

# Preview Document: Daily Country Industry Risk Monitoring and Forecast Model

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# 1 Introduction

Financial market time series generally exhibit volatility clustering during periods of market stress. The property of volatility persistence and hence risk forecasts can be modelled using GARCH models. Such models can be used as a tool for daily monitoring of broad markets and industries, and for forming expectations about possible losses.

- Model inputs:
  - Time series returns
- Model outputs:
  - Risk forecasts

# 2 Brief Summary

Markov-switching GARCH models are utilized to account for regime changes in the volatility dynamics. In the modelling process, two regimes are assumed (lower volatility regime and higher volatility regime).

Risk forecasts are made on a daily basis, and models are always refitted to incorporate the latest data, before making the next set of forecasts. The next set of forecasts are look-ahead estimations of 95% daily VaR and ES. The realized daily returns are compared to the ex-ante forecasts made on the previous day to identify any potential imminent large market movements.

State probabilities of being in the higher volatility regime are also extracted, allowing for comparisons on the evolution of the probability of being in the higher volatility regime through time. The ex-ante probability of being in the higher volatility regime is also forecasted.

Time series of broad markets and industry returns extracted from data vendors. The data then undergoes cleaning and pre-processing.

The best models are then selected based on statistical criteria. The models also undergo backtesting to assess their effectiveness.

### 3 Sample Outputs

This section showcases some examples of analytical outputs for the some GICs stock market sectors, as well as some investment style factors, for USA.

Figure 1 showcases the evolution of higher volatility regime probabilities, which overlay the daily realized returns, over time. Periods of differing volatility regimes and daily return dispersions can be easily identified.

The tables are some examples of daily automated risk monitoring outputs, which are used to identify potential imminent large market movements.

Figures 2 and 3 showcase how daily VaR exceedances can serve as early warning indicators of imminent large market movements.

## Daily Returns and Estimated Smoothed Higher Volatility Regime Probabilities

Main Axis: Daily Returns (%), Secondary Axis: Smoothed Higher Volatility Regime Probabilities

