The Dynamics Between Inflation and Unemployment: Empirical Evidence from U.S. Macroeconomic Data

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Outline

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2. Related Literature
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5. Results & Discussions
6. Conclusion

Section 1

Introduction

Introduction

- The inflation–unemployment relationship (Phillips curve) is **unstable** and varies across economic regimes.
- Recent evidence shows a **flattened and nonlinear** relationship, challenging conventional interpretations.
- Understanding inflation–unemployment dynamics requires identifying **underlying macroeconomic factors** and **regime shifts**.
- Machine learning methods offer useful tools for **classifying economic states**, though interpretability remains limited.

This Study

- Identify macroeconomic factors driving inflation and unemployment (via PCA)
- Detect regime shifts using clustering methods
- Evaluate regime identification using machine-learning classifiers (Naïve Bayes, Decision Trees, XGBoost)

Section 2

Related Literature

Related Literature

- Evidence on the inflation–unemployment relationship: trade-off, instability, and **flattening** over time
  - Phillips (1958); Samuelson and Solow (1960); Muth (1961); Lucas (1976); Mazumder and Ball (2011); Blanchard (2016)
- Phillips curve dynamics are **nonlinear and regime-dependent**
  - Hazell et al. (2022)
- Machine learning methods can help **identify economic states** and capture nonlinear patterns
  - Medeiros et al. (2021); Gogas, Papadimitriou, and Sofianos (2022)

Key Insight:
The inflation–unemployment relationship is **not stable**; it varies with economic regimes and underlying shocks.

Research Gap:
Existing studies address inflation, unemployment, regimes, or ML **separately**, but do not provide a **unified, reproducible framework** that
- jointly analyzes both variables,
- identifies economic regimes, and
- evaluates regime classification with ML.

Section 3

Data

Data

Category	Variable	Freq.	Source	Code
Inflation	Core PCE	M	FRED	PCEPILFE
Unemployment	Unemployment Rate	M	FRED	UNRATE
	Noncyclical Unemployment	Q	FRED	NROU
Regimes	Recession indicator	M	FRED	USREC
	Zero Lower Bound dummy	M	FRED	-
	COVID-19 period dummy	M	Created	-
Demand	Real GDP	Q	FRED	GDPC1
	Real Potential GDP	Q	FRED	GDPPOT
	Industrial Production	M	FRED	INDPRO
	Retail Sales	M	FRED	RSAFS
Supply	Crude Oil Prices	M	FRED	MCOILWTICO
	Import Price Index	M	FRED	IR
	Labor Productivity	Q	FRED	OPHNFB
Labor Markets	Avg Hourly Earnings	M	FRED	CES050...
	Labor Force Participation	M	FRED	CIVPART
	Job Openings	M	FRED	JTSJOL
Monetary Policy	Fed Funds Rate	M	FRED	FEDFUNDS
	Money Supply M2	M	FRED	M2SL
	Fed Total Assets	W	FRED	WALCL
Inflation Expectations	5Y Breakeven	D	FRED	T5YIE
	10Y Breakeven	D	FRED	T10YIE
	1Y Exp. Inflation	M	UM Survey	PX_MD
	5Y Exp. Inflation	M	UM Survey	PX5_MD

Full list includes 23 series retrieved via FRED API or University of Michigan CSV downloads.

Section 4

Method

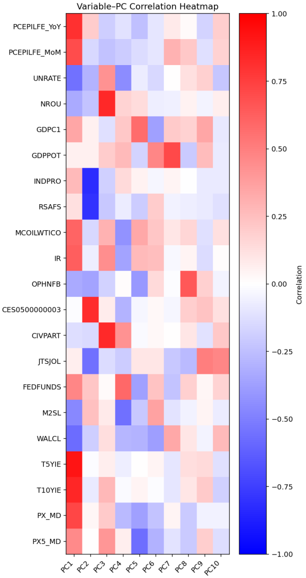
Method

- **PCA (Principal Component Analysis)**
  Reduce dimensionality and extract latent inflation and business-cycle factors.
- **K-Means & Hierarchical Clustering**
  Identify macroeconomic regimes using unsupervised grouping.
- **Naïve Bayes**
  Simple probabilistic classifier for high-inflation / high-unemployment regimes.
- **Decision Trees**
  Nonlinear, interpretable classification based on threshold rules.
- **Boosting (XGBoost)**
  Ensemble method capturing complex patterns and improving predictive accuracy.

