Group 29 BT2201 Finance Report

Tan Sin Chez, Jaron A0238881R, Soh Zuan, Azumi
A0239407B, Roshan Zabiullah A0234036N, Kok Ming Rong
Marcus A0233850J, Tan Wenyuan Ignatius A0233647B

ETF Summary

Equities

	currency	Asset Type	Net Assets (bn)	3 Year Annualised Return	Expense Ratio (%)	Inception Date	Beta
1306.T	JPY	JP Equity Fund	15,706 (Yen)	10.26	0.11	2001-07-11	0.90
VOO	USD	S&P 500	808.86	18.93	0.04	2010-09-07	1.96
VGK	USD	EU Index Fund	26.76	8.30	0.10	2005-03-04	2.17
DBEM	USD	Emerging Market Equity	97.63M	11.06	0.65	2011-06-09	1.58

Fixed Income

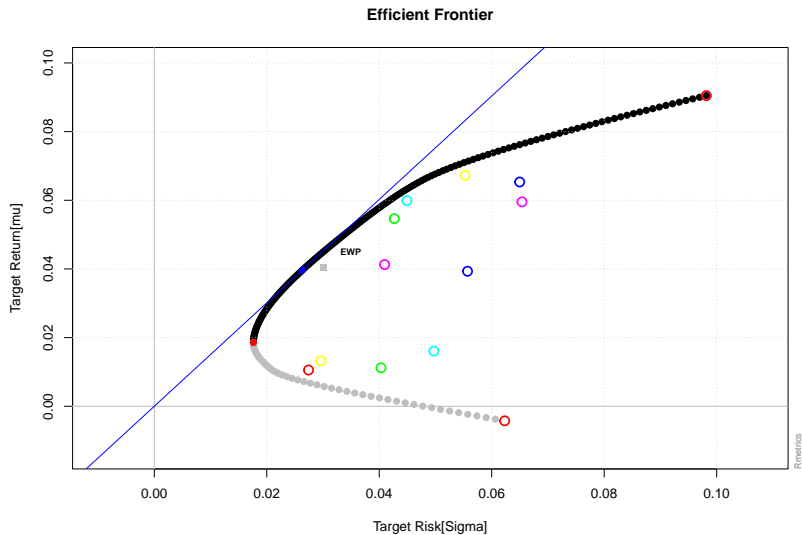|	currency	Asset Type	Net Assets (bn)	3 Year Annualised Return	Expense Ratio (%)	Inception Date	Beta
VCSH	USD	US Short Term Corp Bond	49.77	1.58	0.05	2009-11-19	0.00862
BNDX	USD	International Bond Index	93.83	0.63	0.13	2013-05-31	-0.02660
EDV	USD	US Long Term Bond	2.52	4.24	0.06	2007-12-06	-0.78522
BIV	USD	US Intermediate Term Bond	36.99	2.16	0.07	2007-04-03	-0.04980

ETF Summary

Real Estate Investment Trust

	currency	Asset Type	Net Assets (bn)	3 Year Annualised Return	Expense Ratio (%)	Inception Date	Beta
VNQI	USD	Global REITs (ex US)	5.9	0.41	0.11	2010-11-01	1.36
VNQ	USD	US REITs	84.11	11.39	0.12	2004-09-23	2.02

Gold and Commodity

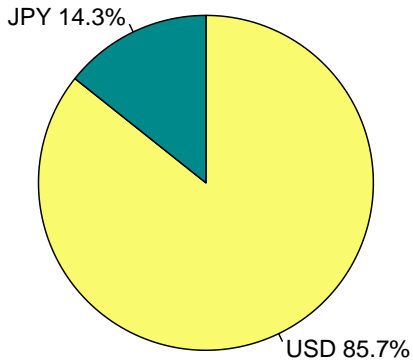|	currency	Asset Type	Net Assets (bn)	3 Year Annualised Return	Expense Ratio (%)	Inception Date	Beta
IAU	USD	Gold Bullion	32.25	12.12	0.25	2005-01-21	0.108
BCI	USD	Commodities	1.06	15.70	0.25	2017-03-30	0.641
ICLN	USD	Clean energy	5.66	38.32	0.42	2008-06-24	2.705