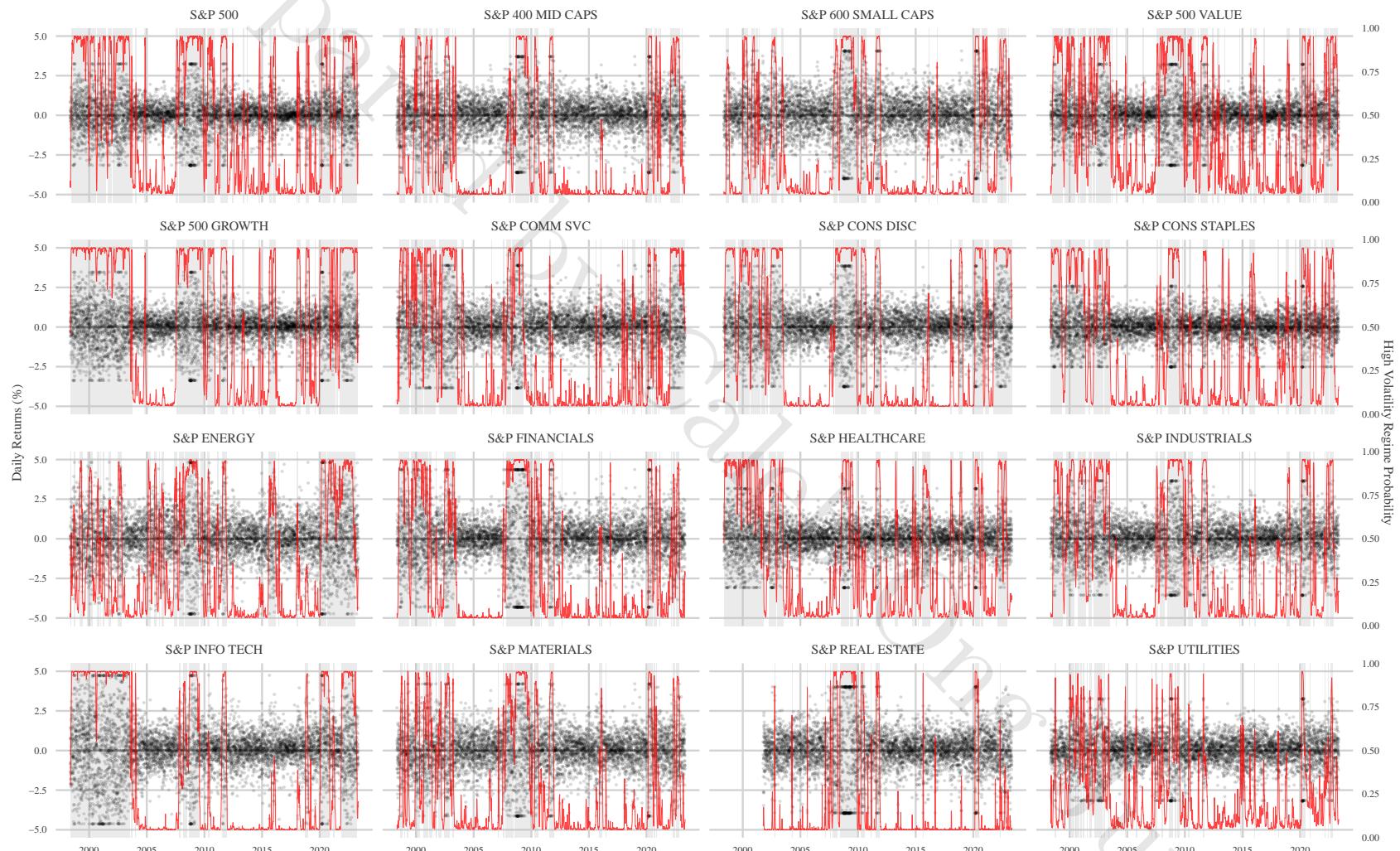


Figure 1: Overlay plot of daily returns and estimated higher volatility regime probabilities across time. The points depict the returns, while the lines depict the probabilities. A greater higher volatility regime probability is associated with an increased dispersion of returns.

Table 1: USA Market Indices 95% Daily VaR Expectations

Industry	Realized Return	T-1 Ex-ante Forecast	Breach	Current Probability	T+1 Probability	T+1	T+2	T+3	T+4	T+5	T+6	T+7
S&P 500	0.05%	-1.61%	No	63.38%	63.31%	-1.64%	-1.64%	-1.72%	-1.76%	-1.8%	-1.79%	-1.65%
S&P 400 MID CAPS	-0.29%	-2.08%	No	1.03%	1.58%	-2.04%	-2.06%	-2.08%	-2.14%	-2.15%	-2.17%	-2.01%
S&P 600 SMALL CAPS	-0.5%	-2.26%	No	6.97%	7.44%	-2.26%	-2.22%	-2.25%	-2.33%	-2.37%	-2.34%	-2.18%
S&P 500 VALUE	-0.04%	-1.64%	No	0.07%	0.12%	-1.64%	-1.61%	-1.68%	-1.72%	-1.75%	-1.73%	-1.59%
S&P 500 GROWTH	0.12%	-1.55%	No	33.74%	35.98%	-1.59%	-1.57%	-1.58%	-1.68%	-1.63%	-1.69%	-1.54%
