Financial Risk Meters in Taiwan's High-Cap Sectors

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FRM quantlet

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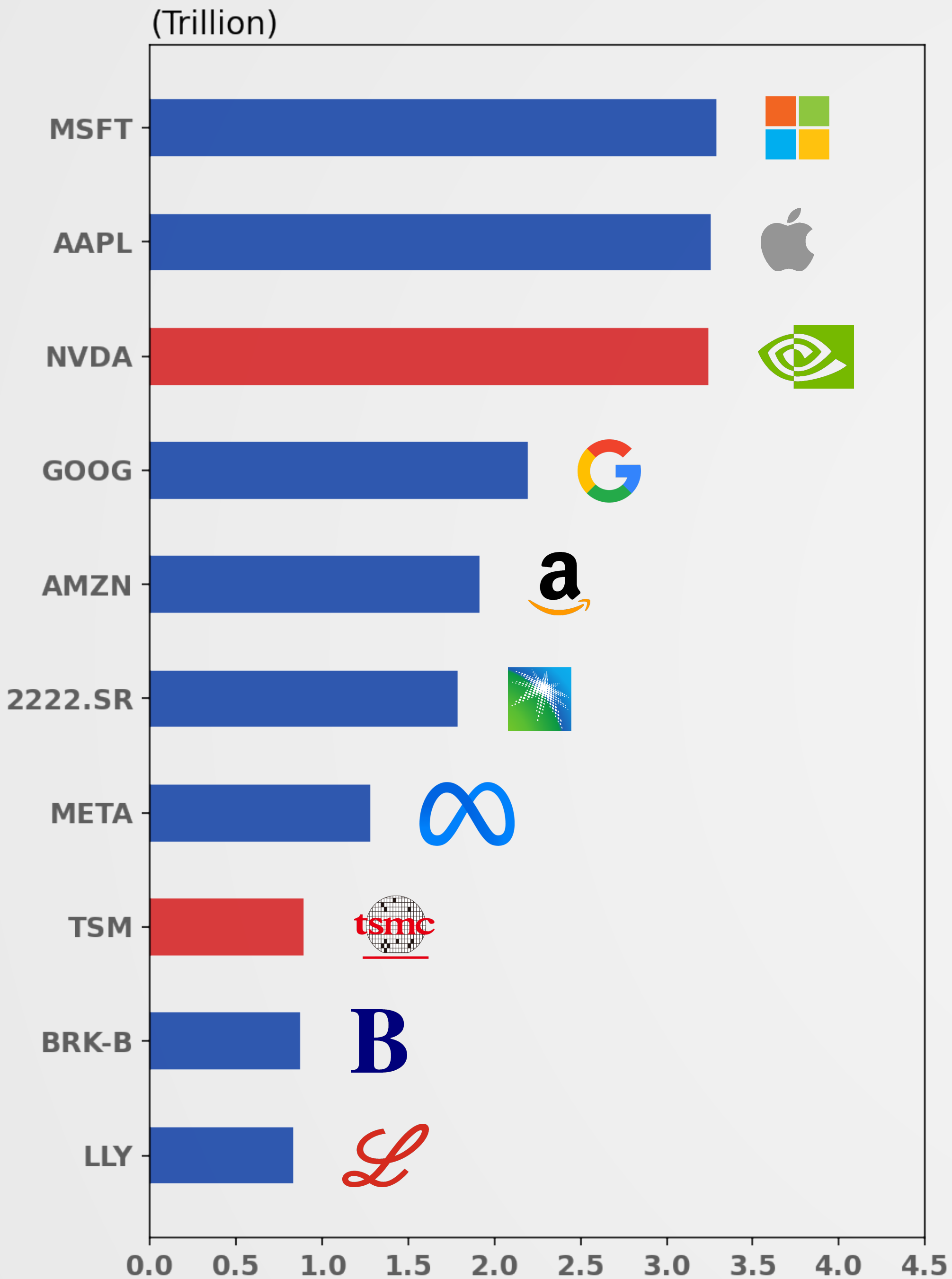
2024/6/17



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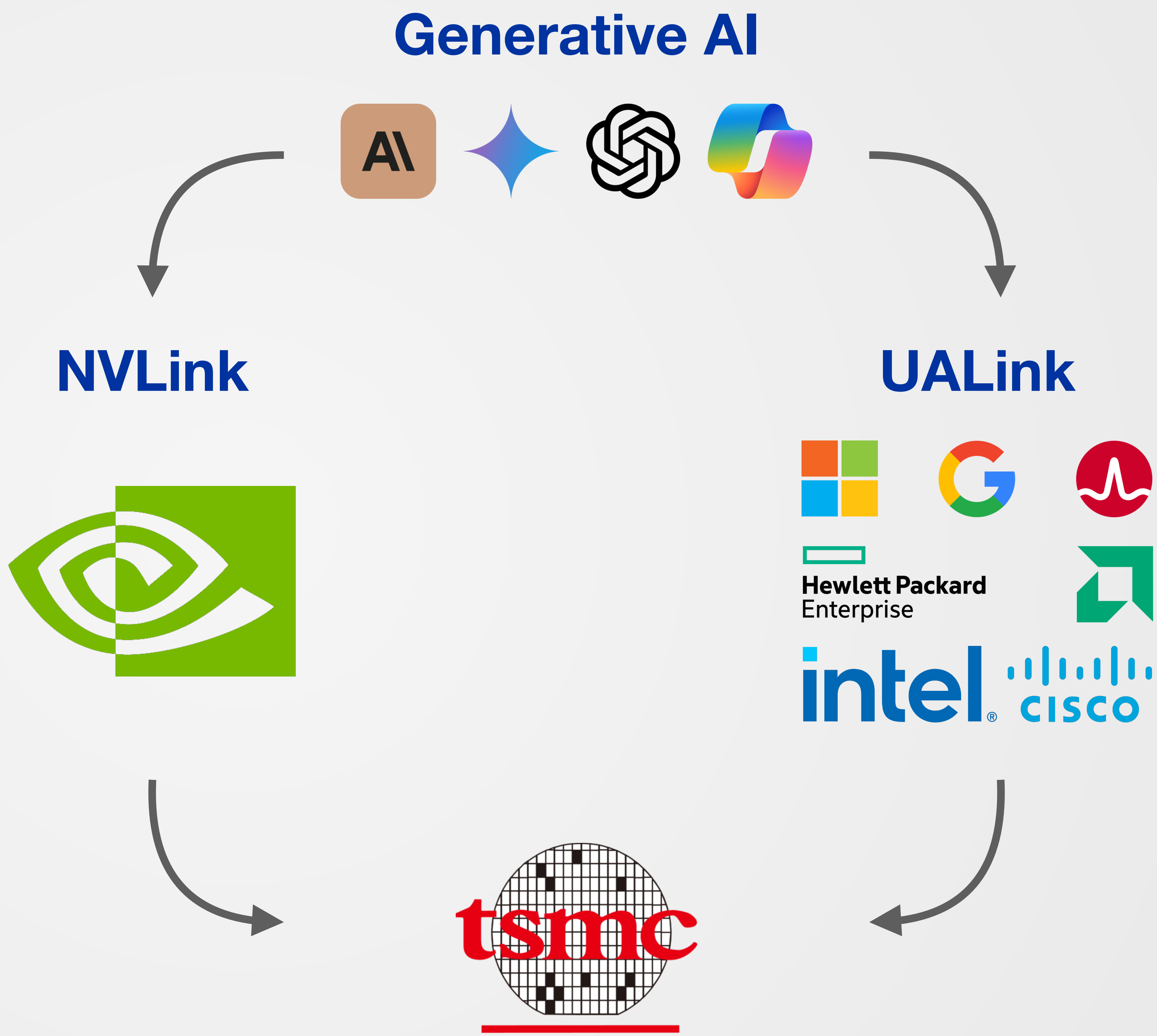
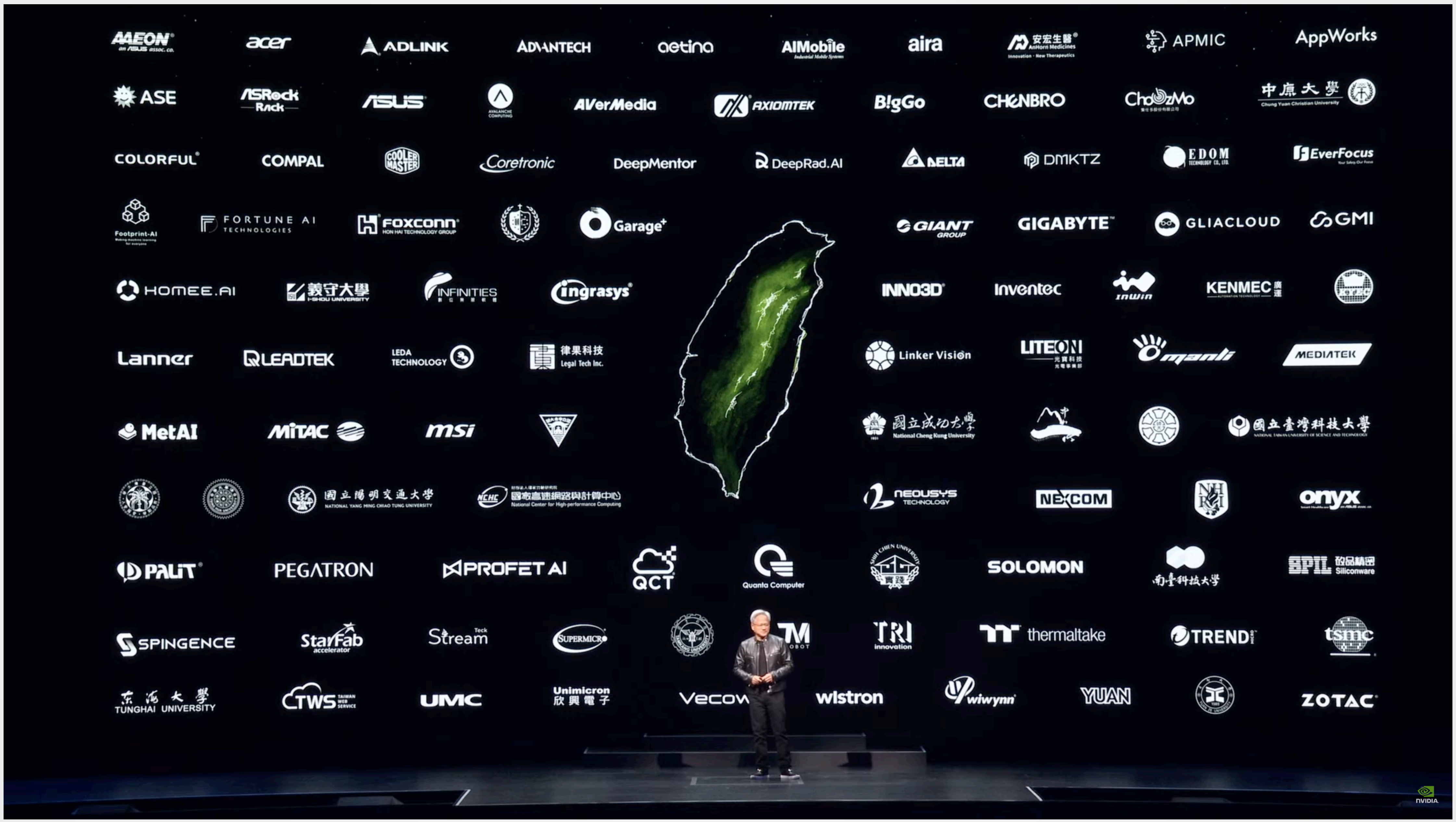


