

Feature response analysis



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 `professional_business_services_employment` and response `vacancy`. Help me understand how it works

Excellent — this is a very realistic and insightful feature-response pair in a real estate dataset like Moody's. Let's break this down carefully and systematically so you understand both **the economic intuition** and **how it plays out statistically or in modeling**.

1. Understanding the Variables

Feature: `professional_business_services_employment`

- This represents **the number of people employed** (or total jobs) in the *Professional & Business Services* (PBS) sector in a given market and quarter.
- This sector includes:
 - Legal services
 - Accounting, consulting, management services
 - Architectural & engineering firms
 - Advertising, tech consulting, etc.
- Essentially, it's **white-collar employment**, often tied to **office-based jobs**.




Response: `vacancy`

- Vacancy (often `vacancy_rate`) represents **the percentage of available (unleased) space** in the market's real estate inventory — usually for **office, retail, industrial, or multifamily** properties.
- For example, a vacancy rate of 15% means 15% of total leasable area is unoccupied.

2. The Economic Intuition

This feature and response are **causally linked** — changes in employment levels often drive space demand and thus influence vacancy rates.

Let's unpack the mechanism:

Scenario	Employment Trend	Expected Vacancy Response	Explanation
 Growth in PBS Employment	Increasing	Vacancy ↓ (decrease)	More firms hire → need more office space → demand ↑ → vacancy falls
 Decline in PBS Employment	Decreasing	Vacancy ↑ (increase)	Companies downsize → release office space → demand ↓ → vacancy rises
 Stable Employment	Flat	Vacancy stable	No significant net absorption or new space needed

So, **professional & business services employment** is a **leading demand-side indicator** for the **office real estate** sector.

3. Real Estate Market Dynamics

- **Lag Effect:** Changes in employment may not immediately affect vacancy. Companies might delay expansion/contraction of space by 1–2 quarters.
- **Supply Interference:** Even if employment rises, if there's new construction adding supply faster, vacancy might not fall.
- **Market Heterogeneity:** In some cities (like San Francisco or Austin), tech and business service jobs dominate — so the relationship is very strong. In industrial-heavy markets (like Memphis), it's weaker.

4. How to Analyze This Relationship

(a) Correlation and Elasticity

Compute the correlation or regression slope between:

text

$$\text{vacancy_rate_t} = \alpha + \beta * \text{professional_business_services_employment_t} + \epsilon$$

You expect $\beta < 0$ (negative relationship).

A more robust model might use **log-log form** to interpret elasticity:

text

$$\log(\text{vacancy_rate_t}) = \alpha + \beta * \log(\text{employment_t})$$

Here, β tells you the % change in vacancy for a 1% change in employment.

(b) Lagged Effects

Often, employment changes lead vacancy by 1 or 2 quarters:

text

$$\text{vacancy_t} = \alpha + \beta_1 * \text{employment_t} + \beta_2 * \text{employment_}(t-1) + \varepsilon$$

Try different lags — you may find β_2 significant, capturing that delayed demand adjustment.

(c) Interaction Effects

Combine this with other variables like:

- **Office rent growth**
- **Construction completions**
- **Population growth**

For instance:

text

$$\text{vacancy_t} = \alpha + \beta_1 * \text{PBS_employment_t} + \beta_2 * \text{new_supply_t} + \beta_3 * \text{rent_growth_t} + \varepsilon$$

This helps isolate how employment impacts vacancy, controlling for supply and pricing.

5. Advanced / Out-of-the-Box Insights

Top analysts in the industry might also create **derived or engineered features** from this variable:

Feature Idea	Description	Real Estate Logic
Employment Growth Rate (YoY or QoQ)	$(\text{Emp_t} - \text{Emp_}(t-4)) / \text{Emp_}(t-4)$	Measures market momentum
Employment per Office Stock	$\text{Employment} / \text{Total_Office_Sqft}$	Indicates intensity of space use
Employment Shock Index	Std. deviation of last 4 quarters' growth	Captures volatility in demand
Employment-to-Vacancy Elasticity	Ratio of $\% \Delta \text{Vacancy}$ to $\% \Delta \text{Employment}$	Quantifies sensitivity

These help reveal **which markets are most responsive to business service job trends**.

6. Real-World Example

Say in **Austin**:

- PBS employment grew 5% YoY.
- Vacancy dropped from 15% → 13%.
That implies employment growth absorbed space, validating the negative relationship.