Efficient Frontier

Efficient Frontier

Low Risk Portfolio

Portfolio omposition

- 1306.T + 27.67 %
- VOO + 25.06 %
- BNDX + 17.82 %
- VGK + 9.76 %
- IAU + 8.94 %
- EDV + 7.67 %
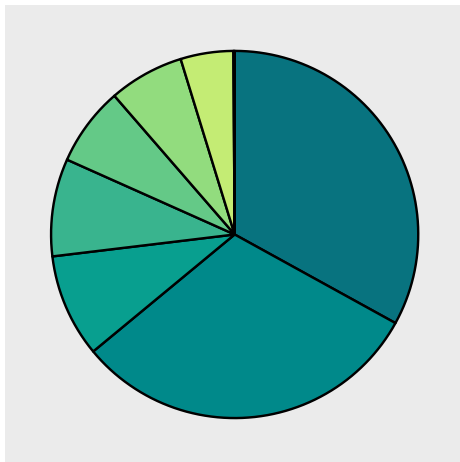- VNQI + 3.07 %
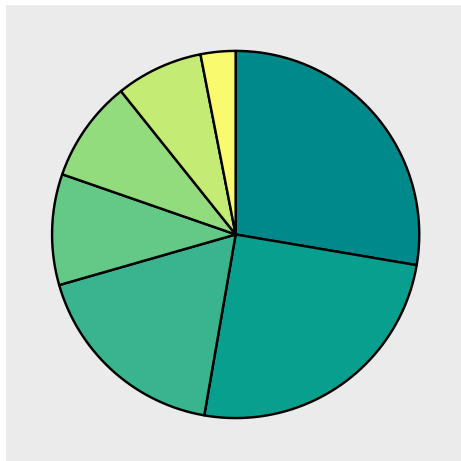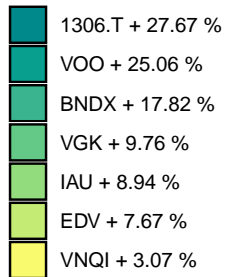
Returns	Risks
1.96 %	1.32 %

Currency breakdown of Low Risk Portfolio

Mid Risk Portfolio

Portfolio omposition

- DBEM + 33.02 %
- VNQI + 30.99 %
- 1306.T + 9.09 %
- EDV + 8.59 %
- VOO + 6.95 %
- BNDX + 6.62 %
- IAU + 4.64 %
- ICLN + 0.11 %
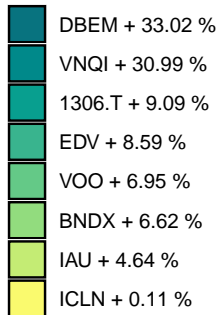
Returns	Risks
4.29 %	2.74 %

Currency breakdown of Mid Risk Portfolio
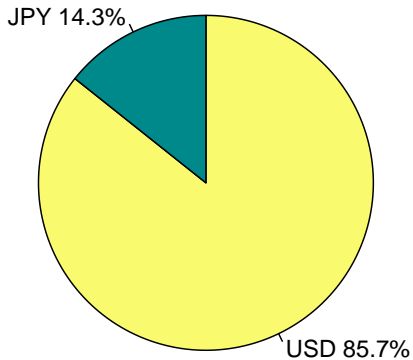
High Risk Portfolio
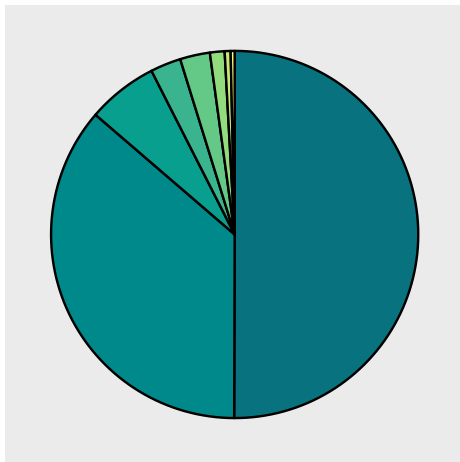
Portfolio omposition

