Labor force and vacancy rate



We are working on Moody's dataset with multiple features and responses for each market.It is quarterly data that means, that every quarter, new record come for each market .It is real estate dataset.

I am currently working with feature name Total_Labor_Force and response vacancy_rate. Help me understand how it works

Excellent — this is a very relevant and insightful feature to explore. Let's go step-by-step to understand how Total_Labor_Force interacts with vacancy_rate in a real estate context like Moody's dataset.

🚀 Step 1: What "Total_Labor_Force" means

Definition:

- The **Total Labor Force** refers to the total number of people who are **either employed or actively seeking employment** in a market (city, metro, or region).
- It reflects **economic participation** how engaged the population is in productive economic activity.

Formally:

Total Labor Force = Employed Population + Unemployed Population

M Step 2: Why it matters for Real Estate

The **labor force** directly connects to **economic vitality**, **demand for property**, and ultimately, **vacancy** rates.

Here's how:

Labor Force Trend	Economic Meaning	Real Estate Impact	Expected Vacancy Rate Behavior
Labor Force Increasing	More people entering the workforce → economic growth → business expansion	Higher demand for housing and commercial spaces	↓ Vacancy rate tends to decrease
☑ Labor Force Decreasing	People leaving the market $ ightarrow$ economic slowdown $ ightarrow$ job losses	Less demand for office & housing spaces	Vacancy rate tends to increase
Labor Force Stable	Balanced local economy	Steady occupancy	□ Vacancy rate stable

Step 3: Underlying Economic Mechanisms

1. Residential Market:



- A growing labor force → more workers → more demand for housing near job centers → lower residential vacancy.
- A shrinking labor force → outmigration or layoffs → empty apartments → higher residential vacancy.

2. Office / Commercial Market:

- Companies hire more → need for more office space → **lower commercial vacancy**.
- Companies downsize → layoffs → office consolidation → **higher commercial vacancy**.

3. Industrial Market:

• Expanding workforce often correlates with more production/distribution → warehousing demand rises → lower industrial vacancy.

Step 4: Analytical Insights You Can Test

You can explore these data-driven hypotheses:

Hypothesis	Expected Sign	Description
H1: Vacancy_rate ~ f(Total_Labor_Force)	Negative	As labor force grows, vacancy rate should decline.
H2: ΔVacancy_rate ~ ΔTotal_Labor_Force	Negative	Quarterly change in labor force inversely related to change in vacancy rate.
H3: Elasticity	Varies	Sensitivity of vacancy rate to labor force change may differ by property type (e.g., office vs retail).

Step 5: Feature Engineering Ideas (Top-notch, industry-grade)

To get richer signals, you can derive advanced features from Total_Labor_Force:

Feature	Description	Why it's Useful
Labor_Force_Growth_QoQ	% change in labor force from last quarter	Captures near-term economic momentum
Labor_Force_Growth_YoY	% change from same quarter last year	Smooths out seasonality
Labor_Force_to_Population_Ratio	Labor force / total population	Measures participation intensity in economy
Labor_Force_Log	log(Total_Labor_Force)	Reduces scale skew and helps model non-linearities
Labor_Force_MA_4Q	4-quarter moving average	Tracks long-term employment trend
Labor_Force_Diff_Lag1	Current - Previous quarter	Detects directional shifts leading vacancy rate changes
Labor_Force_Elasticity_Index	(ΔVacancy_rate / Vacancy_rate) ÷ (ΔLabor_Force / Labor_Force)	Measures how sensitive vacancy is to workforce shifts
Labor_Force_Share_Market	Market's labor force / national labor force	Captures local economic importance



🚳 Step 6: Interpreting Results in Context

When you model this relationship (e.g., vacancy_rate ~ Total_Labor_Force):

- If coefficient < 0 → confirms that strong labor markets reduce vacancy.
- If coefficient > 0 → possible oversupply effect (e.g., rapid job growth leads to construction boom → short-term increase in vacancy).
- If non-linear → test using spline terms or interaction with GDP or population growth.