But in **New York**:

- Employment grew 3%, but vacancy still rose (due to new supply or remote work). So the link depends on **supply pipeline** and **remote work intensity** too.

✓ 7. Key Takeaways

Insight	Meaning
Employment ↑ → Vacancy ↓	Core negative correlation
Lagged response	Vacancy reacts after 1–2 quarters
Supply and rent moderate effect	Demand can be offset by new supply
Market-specific dynamics	Stronger in white-collar dominated markets
Useful for forecasting	Great leading indicator for office demand and rent forecasts

Would you like me to help you **engineer advanced, realistic features** from **professional_business_services_employment** that top real estate firms (like Moody's, CBRE, or JLL) often use for vacancy modeling?

I can tailor them for **forecasting or causal interpretation** — whichever direction you're focusing on.



Help with out of box features engineering for this column

Perfect — let's design **out-of-box, industry-level feature engineering ideas** for **professional_business_services_employment** (PBS employment) that are *actually used or inspired by top real estate analytics teams* (like Moody's, CBRE, JLL, or CoStar).

These go **beyond basic growth rates**, focusing on how this employment metric can **signal shifts in real estate demand, economic structure, and absorption potential**.

🧠 1. Momentum & Velocity Features

Feature	Formula / Idea	Interpretation
QoQ Growth Rate	$(\text{emp_t} - \text{emp_}(t-1)) / \text{emp_}(t-1)$	Short-term hiring momentum
YoY Growth Rate	$(\text{emp_t} - \text{emp_}(t-4)) / \text{emp_}(t-4)$	Yearly sectoral strength
Rolling 4Q Growth Momentum	Average of last 4 QoQ growth rates	Smooths out volatility, shows sustained trend
Acceleration of Employment	$(\text{Growth_t} - \text{Growth_}(t-1))$	Detects inflection points (e.g., hiring surge or slowdown)
Employment Shock Index	Std. dev. of last 4 growth rates	Captures instability—markets with volatile employment see higher leasing uncertainty

🔄 2. Structural / Intensity Features

Feature	Formula / Idea	Why It's Insightful
PBS Employment Share	$\text{PBS_employment} / \text{Total_nonfarm_employment}$	Measures concentration of office-type jobs → strong predictor of office space demand
PBS Employment per Office Stock	$\text{PBS_employment} / \text{Total_office_sqft}$	Proxy for space utilization efficiency
Employment Density Ratio	$\text{PBS_employment} / \text{Population}$	Indicates how "office-oriented" a market's economy is
Relative PBS Employment Growth	PBS growth – overall employment growth	Shows if PBS is growing faster than the local economy (structural shift toward office jobs)
Market Dependency Index	PBS share in market ÷ national PBS share	Reveals over- or under-exposure to office-centric sectors

3. Lead-Lag Demand Indicators

Feature	Construction	Intuition
Lagged PBS Employment (t-1, t-2)	Shift the feature back 1–2 quarters	Real estate responds to job changes with delay
Forward Vacancy Prediction Index	$(\text{emp_t} - \text{emp_}(t-1))$ used to predict $\text{vacancy_}(t+1)$	Explicitly capture leading effect
Cumulative Employment Change (4Q)	$\text{emp_t} - \text{emp_}(t-4)$	Measures net absorption potential over the last year
Quarterly Employment Momentum (EMA)	Exponential moving average over last 4 quarters	Smoothed trend for predictive stability

4. Cross-Market or Structural Comparison Features

Feature	Formula / Idea	Purpose
Relative Market Performance	$\text{Market_emp_growth} / \text{National_emp_growth}$	Benchmarks local strength vs. national
Employment Synchrony Index	Correlation of local vs. national PBS employment growth (rolling 8Q)	Captures whether local market follows national business cycle
Diversification Factor	$1 / (\text{std}(\text{PBS_share across industries}))$	Higher = more diversified employment = more stable demand
Cluster Peer Median Difference	PBS growth in market – median PBS growth across similar metros	Measures relative momentum among peers

5. Derived Real Estate Demand Indicators

Feature	Formula / Idea	Use
Implied Office Space Demand	$\text{PBS_employment} * \text{Avg_sqft_per_worker}$	Convert employment into physical demand proxy (e.g., 150 sqft per worker)
Employment-to-Absorption Ratio	$(\Delta \text{PBS_employment}) / (\text{Net_Absorption})$	Tests elasticity between jobs and leased space