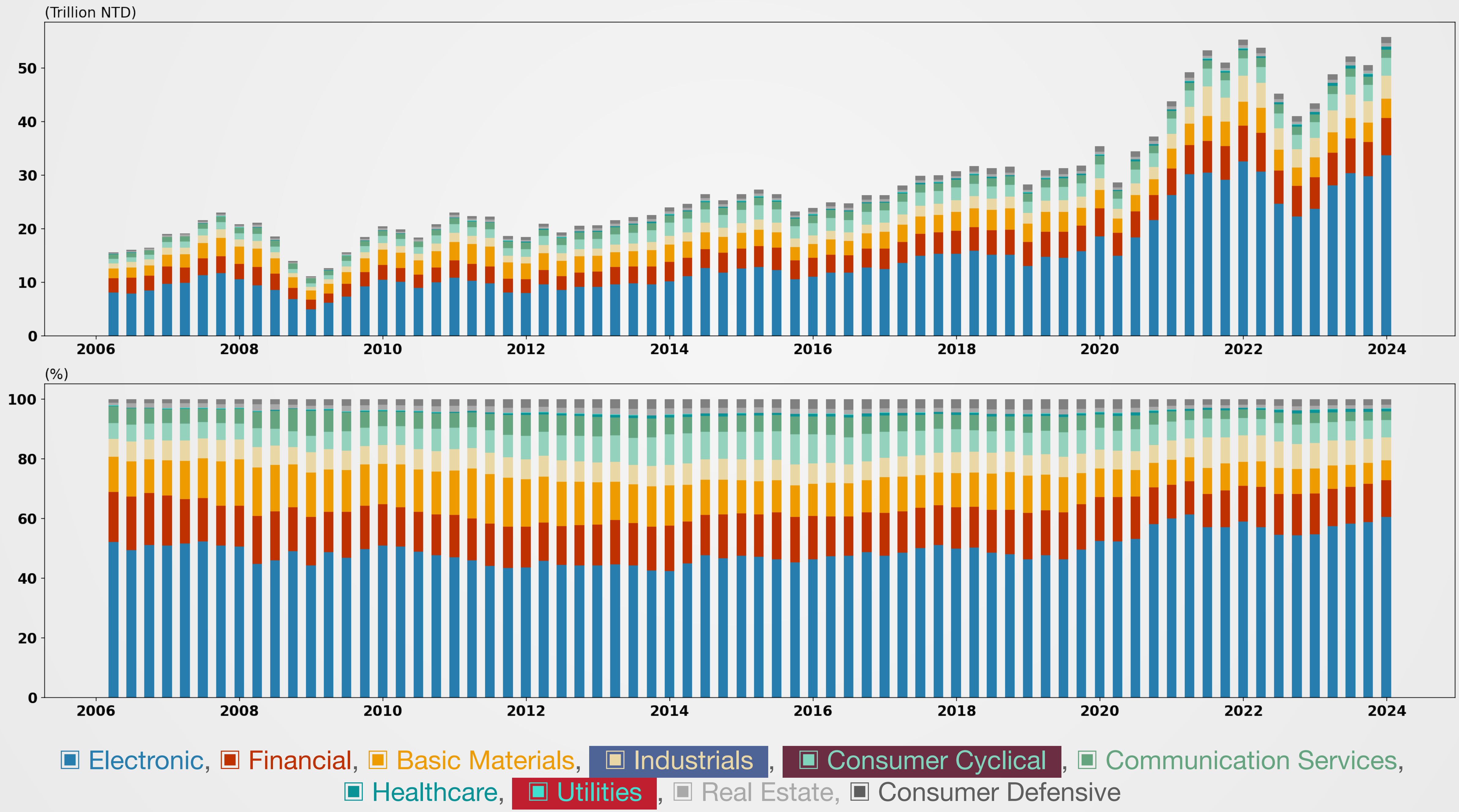
“Taiwan and our partnership has created the world’s AI infrastructure.”

— Jensen Huang



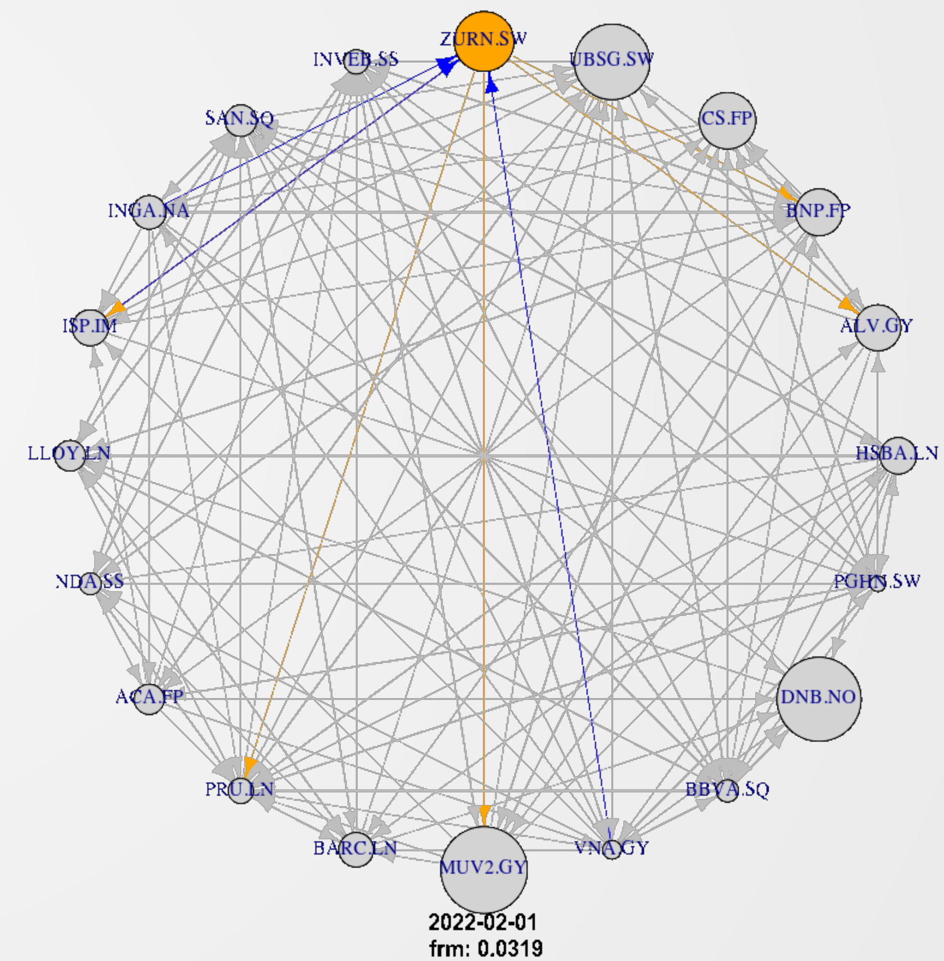
2024/06/03, Computex 2024, Keynote by NVIDIA CEO Jensen Huang

