

Diversifying To Energy and Other Commodity Assets

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Research Motivations



- Work examining commodity (indice) as a new asset class
 - Gorton and Rouwenhorst (2006), Erb and Harvey (2006), Geman (2005), etc.
- Sources of Commodity excess returns
 - Risk premium (e.g. Normal Backwardation)
 - Diversification (low correlation)
- Short comings of analyses
 - Strategy dependent returns, due to lack of market capitalization
 - Data dependent, due to sample selection biases

Research Objective



- Empirically test whether diversifying into real commodity futures (energy, metal, gold) generates superior returns
 - With minimum trading strategies
 - Ex ante portfolio weight selection for rebalance purposes

Data



- Data source: Datastream
- Equity: S&P500
- Bond: US Treasury five year constant maturity bond yield
- Commodity futures: near term contracts
 - Crude contracts (Brent/WTI)
 - Copper contracts (High grade Copper)
 - Gold contracts (100oz Gold)

Data



- Daily data from 1992 to 2008 in the US
 - including several business and market cycles
 - eg. 1997 Asian crisis, 2000 equity boom, 2004-2008 commodity boom
- Total number of 4190 observations after non-trading dates.
 - 140 observations are deleted due to non-trading over the holdout sample period
- Divide the whole data sample under investigation into model estimation and forecast samples
 - training sample of 3200 daily closing price data points (from January 1992 to September 2004)
 - holdout sample of 990 observations (from September 2004 to September 2008)

Table 1. Basic statistics for all risky assets

	Oil	Cooper	Gold	Stock	Bond
Panel A: All sample 01/011992 – 08/09/2008					
Mean	0.0002	0.00012	0.00008	0.00011	0.00001
Std	0	0.006	0.004	0.004	0.001
Skewness	-0.23	-0.3	-0.04	-0.11	-0.23
Kurtosis	5.86	6.87	10.63	6.71	4.99
Panel B: Training sample 01/01/1992 -14/09/2004					
Mean	0.00013	0.00004	0.00002	0.00013	0.00002
Std	0.008	0.006	0.003	0.004	0.001
Skewness	-0.27	-0.26	0.55	-0.1	-0.27
Kurtosis	6.38	6.08	13.91	6.85	4.96
Panel C: Holdout sample 15/09/2004 – 08/09/2008					
Mean	0.00045	0.00039	0.00029	0.00005	0.00001
Std	0.008	0.008	0.005	0.003	0.001
Skewness	-0.03	-0.36	-0.74	-0.19	-0.09
Kurtosis	3.47	6.24	6.19	5.17	5

Table 2. Unconditional correlation matrix**Panel A: All sample 01/011992 – 08/09/2008**

	Oil	Cooper	Gold	Stock	Bond
Oil	1	0.116	0.18	-0.035	-0.006
Cooper	0.116	1	0.273	0.105	-0.075
Gold	0.18	0.273	1	-0.074	0.041
Stock	-0.035	0.105	-0.074	1	-0.125
Bond	-0.006	-0.075	0.041	-0.125	1

Panel B: Training sample 01/01/1992 -14/09/2004

	Oil	Cooper	Gold	Stock	Bond
Oil	1	0.057	0.103	-0.029	-0.014
Cooper	0.057	1	0.131	0.108	-0.066
Gold	0.103	0.131	1	-0.103	0.041
Stock	-0.029	0.108	-0.103	1	-0.059
Bond	-0.014	-0.066	0.041	-0.059	1

Panel C: Holdout sample 15/09/2004—08/09/2008

	Oil	Cooper	Gold	Stock	Bond
Oil	1	0.267	0.375	-0.055	0.022
Cooper	0.267	1	0.497	0.109	-0.099
Gold	0.375	0.497	1	-0.005	0.042
Stock	-0.055	0.109	-0.005	1	-0.381
Bond	0.022	-0.099	0.042	-0.381	1