- DBEM + 50.04 %
- VNQI + 36.26 %
- EDV + 6.21 %
- VCSH + 2.69 %
- ICLN + 2.63 %
- BCI + 1.29 %
- IAU + 0.52 %
- BNDX + 0.35 %

Returns	Risks
5.48 %	3.63 %

Currency breakdown of High Risk Portfolio
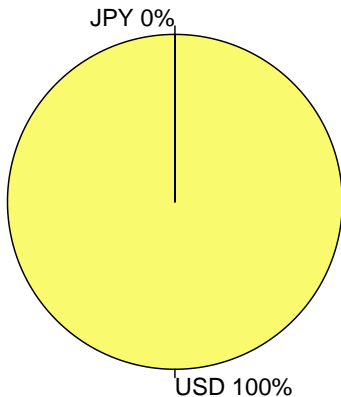
Performance of Portfolios

Appendix

Methodology

1. Identify ETFs
   - Source for other ETFs
   - Omit ETFs (Justification in appendix)
2. Prepare data
   - Obtain adjusted closing price for each ETF
   - Obtain proxies for ETFs that do not have data dating back to our chosen start date
     - VOO proxied by SPY
     - DBEM proxied by EEM
     - VCSH proxied by IGSB
     - BNDX & BIV proxied by AGG
     - BCI proxied by DBC
     - ICLN proxied by PBW
   - Account for currency differences
   - Obtain individual ETF returns, R_i, and market returns, R_{mkt}
   - Get data of a 60% ACWI, 40% BGA market portfolio

Methodology

3. Calculate β_i for each ETF by regressing $R_{i,t} = \alpha + \beta_i R_{mkt,t}$
4. Obtain mean and standard deviation for each ETF
   - Calculate historical mean and standard deviation
   - Calculate CAPM mean using $E(R_i) = \mu_{CAPM} = r_f + \beta_i E(R_{mkt})$
     - Take the risk-free rate to be equivalent to the yield on a 20-year Japanese Government bond, $r_f = 0.76\%$
     - Take the expected market returns to be $E(R_{mkt}) = 5\%$
   - Calculate μ using $\mu = \frac{2}{3}\mu_{CAPM} + \frac{1}{3}\mu_{hist}$
5. Get portfolio
   - Get portfolio weights from μ and covariance
   - Generate efficient frontier using fPortfolio
   - From the efficient frontier, obtain low, medium, high risk portfolios
6. Backtest, amend initial portfolio choices.

Reasons for omitting some ETFs
Equities

- ▶ Omit SPY
    - ▶ SPY an almost identical composition to VOO
    - ▶ However, SPY is omitted due to its higher expense ratio of 0.09% compared to VOO's of 0.04%
- ▶ Omit HVST AU
    - ▶ HVST AU is omitted due to a historical downward trend in daily returns
- ▶ Omit VO & VT
    - ▶ VO and VT are omitted due to its extremely high correlation with VOO

|	VO	VOO	VT
VO	1.00	0.94	0.95
VOO	0.94	1.00	0.94
VT	0.95	0.94	1.00

Reasons for omitting some ETFs

REITs

- ▶ Omit JP 1555
  - ▶ 1555 is omitted due to high expense ratio of 0.45%
- ▶ Omit JP 1343
  - ▶ 1343.JT is omitted as VNQI already possesses stocks in 1343.JT

ICLN introduced

- ▶ iShares Global Clean Energy ETF (ICLN)
  - ▶ Exposure to companies that produce energy from solar, wind, and other renewable sources
 - ▶ Composition (Top 10 Holdings)