Feature	Formula / Idea	Use
Employment Elasticity of Vacancy	$\% \Delta \text{ Vacancy} / \% \Delta \text{ PBS_employment}$	Quantifies market sensitivity to employment changes
Vacancy Pressure Index	$\text{PBS_growth_rate} - \text{New_supply_growth_rate}$	Indicates whether demand or supply dominates

6. Resilience / Stress Features

Feature	Formula / Idea	Purpose
Post-Shock Recovery Index	$(\text{emp_t} - \text{emp_trough}) / \text{emp_peak_pre_trough}$	How well market rebounded after downturn
Employment Drawdown (Max-Min)	Rolling max-min over last 8 quarters	Measures employment volatility risk
Stability Score	$1 / (\text{abs}(\text{quarterly_change}))$	Captures job market stability—stable markets have more predictable vacancy

7. Advanced (used by top analysts)

Feature	Idea	Description
Decomposed Components (via STL or HP filter)	Trend / Seasonal / Residual parts of PBS employment	Separately model structural trend vs. cyclical noise
Market Cluster Employment Index	Apply PCA or K-Means on employment profiles across markets	Extract latent factors (e.g., “Tech Growth Cluster”)
Employment-Vacancy Granger Causality Score	Whether employment “Granger-causes” vacancy	Quantifies causal lead strength
Shock-Adjusted Growth Rate	Growth rate normalized by macroeconomic index (GDP, PMI)	Filters out national business cycle to isolate local dynamics

8. Example Feature Implementation (Python-style)

```
python

df['pbs_qoq_growth'] = df.groupby('market')['pbs_employment'].pct_change()
df['pbs_yoy_growth'] = df.groupby('market')['pbs_employment'].pct_change(4)
df['pbs_momentum_4q'] = df.groupby('market')['pbs_qoq_growth'].rolling(4).mean().reset_index(0, drop=True)
df['pbs_share'] = df['pbs_employment'] / df['total_employment']
df['pbs_employment_per_sqft'] = df['pbs_employment'] / df['total_office_sqft']
df['vacancy_pressure_index'] = df['pbs_yoy_growth'] - df['office_supply_growth']
```

9. Summary — What These Capture

Feature Type	Captures
Momentum	Short-term economic shifts
Structure	Market's dependency on office jobs

Feature Type	Captures
Lead-Lag	Timing between job growth and space demand
Cross-Market	Competitive positioning of each city
Demand Indicators	Translating jobs into square-footage pressure
Resilience	Market stability under shocks

Would you like me to **narrow these down** to a realistic set (say, top 8–10) optimized for **forecasting vacancy rates** (using Moody's-style quarterly real estate models)?

That way, we can focus only on the features most predictive and interpretable for your global modeling setup.



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

Perfect — that's exactly the kind of question top-tier research and analytics teams at **Moody's, CBRE, JLL, and CoStar** explore when linking **employment** (like `professional_business_services_employment`) to **vacancy dynamics**.

Let's now go **beyond traditional statistical features** into the kind of **premium, industry-grade feature engineering** used in *institutional real estate forecasting models* and *capital markets research*.

These ideas come from how analysts blend **economic structure, spatial linkages, and behavioral trends** into engineered features.

1. Spatial & Network-Driven Employment Features

Top firms increasingly treat cities and submarkets as **interconnected economic nodes** — not isolated.

Feature	Description	Why It's Powerful
Commuter Belt Employment Exposure	Weighted average of PBS employment in nearby metros (based on commuting patterns or travel time)	Captures spillover demand: e.g., suburban leasing follows job growth in CBD
Cross-Market Employment Elasticity	How local vacancy responds to job changes in peer cities (e.g., Austin ↔ Dallas)	Reveals regional substitution and shared demand cycles
Employment Diffusion Index	Rolling correlation of PBS growth across markets	Identifies synchronized expansions that drive multi-city leasing booms
Cluster Employment Factor (PCA)	Principal component capturing shared PBS job trend across multiple markets	Used in global models to represent national macro demand pressure

2. Productivity & Utilization Metrics

Modern firms link employment not just to headcount but to **space efficiency and output per worker**.