Methodology



- Dynamic mean-variance framework to optimize portfolio allocation with DCC-GARCH model (Engle (2002))
 - based on traditional mean-variance efficient portfolios that have used static variance-covariance matrix to choose optimal portfolio weights
 - modelling time-varying variance using GARCH
 - modelling conditional correlation change over time (DCC)

Methodology



$$\max_{\omega_t} \{E_{t-1} [U_t]\} = \mu_t^f + \omega_t' \mu_t - \frac{\lambda}{2} \omega_t' H_t \omega_t$$

- ω_t is a vector of risky asset weights chosen at time t-1, with variance-covariance matrix H_t , expected excess return μ_t and a risk-free asset μ_t^f .
- Baseline excess return is model as unconditional averages from t = 1, to t-1 (further robustness checks are to be conducted. We keep this simple method based on the fact that predicting returns is questionable (Chan, Karceski, and Lakonishok (1999), Ang and Bekaert (2007))

$$\mu_t = \frac{1}{t-1} \sum_{\tau=1}^{t-1} u_\tau$$

Methodology

- DCC model

$$r_t | I_{t+1} \sim N(0, D_t R_t D_t)$$

$$h_{i,t} = \omega_i + \alpha_i r_{i,t-1}^2 + \beta_i h_{i,t-1}; \quad i = 1, \dots, k$$

$$\varepsilon_t = D_t^{-1} r_t$$

$$R_t = \text{diag}(Q_t)^{\frac{1}{2}} Q_t \text{diag}(Q_t)^{-\frac{1}{2}}$$

$$Q_t = (1 - a - b) \bar{Q} + a \varepsilon_{t-1} \varepsilon_{t-1}' + b Q_{t-1}$$

$r_t = [r_{1t}, \dots, r_{kt}]$ as the vector of zero mean excess risky return, D_t as a $k \times k$ diagonal matrix of conditional standard deviations, i.e., $D_t = \text{diag}[\sqrt{h_{1,t}}, \dots, \sqrt{h_{k,t}}]$
 R_t as the $k \times k$ time varying correlation matrix, and $Q = E(\varepsilon_t \varepsilon_t')$

as the unconditional covariance matrix of standardized variables.

Methodology



- Log likelihood function

$$L = -0.5 \sum_{t=1}^T \left(2 \log(|D_t|) + \log(|R_t|) + \varepsilon_t' R_t^{-1} \varepsilon_t \right)$$

- r- step ahead of forecast is given

$$h_{t+r|t-1} = \frac{\omega}{1-\alpha-\beta} + (\alpha + \beta)^r \left(h_t - \frac{\omega}{1-\alpha-\beta} \right)$$

