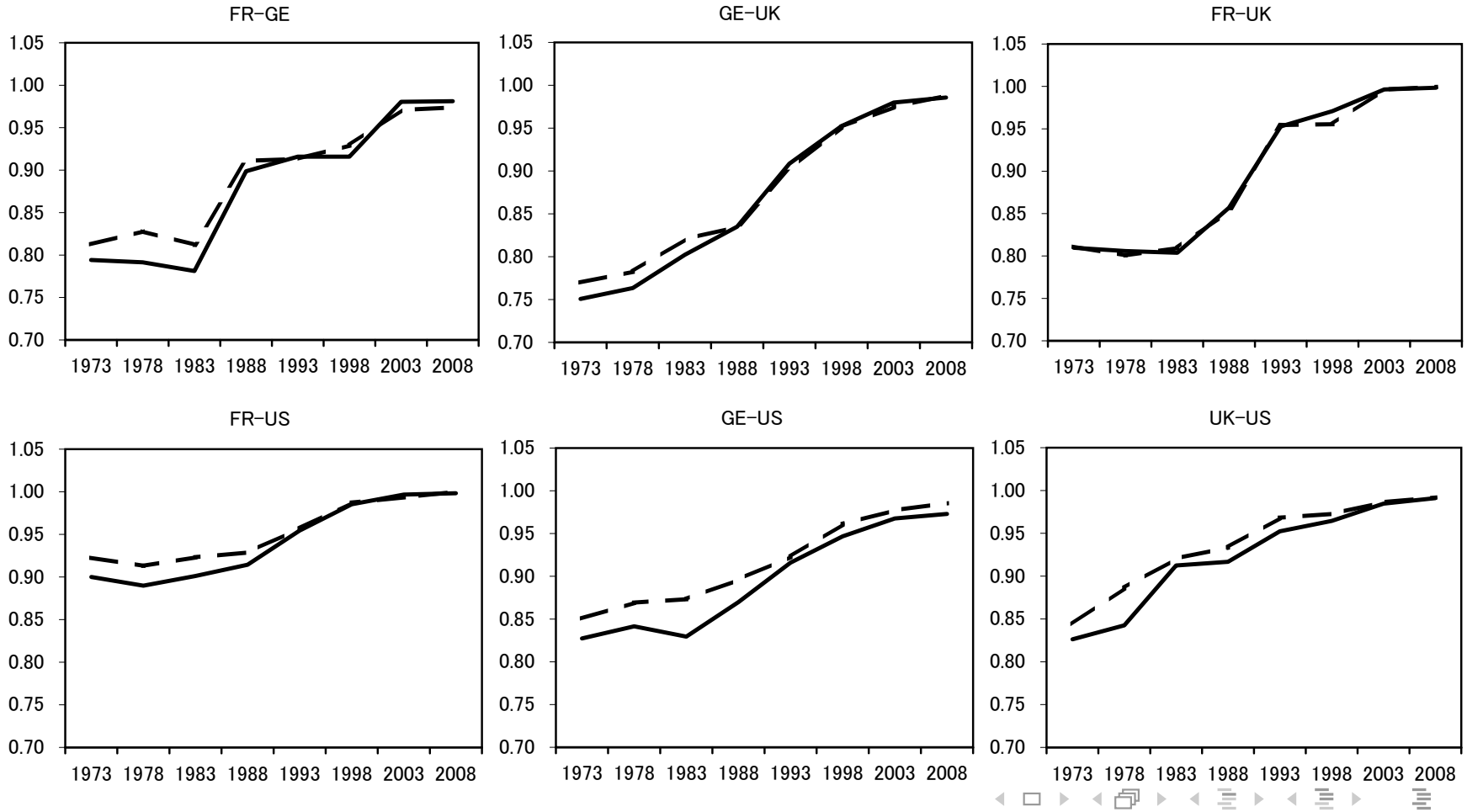
Okimoto (2014, JBF)

- Risk measures have increased by about 20% over the last 35 years



Okimoto (2014, JBF)

12 Diversification effects have almost diminished in 2008



Implications on asset allocation 1

1. Dependence in international equity markets has increased, particularly for major equity markets
2. Effects of diversification has reduced considerably in recent years
3. Investors need more sophisticated investment strategies to control their risk
4. Select sectors and countries more carefully

Ohmi and Okimoto (2016, AE)