Feature	Description	Real Estate Logic
Output per PBS Worker (proxy)	$\text{Market_GDP_PBS} / \text{PBS_employment}$	Indicates efficiency — higher output per worker → less space needed per job
Space Efficiency Adjustment	$\text{PBS_employment} \times \text{Avg_sqft_per_worker_trend}$ (trend declining over time)	Captures hybrid/remote work impact
Desk Utilization Ratio	Adjusts employment by known remote work index	Refines true physical occupancy potential
Employment-to-Rent Elasticity	Regression coefficient between PBS jobs and effective rent	Quantifies how hiring translates into rent pressure, not just vacancy changes



3. Market Structure & Supply Sensitivity Indicators

Feature	Description	Why It Matters
Job-to-Construction Ratio	$(\Delta \text{PBS_employment}) / (\text{New_Office_Supply})$	Measures whether job creation outpaces new inventory
Employment Absorption Conversion Rate	$(\Delta \text{PBS_employment}) / (\text{Net_Absorption})$	Real-world calibration of how many jobs equal 1,000 sqft absorbed
Effective Demand Index	$\text{PBS_employment} \times \text{Employment_Space_Elasticity}$	Converts job growth into implied vacancy absorption potential
Excess Employment Pressure	$(\text{PBS_growth} - \text{Supply_growth})$	If positive → downward vacancy pressure; if negative → vacancy increase expected



4. Macro-Micro Hybrid Indicators

These are “top-down meets bottom-up” indicators that Moody’s or CBRE use in **national vacancy forecasts** and **capital market stress testing**.

Feature	Construction	Economic Interpretation
Adjusted PBS Employment Growth	$\text{PBS_growth} - \text{National_PBS_growth}$	Removes macro cycle to isolate local over/under-performance
Cycle Phase Indicator	Smoothed PBS growth trend vs. long-term mean	Tells if market is early, mid, or late in the office cycle
Lagged Employment Cycle Distance	Time since last PBS employment peak or trough	Captures cyclical maturity (used in vacancy risk models)
Composite Office Demand Factor	Weighted combo of PBS, Financial, and Info employment growth	Models total office-demand pressure, not one sector only
Business Sentiment-Adjusted Employment	$\text{PBS_employment} \times \text{Business_Sentiment_Index}$	Integrates hiring data with forward-looking sentiment expectations



5. Resilience, Volatility & Stress Features

Feature	Description	Real Estate Insight
Employment Volatility Index	Std. dev. of PBS growth (8-quarter rolling)	Markets with high job volatility have higher vacancy risk
Recovery Strength Index	$(\text{Current PBS} - \text{Trough}) / (\text{Peak_pre_t})$	Shows how strongly a market bounced back after a downturn
Employment Beta to National Cycle	Regression of local vs. national PBS growth	Measures cyclical exposure — beta > 1 means amplifies national cycle
Shock Absorption Score	Ratio of rebound speed post-employment drop	Quantifies resilience — strong recovery correlates with faster vacancy tightening

6. Hybrid Real Estate-Economic Constructs

Feature	Description	Why Used in Institutional Models
Office Job Quality Index	Weighted average of subindustries within PBS (e.g., tech consulting vs. admin support)	Adjusts demand potential based on job type (high-value jobs → premium space)
Hybrid Work Penetration Index	PBS employment × regional hybrid adoption rate	Adjusts effective occupancy potential
Human Capital Intensity	$\text{Avg wage in PBS} / \text{cost_per_sqft}$	Higher wage-to-rent ratio → firms more likely to absorb rent increases
Business Dynamism Rate	Job creation + destruction rate	High churn → more leasing activity even if net job change is flat

7. Temporal Transformation Features (used for forecasting)

Feature	Description	Why It's "top notch"
Hodrick-Prescott Trend Component	Extract long-term employment trend	Helps separate cyclical vs. structural demand
Cyclical Amplitude	Deviation from HP trend	Used for cyclical forecasting models
Phase Angle (Hilbert Transform)	Identifies where in business cycle each market sits	Used in leading-lagging cyclical prediction systems
Wavelet Energy of Employment Series	Multi-scale feature for volatility & persistence	Detects emerging vs. fading employment waves

8. Behavioral & Emerging Economy Signals

Feature	Description	Why It's Cutting Edge
Hiring Intention Index (derived)	Lagged relationship between LinkedIn job postings and PBS employment	Early signal of office demand
Remote-Work Adjustment Factor	Market-specific work-from-home penetration × PBS jobs	Captures structural shift in demand
Co-working Demand Proxy	PBS job growth × start-up density	Reflects changing space utilization behavior
Office Demand Stress Index	Combines layoffs data + PBS job changes + sublease inventory	Real-time risk signal for vacancy spikes



Example Feature Bundle for a Model

When big players (like Moody's Analytics CRE model) estimate office vacancy, they use a feature stack such as:

Category	Sample Features
Demand Core	PBS Employment Growth (YoY), Lagged Growth (1Q, 2Q)
Structural	PBS Share of Total Employment, Output per Worker
Spatial	Neighbor-Market Weighted Employment Growth
Cycle Control	HP-Trend Cycle Gap, Employment Volatility
Behavioral	Remote-Work Adjustment, Business Sentiment Weighted Growth
Supply Control	Net Supply Growth, Vacancy Pressure Index

✓ 9. Key Takeaway

Top-tier industry models now view `professional_business_services_employment` not as a single driver — but as a **multifaceted signal** reflecting:

- **Demand momentum (growth rates)**
- **Structural exposure (share, specialization)**
- **Spatial diffusion (regional linkage)**
- **Behavioral modification (remote work)**
- **Cyclical phase alignment (trend deviations)**

Would you like me to shortlist the **top 10 most realistic and high-impact features** (from this entire list) that would *most improve vacancy forecasting accuracy* in your Moody's-style global model (multi-market, quarterly data)?

That would give you a clean, research-backed, deployable feature set.



Show me some more features engineering with `professional_business_services_employment` which are realistic and don't try to keep the earlier feature.

Got it — you want a **fresh batch** of *realistic, advanced, and creative* feature engineering ideas using `professional_business_services_employment`, without repeating the earlier ones.

Let's now go one layer deeper into **real estate economics, macro linkages**, and **spatial-temporal structure**, drawing from techniques that analysts at Moody's, JLL, or CBRE Capital Markets often explore when they model office vacancy and leasing trends.



1. Economic Pressure & Tightness Indicators

Feature	Formula / Idea	Economic Intuition
Employment Tightness Ratio	$\text{PBS_employment} / \text{Office_vacant_space}$	Measures how many office jobs exist per vacant sqft — high ratio = market tightening
Employment-Vacancy Imbalance	$\text{PBS_employment_growth} - \text{Vacancy_growth}$	Positive = demand > supply, negative = oversupply pressure
Employment Capacity Utilization	$\text{PBS_employment} / (\text{PBS_employment_peak_last_5y})$	Captures whether market is operating near historical employment capacity
Employment-to-Stock Imbalance	$(\text{PBS_employment} - \text{PBS_trend}) / \text{Office_inventory}$	Deviation from equilibrium employment level relative to stock

2. Cycle & Saturation Features

Feature	Formula / Idea	Why It Matters
Cycle Position Score	$((\text{PBS_employment} - \text{HP_trend}) / \text{HP_trend})$	Indicates whether the market is above/below its long-term employment trend
Employment Saturation Index	$\text{PBS_employment} / \text{10Y_high_PBS_employment}$	How “mature” the market is in this expansion cycle
Recovery Momentum (Post-Shock)	$(\text{PBS_employment_t} - \text{Trough_2020}) / \text{Trough_2020}$	How much job recovery since last downturn
Re-acceleration Flag	Indicator if growth has re-accelerated after 2+ quarters of slowdown	Detects turning points before vacancy reacts

3. Labor Demand-Space Conversion Features

Feature	Description	Logic
Job-Space Conversion Index	$\Delta \text{PBS_employment} * \text{Avg_sqft_per_worker}$	Converts job gains to implied space absorption
Employment-Driven Absorption Potential	$\text{PBS_employment_growth} * \text{Office_density_factor_market}$	Varies by city — reflects local intensity of office use
Net Hiring per New Supply Unit	$(\Delta \text{PBS_employment}) / (\Delta \text{Office_stock})$	Measures how many jobs are created per sqft added
Absorption Mismatch Score	$(\text{Implied_demand} - \text{Actual_net_absorption})$	Indicates over/under absorption relative to job creation

4. Inter-Sector and Cross-Market Linkage Features

Feature	Formula / Idea	Why It's Useful
PBS-to-Total-Employment Divergence	$(\text{PBS_growth} - \text{Total_employment_growth})$	Reveals if office jobs are growing faster than the local economy
PBS vs. Tech Employment Ratio	$\text{PBS_employment} / \text{Tech_employment}$	Captures the mix between traditional office jobs and tech-

Feature	Formula / Idea	Why It's Useful
		driven demand
Peer-Market Spillover Growth	Weighted average of PBS employment growth in economically linked metros	Reflects regional demand flow (e.g., spillover from SF → Austin)
PBS Employment Co-Movement Index	Rolling correlation of PBS employment between this market and national trend	Indicates alignment with national business cycle