$$R_{t+r|t-1} = \sum_{i=0}^{r-2} (1-a-b) \bar{R} (a+b)^i + (a+b)^{r-1} R_t$$

Methodology

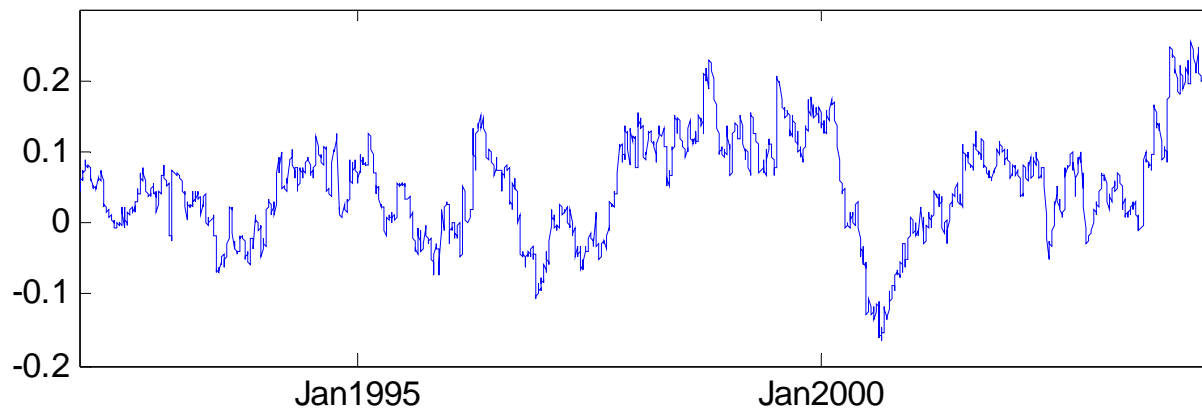


- Forecasted portfolio weights generating process
 - portfolio weights are computed every day for the holdout sample by optimizing the utility function
 - r-step ahead conditional correlation and variance forecasts are computed
 - r-step ahead portfolio weights are generated using the above conditional correlation and variance
 - the conditional volatility parameters are re-estimated every month, since the parameters of GARCH models change little on a daily basis

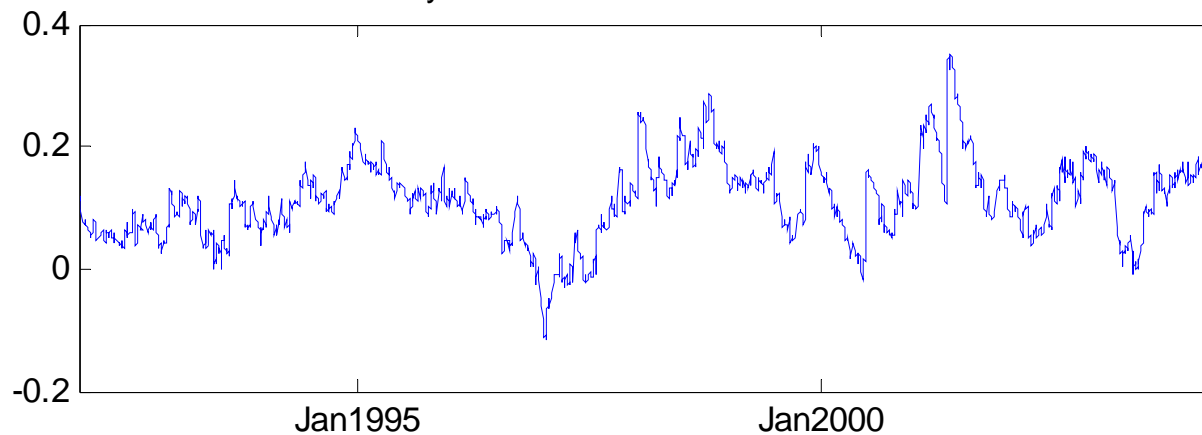
Empirical results (dynamic correlation)