Unique Market Cap Structure



FRM FinancialRiskMeter

- Identify different systemic risk levels in the market over time
- Capture tail event co-movements
- Predict recession probabilities



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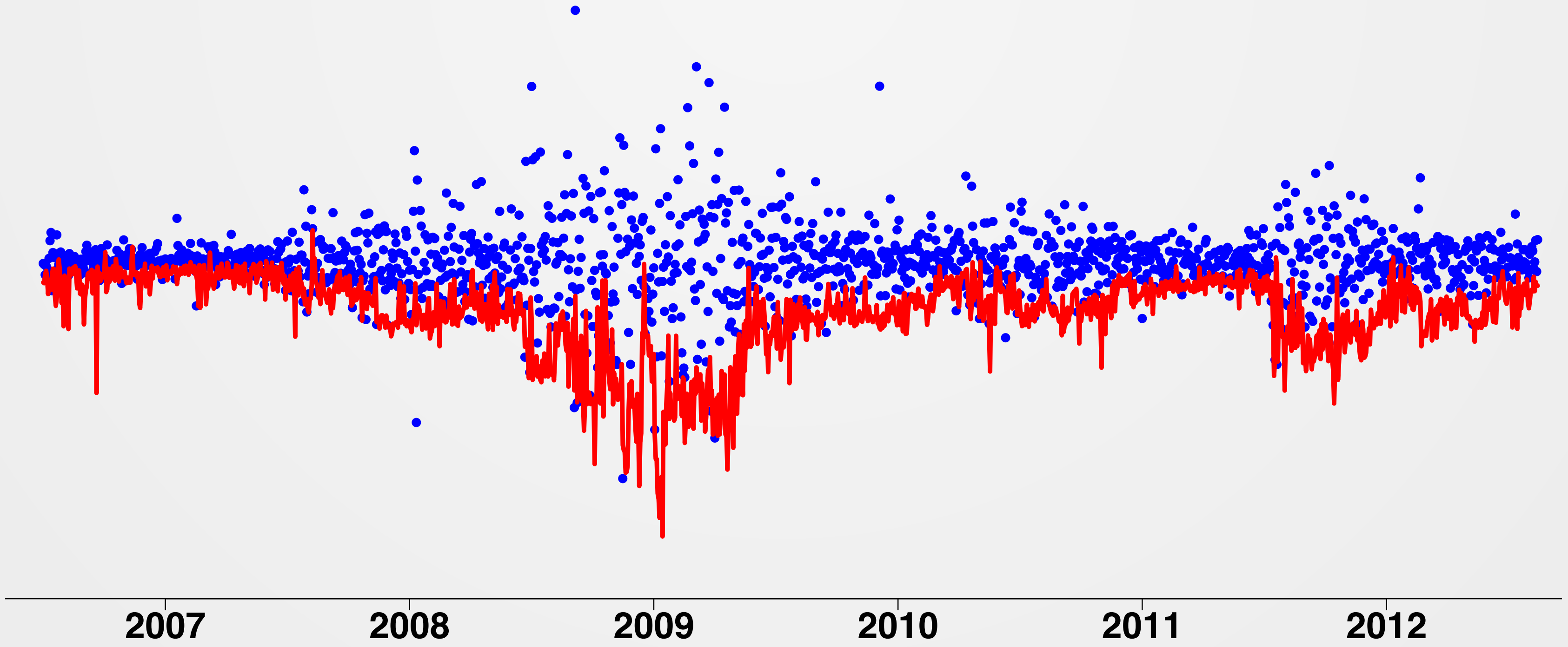
Outline

Value at Risk (VaR)

- Probability measure based

$$\mathrm{P}(X_{i,t} \leq \mathrm{VaR}_{i,t,\tau}) \stackrel{\text{def}}{=} \tau, \quad \tau \in (0,1)$$

- $X_{i,t}$ log return of asset i at t



Conditional Value at Risk (CoVaR)

- CoVaR of a company j at $\tau \in (0, 1)$ at time t, $\mathrm{CoVaR}_{j,t,\tau|\mathbb{C}(X^i)}$, satisfies

$$P\left\{X_{j,t} \leq \mathrm{CoVaR}_{j,t,\tau|\mathbb{C}(X^i)} \,|\, \mathbb{C}(X^i)\right\} \stackrel{\text{def}}{=} \tau$$

- $\mathbb{C}(X^i)$: The information set which includes $X_{i,t} = \mathrm{VaR}_{i,t,\tau}$ and M_{t-1}.
  - M_{t-1} : A vector of macro-state variables reflecting the general state of the economy.
- Represents the potential losses that another company may face when one company experiences VaR.

CoVaR

- CoVaR technique

$$X_{i,t} = \alpha_i + \gamma_i^\top M_{t-1} + \varepsilon_{i,t}$$

$$X_{j,t} = \alpha_{j|i} + \beta_{j|i} X_{i,t} + \gamma_{j|i}^\top M_{t-1} + \varepsilon_{j,t}$$

- Assume $F_{\varepsilon_{i,t}}^{-1}(\tau \,|\, M_{t-1}) = 0$ and $F_{\varepsilon_{j,t}}^{-1}(\tau \,|\, M_{t-1}, X_{i,t}) = 0$

$$\widehat{VaR}_{i,t}^{\tau} = \widehat{\alpha}_i + \widehat{\gamma}_i^\top M_{t-1}$$

$$\widehat{CoVaR}_{j|i,t}^{\tau} = \widehat{\alpha}_{j|i} + \widehat{\beta}_{j|i} \widehat{VaR}_{i,t}^{\tau} + \widehat{\gamma}_{j|i}^\top M_{t-1}$$

CoVaR: First calculate VaRs, then compute the CoVaR given a stressed risk factor.

Linear Quantile Regression

- The log return series $X_{j,t}$ in a window of H days is given by

$$X_{j,t} = \alpha_j + A_{j,t}\beta_j + \varepsilon_{j,t}, \quad j \in \{1, 2, \cdots, J\} \tag{1}$$

with N financial institutions and m macroeconomic variables.

  - $A_{j,t} = \left[X_{-j,t}, M_{t-1}\right]$: a $p = (J + M - 1)$ dimensional vector of covariates.
  - T: the total number of observations and $t \in \{1,\ \cdots, H\}$.
  - $X_{-j,t}$: the log return of all the FIs except the j-th FI on day t.
  - M: the number of macroeconomic variables.
  - β_j: a $p \times 1$ vector of coefficients.

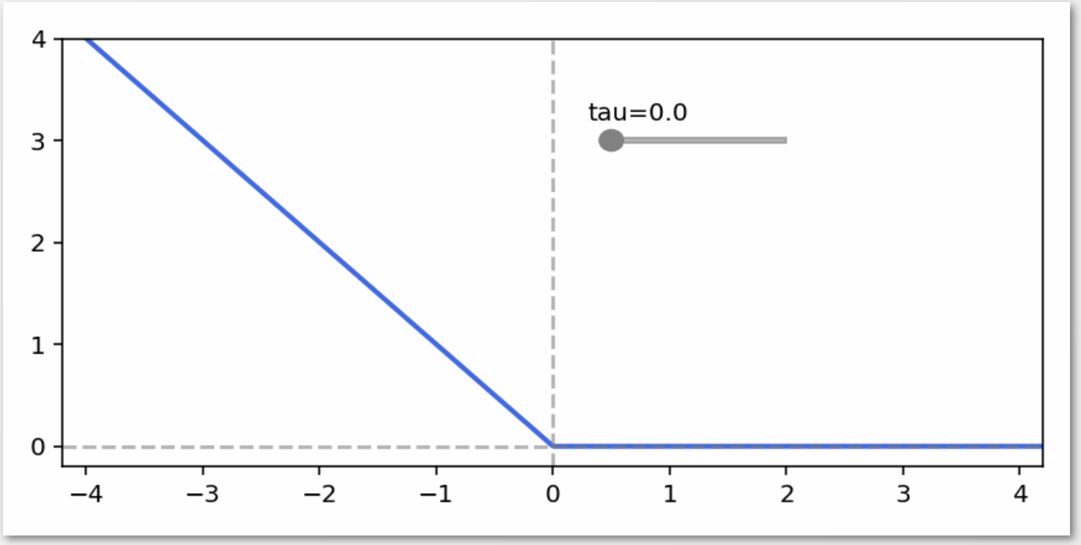
Linear Quantile Regression

- The estimation of the coefficient $\widehat{\beta}_\tau$

$$\widehat{\beta}_{j,\tau} = \underset{\alpha_j,\beta_j}{\arg\min}\ \mathbb{E}_{X_j,A_j}\left[\rho_\tau\left(X_j - \alpha_j - A_j\beta_j\right)\right]$$

with the quantile loss function, given tail risk level τ, denoted as

$$\rho_\tau(u) = \left|\tau - \mathbf{I}\{u \leq 0)\}\right| |u| = \begin{cases} \left|\tau\right| |u| & \text{, if } u > 0 \\ \left|\tau - 1\right| |u|, & \text{if } u \leq 0 \end{cases}$$