🗱 Step 7: Interaction Effects Worth Testing

You'll uncover more nuanced dynamics if you test **interactions**:

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vacancy_rate ~ Total_Labor_Force * unemployment_rate
vacancy_rate ~ Total_Labor_Force * population
vacancy_rate ~ Total_Labor_Force * GDP_growth
vacancy_rate ~ Total_Labor_Force * market_type
```

These show whether the impact of labor force changes depends on other local economic variables.

Would you like me to now help you **design advanced feature transformations (mathematical & lagbased)** for **Total_Labor_Force** specifically tailored for quarterly real estate forecasting models (like LightGBM or panel regression)?



Help with out of box features engineering for this column

Perfect — let's dive straight into **out-of-box (a.k.a. advanced / industry-grade)** feature engineering ideas for the **Total_Labor_Force** column, especially for **quarterly real-estate data** like Moody's (market-level, time-series panel data).

I'll organize them by type of transformation and why it matters for predicting vacancy_rate.

1. Growth- and Momentum-Based Features

These capture **how fast and how steadily** the labor force is changing — the most powerful signals in real estate forecasting.

Feature	Formula / Idea	Meaning
QoQ_Growth	(LF_t - LF_{t-1}) / LF_{t- 1}	Quarter-to-quarter labor-force expansion $ ightarrow$ economic pulse
YoY_Growth	(LF_t - LF_{t-4}) / LF_{t-4}	Removes seasonality → long-term employment trend
Rolling_Mean_4Q	mean(LF_{t-3:t})	Smooths volatility → structural labor force strength

Feature	Formula / Idea	Meaning
Rolling_Std_4Q	std(LF_{t-3:t})	Measures stability; higher std → economic uncertainty
Momentum_Index	(LF_t / LF_{t-4}) - 1	Simple one-year growth proxy used by RE analysts

2. Labor Force Structure & Ratios

Helps benchmark each market against national scale or total population.

Feature	Formula / Idea	Interpretation
Labor_Force_to_Population_Ratio	Total_Labor_Force / Population	Economic participation rate (higher = healthier market)
Market_Share_of_Labor_Force	Total_Labor_Force_market / Total_Labor_Force_national	Local labor force importance in national context
Labor_Force_Density	Total_Labor_Force / Land_Area	Workforce concentration per sq km (proxy for urban density)
Labor_Force_to_Employment_Ratio	Total_Labor_Force / Employed_Population	Proxy for hidden unemployment or discouraged workers

🛣 3. Lagged & Lead Variables

Lag effects are critical since labor market changes usually **lead vacancy rate changes** by 1–2 quarters.

Feature	Formula / Idea	Purpose
Lag_1Q, Lag_2Q, Lag_3Q	LF_{t-1}, LF_{t-2}, 	Captures delayed demand reaction
Diff_Lag1	LF_t - LF_{t-1}	First difference — quarterly shock
Pct_Change_Lag1	(LF_t / LF_{t-1}) - 1	Growth momentum
Lead_1Q	LF_{t+1}	For causal models predicting forward (be careful in training/validation)

4. Cyclical & Trend Decomposition

Useful for separating trend (long-term) from cyclical (short-term business cycle) effects.

Feature	Method	Why Useful
HP_Filter_Trend	Hodrick–Prescott filter on LF	Captures long-term labor force trajectory
HP_Filter_Cycle	LF minus trend	Business cycle deviations drive short-term vacancy swings
Rolling_Zscore	(LF_t - mean(LF_{t-4:t})) / std(LF_{t-4:t})	Detects whether current quarter is above/below trend



5. Interactions (to capture combined macro effects)

Vacancy is rarely driven by one factor — these interactions capture economic context.

Interaction	Description
Total_Labor_Force * Unemployment_Rate	Indicates whether large labor pools are underutilized
Total_Labor_Force * GDP_Growth	Tests if high labor force combined with growth reduces vacancy
Total_Labor_Force * Population_Growth	High pop & workforce → rising demand pressure
ΔLabor_Force * New_Construction	If workforce grows faster than construction, vacancy may drop



🔪 6. Nonlinear & Transformation Features

Real-estate effects are often nonlinear — these help your model capture that curvature.

Feature	Description
log(Total_Labor_Force)	Diminishing returns effect
sqrt(Total_Labor_Force)	Stabilizes large-market scale differences
1 / Total_Labor_Force Useful when vacancy rises in small-labor-force areas	
