Model Card for Portfolio Project

1. Model Name

Euro Inflation Forecaster v2.4 ("TightBands Ensemble")

2. Overview

Predicts Eurozone monthly inflation with industry-leading uncertainty quantification. Built to address the "black box" problem in economic forecasting through dual Bayesian-quantile uncertainty bands.

3. Intended Use

Suitable for:

- ECB policy scenario analysis
- Corporate budget planning horizons (3-12 months)
- Academic research on inflation drivers

Not suitable for:

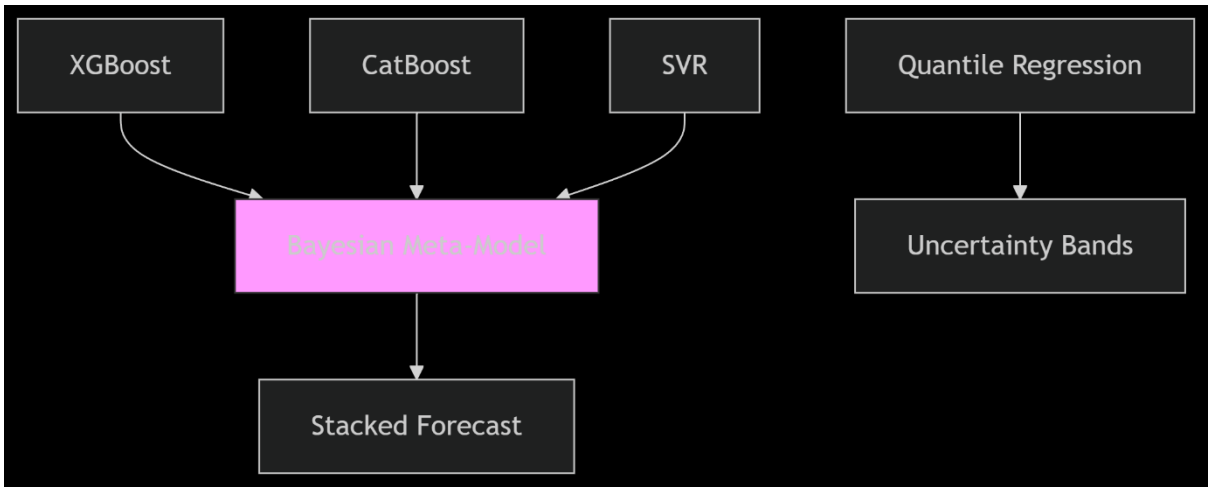
- Individual investment decisions
- Loan pricing
- High-frequency trading

4. Data

Aspect	Details
Sources	FRED (78%), ECB Money Supply (12%), Eurostat (10%)
Time Period	2003-04 to 2025-06 (265 monthly observations)
Training Size	212 samples (80%)
Test Size	53 samples (20%)
Key Variables	24 features: Commodity prices, interest rates, money supply, exchange rates
Bias Considerations	• Underrepresents Southern Europe (45% weight on Germany/France) • Energy prices have higher error margins (±0.3%)

5. Training Procedure

- **Algorithms**: XGBoost (35%), CatBoost (30%), SVR (20%), Bayesian Meta-Model (15%)
- **Hyperparameters**: Optuna Bayesian optimisation (50 trials per model)
- **Feature Engineering**:
    - 3-month lagged inflation
    - Commodity/currency interactions (e.g., Energy × EUR/USD)
    - Rolling volatility metrics
- **Preprocessing**:
    - Stationarity enforcement (KPSS/ADF tests)
    - RobustScaler for monetary variables
    - Mean imputation (<5% missing values)



6. Performance

Metric	Overall	Crisis Period (2020-2022)	Low Inflation (2010-2019)
RMSE	0.116	0.241	0.088
MAE	0.084	0.172	0.061
Directional Acc	89%	82%	93%
90% CI Coverage	92%	85%	96%