Quantile Loss Function at $\tau \in (0, 1)$

Linear Quantile Lasso Regression

$$\widehat{\alpha_j}(\lambda_j), \widehat{\beta_j}(\lambda_j) = \arg\min_{\alpha_j,\beta_j} \left\{ \frac{1}{H} \sum_{t=1}^{H} \rho_\tau \left(X_{j,t} - \alpha_j - A_{j,t}\beta_j \right) + \lambda_j \left\| \beta_j \right\|_1 \right\} \tag{3}$$

- Generalized Approximate CrossValidation

$$\mathrm{GACV}(\lambda_j) = \frac{\sum_{t=1}^{H} \rho_\tau \left(X_{j,t} - \alpha_j(\lambda_j) - A_{j,t}\beta_j(\lambda_j) \right)}{H - df}$$

Number of non-zero β

Window size

- λ_j^* minimizes GACV (Yuan, 2006)

$$\lambda_j^* = \arg\min \mathrm{GACV}(\lambda_j) \tag{4}$$

FRM

- FRM daily index at time t

$$\text{FRM}_t = \frac{1}{J}\sum_{j=1}^{J}\lambda^*_{j,t} \qquad (5)$$

the average of the penalties of the quantile lasso regression.

- The evolution of averaged λ_j represents the dynamic systemic tail risks
- FRM thus measures joint tail events.

FRM courselet

Linear Quantile LASSO Regression

- Incorporate the linear quantile regression with an L_1-norm constraint

$$\left\|\beta_j\right\|_1 \leq b$$

- The optimization of the constraint level b:

$$b^* = \arg\min_b \left\{ \mathbb{E}_{X_j, A_j}\left[\rho_\tau\left(X_j - \widehat{\alpha}_{j,\tau} - A_j \widehat{\beta}_{j,\tau}(b)\right)\right] \right\}$$

Constrained Optimization Problem

- The convex programming problem that quantile LASSO solves

$$\underset{\alpha_j,\beta_j}{\arg\min}\left\{\mathbb{E}_{X_j,A_j}\left[\rho_\tau\left(X_j-\alpha_j-A_j^\top\beta_j\right)\right]\right\}\quad \text{s.t.}\quad \left\|\beta_j\right\|_1\leq b$$

- Denoted the expected gain $R\left(\beta_j\right)$ and the constraint function $B\left(\beta_j\right)$

$$R(\beta_j)=-\mathbb{E}_{X_j,A_j}\left\{\rho_\tau\left(X_j-\alpha_j-A_j\beta_j\right)\right\}$$
$$B(\beta_j)=\|\beta_j\|_1$$

- The lagrangian formulation of the optimization objective is

$$\mathfrak{L}\left(\beta_j,\lambda_j\right)=R\left(\beta_j\right)-\lambda_j\left\{B\left(\beta_j\right)-b\right\}$$

Constrained Optimization Problem

- View $\mathfrak{L}\left\{\beta_j(b), \lambda_j(b), b\right\}$ as a function of the budget constraint b.
- λ_j becomes a derivative with respect to b when evaluated at the solution $\left\{\beta_j^*(b), \lambda_j^*(b)\right\}$
- Due to KKT c=onditions and the chain rule,

$$\frac{d}{db}\mathfrak{L}\left\{\beta_j^*(b), \lambda_j^*(b), b\right\} = \underbrace{\frac{d\mathfrak{L}}{d\beta_j}}_{=0}\frac{d\beta_j^*}{db} + \underbrace{\frac{d\mathfrak{L}}{d\lambda_j}}_{=0}\frac{d\lambda_j^*}{db} + \frac{d\mathfrak{L}}{db} = \lambda_j^*(b) \quad (2)$$

Constrained Optimization Problem

- Note that at the optimal value the Lagrangian equals the expected gain R:

$$\mathfrak{L}\left(\beta_j^*, \lambda_j^*, b\right) = R\left(\beta^*\right) - \lambda_j^* \underbrace{\left\{B\left(\beta_j^*\right) - b\right\}}_{=0} = R^*(b) \qquad (3)$$

- Combing Eq. (2) and (3), we can regard λ_j as the rate of change of the expected gain with respect to the budget constraint:

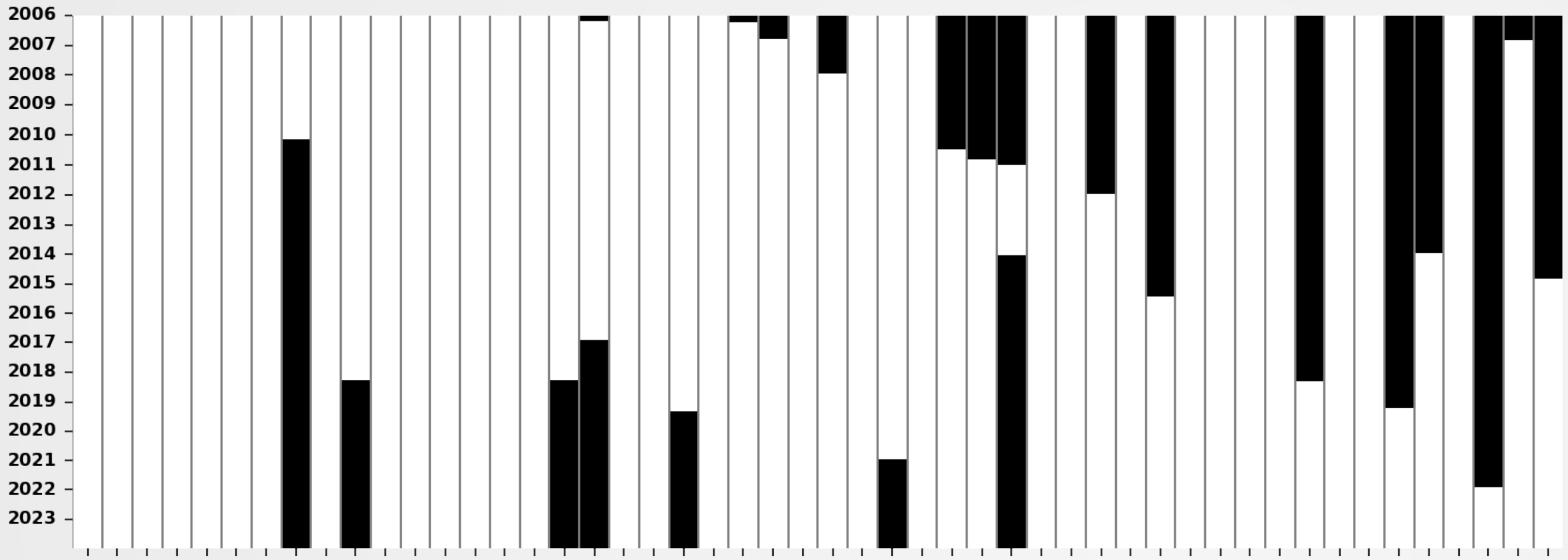
$$\lambda_j^*\left(b_0\right) = \left.\frac{dR^*}{db}\right|_{b=b_0}$$

- When considering a regression model as a predictive tool, λ_j can be seen as a **shadow price**. (Marginal predictability gain)

Data

- Time period: 2006/12/31~2023/12/31
- Company selected
  - FRM^{C} - Top 20 largest companies from the market
  - FRM^{F} - Top 20 largest companies from the financial sectors
  - FRM^{E} - Top 20 largest companies from the electronic sectors
  - FRM^{FE} - Top 10 electronics and top 10 financial
- Window size: 63, 126 days

Dynamic Selection (FRM^{E})