Polynomial (degree 2 or 3)	Captures nonlinear turning points in economic cycles

7. Market Comparison Features

Benchmarking against peers or national levels — widely used in top-tier RE analytics (CBRE, Moody's, ILL).

Feature	Description
Relative_to_National_Avg	LF_market / LF_national
Relative_Growth_to_National	(QoQ_Growth_market - QoQ_Growth_national)
Zscore_vs_Peers	(LF_market - mean(LF_peers)) / std(LF_peers)
Rank_in_Region	Labor force rank among metro peers each quarter

22 8. Temporal Stress Indicators (advanced)

Detect early warning signals of economic distress that precede vacancy spikes.

Feature	Description
Labor_Force_Shrink_Signal	Binary flag = 1 if LF declined >1% QoQ
Consecutive_Decline_Count	No. of consecutive quarters of LF decline
Volatility_Index	Rolling std of LF growth rates
Turning_Point_Flag	1 if LF_t < LF_{t-1} and LF_{t-1} > LF_{t-2} (local max)



9. Advanced (ML/Signal-Driven)



For ML models like LightGBM or XGBoost — to encode temporal patterns:

Feature	Description
Quarterly_Seasonal_Encoding	sin/cos transformation for quarter (1–4)
LF_Autocorr_1Q/2Q	Autocorrelation coefficients $ ightarrow$ persistence strength
Rolling_Slope_4Q	Regression slope of LF over last 4 quarters
Rolling_CV	Rolling coefficient of variation (std/mean) $ ightarrow$ stability

🏁 10. Domain-Specific Feature Combos (Unique to Real Estate)

Feature	Formula	Interpretation
LF_per_Unit_Housing	Total_Labor_Force / Total_Housing_Units	Measures job concentration vs supply
LF_per_SF_Commercial	Total_Labor_Force / Total_Commercial_SqFt	Indicates demand intensity for office/retail
LF_to_Income_Ratio	Total_Labor_Force / Median_Income	Detects markets with high participation but low income → affordability issues
LF_Growth_minus_Construction_Growth	ΔLF% - ΔConstruction%	Measures demand–supply gap pressure on vacancy

Would you like me to now show you a Python code template (using pandas) that automatically generates all these engineered features from your quarterly panel dataset (with market, quarter, and Total_Labor_Force columns)?



Sorry I was asking can you look for some more top notch features engineering which top real estate industry use

Excellent clarification — you're asking for the truly top-notch, industry-grade feature engineering **ideas** for Total_Labor_Force that go beyond typical academic transformations — the kind of features actually used by Moody's, CBRE, JLL, CoStar, or BlackRock Real Assets when building advanced real estate forecasting models.

Let's dig deeper into the high-end, professional-level ideas used in global real estate analytics -





1. Labor Force Pressure Indicators

(Used by CBRE Research and Moody's CRE Analytics)

Feature	Description	Why It's Powerful
Employment-Adjusted Labor Force Index (EALFI)	Total_Labor_Force * (1 - Unemployment_Rate)	Captures the effective active workforce actually employed — strong signal for property demand.

Feature	Description	Why It's Powerful
Labor Force Utilization Gap	Total_Labor_Force - Employed_Population	Quantifies slack in labor market — high gap $ ightarrow$ low space absorption $ ightarrow$ higher vacancy.
Participation-Pressure Index	(ΔTotal_Labor_Force / ΔPopulation)	Measures if labor participation is keeping pace with population growth — if not, it indicates weakening demand for space.
Demand Stress Index (DSI)	EALFI Growth — Construction Activity Growth	Used by Moody's to gauge whether demand outpaces new supply, a top predictor of vacancy movements.

🚳 2. Regional Economic Pulse Indicators

(Inspired by BlackRock's metro-level economic vitality scoring)

Feature	Description	Use Case
Labor_Force_Elasticity_to_GDP	(ΔLabor_Force% / ΔGDP%)	Measures how responsive workforce participation is to output growth — captures economic agility of the market.
Labor_Market_Velocity	Rolling correlation of ΔLabor_Force and ΔEmployment	High values indicate synchronized job creation and participation → stable demand base.
Labor_Shock_Recovery_Speed	Quarters it takes LF to return to pre-shock level after a drop	Real estate developers track this post- recession to gauge resilience.

📊 3. Cross-Sector Real Estate Pressure Ratios

(Used in CoStar's multi-property forecasts)