ICLN Top 10 Holdings [View All]
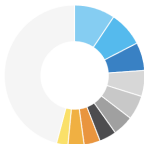
Enphase Energy, Inc.	9.39%	Plug Power Inc.	4.76%
Vestas Wind Syste...	8.02%	SSE plc	3.93%
Consolidated Edison...	6.46%	EDP-Energias de Po...	3.73%
Orsted	5.98%	Iberdrola SA	3.70%
SolarEdge Technolo...	5.56%	Xinyi Solar Holdings ...	2.63%
		Total Top 10 Weight...	54.16%

Correlation Matrix

|	BIV	VCSH	BNDX	VNQI	VNQ	1306.T	EDV	VGK	VOO	IAU	BCI	DBEM	ICLN
BIV	1.00	0.15	0.20	0.22	0.14	-0.05	0.72	0.02	-0.02	0.19	-0.05	0.05	0.05
VCSH	0.15	1.00	0.10	0.56	0.17	0.04	0.05	0.17	0.18	0.26	0.10	0.18	0.14
BNDX	0.20	0.10	1.00	0.10	0.11	0.00	0.23	0.10	0.06	0.24	0.01	0.09	0.05
VNQI	0.22	0.56	0.10	1.00	0.71	0.61	-0.21	0.84	0.72	0.25	0.47	0.54	0.64
VNQ	0.14	0.17	0.11	0.71	1.00	0.46	-0.03	0.68	0.73	0.10	0.28	0.53	0.52
1306.T	-0.05	0.04	0.00	0.61	0.46	1.00	-0.33	0.66	0.66	-0.10	0.29	0.40	0.54
EDV	0.72	0.05	0.23	-0.21	-0.03	-0.33	1.00	-0.27	-0.28	0.20	-0.39	-0.14	-0.21
VGK	0.02	0.17	0.10	0.84	0.68	0.66	-0.27	1.00	0.86	0.15	0.55	0.71	0.70
VOO	-0.02	0.18	0.06	0.72	0.73	0.66	-0.28	0.86	1.00	0.05	0.44	0.65	0.68
IAU	0.19	0.26	0.24	0.25	0.10	-0.10	0.20	0.15	0.05	1.00	0.37	0.22	0.15
BCI	-0.05	0.10	0.01	0.47	0.28	0.29	-0.39	0.55	0.44	0.37	1.00	0.49	0.37
DBEM	0.05	0.18	0.09	0.54	0.53	0.40	-0.14	0.71	0.65	0.22	0.49	1.00	0.61
ICLN	0.05	0.14	0.05	0.64	0.52	0.54	-0.21	0.70	0.68	0.15	0.37	0.61	1.00