Dynamic correlation Oil vs. Cooper



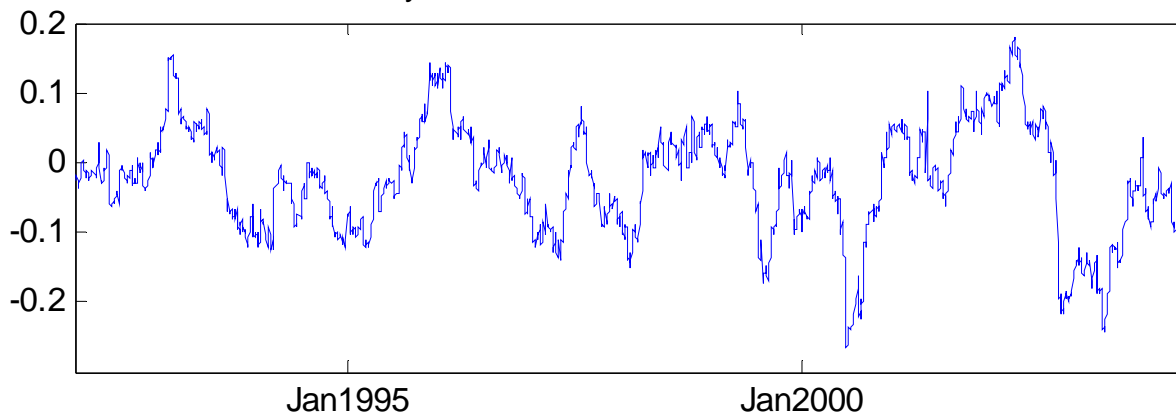
Dynamic correlation Oil vs. Gold



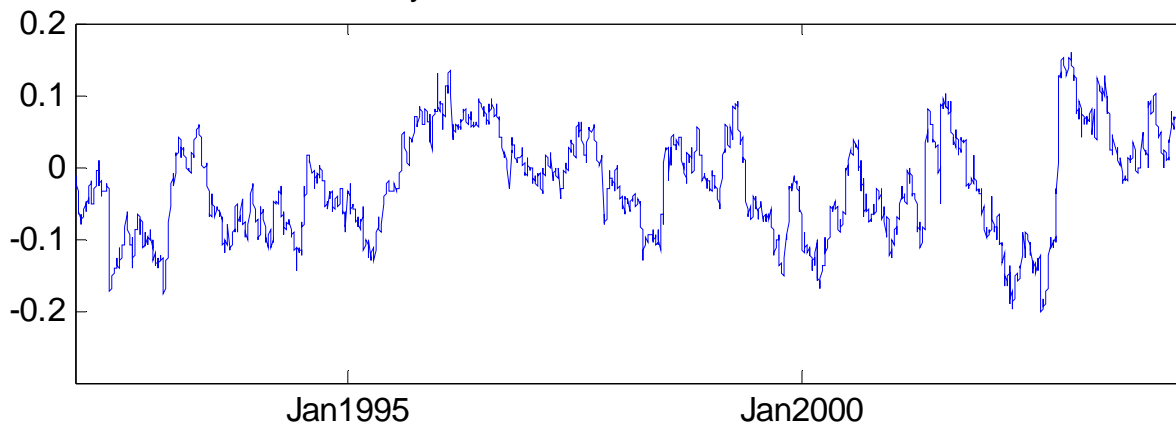
Empirical results (dynamic correlation)