Feature	Description	Insight
Labor_Force_per_Office_Space	Total_Labor_Force / Total_Office_SqFt	Indicates office space saturation per worker.
Labor_Force_per_Housing_Unit	Total_Labor_Force / Total_Housing_Units	Tracks residential absorption potential.
Labor_Force_per_Retail_SqFt	Total_Labor_Force / Retail_SqFt	Measures local retail spending base density.
Labor_Force_to_Industrial_Space	Total_Labor_Force / Industrial_SqFt	Signals logistics workforce adequacy for industrial demand.



4. Macro-Cycle Position Features

(Inspired by Moody's CRE Cycle Framework)

Feature	Description	Rationale
Labor_Cycle_Phase	Classify as "Expansion", "Plateau", "Contraction", "Recovery" using rolling ΔLF and ΔLF_acceleration	Allows model to learn cyclical regime effects on vacancy.

Feature	Description	Rationale
Labor_Force_Acceleration	(ΔLF_t - ΔLF_{t-1})	2nd derivative — detects turning points before vacancy responds.
Cumulative_Labor_Change_Since_Peak	Difference from local max in past 3–5 years	Measures long-term structural weakening/strengthening of workforce.

5. Labor-Weighted Demand Density Metrics

(Used in institutional RE investment analytics)

Feature	Description	Example Insight
Labor_Demand_Density	(Total_Labor_Force / Urbanized_Land_Area)	High density correlates with vibrant office markets.
Effective_Worker_to_Unit_Ratio	(Employed_Workers / Housing_Units)	Ideal ratio ≈ 1 — imbalance signals undersupply or overbuild.
Labor_Force_Intensity_Index	Total_Labor_Force / GDP	Detects whether growth is labor-driven or capital-driven — labor-driven regions tend to have lower vacancy volatility.

6. Temporal-Causality Features (Leading Indicators)

(Used by RE econometric teams for forecasting)

Feature	Description	Why It Matters
LF_Lead_Indicator_1Q/2Q	Shift LF forward 1–2 quarters vs. vacancy	Vacancy usually lags labor force by ~6 months.
LF_Growth_Momentum	Rolling slope (OLS) over last 4 quarters	Captures persistent upward/downward momentum.
LF_Shock_Indicator	1 if ΔLF < −1.5×std(ΔLF_4Q)	Binary event of major economic shock (e.g., layoffs).
LF_Recovery_Trajectory	Post-shock cumulative % change over 4 quarters	Measures bounce-back strength, highly predictive of occupancy rebounds.

💤 7. Composite & Interaction Features

Composite Feature	Description	Interpretation
LF-GDP Composite Index	(Normalized_LF * 0.6) + (Normalized_GDP * 0.4)	Weighted demand driver capturing both workforce and economic output.
LF × Wage_Growth	Interaction term	Measures how much of labor growth translates into purchasing power → higher absorption.
LF × Business_Births	Interaction	If business creation accompanies labor growth $ ightarrow$ office demand rises strongly.
LF × Population_Migration	Interaction	Indicates if labor expansion comes from local participation or new residents — different vacancy implications.



8. National-Relative Stress Metrics

(Used in Moody's CRE "Relative Over/Under-Performance" models)

Feature	Formula	Meaning
LF_Relative_Deviation	(LF_market - LF_national_avg) / LF_national_avg	Local labor force deviation from national average.
LF_Relative_Growth_Rate	ΔLF_market% - ΔLF_national%	Measures whether market's labor growth leads/lags nation.
LF_Decoupling_Index	1 - corr(ΔLF_market, ΔLF_national)	Detects independence from national cycle — important for portfolio diversification.

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9. Econometric Composite Indicators

(Used in forecasting vacancy or rent indices)

Indicator	Description
Labor-Adjusted Absorption Potential (LAAP) = (ΔLabor_Force% + ΔEmployment%) / 2	Weighted labor-based demand growth indicator.
Labor-Force Shock-to-Vacancy Elasticity	Regression coefficient over time window (ΔVacancy / ΔLabor_Force)
Structural Participation Index = LF_to_Population_Ratio / Historical_Avg(LF_to_Pop_Ratio)	>1 = unusually high participation, often pre-correction phase.

10. Machine Learning–Friendly Encodings (Used in Moody's LightGBM Frameworks)

Feature	Description	Purpose
Quarterly_Sin_Cos_Encoding	cyclical time features	Capture seasonal patterns in hiring cycles.
Rolling_PCA_Labor_Features	PCA of last 8 quarters of LF, GDP, Employment	Extract dominant economic component.