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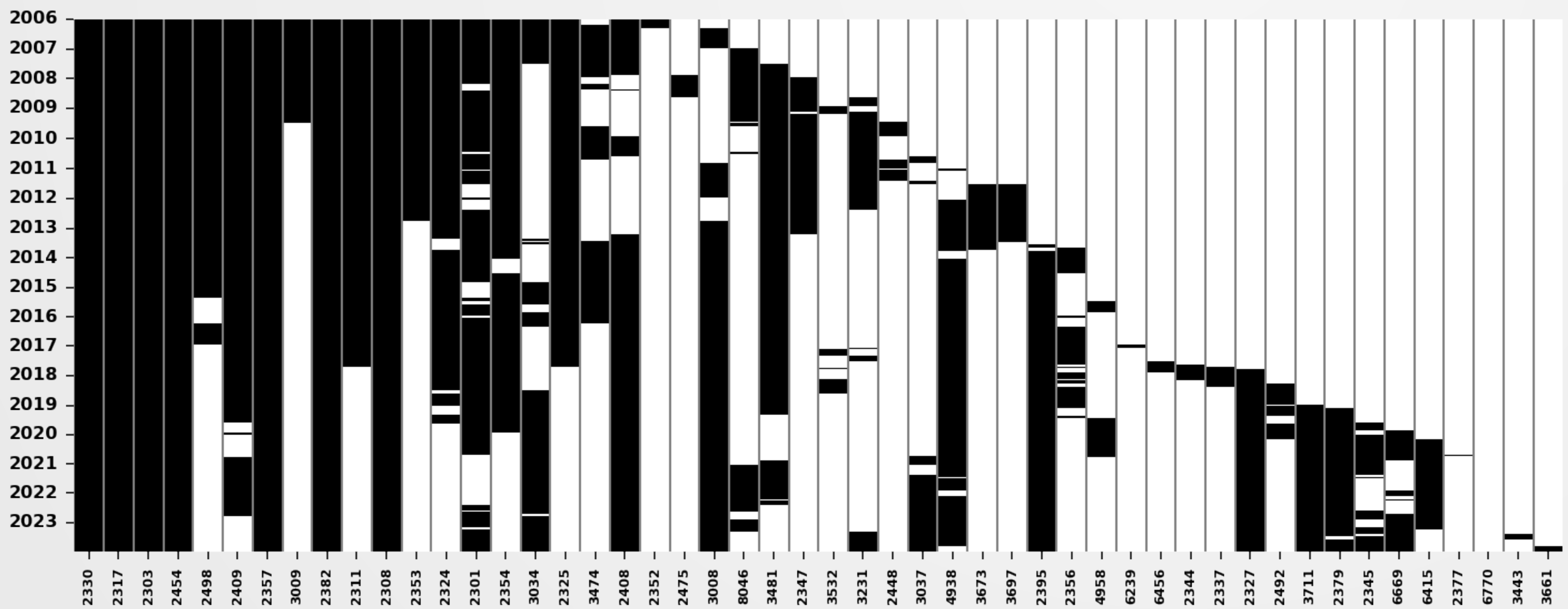
Missing data caused by companies delisting



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Selected top 20 capitalization companies in each day

Macroeconomic Variables

- Select ten macroeconomic variables from developed market risk factors.

Ticker	Description
TAIEX	Taiwan Stock Exchange Capitalization Weighted Stock Index
TELI	TAIEX Electronic Sub-Index
TFNI	TAIEX Finance and Insurance Sub-Index
SP500	Standard & Poor's 500 Index
REITs	Average of Taiwan's 10 REIT
TW2Y	Taiwan 2-year Treasury Note rate.
Slope	Spread between 2-year and 10-year Taiwan Treasury Bonds
VIXTWN	TAIEX Options Volatility Index
USDTWD	USD/TWD Exchange Rate
ONIR	Taiwan's Overnight Interbank Offer Rate

Data - Macroeconomic Variables

- Select four macroeconomic variables with the weakest correlations

	TAIEX	Electronic	Financial	SP500	REITs	TW2Y	Slope	VIXTWN	USDTWD	ONIR
TAIEX	1.00	0.96***	0.85***	0.17***	0.28***	0.02	0.10***	-0.51***	-0.45***	-0.03*
Electronic	0.96***	1.00	0.72***	0.16***	0.26***	0.00	0.09***	-0.49***	-0.42***	-0.03*
Financial	0.85***	0.72***	1.00	0.13***	0.27**	0.01	0.08***	-0.39***	-0.38***	-0.02
SP500	0.17***	0.16***	0.13***	1.00	0.02	0.00	0.12***	-0.10***	-0.10***	0.02
REITs	0.28***	0.26***	0.27**	0.02	1.00	0.01	0.16***	-0.13***	-0.16***	-0.01
TW2Y	0.00	0.00	0.01	0.00	0.01	1.00	-0.04**	-0.01	0.03**	0.01
Slope	0.10***	0.09***	0.08***	0.12***	0.16***	-0.04**	1.00	-0.02	-0.06***	-0.01
VIXTWN	-0.51***	-0.49***	-0.39***	-0.10***	-0.13***	-0.01	-0.02	1.00	0.22***	-0.02
USDTWD	-0.45***	-0.42***	-0.38***	-0.10***	-0.16***	0.03**	-0.06***	0.22***	1.00	-0.02
ONIR	-0.03*	-0.03*	-0.02	0.02	-0.01	0.01	-0.01	-0.02	-0.02	1.00

Business Cycle Monitor Indicators (MI)

- 9 Indicators, each indicator's score is from 1 to 5.
  - Monetary Aggregate, M1B
  - Stock Price Index
  - Industrial Production Index
  - Non-agricultural Sector Employment
  - Customs Export Value
  - Import Value of Machinery and Electrical Equipment
  - Manufacturing Sales Volume Index
  - Wholesale, Retail, and Food Service Sales
  - Manufacturing Business Climate Survey Point

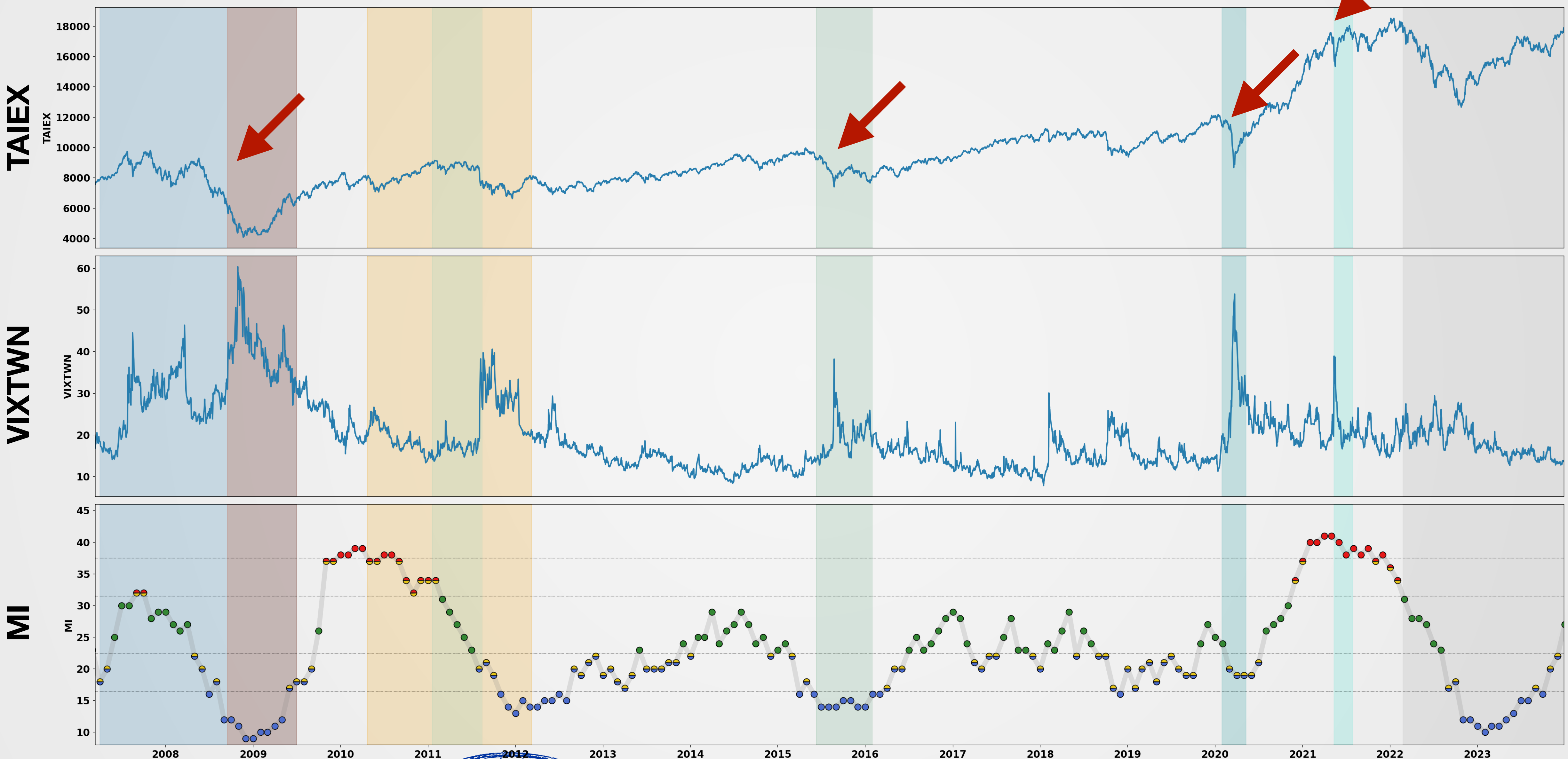
Business Cycle Monitor Indicators (MI)

- The calculation of MI is $\sum_{i=1}^{9} \text{Indicator}_i$
- Therefore the MI $\in [9, 45]$
  - **Blue light (Sluggish; Recession):** MI $\in [9, 16]$
  - **Blue yellow light (Transitional):** MI $\in [17, 22]$
  - **Green light (Stable):** MI $\in [23, 31]$
  - **Yellow red light (Transitional):** MI $\in [32, 37]$
  - **Red light (Booming):** MI $\in [38, 45]$
- Announce at the end of next month.