S&P COMM SVC	1.27%	-2.05%	No	99.99%	99.97%	-2.08%	-2.03%	-2.12%	-2.19%	-2.18%	-2.14%	-1.97%
S&P CONS DISC	0.3%	-2.18%	No	60.11%	59.81%	-2.03%	-2%	-2.01%	-2.1%	-2.13%	-2.12%	-2.03%
S&P CONS STAPLES	-0.22%	-0.99%	No	0.59%	1.48%	-1.01%	-1.01%	-1.04%	-1.08%	-1.11%	-1.15%	-1.1%
S&P ENERGY	0.07%	-3.06%	No	36.03%	36.24%	-2.88%	-2.84%	-2.93%	-2.91%	-3.06%	-3.03%	-2.78%
S&P FINANCIALS	0.21%	-2.28%	No	0.53%	0.9%	-2.21%	-2.18%	-2.21%	-2.36%	-2.35%	-2.32%	-2.13%
S&P HEALTHCARE	-0.22%	-1.36%	No	0.73%	1.55%	-1.42%	-1.43%	-1.48%	-1.52%	-1.58%	-1.57%	-1.48%
S&P INDUSTRIALS	-0.37%	-1.97%	No	10.19%	10.54%	-1.87%	-1.86%	-1.89%	-1.96%	-1.91%	-1.99%	-1.81%
S&P INFO TECH	-0.02%	-1.98%	No	13.21%	13.76%	-2.12%	-2.1%	-2.15%	-2.2%	-2.27%	-2.27%	-2.21%
S&P MATERIALS	-0.3%	-2.07%	No	13.55%	14.23%	-2.15%	-2.14%	-2.22%	-2.28%	-2.3%	-2.25%	-2.1%
S&P REAL ESTATE	-0.69%	-2.05%	No	52.03%	51.91%	-1.98%	-1.95%	-2%	-2.11%	-2.09%	-2.07%	-1.89%
S&P UTILITIES	-0.33%	-1.63%	No	0.33%	0.85%	-1.59%	-1.57%	-1.61%	-1.69%	-1.67%	-1.7%	-1.59%