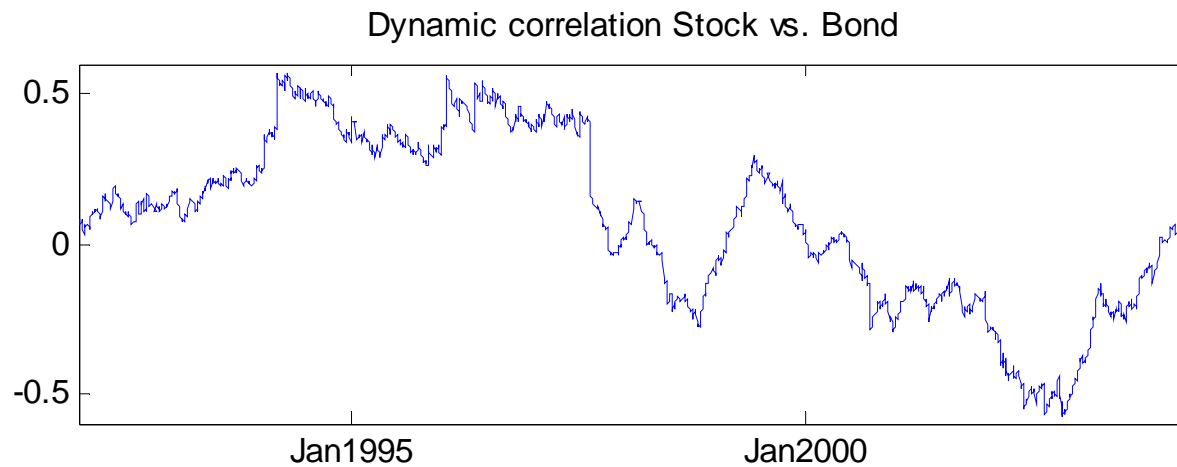
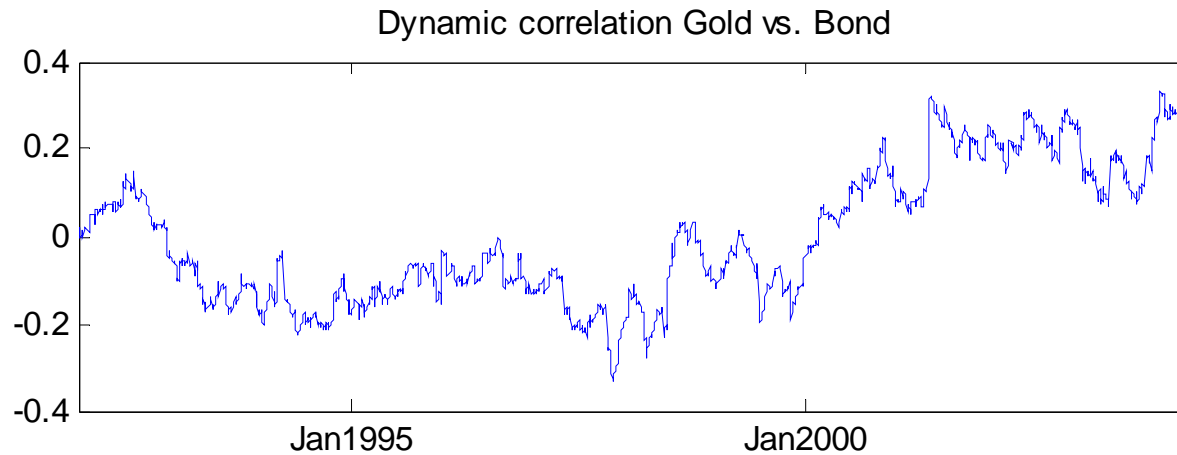
Dynamic correlation Oil vs. Stock