Defining Periods of Economic Turmoil

Start Date	End Date	Event
2007-04-02	2009-06-30	Subprime Mortgage Crisis
2008-09-15	2009-06-30	Lehman Brothers Bankruptcy
2010-04-23	2012-03-09	European Debt Crisis
2011-01-19	2011-08-15	US Debt Crisis
2015-06-12	2016-01-31	Chinese Stock Market Crash
2020-01-30	2020-05-10	First Taiwan's COVID-19 Outbreak
2021-05-11	2021-07-27	Second Taiwan's COVID-19 Outbreak
2022-02-24	2023-12-29	Russia-Ukraine War and US Interest Rate Hikes

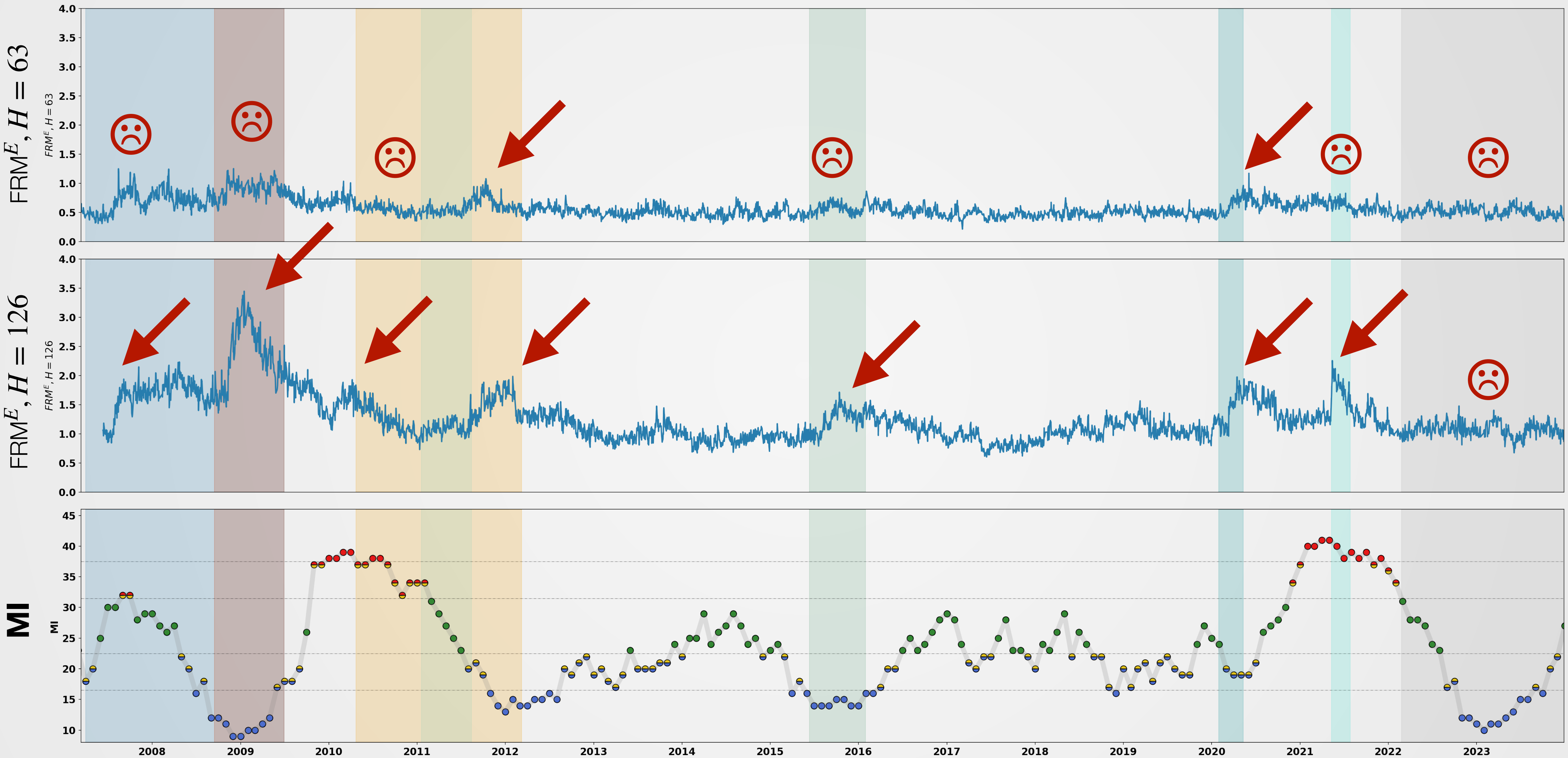
TAIEX, VIXTWN, MI



• 9~16; • 17~22; • 23~32; • 33~37; • 38~45

Recession

Empirical Results - FRM^E



Cross-validation with 5-fold splits

- Response variable: $I_t^{(M)}$ represents the recession at the end of the month M, t

$$I_t^{(M)} = \begin{cases} 1, & \mathrm{MI}_t^{(M+1)} \in [9, 16] \\ 0, & \text{o.w.} \end{cases}$$

- Three sets of explanatory variables, $W = 63$
  - λ_j for $j = 1, \ldots, J$: $\mathbb{F}_t^{(M)} = \left\{ \underline{\lambda_{1,t}^{(M)}, \lambda_{1,t-1}^{(M)}, \cdots, \lambda_{1,t-W}^{(M)}, \cdots, \lambda_{J,t}^{(M)}, \lambda_{J,t-1}^{(M)}, \cdots, \lambda_{J,t-W}^{(M)}} \right\}$
  - FRM: $\mathbb{FRM}_t^{(M)} = \left\{ \mathrm{FRM}_t^{(M)}, \mathrm{FRM}_{t-1}^{(M)}, \cdots, \mathrm{FRM}_{t-W}^{(M)} \right\}$

    $(W+1) \times J = 64 \times 20 = 1280$ features
  - VIXTWN: $\mathbb{V}_t^{(M)} = \left\{ \mathrm{VIX}_t^{(M)}, \mathrm{VIX}_{t-1}^{(M)}, \cdots, \mathrm{VIX}_{t-(H+W)}^{(M)} \right\}$
- Estimate $P\left(I_t^{(M)} = 1 \,|\, X_t^{(M)}\right)$
  - Parametric method: Logistic Regression
  - Nonparametric method: XGBoost