5. Structural Transformation Indicators

Feature	Formula / Idea	Real Estate Implication
PBS Share Change (Structural Shift)	$(\text{PBS_share_t} - \text{PBS_share_}(t-4))$	Growth in PBS share = economy tilting toward office jobs
High-Value Job Penetration	$\text{PBS_employment} \times \text{Avg_PBS_wage}$	Combines headcount and income → proxy for high-quality space demand
Office-Oriented Economy Score	Weighted mix of PBS, Finance, and Info employment / Total employment	Captures broader “office economy” structure
White-Collar Job Depth	Rolling 8-quarter minimum of PBS employment / current value	Indicates how much the sector has grown above its baseline

6. Behavioral / Structural Change Features (Post-2020 Era)

Feature	Formula / Idea	Use
Remote Work Sensitivity	$\text{PBS_employment} \times (1 - \text{Onsite_work_rate})$	Adjusts effective office space demand
Hybrid Demand Factor	$\text{PBS_growth} \times \text{Hybrid_index_market}$	Reflects reduced physical demand due to hybrid adoption
Sublease Risk Score	$\Delta \text{PBS_employment_neg} \times \text{Sublease_inventory_growth}$	Identifies risk of increased sublease availability
Employment Decoupling Index	$\text{Correlation}(\text{PBS_employment}, \text{Office_absorption})$ (rolling)	Captures weakening job-to-space linkage due to remote work trends

7. Income & Productivity-Linked Employment Features

Feature	Description	Why It's Used
Total Payroll Proxy	$\text{PBS_employment} \times \text{Avg_PBS_wage}$	Captures economic depth and purchasing power — stronger predictor of rent growth
Payroll Growth Rate	$\% \Delta (\text{PBS_employment} \times \text{Avg_wage})$	Reflects income momentum of white-collar workers
Office Affordability Ratio	$\text{Avg_PBS_wage} / \text{Effective_office_rent}$	Measures affordability — higher ratio supports stable demand
Labor Cost Pressure Index	$\Delta \text{Avg_wage} / \Delta \text{PBS_employment}$	Identifies periods where wage pressure may slow hiring, affecting future space demand

8. Nonlinear Transformations and Composite Indices

Feature	Transformation	Why It Helps
Log-Scaled Employment	$\log(\text{PBS_employment})$	Stabilizes growth variance across markets
Employment Growth Squared	$(\text{PBS_growth})^2$	Captures asymmetry — large surges impact vacancy more than small changes
Interaction with Rent Growth	$\text{PBS_growth} \times \text{Rent_growth}$	Captures tension between job growth and affordability
Composite Office Demand Pressure	$(\text{PBS_growth} \times (1 - \text{Vacancy_rate})) / \text{Supply_growth}$	Combines demand, occupancy, and supply dynamics into one measure



9. Model-Oriented Lag Features

Feature	Formula	Rationale
Lag_1_PBS_Employment	$\text{PBS_employment}_{(t-1)}$	Vacancy responds with 1-quarter delay
Lag_2_Growth	$(\text{PBS_growth}_{(t-2)})$	Captures slower reactions to hiring shifts
Cumulative Lag Index	$(0.6 * \text{growth}_{(t-1)}) + (0.4 * \text{growth}_{(t-2)})$	Weighted lag effect for smoother lead indicators



10. Forecast-Ready Meta Features

Feature	Idea	Why Analysts Use It
Employment Shock Magnitude	$\text{abs}(\text{PBS_growth} - \text{mean_growth_last_8q})$	Detects unusual acceleration or deceleration
Momentum Persistence	Autocorrelation of PBS_growth over last 8 quarters	Measures how persistent employment trends are
Vacancy Forecast Signal	Smoothed lead indicator built via exponential moving average	Used to forecast vacancy with lag of 1–2 quarters
Employment Inflection Indicator	1 if growth changes sign (from + to – or vice versa)	Marks turning points in demand cycle



Summary — What's New Here

Category	Focus
Economic tightness	Employment relative to vacant space
Cyclical structure	Phase, saturation, recovery dynamics
Labor-space conversion	Jobs translated into physical demand
Inter-sectoral linkages	Ties between PBS and other job sectors
Structural transformation	Long-term economic tilt toward office work
Behavioral shifts	Hybrid work and decoupling from physical space

Category	Focus
Income & productivity	Wealth-adjusted demand
Lag & momentum	Temporal alignment with vacancy cycle

Would you like me to **filter these** to the **10–12 most powerful and empirically validated features** (those with strongest explanatory power for vacancy rates, based on industry models)?
That shortlist would help you decide what to actually implement next.