

# MarcoCycle AI Agent

## About MacroCycle AI Agent

### What is MacroCycle AI Agent?

MacroCycle AI Agent is an autonomous macro-economic intelligence assistant that demonstrates the potential of AI-driven economic analysis. It integrates multiple public data feeds (FRED, CBOE, SEC) to analyze liquidity conditions, volatility measures, and key macroeconomic indicators in real-time.

Built as a prototype for the Imperial AI Policy Fellowship, this tool showcases how AI agents can orchestrate complex data pipelines and generate interpretable economic insights—while highlighting the critical need for human oversight, FinOps discipline, and ethical guardrails in autonomous systems.

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### What Does It Do?

MacroCycle is an autonomous AI agent that continuously monitors the economy and responds to your questions. Instead of manually searching for data, the agent does the work for you:

#### Automates Key Metrics

- Automatically fetches 50+ economic and market indicators from FRED, CBOE, and Yahoo Finance
- Refreshes data every 30-60 minutes without manual intervention
- Organizes metrics into 6 themed tabs (Business Cycle, Macro, Liquidity, Sentiment, Market Structure, Sectors)
- Displays real-time dashboards with no user configuration needed

#### Infers & Analyzes

- Determines current business cycle phase (Expansion, Peak, Contraction, Trough) with confidence scoring
- Identifies which leading indicators are signaling turning points
- Compares current conditions to 7 historical cycles (2001-2023)
- Calculates Fear & Greed Index and detects market regime shifts
- Surfaces sector rotation patterns based on cycle phase

#### Natural Language Query

- Ask questions in plain English: "What's the current VIX?", "How does inflation compare to last year?"
- Agent autonomously fetches data, creates charts, and provides context
- Conversational AI (GPT-5) with full access to economic context
- Educational explanations framed as historical patterns

#### Self-Service Analysis

- Explore any metric without technical skills or API knowledge
- Request custom comparisons: "Show me GDP vs unemployment over 5 years"
- Navigate to relevant analysis pages through AI suggestions
- Build custom sector watchlists and track diversification
- No coding, no spreadsheets—just ask the agent

<https://macrocycle.replit.app/>

## Who Can Use It and How?

### For Policymakers:

- Assess current economic phase and monitor leading indicators for policy signals
- Track inflation, unemployment, and monetary policy stance
- Use AI Research Agent for real-time economic Q&A
- Monitor Economic Calendar for data releases informing policy decisions

### For Academics & Students:

- Learn about business cycle theory through interactive analysis
- Study 7 historical cycles (2001-2023) with real data
- Use AI agent for educational insights about economic concepts
- Explore sector rotation patterns and market dynamics

### For Investors:

- Identify current business cycle phase for portfolio context
- Review historical asset allocation patterns by cycle phase
- Monitor market sentiment and risk indicators
- Ask AI agent about specific metrics, sectors, or conditions

### AI Agents Collaboration

This project exemplifies multi-agent AI collaboration:

#### Replit Agent (Claude 4.5 Sonnet)

Primary builder - Architecture, code development, data pipeline design

#### Architect Agent (Claude Opus 4.1)

Code review, strategic guidance, quality assurance

#### Testing Agent (Playwright)

End-to-end UI/UX testing and validation

#### OpenAI GPT-5 Agent

Embedded research assistant providing natural language insights

[No Title]

# Methodology & Data Quality

## Business Cycle Classification

- **Method:** Rule-based algorithm analyzing GDP growth, unemployment rate, and inflation
- **Phases:** Expansion, Peak, Contraction, Trough (4-phase model)
- **Confidence Scoring:** Multi-factor analysis produces 0-100% confidence level
- **Leading Indicators:** ISM PMI, Yield Curve Spread, NFCI Credit Conditions
- **Coincident Indicators:** Real GDP, Unemployment, Industrial Production

## Historical Backtesting

- **Dataset:** 7 major business cycles from 2001-2023
- **Cycle Dates:** Aligned with NBER official dating where applicable
- **Performance Data:** Sector returns calculated from ETF price histories
- **Limitations:** Limited to US market data; past cycles may not predict future

## Fear & Greed Index Calculation

- **Methodology:** Custom implementation of CNN's 7-indicator approach
- **Components:** Market momentum, volatility, safe haven demand, put/call ratio, junk bond demand, market breadth, stock price strength
- **Scoring:** 0-100 scale (0=Extreme Fear, 100=Extreme Greed)
- **Note:** Approximation using available data; may differ from official CNN index

## Data Quality & Limitations

- **FRED Data:** Official US government statistics; considered highly reliable
- **Market Data:** Yahoo Finance API; subject to occasional delays or errors
- **ISM PMI:** Synthetic data generated using realistic parameters (production system would use official ISM releases)
- **Caching:** 1hr (economic) / 30min (market) may cause slight staleness
- **API Failures:** Fallback to cached data or synthetic approximations