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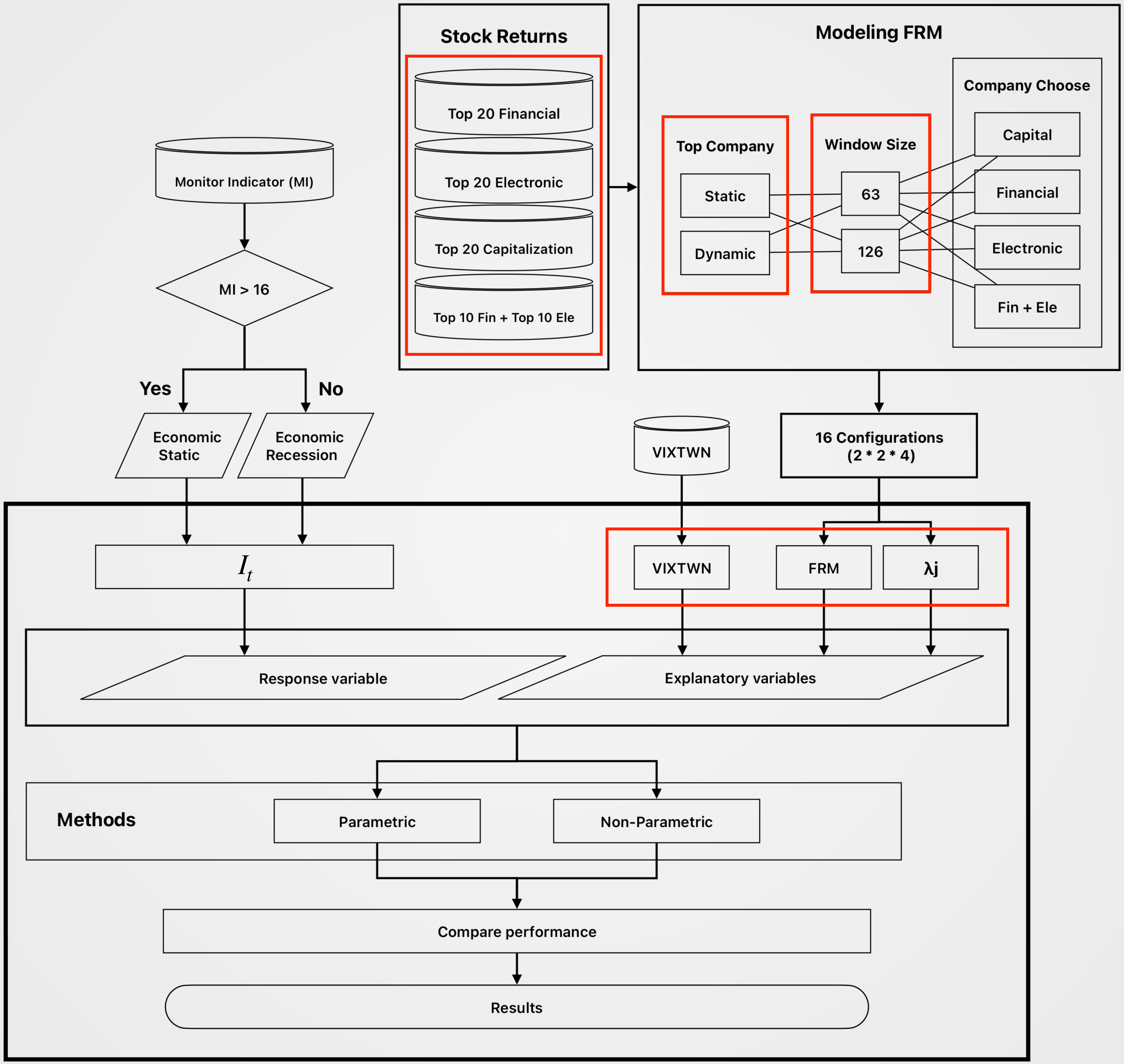
Stock Returns
Top 20 Financial
Top 20 Electronic
Top 20 Capitalization
Top 10 Fin + Top 10 Ele
Modeling FRM
Company Choose
Top Company
Window Size
Static
Dynamic
63
126
Capital
Financial
Electronic
Fin + Ele
Monitor Indicator (MI)
MI > 16
Yes
No
Economic Static
Economic Recession
VIXTWN
16 Configurations (2 * 2 * 4)
I_t
VIXTWN
FRM
λj
Response variable
Explanatory variables
Methods
Parametric
Non-Parametric
Compare performance
Results

Performance (AUC)

Company Choose	Window Size	Dynamic Selection				Static Selection			
		Parametric		Non-parametric		Parametric		Non-parametric	
		FRM	λ_j	FRM	λ_j	FRM	λ_j	FRM	λ_j
In-sample analysis, H=63									
VIXTWN	0 + 126	0.94		1.00		0.94		1.00	
Cap	63 + 63	0.76	1.00	1.00	1.00	0.67	1.00	1.00	1.00
Fin	63 + 63	0.72	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Ele	63 + 63	0.79	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	63 + 63	0.73	1.00	1.00	1.00	0.70	1.00	1.00	1.00
Out-of-sample analysis, H=63									
VIXTWN	0 + 126	0.54		0.41		0.54		0.41	
Cap	63 + 63	0.61	0.46	0.46	0.59	0.69	0.57	0.54	0.52
Fin	63 + 63	0.71	0.63	0.41	0.50	0.71	0.64	0.50	0.59
Ele	63 + 63	0.69	0.53	0.57	0.65	0.75	0.52	0.68	0.64
Fin + Ele	63 + 63	0.67	0.70	0.45	0.66	0.72	0.73	0.49	0.65
In-sample analysis, H=126									
VIXTWN	0 + 189	0.98		1.00		0.98		1.00	
Cap	126+63	0.87	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Fin	126+63	0.81	1.00	1.00	1.00	0.75	1.00	1.00	1.00
Ele	126+63	0.85	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	126+63	0.83	1.00	1.00	1.00	0.76	1.00	1.00	1.00
Out-of-sample analysis, H=126									
VIXTWN	0 + 189	0.54		0.43		0.54		0.43	
Cap	126+63	0.57	0.55	0.33	0.39	0.61	0.65	0.48	0.65
Fin	126+63	0.59	0.59	0.51	0.41	0.73	0.31	0.46	0.32
Ele	126+63	0.70	**0.80**	0.47	0.78	0.63	0.48	0.28	0.56
Fin + Ele	126+63	0.70	0.46	0.58	0.49	0.67	0.52	0.64	0.50

Performance (AUC): In-Sample

Company Choose	Window Size	Dynamic Selection				Static Selection			
		Parametric		Non-parametric		Parametric		Non-parametric	
		FRM	λ_j	FRM	λ_j	FRM	λ_j	FRM	λ_j
In-sample analysis, H=63									
VIXTWN	0 + 126	0.94		1.00		0.94		1.00	
Cap	63 + 63	0.76	1.00	1.00	1.00	0.67	1.00	1.00	1.00
Fin	63 + 63	0.72	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Ele	63 + 63	0.79	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	63 + 63	0.73	1.00	1.00	1.00	0.70	1.00	1.00	1.00
Out-of-sample analysis, H=63									
VIXTWN	0 + 126	0.54		0.41		0.54		0.41	
Cap	63 + 63	0.61	0.46	0.46	0.59	0.69	0.57	0.54	0.52
Fin	63 + 63	0.71	0.63	0.41	0.50	0.71	0.64	0.50	0.59
Ele	63 + 63	0.69	0.53	0.57	0.65	0.75	0.52	0.68	0.64
Fin + Ele	63 + 63	0.67	0.70	0.45	0.66	0.72	0.73	0.49	0.65
In-sample analysis, H=126									
VIXTWN	0 + 189	0.98		1.00		0.98		1.00	
Cap	126+63	0.87	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Fin	126+63	0.81	1.00	1.00	1.00	0.75	1.00	1.00	1.00
Ele	126+63	0.85	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	126+63	0.83	1.00	1.00	1.00	0.76	1.00	1.00	1.00
Out-of-sample analysis, H=126									
VIXTWN	0 + 189	0.54		0.43		0.54		0.43	
Cap	126+63	0.57	0.55	0.33	0.39	0.61	0.65	0.48	0.65
Fin	126+63	0.59	0.59	0.51	0.41	0.73	0.31	0.46	0.32
Ele	126+63	0.70	0.80	0.47	0.78	0.63	0.48	0.28	0.56
Fin + Ele	126+63	0.70	0.46	0.58	0.49	0.67	0.52	0.64	0.50

Performance (AUC): Out-of-Sample, Dynamic vs. Static

Company Choose	Window Size	Dynamic Selection				Static Selection			
		Parametric		Non-parametric		Parametric		Non-parametric	
		FRM	λ_j	FRM	λ_j	FRM	λ_j	FRM	λ_j
In-sample analysis, H=63									
VIXTWN	0 + 126	0.94		1.00		0.94		1.00	
Cap	63 + 63	0.76	1.00	1.00	1.00	0.67	1.00	1.00	1.00
Fin	63 + 63	0.72	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Ele	63 + 63	0.79	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	63 + 63	0.73	1.00	1.00	1.00	0.70	1.00	1.00	1.00
Out-of-sample analysis, H=63									
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Fin	63 + 63	0.71	0.63	0.41	0.50	0.71	0.64	0.50	0.59
Ele	63 + 63	0.69	0.53	0.57	0.65	0.75	0.52	0.68	0.64
Fin + Ele	63 + 63	0.67	0.70	0.45	0.66	0.72	0.73	0.49	0.65
In-sample analysis, H=126									
VIXTWN	0 + 189	0.98		1.00		0.98		1.00	
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Fin	126+63	0.81	1.00	1.00	1.00	0.75	1.00	1.00	1.00
Ele	126+63	0.85	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	126+63	0.83	1.00	1.00	1.00	0.76	1.00	1.00	1.00
Out-of-sample analysis, H=126									
VIXTWN	0 + 189	0.54		0.43		0.54		0.43	
Cap	126+63	0.57	0.55	0.33	0.39	0.61	0.65	0.48	0.65
Fin	126+63	0.59	0.59	0.51	0.41	0.73	0.31	0.46	0.32
Ele	126+63	0.70	0.80	0.47	0.78	0.63	0.48	0.28	0.56
Fin + Ele	126+63	0.70	0.46	0.58	0.49	0.67	0.52	0.64	0.50