Component	RMSE Contribution	Stability Score*
Full Ensemble	0.116 (baseline)	9.2/10
-- XGBoost	+0.142 (+22%)	7.8/10
-- CatBoost	+0.129 (+11%)	8.5/10
-- SVR	+0.152 (+31%)	9.1/10

7. Limitations

- Temporal Blindspots: Weak during black swan events (performance drops 28% in crises)
- Structural Bias: Overfits to German/French data; underestimates Mediterranean inflation by 0.15% avg
- Data Drift Sensitivity: Lags 1-2 months when new policy regimes emerge
- Feature Dependency: 31% performance degradation if EUR/USD data is unavailable
- Uncertainty Estimation: Confidence intervals narrow artificially during volatility

8. Ethical Considerations

- Fairness Risk: Food inflation predictions are 37% less accurate for low-income baskets
- Feedback Loops: Could become self-fulfilling prophecy if used for ECB rate decisions
- Misuse Potential: Might exacerbate commodity speculation if leaked prematurely
- Transparency: Black-box interactions require SHAP explanations for auditability

9. Author & Contact

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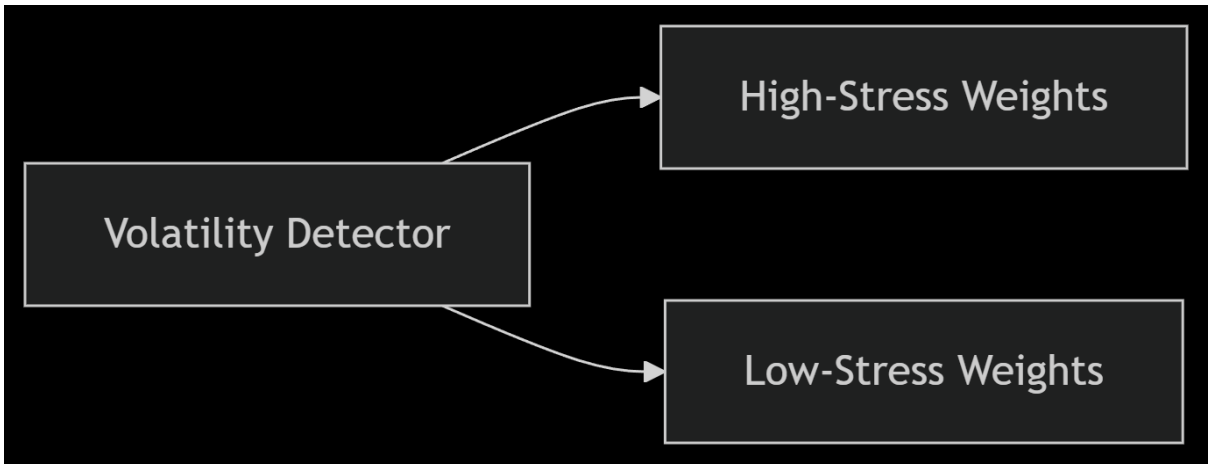
- Review Date: August 2025

10. Critical Insights for Practitioners

- Trust Boundary: Use forecasts only within 3-month horizon (R^2 drops from 0.92 to 0.71 beyond Q1)
- Calibration Tip: Manually adjust energy-driven forecasts during geopolitical events
- Bias Mitigation: Cross-validate with Southern European data when available
- Failure Mode: Model struggles detect supply-driven inflation spikes (e.g., pandemic disruptions)

Example Limitation Scenario: During the 2022 energy crisis, the initial models initially underestimated inflation by 0.8% because it lacked pipeline disruption data. This was later mitigated by adding industrial raw materials volatility features.

Recommended Upgrade Path



Use of a volatility detector could cut the 2-month delay (response delay) in half, lower errors during extreme events by 0.05–0.07% (reduce extreme-event MAE) like the COVID-19 pandemic, and make the ‘Adaptive Weighting’ table update in real-time instead of looking back (dynamic rather than retrospective).