1. Identify the determinants of stock-bond correlations
   1. VIX
   2. Short-term rates
   3. Term spread
   4. Trend
2. Apply smooth transition regression (STR) model with multiple transition variables

$$
\begin{aligned}
FRC_t &= \rho_1\{1 - F(s_{t-1})\} + \rho_2 F(s_{t-1}) + \phi FRC_{t-1} + \varepsilon_t \\
F(s_{t-1}) &= \frac{1}{1 + \exp[-\gamma_1(s_{1,t-1} - c) + \cdots - \gamma_K(s_{K,t-1} - c)]}
\end{aligned}
$$

3. Monthly data from 1991.1 to 2012.12 for US, UK, GE as well as AU, CA, FR, SW, JP, IT, PO, SP

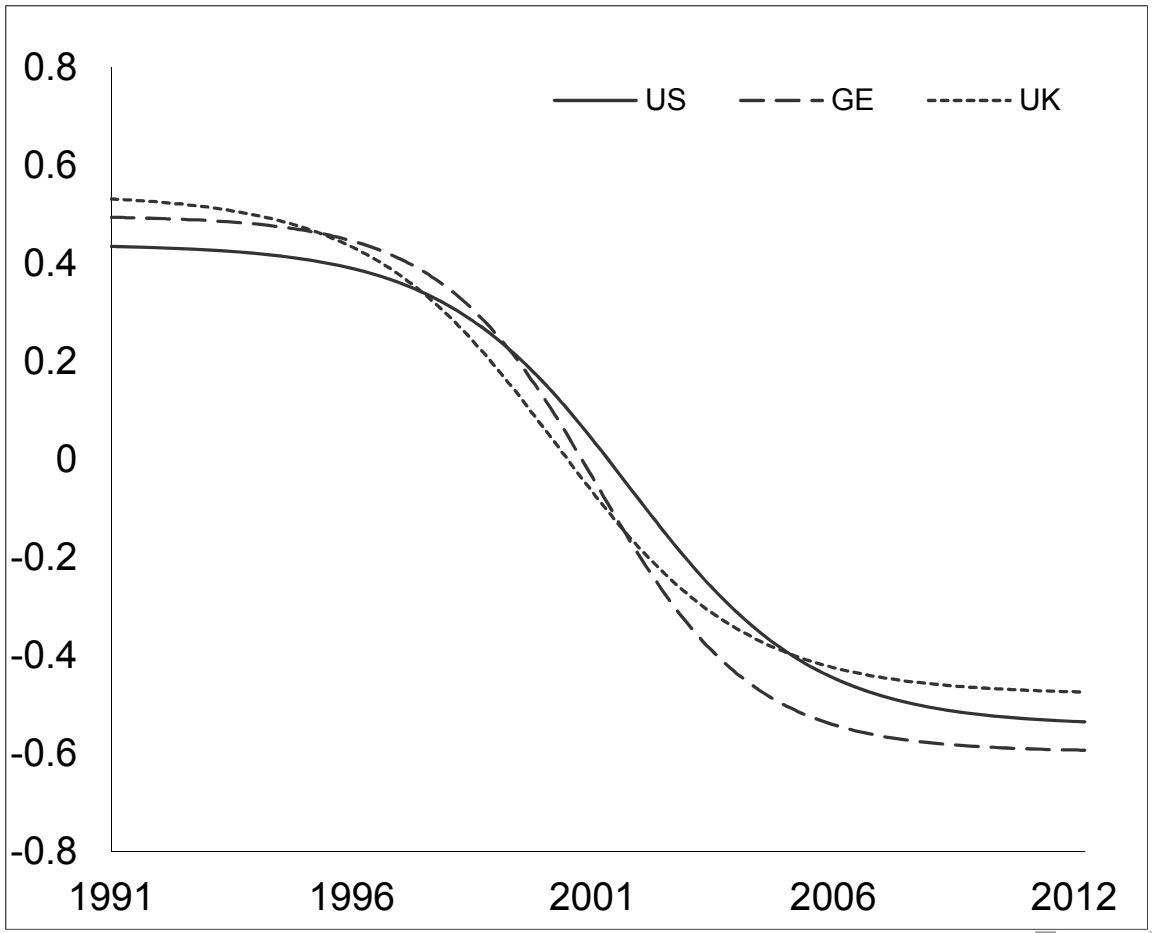
Ohmi and Okimoto (2016, AE)