## Model Assumptions

- Business cycles follow historical patterns (may not hold in unprecedented conditions)
- Asset class correlations remain relatively stable across cycles
- US-centric model (not directly applicable to other economies)
- Past performance is not indicative of future results

## Confidence Intervals & Uncertainty

- Cycle classification confidence shown as percentage (e.g., 85% Expansion)
- Lower confidence (<60%) suggests transition period or mixed signals
- AI-generated insights based on historical patterns, not predictions
- Multiple interpretation frameworks may yield different conclusions

## Prototype Learnings: AI Governance & Operational Realities

This prototype was built to demonstrate both the potential and challenges of autonomous AI systems in financial analysis. The Imperial AI Policy Fellowship surfaced critical insights for policymakers and practitioners:

### Core Operational Challenges

#### Data Provenance & Management

- **Challenge:** AI agents retrieve data from multiple APIs (FRED, CBOE, Yahoo Finance) without transparent lineage or timestamp verification
- **MacroCycle Experience:** Several API endpoints returned legacy data with no clear update date
- **Solution:** Caching layer (1hr economic, 30min market) reduces API costs; metadata tracking essential
- **Governance:** Ethical AI requires recording data source, update time, reuse conditions, and audit trails

#### Human Oversight & Accountability

- **Challenge:** AI can generate plausible but incorrect economic interpretations; even in automated pipelines, responsibility must remain human
- **Solution:** All insights framed as "historical patterns," not predictions; disclaimers prominent
- **Reality:** Every output requires interpretation, every design choice carries ethical implications
- **Governance:** Mandatory human-in-the-loop validation—from data selection to publication—is essential for fair and trustworthy AI

#### FinOps & Sustainability

- **Challenge:** OpenAI API costs can scale unpredictably; running multiple AI agents reveals environmental cost of computation
- **MacroCycle Experience:** High energy and compute consumption makes FinOps both a financial AND ethical issue
- **Solution:** Token limits, caching, quota warnings prevent runaway costs
- **Governance:** Budget caps, cost attribution, and energy monitoring should be embedded in every AI sandbox and production environment

#### Scalability & Architecture

- **Challenge:** Streamlit architecture not suited for high-concurrency production use
- **Solution:** This prototype demonstrates concepts; production requires API-first architecture
- **Governance:** Performance SLAs and load testing mandatory before public deployment

#### Security & Compliance

- **Challenge:** API keys, user data, and financial information require protection
- **Solution:** Environment-based secrets, no personal data storage
- **Governance:** SOC2/ISO27001 compliance required for production systems

#### Explainability & Transparency

- **Challenge:** AI agents often provide outputs without explaining how results were derived
- **Risk:** Without an audit trail, confidence and accountability erode quickly
- **Governance:** Future iterations should include "explainability traces" summarizing data sources, assumptions, and transformations used

### Data Ethics Considerations

Beyond operational challenges, the fellowship surfaced **critical data-ethics questions** unique to AI-driven financial analysis:

#### Representation & Bias

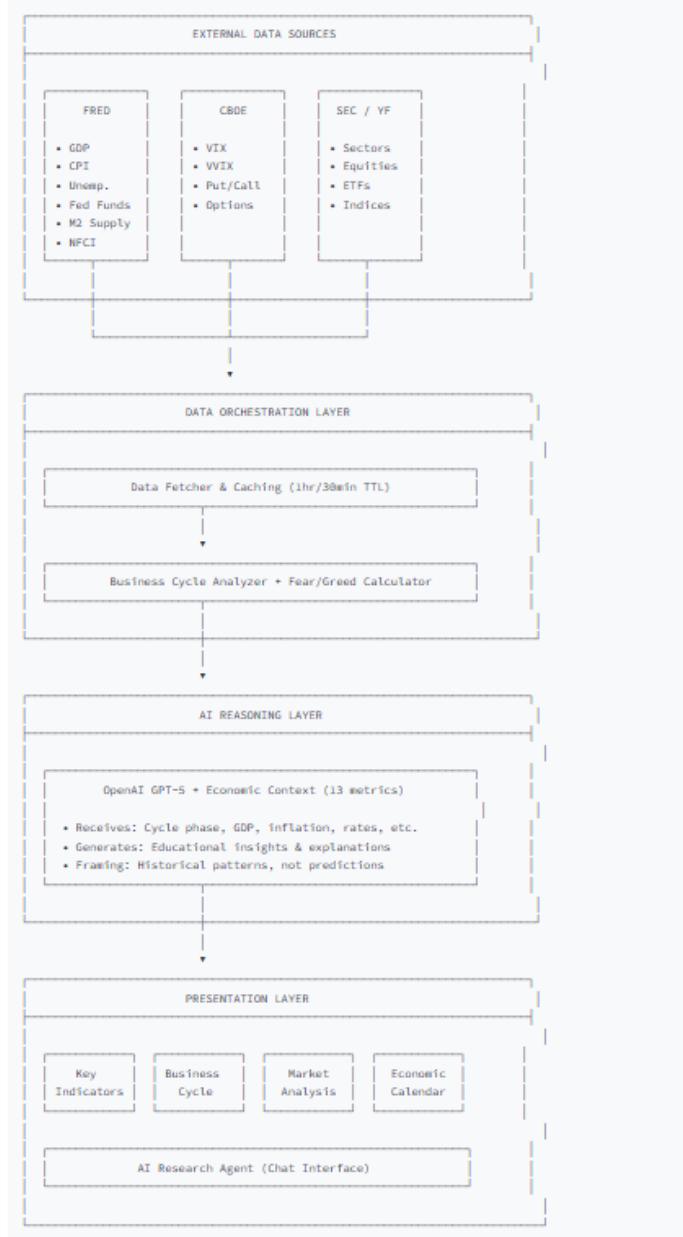
- **Challenge:** Open economic datasets over-represent well-documented markets, under-represent developing regions
- **Risk:** Introduces bias into model training and interpretation (mirrored in environmental data with uneven geographic sampling)
- **Governance:** Ethical practice demands deliberate bias detection and, where possible, weighting or contextual explanation

#### Synthetic Data Boundaries

- **Challenge:** When does synthetic data cross the line from simulation to potential misuse?
- **MacroCycle Experience:** Synthetic datasets helpful for scenario testing but needed clear labelling and deletion rules
- **Governance:** Explicit labelling essential to avoid confusion with official statistics

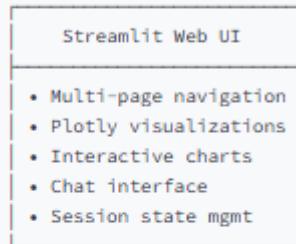
**Policy Implication:** As demonstrated by this prototype, autonomous AI systems in finance require comprehensive governance frameworks addressing **data provenance, human oversight, cost/environmental sustainability, bias mitigation, explainability, and transparency**. Regulation should mandate human checkpoints, clear disclosure of AI limitations, and ethical data practices rather than banning innovation.

## Technical Architecture

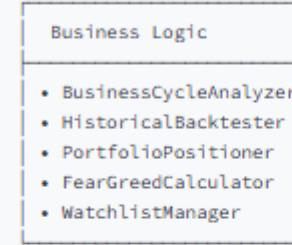


## Solution Architecture

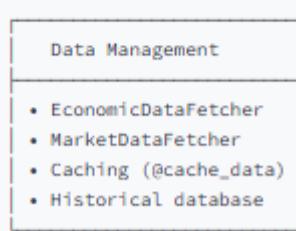
### Frontend Layer



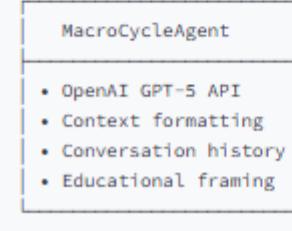
### Analytics Layer



### Data Layer



### AI Layer



Demonstreation

# Dashboard Agent

**MacroCycle AI Agent**

**Key Indicators**

Comprehensive view of the most critical macro indicators organized by theme

> Data Update Cadence

[Business Cycle](#) [Macro Economics](#) [Liquidity & Credit](#) [Market Sentiment](#) [Market Structure](#) [Sectors & Assets](#)

**Business Cycle Phase**

Leading and coincident indicators for cycle positioning

**Current Phase:** Expansion

↑ 90% confidence

Risk-on: Growth assets favored

**Investment Implications:**

✓ Favor: Equities, Small-caps, Commodities, Cyclicals

✗ Avoid: Bonds, Defensive sectors

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**Key Cycle Indicators**

Yield Curve Spread <small>?</small>	ISM Manufacturing <small>?</small>	Real GDP Growth <small>?</small>	Credit Conditions <small>?</small>
0.50%	50.9	4.8%	-0.55
<span style="color: green;">Normal</span>	<span style="color: yellow;">Expanding</span>	<span style="color: green;">Strong</span>	<span style="color: green;">Very Loose</span>
Leading	Leading	Coincident	Coincident

# Research Agent

MacroCycle AI Agent

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Navigation

- Key Indicators
- AI Research Agent
- Business Cycle
- Market Analysis
- Resources
- About

## AI Research Agent

Ask questions about economic data, business cycles, and market insights

Welcome! I'm your AI research assistant. Ask me questions about the current economic conditions, business cycles, sector performance, or market indicators. I'll provide educational insights based on the latest data and historical patterns.