Table 2: USA Market Indices 95% Daily VaR Expectations (Cumulative)

Industry	Realized Return	T-1 Ex-ante Forecast	Breach	Current Probability	T+1 Probability	T+1	T+2	T+3	T+4	T+5	T+6	T+7
S&P 500	0.05%	-1.61%	No	63.38%	63.31%	-1.64%	-2.39%	-2.85%	-3.54%	-3.94%	-4.39%	-4.63%
S&P 400 MID CAPS	-0.29%	-2.08%	No	1.03%	1.58%	-2.04%	-3.05%	-3.48%	-4.19%	-4.76%	-5.27%	-5.54%
S&P 600 SMALL CAPS	-0.5%	-2.26%	No	6.97%	7.44%	-2.26%	-3.26%	-3.84%	-4.7%	-5.31%	-5.83%	-6.06%
S&P 500 VALUE	-0.04%	-1.64%	No	0.07%	0.12%	-1.64%	-2.43%	-2.81%	-3.44%	-3.87%	-4.24%	-4.41%
S&P 500 GROWTH	0.12%	-1.55%	No	33.74%	35.98%	-1.59%	-2.35%	-2.77%	-3.49%	-3.87%	-4.35%	-4.57%
S&P COMM SVC	1.27%	-2.05%	No	99.99%	99.97%	-2.08%	-3.08%	-3.57%	-4.33%	-4.81%	-5.28%	-5.5%
S&P CONS DISC	0.3%	-2.18%	No	60.11%	59.81%	-2.03%	-2.87%	-3.42%	-4.18%	-4.58%	-5.1%	-5.54%
S&P CONS STAPLES	-0.22%	-0.99%	No	0.59%	1.48%	-1.01%	-1.53%	-1.76%	-2.13%	-2.37%	-2.71%	-2.9%
S&P ENERGY	0.07%	-3.06%	No	36.03%	36.24%	-2.88%	-4.21%	-4.85%	-5.84%	-6.52%	-7.12%	-7.92%
S&P FINANCIALS	0.21%	-2.28%	No	0.53%	0.9%	-2.21%	-3.3%	-3.75%	-4.66%	-5.2%	-5.8%	-6%
S&P HEALTHCARE	-0.22%	-1.36%	No	0.73%	1.55%	-1.42%	-2.14%	-2.47%	-3.02%	-3.38%	-3.79%	-4.07%
S&P INDUSTRIALS	-0.37%	-1.97%	No	10.19%	10.54%	-1.87%	-2.76%	-3.16%	-3.85%	-4.28%	-4.76%	-4.95%
S&P INFO TECH	-0.02%	-1.98%	No	13.21%	13.76%	-2.12%	-3.12%	-3.55%	-4.42%	-4.89%	-5.47%	-5.85%
S&P MATERIALS	-0.3%	-2.07%	No	13.55%	14.23%	-2.15%	-3.14%	-3.72%	-4.5%	-4.99%	-5.5%	-5.93%
S&P REAL ESTATE	-0.69%	-2.05%	No	52.03%	51.91%	-1.98%	-2.79%	-3.36%	-4.06%	-4.51%	-4.94%	-5.2%
S&P UTILITIES	-0.33%	-1.63%	No	0.33%	0.85%	-1.59%	-2.34%	-2.63%	-3.22%	-3.56%	-4.03%	-4.22%