Plot of BDNX Returns against AGG Returns
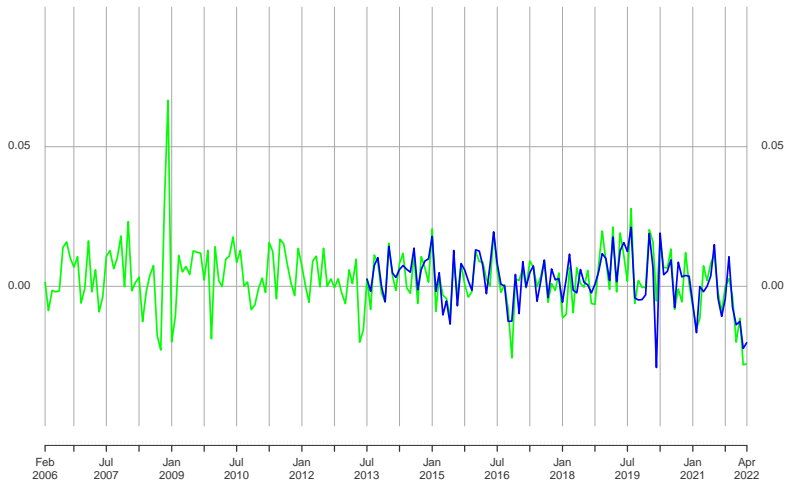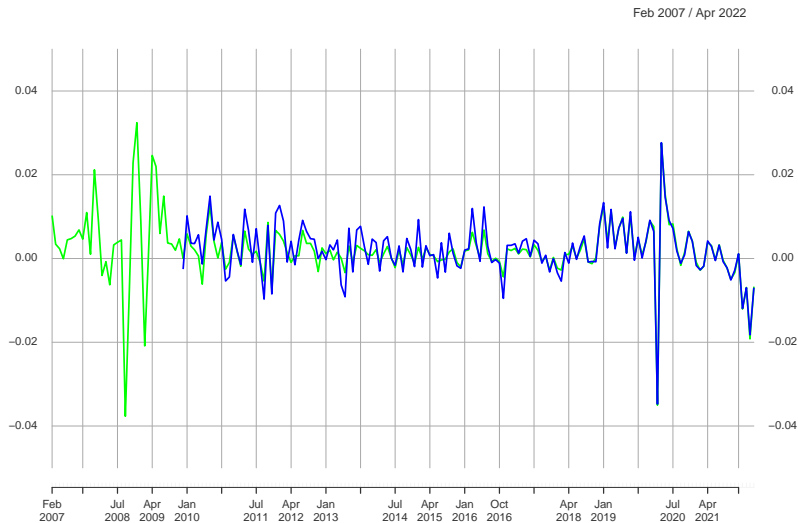
Feb 2006 / Apr 2022

Legend: Proxy: AGG , BNDX

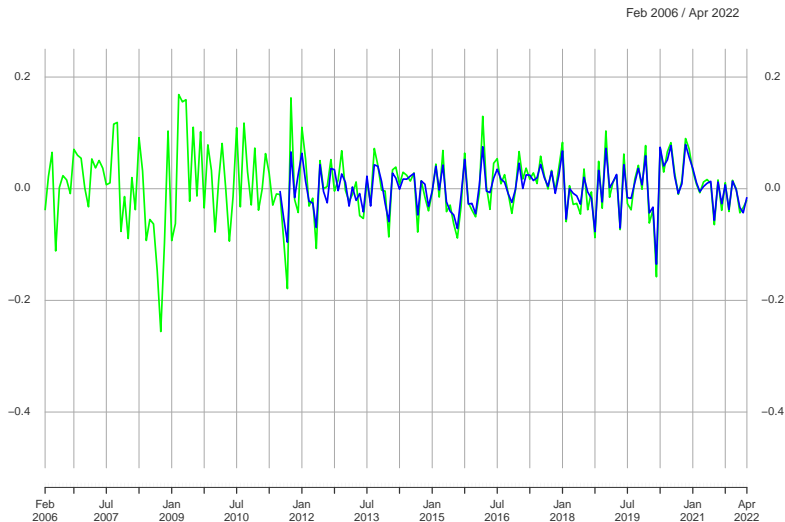# Plot of BIV Returns against AGG Returns