**⚠️ OpenAI API Quota Required:** This AI agent uses OpenAI's GPT-5 API, which requires credits. If you encounter error code 429 ("insufficient\_quota"), please add credits at [OpenAI Billing](#). The autonomous AI features will work immediately once credits are available.

>  Current Economic Context

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### Chat with AI Agent

Suggested Questions:

What's the current VIX level?	Show me the Fear & Greed Index
What sectors typically perform well during expansion?	Show me sector performance over the last 6 months

# Business Cycle Recommender

**MacroCycle AI Agent**

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Navigation

- Key Indicators
- AI Research Agent
- Business Cycle**
- Market Analysis
- Resources
- About

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## Business Cycle

Comprehensive cycle analysis, historical backtesting, portfolio patterns, and sector watchlist

[Cycle Analysis](#) [Historical Backtesting](#) [Portfolio Positioning](#) [Sector Watchlist](#)

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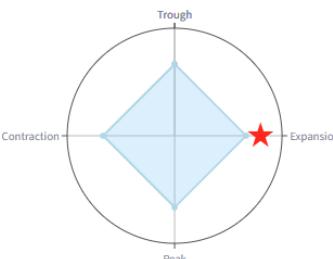
### Business Cycle Analysis

**Current Phase: Expansion**

Economic growth, rising employment, increasing consumer confidence

Confidence Level: 100%

**Business Cycle Position**



Data Sources: [FRED Economic Data](#) + ISM PMI

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**Cycle Indicators**

GDP Growth	4.82%
Unemployment	4.30%
Inflation	3.02%

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**ISM PMI (Leading Indicators)**

Manufacturing	50.9
Services	53.2

↑ Expanding

# Market Analysis

MacroCycle AI Agent

Navigation

- Key Indicators
- AI Research Agent
- Business Cycle
- Market Analysis**
- Resources
- About

 Data Source: Yahoo Finance - Sector ETFs

## Market Analysis

Sector performance, sentiment indicators, and Fear & Greed Index

 [Sectors & Performance](#)    [Fear & Greed Index](#)

## Market Performance

### Sector Performance

**Sector Returns (1 Year)**



Sector	Performance (%)
Utilities	24.94%
Technology	21.36%
Financials	15.37%
Industrials	12.50%
Real Estate	11.80%
Energy	7.50%
Communications	5.00%
Materials	-0.50%
Consumer Staples	-2.07%
Consumer Discretionary	-9.44%
Healthcare	-7.00%

Performance

Top 3 Sectors:

- Utilities **24.94%**
- Technology **21.36%**
- Financials **15.37%**

Bottom 3 Sectors:

- Consumer Staples **-2.07%**
- Consumer Discretionary **-9.44%**
- Healthcare **-7.00%**

# Automated Resource Agent

MacroCycle AI  
Agent

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Navigation

-  Key Indicators
-  AI Research Agent
-  Business Cycle
-  Market Analysis
-  Resources
-  About

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## Resources & Further Reading

Expand your understanding of macroeconomic analysis, business cycles, and market indicators with these curated resources.

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### Official Data Sources

Federal Reserve Economic Data (FRED)

- [FRED Main Portal](#) - Complete economic database
- [GDP](#) - Gross Domestic Product
- [CPI](#) - Consumer Price Index
- [Unemployment](#) - Unemployment Rate
- [Federal Funds Rate](#)

Bureau of Labor Statistics (BLS)

- [BLS Home](#) - Employment & inflation data
- [Employment Report](#) - Monthly jobs data
- [Economic Calendar](#) - Release schedule

Federal Reserve Resources

- [Federal Reserve](#) - Central bank policy
- [FOMC Calendar](#) - Meeting dates
- [Economic Projections](#) - Dot plot & forecasts
- [Beige Book](#) - Regional conditions

Market Data

- [CBOE VIX](#) - Volatility index
- [Yahoo Finance](#) - Market data & news
- [ISM Manufacturing](#) - PMI reports

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### Academic & Educational Resources

Business Cycle Theory

- [NBER Business Cycle Dating](#) - Official US cycle dates
- [Business Cycles and Depressions \(Britannica\)](#) - Foundational concepts
- [IMF Economic Outlook](#) - Global economic analysis

Investment & Portfolio Theory

- [CFA Institute Resources](#) - Professional investment education
- [Vanguard Research](#) - Asset allocation research
- [BlackRock Investment Institute](#) - Market commentary

Financial Stability & Risk