Table 3: USA Market Indices 95% Daily ES Expectations

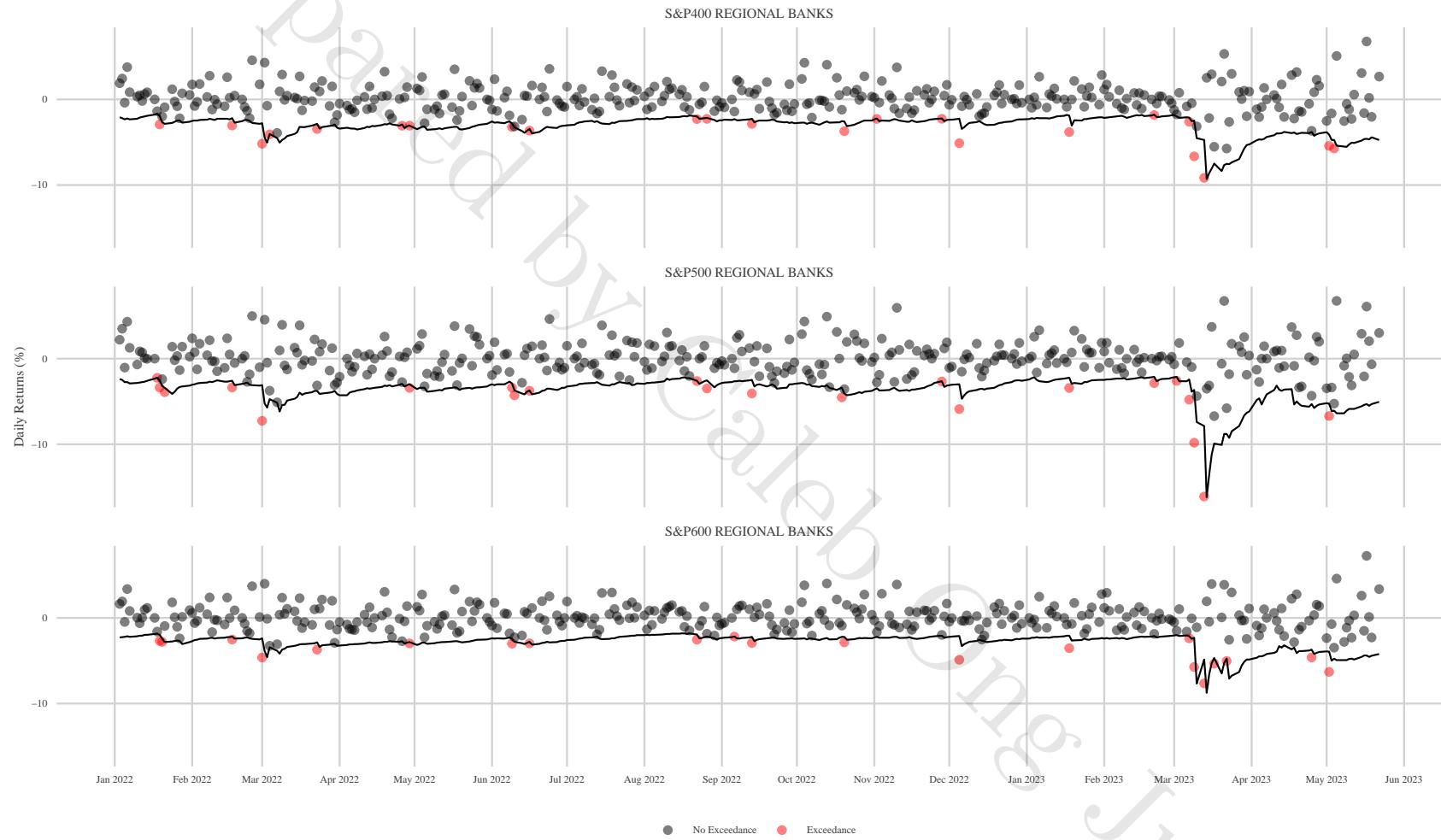
Industry	Realized Return	T-1 Ex-ante Forecast	Breach	Current Probability	T+1 Probability	T+1	T+2	T+3	T+4	T+5	T+6	T+7
S&P 500	0.05%	-2.11%	No	63.38%	63.31%	-2.18%	-2.29%	-2.28%	-2.32%	-2.43%	-2.48%	-2.33%
S&P 400 MID CAPS	-0.29%	-2.66%	No	1.03%	1.58%	-2.6%	-2.65%	-2.68%	-2.7%	-2.79%	-2.82%	-2.71%
S&P 600 SMALL CAPS	-0.5%	-2.89%	No	6.97%	7.44%	-2.88%	-2.95%	-2.93%	-3%	-3.08%	-3.06%	-2.95%
S&P 500 VALUE	-0.04%	-2.18%	No	0.07%	0.12%	-2.19%	-2.25%	-2.25%	-2.28%	-2.38%	-2.37%	-2.22%
S&P 500 GROWTH	0.12%	-2.1%	No	33.74%	35.98%	-2.24%	-2.55%	-2.41%	-2.48%	-2.61%	-2.72%	-2.49%
S&P COMM SVC	1.27%	-2.72%	No	99.99%	99.97%	-2.73%	-2.75%	-2.87%	-2.91%	-2.89%	-2.96%	-2.72%
S&P CONS DISC	0.3%	-2.7%	No	60.11%	59.81%	-2.54%	-2.6%	-2.59%	-2.67%	-2.72%	-2.75%	-2.59%
S&P CONS STAPLES	-0.22%	-1.34%	No	0.59%	1.48%	-1.35%	-1.4%	-1.42%	-1.47%	-1.52%	-1.58%	-1.52%
S&P ENERGY	0.07%	-3.88%	No	36.03%	36.24%	-3.7%	-3.77%	-3.75%	-3.78%	-3.88%	-3.89%	-3.71%
S&P FINANCIALS	0.21%	-3.04%	No	0.53%	0.9%	-2.92%	-3.01%	-2.98%	-3.09%	-3.2%	-3.18%	-3.01%
S&P HEALTHCARE	-0.22%	-1.83%	No	0.73%	1.55%	-1.9%	-1.94%	-1.97%	-2.03%	-2.09%	-2.13%	-2.01%
S&P INDUSTRIALS	-0.37%	-2.59%	No	10.19%	10.54%	-2.45%	-2.49%	-2.51%	-2.54%	-2.61%	-2.63%	-2.53%
S&P INFO TECH	-0.02%	-2.64%	No	13.21%	13.76%	-2.84%	-2.93%	-2.91%	-2.92%	-3.1%	-3.14%	-3.1%
S&P MATERIALS	-0.3%	-2.68%	No	13.55%	14.23%	-2.79%	-2.85%	-2.85%	-2.9%	-2.94%	-2.98%	-2.82%
S&P REAL ESTATE	-0.69%	-2.68%	No	52.03%	51.91%	-2.6%	-2.67%	-2.66%	-2.74%	-2.72%	-2.79%	-2.66%
S&P UTILITIES	-0.33%	-2.14%	No	0.33%	0.85%	-2.1%	-2.14%	-2.16%	-2.2%	-2.22%	-2.27%	-2.14%

Table 4: USA Market Indices 95% Daily ES Expectations (Cumulative)