Dynamic correlation Oil vs. Bond



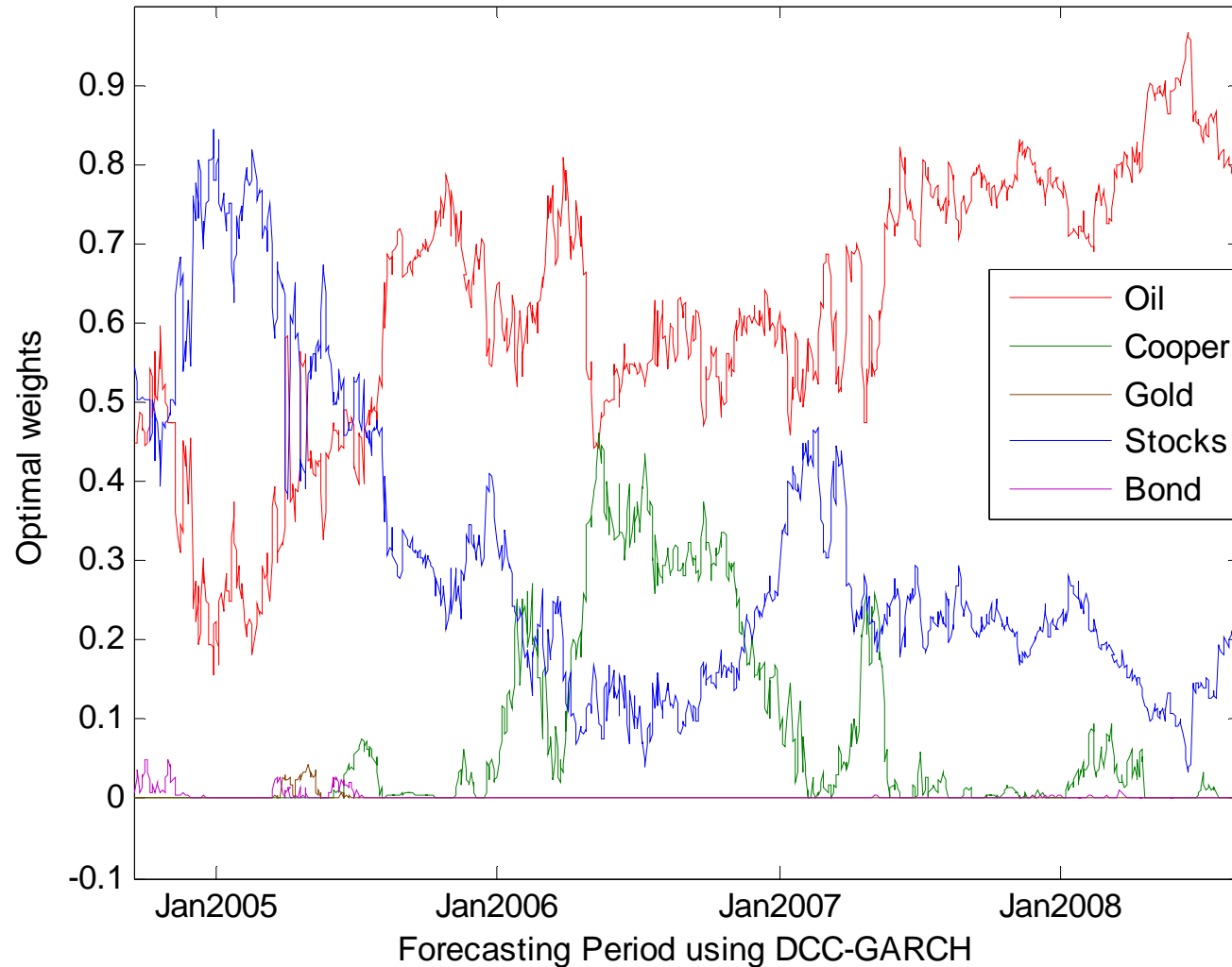
Empirical results (dynamic correlation)



Empirical results (ex-ante optimal portfolio weights)