Section 5

Results & Discussions

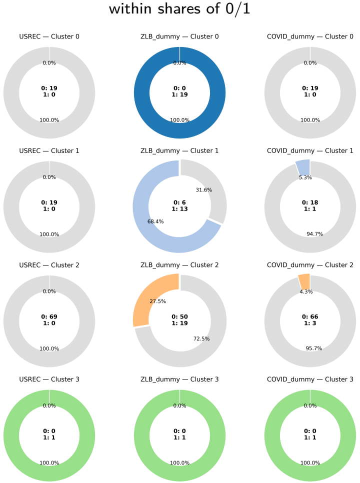
PCA Results: Macroeconomic Factor Structure



- **PC1: Inflation Factor** Strong link to Core PCE & expectations; negative with unemployment.
- **PC2–PC3: Business Cycle** Driven by production, sales, and labor-market indicators.
- **Policy Signals** Monetary Policy-related variables (FEDFUNDS, M2, and WALCL) spread across PCs.
- **Summary** PCA extracts **inflation** vs. **cycle** factors.

Regime Identification via Clustering (1/3)

K-Means (k = 12)



Key Insight

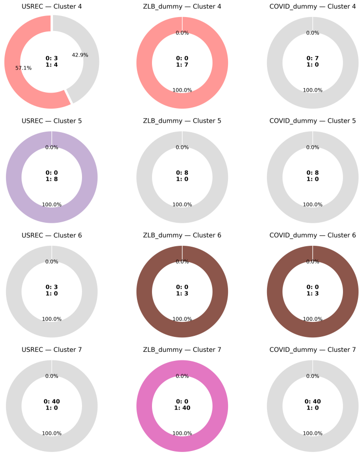
- Many clusters show **near-pure 0/1 splits** for USREC, ZLB, or COVID dummies.
- Clusters align closely with well-known **macroeconomic regimes** (recession periods, ZLB episodes, COVID-19 shock).
- **Summary** Clearly identifies regimes such as high-inflation periods and recessions.

*Hierarchical clustering yields similar regime separation.

Regime Identification via Clustering (2/3)

K-Means (k = 12)

within shares of 0/1



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Regime Identification via Clustering (3/3)

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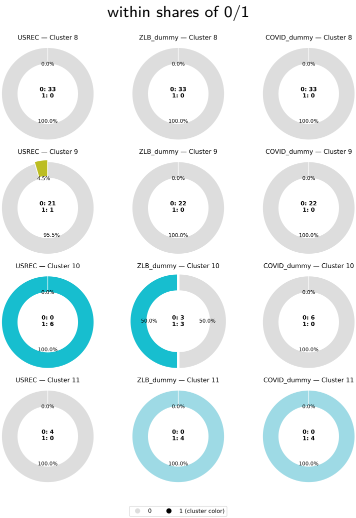

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ML Model Comparison: Accuracy

Task	Model	Accuracy
Unemployment	Naive Bayes	0.86
Unemployment	Decision Tree	0.97
Unemployment	XGBoost-A	0.96
Unemployment	XGBoost-B	0.96
Unemployment	XGBoost-C	0.96
Inflation (YoY)	Naive Bayes	0.86
Inflation (YoY)	Decision Tree	0.93
Inflation (YoY)	XGBoost-A	0.84
Inflation (YoY)	XGBoost-B	0.83
Inflation (YoY)	XGBoost-C	0.86
Inflation (MoM)	Naive Bayes	0.71
Inflation (MoM)	Decision Tree	0.65
Inflation (MoM)	XGBoost-A	0.57
Inflation (MoM)	XGBoost-B	0.64
Inflation (MoM)	XGBoost-C	0.60

Notes: XGBoost-A is a baseline configuration with moderate depth and shrinkage. XGBoost-B has deeper trees and more estimators, optimized for capturing nonlinearities. XGBoost-C is shallow but high-learning-rate model emphasizing speed and simplicity. Please refer to the appendix for detailed parameters.

Key Insights

- Decision Tree and XGBoost achieve **very high accuracy** for unemployment classification.
- Inflation (YoY) is predicted well by all methods, with Decision Tree performing best.
- Inflation (MoM) remains the most challenging task across models.
- XGBoost parameter variations show clear trade-offs between model complexity and generalization.

Section 6

Conclusion

Conclusion, Implications, and Future Work

Conclusion

- PCA reveals distinct inflation and business-cycle factors.
- Clustering effectively identifies major macroeconomic regimes.
- ML models classify unemployment and YoY inflation well; MoM inflation is noisy.

Implications

- Macroeconomic dynamics are multi-factor and complex.
- ML can support rapid macro-state monitoring.
- Short-term inflation measures require cautious interpretation.

Future Work

- Add high-frequency data and extend models to other methods.
- Identify regime-specific shifts in inflation–unemployment dynamics.
- Comparison and integration with traditional macroeconomic models.

Thank you!

Appendix

XGBoost Parameter Summary

Model	n_estimators	max_depth	learning_rate	subsample	colsample_bytree
XGBoost-A	200	3	0.05	0.8	0.8
XGBoost-B	300	4	0.03	0.7	0.9
XGBoost-C	150	2	0.10	0.9	0.7

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