Industry	Realized Return	T-1 Ex-ante Forecast	Breach	Current Probability	T+1 Probability	T+1	T+2	T+3	T+4	T+5	T+6	T+7
S&P 500	0.05%	-2.11%	No	63.38%	63.31%	-2.18%	-3.35%	-4.06%	-4.74%	-5.34%	-6.12%	-6.6%
S&P 400 MID CAPS	-0.29%	-2.66%	No	1.03%	1.58%	-2.6%	-4%	-4.79%	-5.52%	-6.17%	-7.04%	-7.59%
S&P 600 SMALL CAPS	-0.5%	-2.89%	No	6.97%	7.44%	-2.88%	-4.34%	-5.23%	-6.05%	-6.81%	-7.73%	-8.3%
S&P 500 VALUE	-0.04%	-2.18%	No	0.07%	0.12%	-2.19%	-3.29%	-3.94%	-4.61%	-5.19%	-5.92%	-6.34%
S&P 500 GROWTH	0.12%	-2.1%	No	33.74%	35.98%	-2.24%	-3.75%	-4.54%	-5.32%	-5.86%	-6.91%	-7.4%
S&P COMM SVC	1.27%	-2.72%	No	99.99%	99.97%	-2.73%	-4.13%	-4.89%	-5.71%	-6.27%	-7.12%	-7.42%
S&P CONS DISC	0.3%	-2.7%	No	60.11%	59.81%	-2.54%	-3.82%	-4.55%	-5.26%	-5.93%	-6.8%	-7.24%
S&P CONS STAPLES	-0.22%	-1.34%	No	0.59%	1.48%	-1.35%	-2.08%	-2.45%	-2.85%	-3.21%	-3.7%	-4.02%
S&P ENERGY	0.07%	-3.88%	No	36.03%	36.24%	-3.7%	-5.49%	-6.54%	-7.48%	-8.44%	-9.56%	-10.28%
S&P FINANCIALS	0.21%	-3.04%	No	0.53%	0.9%	-2.92%	-4.4%	-5.22%	-6.11%	-6.89%	-7.87%	-8.49%
S&P HEALTHCARE	-0.22%	-1.83%	No	0.73%	1.55%	-1.9%	-2.86%	-3.41%	-3.97%	-4.51%	-5.18%	-5.57%
S&P INDUSTRIALS	-0.37%	-2.59%	No	10.19%	10.54%	-2.45%	-3.59%	-4.28%	-4.95%	-5.56%	-6.33%	-6.77%
S&P INFO TECH	-0.02%	-2.64%	No	13.21%	13.76%	-2.84%	-4.27%	-5.15%	-5.9%	-6.68%	-7.6%	-8.27%
S&P MATERIALS	-0.3%	-2.68%	No	13.55%	14.23%	-2.79%	-4.13%	-4.92%	-5.78%	-6.52%	-7.37%	-7.91%
S&P REAL ESTATE	-0.69%	-2.68%	No	52.03%	51.91%	-2.6%	-3.84%	-4.58%	-5.34%	-5.92%	-6.72%	-7.17%
S&P UTILITIES	-0.33%	-2.14%	No	0.33%	0.85%	-2.1%	-3.09%	-3.66%	-4.22%	-4.68%	-5.37%	-5.79%

## One-step Ahead Daily 95% VaR Forecasts and Realized Daily Returns for Selected US Regional Bank Indices

Forecasts are based on rolling windows



The line charts the one-step ahead daily 95% VaR forecasts.

Figure 2: Out-of-sample VaR forecasts and realized daily returns. In addition to providing insight on model efficacy, the plot demonstrates how VaR exceedances tend to be followed by increased dispersion of returns.