4. VIX and trend are two of the most important determinants of stock-bond correlations

	US		GER		UK	
	Coef	St. err	Coef	St. err	Coef	St. err
ρ_1	0.297**	0.140	0.630***	0.052	0.502***	0.117
ρ_2	-0.368***	0.099	-0.580***	0.027	-0.440	0.075
ϕ	0.346*	0.192	0.140***	0.028	0.156	0.105
VIX	1.925***	0.616	1.142***	0.083	1.163***	0.354
R	-0.576	0.461	1.323***	0.039	0.159	0.140
SPR	-0.294	0.672	0.051	0.049	-0.450***	0.161
T	2.571***	0.943	2.804***	0.010	2.725***	0.311
c	0.071	0.165	-0.144***	0.054	-0.065	0.158
Log-likelihood	-248.23		-248.25		-247.29	
Linearity test	10.95***		24.26***		21.54***	
Additive nonlinearity test	1.28		2.55		0.09	

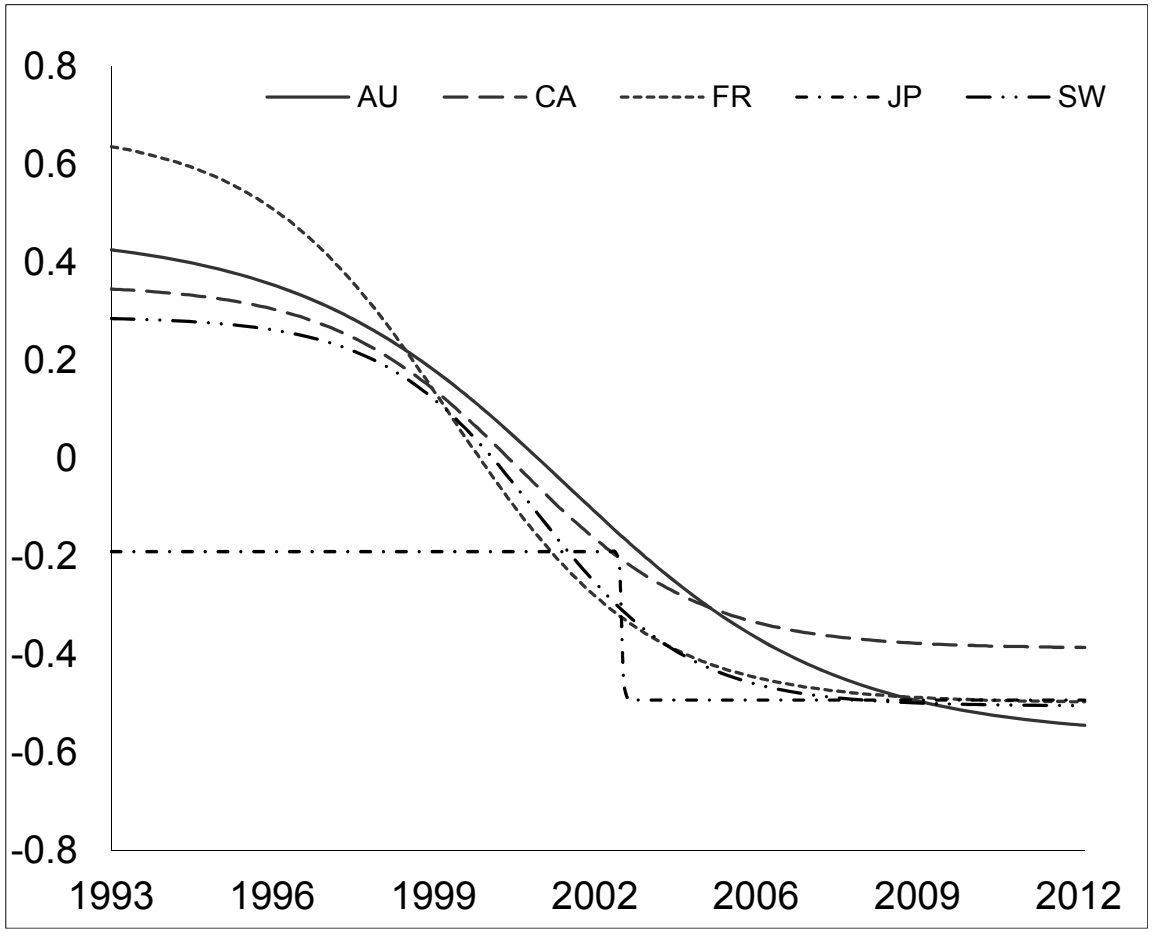
Ohmi and Okimoto (2016, AE)