Figure 2a. Ex-ante optimal weights for holdour sample

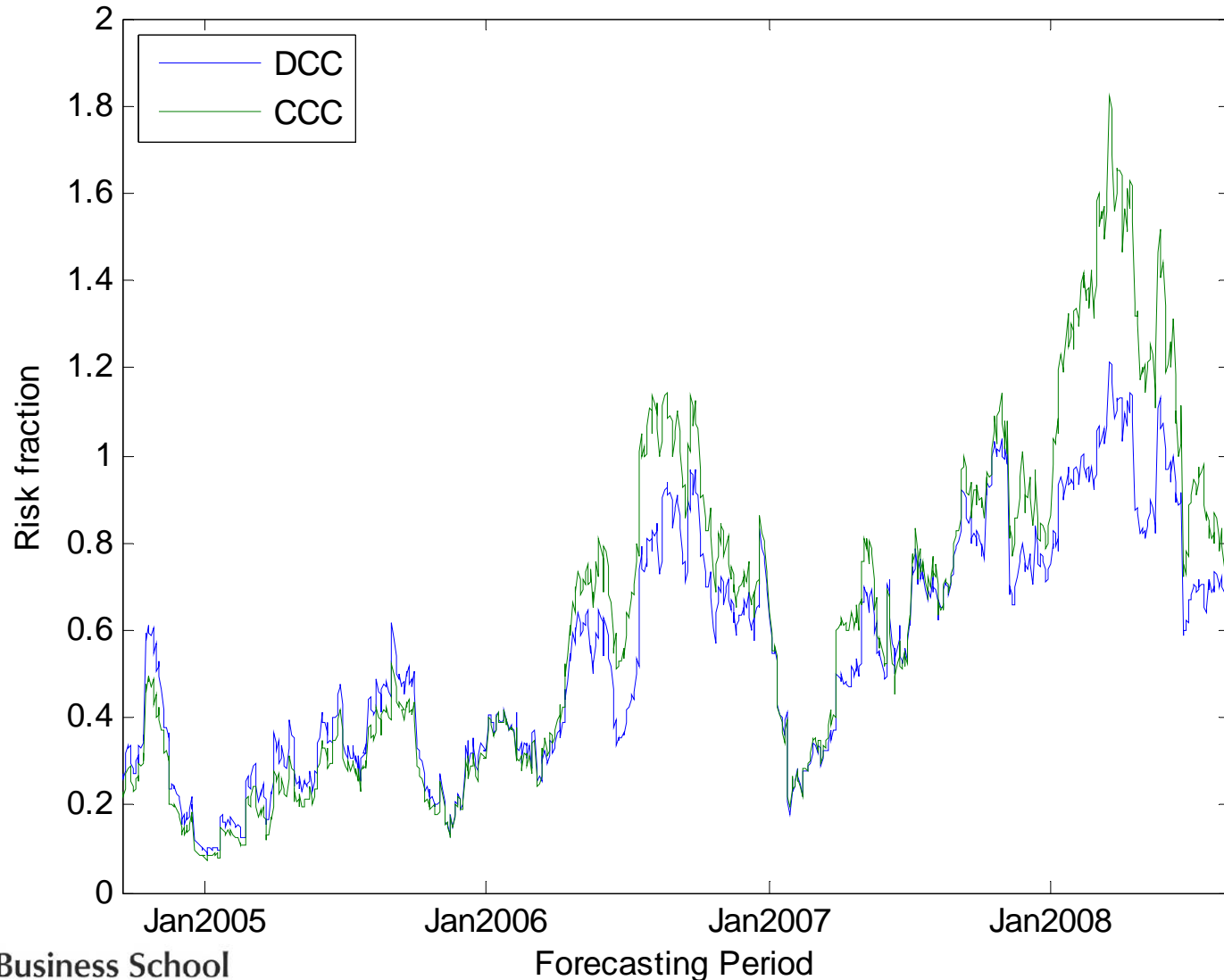


Empirical result

(risky fraction of portfolio using DCC & CCC)