### Cumulative Returns of Selected US Regional Bank Indices

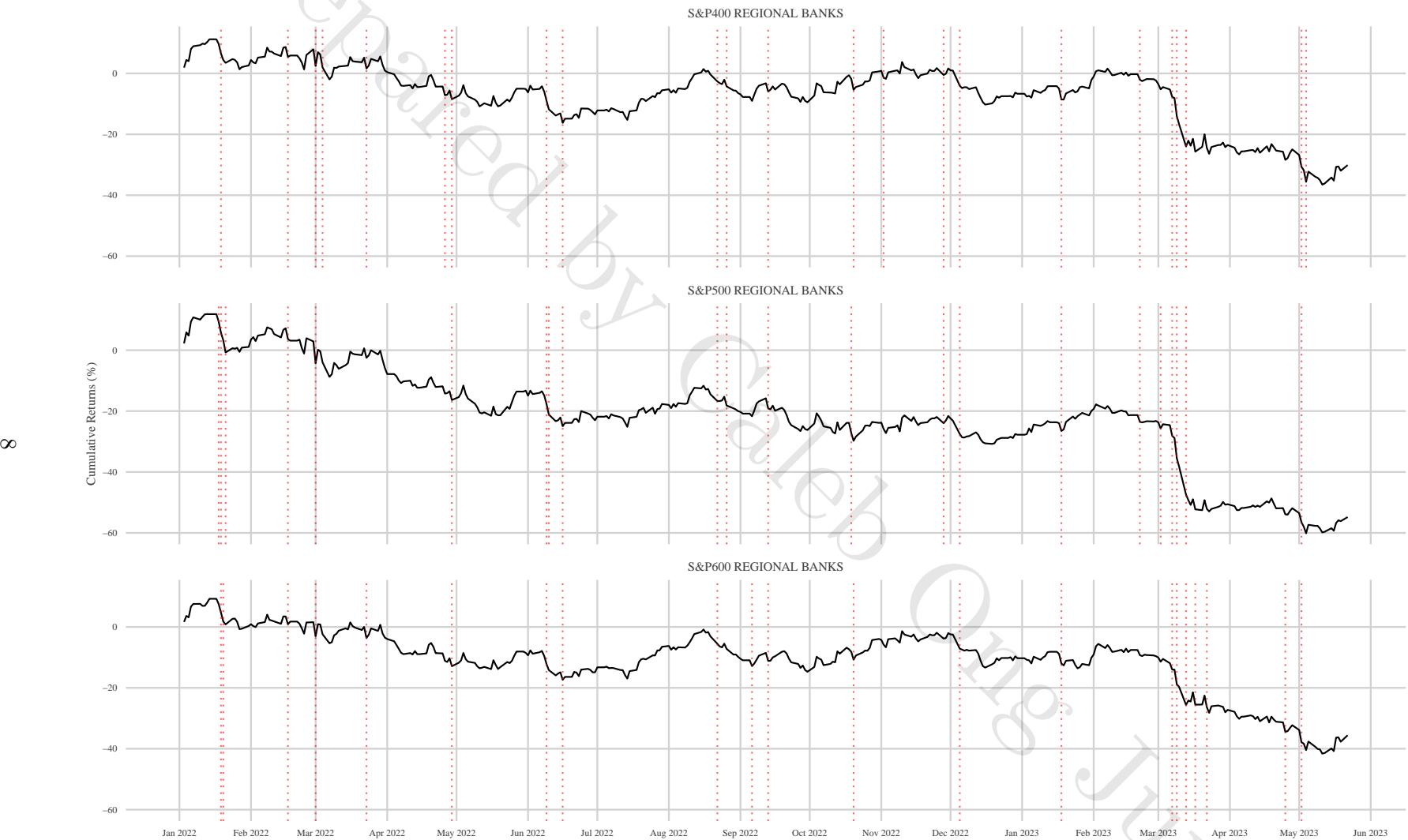


Figure 3: Cumulative returns of selected US regional bank indices, overlaid with out-of-sample daily 95% VaR exceedances, which are indicated by the dashed lines. VaR exceedances provide pre-emptive insights, which can be used as a signals for further investigation, on imminent materialization of negative market events, such as the contagion effects stemming from the collapse of Sillicon Valley Bank and collapse of Credit Suisse AG in early March 2023.

## 4 Ending Notes

The risk forecasts provide quick insights and signals on short to medium term risk areas and investment opportunities. The risk outputs also allow for comparison of risk expectations and classification of volatility regimes across different industries.