Performance (AUC): Out-of-Sample, Parametric vs. Non-Parametric

Company Choose	Window Size	Dynamic Selection				Static Selection			
		Parametric		Non-parametric		Parametric		Non-parametric	
		FRM	λ_j	FRM	λ_j	FRM	λ_j	FRM	λ_j
In-sample analysis, H=63									
VIXTWN	0 + 126	0.94		1.00		0.94		1.00	
Cap	63 + 63	0.76	1.00	1.00	1.00	0.67	1.00	1.00	1.00
Fin	63 + 63	0.72	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Ele	63 + 63	0.79	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	63 + 63	0.73	1.00	1.00	1.00	0.70	1.00	1.00	1.00
Out-of-sample analysis, H=63									
VIXTWN	0 + 126	0.54		0.41		0.54		0.41	
Cap	63 + 63	0.61	0.46	0.46	0.59	0.69	0.57	0.54	0.52
Fin	63 + 63	0.71	0.63 >	0.41	0.50	0.71	0.64 >	0.50	0.59
Ele	63 + 63	0.69	0.53	0.57	0.65	0.75	0.52	0.68	0.64
Fin + Ele	63 + 63	0.67	0.70	0.45	0.66	0.72	0.73	0.49	0.65
In-sample analysis, H=126									
VIXTWN	0 + 189	0.98		1.00		0.98		1.00	
Cap	126+63	0.87	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Fin	126+63	0.81	1.00	1.00	1.00	0.75	1.00	1.00	1.00
Ele	126+63	0.85	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	126+63	0.83	1.00	1.00	1.00	0.76	1.00	1.00	1.00
Out-of-sample analysis, H=126									
VIXTWN	0 + 189	0.54		0.43		0.54		0.43	
Cap	126+63	0.57	0.55	0.33	0.39	0.61	0.65	0.48	0.65
Fin	126+63	0.59	0.59 >	0.51	0.41	0.73	0.31 >	0.46	0.32
Ele	126+63	0.70	0.80	0.47	0.78	0.63	0.48	0.28	0.56
Fin + Ele	126+63	0.70	0.46	0.58	0.49	0.67	0.52	0.64	0.50

Performance (AUC): Out-of-Sample, FRM, λ_j vs. Benchmark

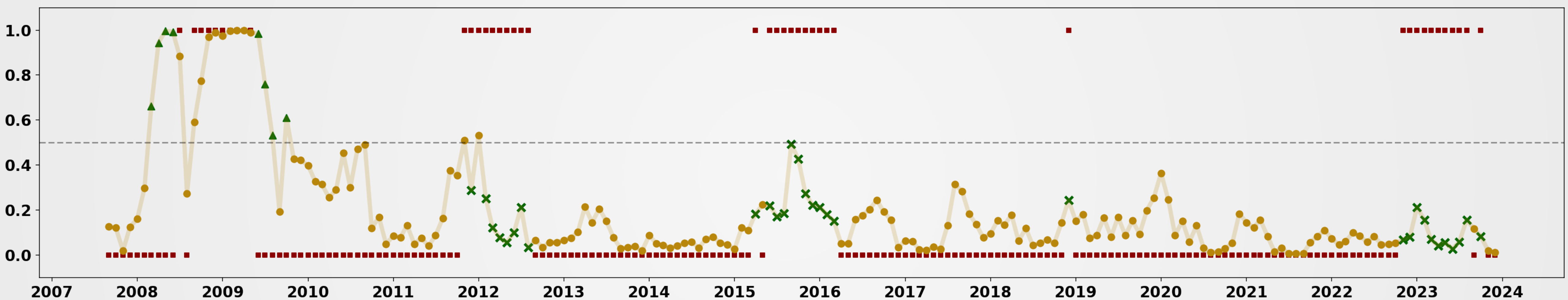
Company Choose	Window Size	Dynamic Selection				Static Selection			
		Parametric		Non-parametric		Parametric		Non-parametric	
		FRM	λ_j	FRM	λ_j	FRM	λ_j	FRM	λ_j
In-sample analysis, H=63									
VIXTWN	0 + 126	0.94		1.00		0.94		1.00	
Cap	63 + 63	0.76	1.00	1.00	1.00	0.67	1.00	1.00	1.00
Fin	63 + 63	0.72	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Ele	63 + 63	0.79	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	63 + 63	0.73	1.00	1.00	1.00	0.70	1.00	1.00	1.00
Out-of-sample analysis, H=63									
VIXTWN	0 + 126	0.54		0.41		0.54		0.41	
Cap	63 + 63	0.61	0.46	0.46	0.59	0.69	0.57	0.54	0.52
Fin	63 + 63	0.71	0.63	0.41	0.50	0.71	0.64	0.50	0.59
Ele	63 + 63	0.69	0.53	0.57	0.65	0.75	0.52	0.68	0.64
Fin + Ele	63 + 63	0.67	0.70	0.45	0.66	0.72	0.73	0.49	0.65
In-sample analysis, H=126									
VIXTWN	0 + 189	0.98		1.00		0.98		1.00	
Cap	126+63	0.87	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Fin	126+63	0.81	1.00	1.00	1.00	0.75	1.00	1.00	1.00
Ele	126+63	0.85	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	126+63	0.83	1.00	1.00	1.00	0.76	1.00	1.00	1.00
Out-of-sample analysis, H=126									
VIXTWN	0 + 189	0.54		0.43		0.54		0.43	
Cap	126+63	0.57	0.55	0.33	0.39	0.61	0.65	0.48	0.65
Fin	126+63	0.59	0.59	0.51	0.41	0.73	0.31	0.46	0.32
Ele	126+63	0.70	0.80	0.47	0.78	0.63	0.48	0.28	0.56
Fin + Ele	126+63	0.70	0.46	0.58	0.49	0.67	0.52	0.64	0.50

Performance (AUC): Out-of-Sample, FRM vs. λ_j

Company Choose	Window Size	Dynamic Selection				Static Selection			
		Parametric		Non-parametric		Parametric		Non-parametric	
		FRM	λ_j	FRM	λ_j	FRM	λ_j	FRM	λ_j
In-sample analysis, H=63									
VIXTWN	0 + 126	0.94		1.00		0.94		1.00	
Cap	63 + 63	0.76	1.00	1.00	1.00	0.67	1.00	1.00	1.00
Fin	63 + 63	0.72	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Ele	63 + 63	0.79	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	63 + 63	0.73	1.00	1.00	1.00	0.70	1.00	1.00	1.00
Out-of-sample analysis, H=63									
VIXTWN	0 + 126	0.54		0.41		0.54		0.41	
Cap	63 + 63	0.61	0.46	0.46	0.59	0.69	0.57	0.54	0.52
Fin	63 + 63	0.71	0.63	0.41	0.50	0.71	0.64	0.50	0.59
Ele	63 + 63	0.69	0.53	0.57	0.65	0.75	0.52	0.68	0.64
Fin + Ele	63 + 63	0.67	0.70	0.45	0.66	0.72	0.73	0.49	0.65
In-sample analysis, H=126									
VIXTWN	0 + 189	0.98		1.00		0.98		1.00	
Cap	126+63	0.87	1.00	1.00	1.00	0.72	1.00	1.00	1.00
Fin	126+63	0.81	1.00	1.00	1.00	0.75	1.00	1.00	1.00
Ele	126+63	0.85	1.00	1.00	1.00	0.74	1.00	1.00	1.00
Fin + Ele	126+63	0.83	1.00	1.00	1.00	0.76	1.00	1.00	1.00
Out-of-sample analysis, H=126									
VIXTWN	0 + 189	0.54		0.43		0.54		0.43	
Cap	126+63	0.57	0.55	0.33	0.39	0.61	0.65	0.48	0.65
Fin	126+63	0.59	0.59	0.51	0.41	0.73	0.31	0.46	0.32
Ele	126+63	0.70	0.80	0.47	0.78	0.63	0.48	0.28	0.56
Fin + Ele	126+63	0.70	0.46	0.58	0.49	0.67	0.52	0.64	0.50

Predict Performance (Dynamic, Ele, ws=126, parametric, λ_j)

- Merged results in the 5-fold test sets



■ - Actual recession ● - Estimate probability

✖ - False negatives

▲ - False positives

Summary

- Results
  - Dynamic ~ Static
  - Parametric > Non-parametric
  - FRM~ λ_j > VIXTWN
- Best configuration to predict recession (AUC = 0.8037)
  - Dynamic selection
  - Using stocks from high-cap electronic sectors
  - $H = 126$
  - Parametric method
  - Using all λ_j

Financial Risk Meters in Taiwan’s High-Cap Sectors

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