Figure 3. Risky fraction for portfolio using DCC & CCC



Empirical results

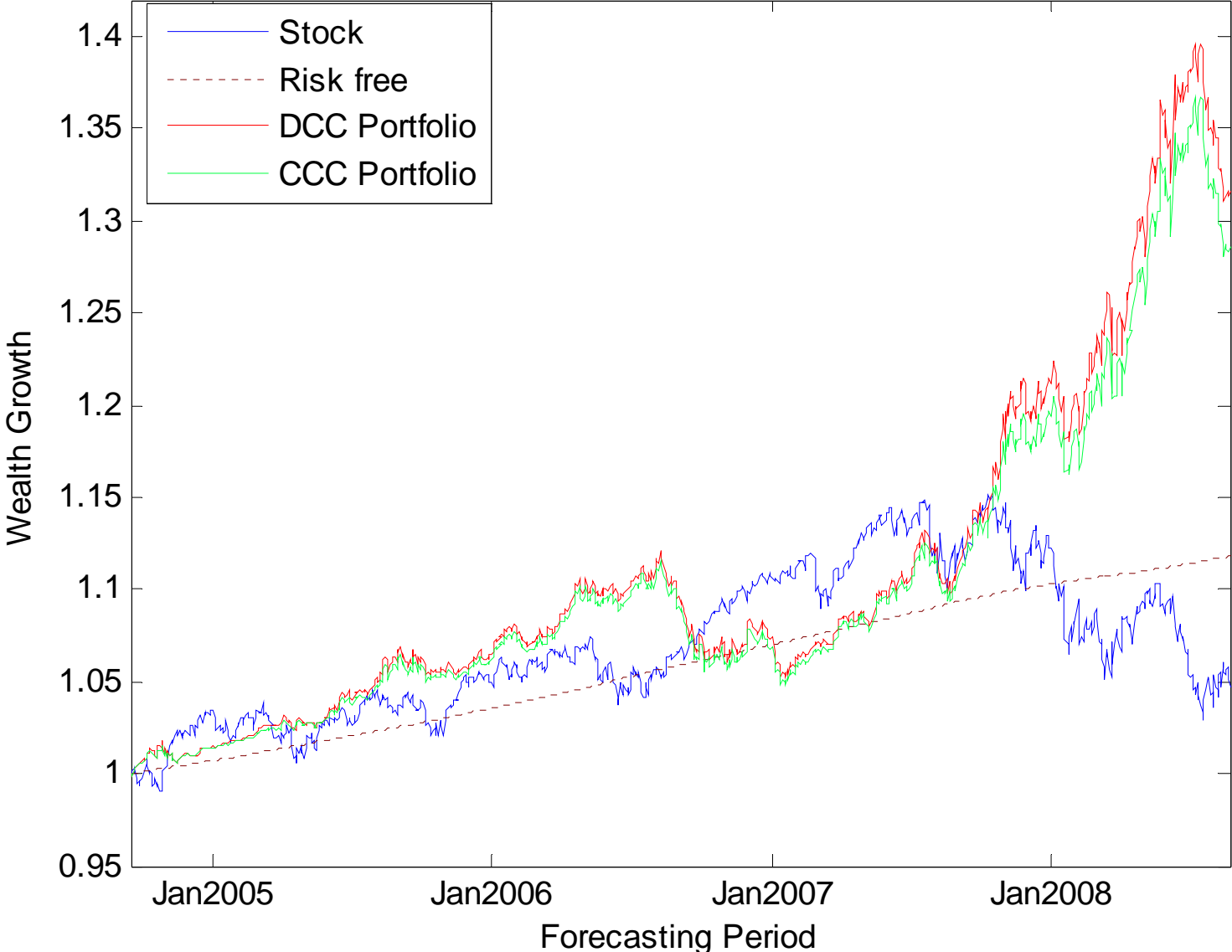


Table 3. Maximum likelihood estimation of the DCC-GARCH(1,1) specification

	Oil	Cooper	Gold	Stock	Bond
GARCH parameters					
ω	0.000(0.00) **	0.000(0.00) **	0.000(0.00) **	0.000(0.00) **	0.000(0.00) **
α	0.043(0.14)	0.038(0.08)	0.039(0.08)	0.063(0.16)	0.047(0.04)
β	0.954(0.13) **	0.950(0.13) **	0.960(0.05) **	0.934(0.12) **	0.929(0.05) **
DCC parameters					
a			0.009(0.00)**		
b			0.988(0.00)**		
loglikeliho			-66961		
od					

Notes: Values in parenthesis are standard deviations. ** denotes significant at 0.05 level.

Figure 4b. Ex-ante optimal wealth growth with threshold



Conclusions



- Diversification to commodity futures add value to traditional equity portfolio mix
- Gain is unlikely to come from strategies,
- Gain is likely to come from diversification/risk premium
- DCC model performs better than CCC when markets are volatile (e.g. credit crunch conditions)

Further work



- Robustness checks
- Portfolio evaluation
- Sources of the excess returns

Questions/Comments?



Questions?



- Excess returns are set as R of risky assets - risk free rate, what is this risk free rate? Did we use an interest rate or simply treasury bond rate? Did we use cash as well?
- Balancing portfolio: do we assume every day the portfolio is balance with/without threshold (5%)?
- Do we do 22- step forecasts? and weights updates everyday? Effectively, we are using one-step ahead forecast and update them everyday?
- Do we use fully-collateralized futures positions?
 - fully-collateralized means that 1\$ investment in futures, there is also 1\$ invested in treasury bill.
- Risk parameter in utility function parameter is 3, correct? or for risk adverse (picking portfolio in efficient frontier)
- Risky asset >1 means borrowing fund to invest in risk assets, right?