5. Negative trend exists in stock-bond correlation for major countries



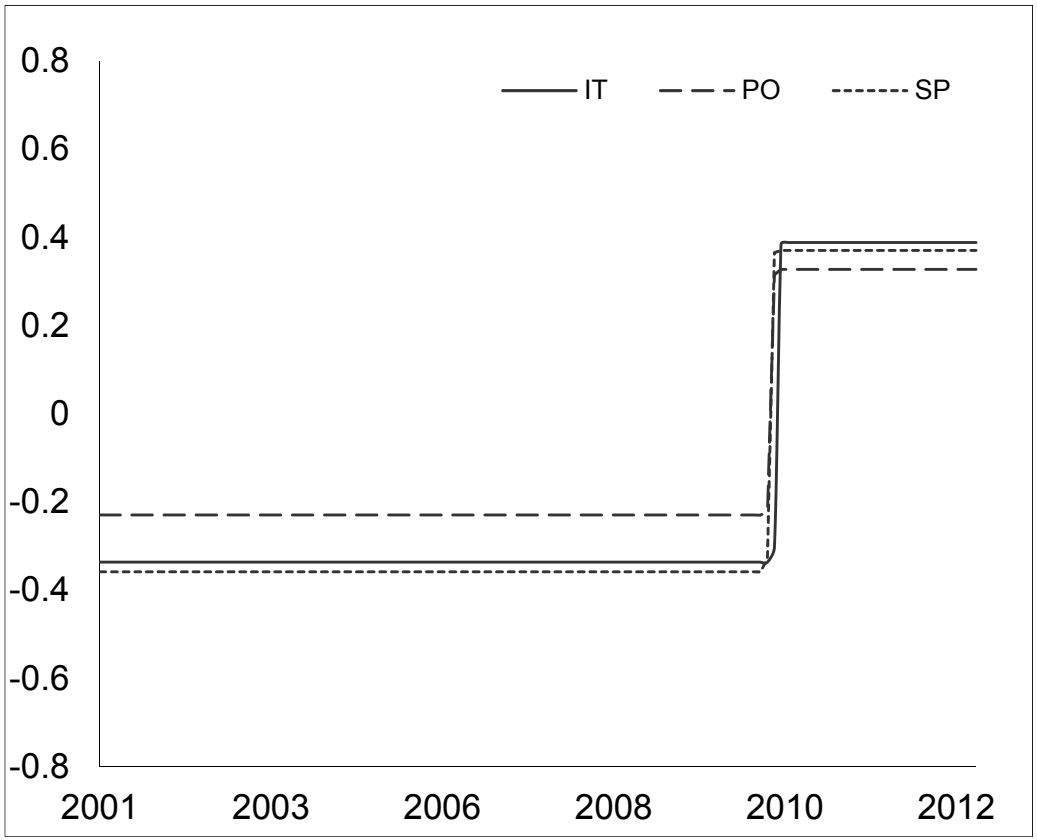
Ohmi and Okimoto (2016, AE)

6 Other many countries also have a negative trend



Ohmi and Okimoto (2016, AE)

7. Stock-bond correlation for riskier countries has increased significantly and suddenly around the beginning of the Euro crisis



Implications on asset allocation 2

1. Stock and bond prices tend to move together in 1990s, but oppositely in more recent years
2. Flight-to-quality behavior has become stronger in more recent years, making greater use of bond markets to control risk exposure
3. Investor can use the bond markets to control their risk as long as bond markets are healthy
4. Large diversification effect can be achieved by investing in stocks and bonds for those countries with low credit risk

Implications on asset allocation

5. Flight-to-quality behavior induces capital outflow from both stock and bond markets in riskier countries in bear markets
6. Riskier bond markets increase the possibility of simultaneous sharp decline of stock and bond prices
7. Investors believe that the Japanese bond market is still safe despite the huge government debt
8. JGB has been useful to effectively diversify the risk
9. Not surprising that JGB is considered as a risky asset near future, reducing the diversification effects considerably

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