Feb 2006 / Apr 2022
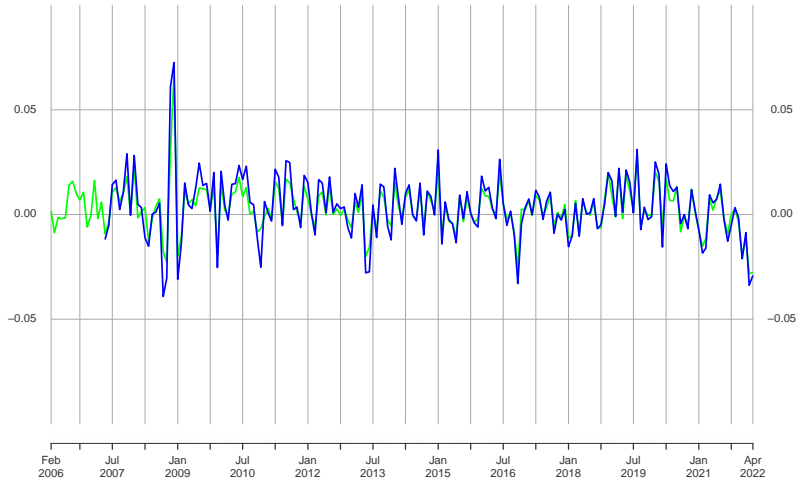
Legend: Proxy: AGG , BIV
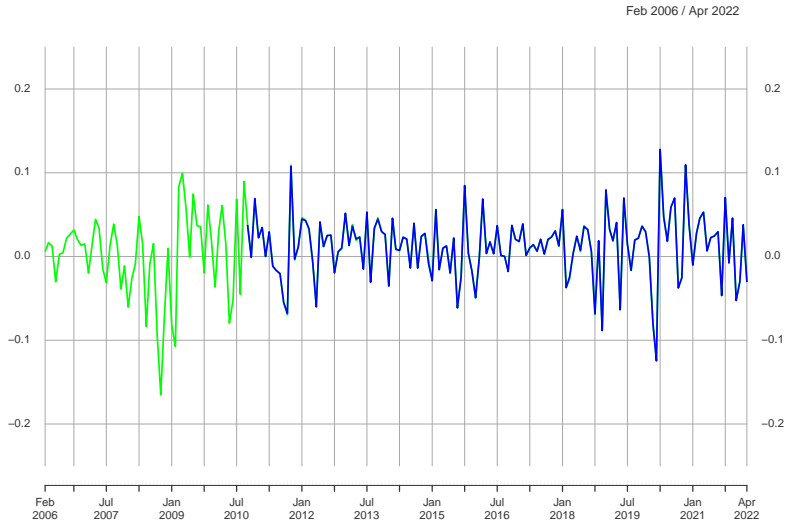
Plot of VCSH Returns against IGSB Returns

Feb 2007 / Apr 2022

Legend: Proxy: IGSB , VCSH

Plot of DBEM Returns against EEM Returns

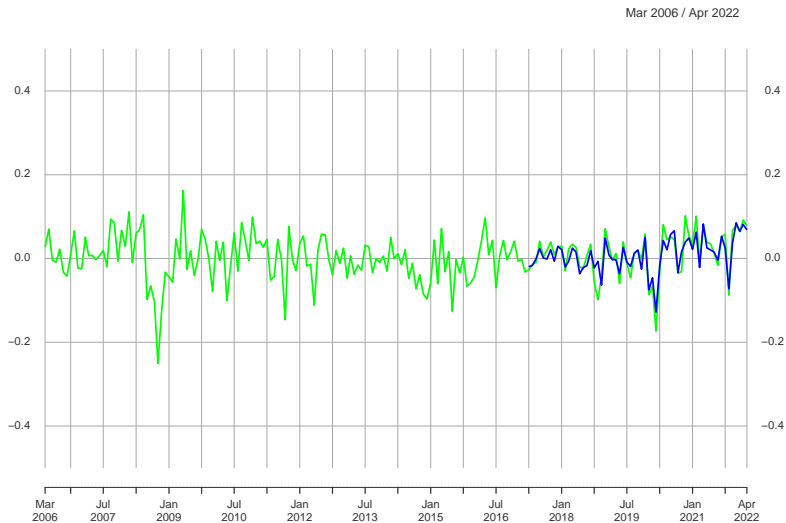Feb 2006 / Apr 2022

Legend: Proxy: EEM , DBEM

Plot of VOO Returns against SPY Returns

Legend: Proxy: SPY , VOO

Plot of BCI Returns against DBC Returns

Mar 2006 / Apr 2022

Legend: Proxy: DBC , BCI

Plot of ICLN Returns against PBW Returns

Feb 2006 / Apr 2022

Legend: Proxy: PBW , ICLN