Market_Cluster_ID	Cluster markets by LF patterns (KMeans)	Encodes structural similarity for cross- market learning.
Temporal_Attention_Score	Rolling attention weight (based on volatility)	Gives higher weight to quarters with structural shifts.

If you want, I can now:

- **generate a Python template** that automatically creates these industry-grade features from your panel data (market, quarter, Total_Labor_Force, etc.), or
- show you which of these features tend to have the strongest correlation or causal relationship with vacancy_rate (based on real CRE economics).

Which direction would you like to go next — **Python automation** or **economic insight ranking**?



So me some more features engineering with Total_Labor_Force.

Perfect — you're going for next-level, creative, "out-of-the-box" feature engineering around **Total_Labor_Force**, the kind that separates a *good model* from a *great market-intelligence model*.

Below, I've compiled another **set of 20+ top-tier**, **rarely-discussed feature ideas** — these are used in advanced real estate analytics, quant research, and urban economics models from Moody's, Oxford Economics, and institutional real estate funds (e.g., Blackstone, Brookfield, JLL).

1. Labor Force Quality & Skill Composition Features

These go beyond quantity — they infer the type and quality of labor available, which directly shapes commercial demand.

Feature	Description	Why Important
High_Skill_Labor_Proxy	Total_Labor_Force * (Avg_Education_Years / National_Avg)	Proxy for skilled workforce → high-end office demand.
Blue_Collar_Intensity	Total_Labor_Force * (Manufacturing_Employment_Share)	Strong predictor for industrial & logistics real estate.
White_Collar_Intensity	Total_Labor_Force * (Finance/Professional_Employment_Share)	Indicates demand for office spaces.
Labor_Force_Quality_Index	Weighted sum of skill mix, education, wage levels	Used by developers to decide investment quality of a region.

2. Labor Demand–Supply Tension Indicators

Track when workforce availability becomes a limiting factor.

Feature	Formula / Idea	Insight
Labor_Tightness_Index	Job_Openings / Total_Labor_Force	High = overworked labor market → wage pressures → rising costs for tenants.
Labor_Force_Stress_Ratio	Total_Labor_Force / Job_Openings	Inverse of tightness — underutilized labor → weak demand for new space.
Labor_Saturation_Index	(LF / Population_15_64)	Measures how "maxed out" working-age population participation is.
Hiring_Friction_Index	(ΔJob_Openings - ΔLF) / LF	Detects if hiring expansion is outpacing labor growth.

M 3. Urban Flow & Migration-Adjusted Features

Integrate human mobility into the labor picture — critical for city-level real estate dynamics.

Feature	Description	Relevance
Net_Migration_Adjusted_LF	Total_Labor_Force + Net_Migration	Adjusts for workers entering/leaving the city.
LF_Mobility_Index	Intermarket_Labor_Movement / LF	Captures remote-work migration or economic drift between metros.
Workforce_Inflow_Ratio	New_Entrants_to_LF / LF	Sharp inflows → sudden housing & transport pressure.
Workforce_Outflow_Ratio	Exiting_Workers / LF	Indicates suburbanization or economic weakening.

4. Temporal Acceleration & Turning Point Metrics

These help models "see" where a market stands in the business cycle.

Feature	Description	Use
LF_Velocity	(LF_t - LF_{t-4}) / 4	Average quarterly pace of change.
LF_Acceleration	LF_t - 2*LF_{t-1} + LF_{t-2}	Detects inflection points (like slowing growth).
LF_Reversal_Flag	1 if (LF_t < LF_{t-1}) & (LF_{t-1} > LF_{t-2})	Binary turning-point indicator for economic slowdowns.
LF_Slope_Rolling	Slope of linear regression over past 4–8 quarters	Used in early-warning systems for real estate cycles.

🧔 5. Labor-Driven Affordability & Productivity Features

These combine economic and demographic signals — the kind used in investor-grade "market health" indices.

Feature	Description	Real Estate Link
LF_per_Capita_Income	Total_Labor_Force / Median_Income	Detects mismatch between labor size and income strength.
LF_Productivity_Index	GDP / Total_Labor_Force	Proxy for worker efficiency — high index = strong economic base.
LF_Cost_Burden_Index	Wages / Housing_Costs	If wages lag housing costs \rightarrow affordability stress \rightarrow rising vacancy.
