

# Transfer Learning using quasi-randomized networks

## Abstract

The study introduces a transfer learning approach (based on ridge2f from Tehtonique's package ahead) for financial time series forecasting. Using Bayesian-optimized architectural priors learned from synthetic data, ridge2f demonstrates robust prediction interval coverage while maintaining competitive probabilistic forecasting performance.

## Methodology

- ▶ ridge2f (from paper <https://www.mdpi.com/2227-9091/6/1/22>) is available in R and Python: <https://docs.techtonique.net/ahead/> or [https://docs.techtonique.net/ahead\\_python/ahead.html#Ridge2Regressor](https://docs.techtonique.net/ahead_python/ahead.html#Ridge2Regressor)
- ▶ Bayesian-optimized architecture including choice of **number of regime clusters**
- ▶ Learned from **1000 synthetic financial returns paths with stock market stylized facts**
- ▶ Frozen feature map, then model coefficients achieving fine-tuning on new data via convex optimization
- ▶ Moving block bootstrap for prediction intervals at inference

### GARCH Models for benchmarks:

- ▶ rugarch: Standard GARCH(1,1) implementation in R
- ▶ fGarch: Alternative GARCH implementation in R
- ▶ Normal distribution, zero mean specification
- ▶ 95% prediction intervals

### Evaluation Dataset:

- ▶ Euronext stock indices: DAX, SMI, CAC, FTSE
- ▶ 500 days of return data per index
- ▶ 80/20 train-test split
- ▶ Metrics: coverage rate and Winker score

## Performance Comparison

### Median Test Set Perf. Across the 4 Indices

Metric	ridge2f	rugarch	fGarch
Coverage Rate	94.5%	93.5%	93.5%

### Statistical Significance

Paired t-tests (slight abuse, because small data):

- ▶ **Winkler score (penalizing large intervals and miscoverage):** No significant difference with GARCH ( $p = 0.09$ )
- ▶ **Coverage:** Small advantage for ridge2f ( $p$ -value = 0.06)

## Detailed Results by Market Index

80/20 train-test split:

Index	Method	Winkler	Coverage	Width
3*DAX	ridge2f	0.0639	95%	0.0549
	rugarch	0.0625	94%	0.0507
	fGarch	0.0626	94%	0.0504
3*SMI	ridge2f	0.0628	94%	0.0446
	rugarch	0.0610	93%	0.0455
	fGarch	0.0611	93%	0.0453
3*CAC	ridge2f	0.0577	96%	0.0505
	rugarch	0.0574	95%	0.0496
	fGarch	0.0574	95%	0.0494
3*FTSE	ridge2f	0.0526	93%	0.0347
	rugarch	0.0488	93%	0.0352
	fGarch	0.0489	93%	0.0351

## Key Findings

- ▶ **ridge2f achieves robust median coverage** (94.5% vs 93.5%)
- ▶ **Competitive probabilistic forecasting** (no significant Winkler difference with GARCH)
- ▶ **Transfer learning advantage:** Model trained on synthetic returns + No strong distributional assumptions required + Plug-and-play

## Conclusion

The ridge2f transfer learning approach demonstrates excellent coverage reliability while maintaining competitive probabilistic forecasting performance. This represents a promising alternative to traditional GARCH methodologies, particularly for risk management applications where coverage reliability is paramount.

**Future Work:** These promising results need to be generalized to more stocks + use conformal prediction for better.

**Example in the repo on 10 CAC40 stocks:** best coverage and best Winkler score achieved for ridge2f.