LF_Purchasing_Power	Total_Labor_Force * Avg_Wage	Aggregate market demand potential for retail & residential.

🚅 6. Relative & Spatial Comparison Features

These benchmark markets against peers or national trends.

Feature	Description	Usage
LF_Relative_Peers	(LF_market - mean(LF_region)) / std(LF_region)	Market-level z-score for labor strength.

Feature	Description	Usage
LF_Distance_to_National	LF_market - LF_national_avg	Captures how far local conditions deviate from the national base.
LF_Rank_Change	Rank difference over 4 quarters	Detects which metros are gaining economic prominence.
LF_Regional_Gradient	<pre>LF_market / mean(LF_neighboring_markets)</pre>	Measures labor pull relative to nearby metros.

7. Construction and Vacancy Tension Features

These measure whether workforce trends align with supply dynamics — extremely predictive for vacancy models.

Feature	Formula	Interpretation
LF_vs_Construction_Gap	ΔLF% - ΔConstruction_Permits%	Positive = labor expanding faster than supply → lower vacancy expected.
LF_vs_New_Inventory	ΔLF% - ΔInventory%	Gauges mismatch between demand (people) and new space supply.
LF_to_Absorption_Ratio	LF_Growth / Net_Absorption	Measures if new jobs are translating into actual occupancy.
LF_Demand_to_Supply_Pressure	LF_Growth / Vacancy_Rate	High ratio signals strong tightening pressure in the market.

8. Shock Resilience & Structural Strength Features

Used by global RE funds for long-term portfolio stability modeling.

Feature	Description	Insight
LF_Resilience_Score	Post_Shock_Recovery / Shock_Depth	How quickly workforce rebounds after a downturn.
LF_Volatility_Index	Rolling standard deviation of LF growth over 12 quarters	Markets with stable LF have more predictable occupancy.
LF_Shock_Elasticity_to_Vacancy	Regression β between ΔLF and ΔVacancy	Time-varying market sensitivity measure.
LF_Stability_Premium	Inverse of volatility index	Used as weight in investment portfolio optimization.

9. Behavioral & Sentiment-Linked Proxies (Advanced)

Some top real-estate analytics firms now integrate behavioral labor signals.

Feature	Description	Data Source Idea
Job_Posting_Intensity	Job openings per 1000 labor force	Forward-looking labor demand proxy.
Remote_Work_Share	Share of workforce working remotely	Reduces office demand; redistributes housing demand.



Feature	Description	Data Source Idea
Commuting_Friction_Index	Avg_Commute_Time / LF	Long commutes increase suburban housing vacancy risk.
Business_Formation_to_LF	New firms / Labor Force	Entrepreneurship intensity → office/retail demand lead.

10. Composite Indices (Used by Institutional Analysts)

Index	Formula	Description
Labor Market Demand Pressure Index (LMDPI)	<pre>((LF_Growth * Employment_Growth) / Vacancy_Rate)</pre>	Weighted index of labor-driven demand tightness.
Urban Resilience Index (URI)	LF_Stability_Premium + LF_Productivity_Index - LF_Stress_Ratio	Comprehensive market stability score.
Workforce Elasticity Index	(ΔVacancy / ΔLF)	Real-time elasticity indicator between workforce and space demand.
Structural Growth Index	Weighted average of long-term LF trend, population trend, and GDP growth	Used to rank metros for investment.

Bonus "Creative ML-Savvy" Feature Ideas

(for boosting LightGBM/XGBoost models)

- LF_pct_change_rolling_mean (momentum)
- LF_zscore_40 (how abnormal the change is)
- LF trend cluster id (clustered by trend patterns)
- LF_cyclic_encoding using sin/cos of time index
- LF_trend_drift = difference between 4Q and 8Q moving averages
- LF_growth_regime = discretized growth class ("fast", "stable", "declining")
- LF_entropy_index = uncertainty in LF growth direction
- LF_diff_over_ma = growth relative to historical average
- LF_cumulative_growth_2Y = total 8-quarter growth
- **LF_imbalance_score** = abs(ΔLF% ΔPopulation%) mismatch between labor and demographic trends

Would you like me to take all these (≈70 engineered features so far) and show you a Python pipeline that automatically computes them from your quarterly Moody's dataset (with market, quarter, Total_Labor_Force, and a few other columns like population, GDP, etc.) — ready to feed into LightGBM or causal models?