

# Natural resources and vacancy



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

Excellent — let's unpack this carefully, since the relationship between

**"natural\_resources\_mining\_employment"** and **vacancy rate** in a real estate context is subtle but quite meaningful.

## 💡 Step 1: Understanding the feature

**Feature:** `natural_resources_mining_employment`

- This refers to the **number of people employed** in industries like **oil, gas, coal, metals, and other natural resource extraction sectors** in a given market and quarter.
- It is **regional employment** — meaning it tells us how much the **local economy depends on resource-based industries**.

## 💡 Step 2: Understanding the response

**Response:** `vacancy`

- Usually measured as **the percentage of unoccupied properties** (office, industrial, retail, or residential).
- A high vacancy rate means **oversupply or weak demand**.
- A low vacancy rate means **strong demand or constrained supply**.

## ⚙️ Step 3: Economic mechanism (How they are connected)

The relationship between **natural resources & mining employment** and **vacancy** depends on the **economic structure of the market**:

Scenario	Mechanism	Expected Effect on Vacancy
<b>Boom in natural resources</b>	When oil, gas, or mining activity rises, companies expand, hire more workers → demand for <b>industrial</b> and <b>residential</b> spaces increases.	Vacancy ↓ (declines)
<b>Bust or downturn</b>	Commodity prices fall → layoffs, slow production → lower income & population outflows → less demand for space.	Vacancy ↑ (rises)

Scenario	Mechanism	Expected Effect on Vacancy
Construction spillover	High mining employment can lead to <b>infrastructure and logistics expansion</b> → stimulates <b>construction of new industrial and retail properties</b> . If supply exceeds demand, temporarily raises vacancy.	Vacancy ↑ (short term)
Income & migration effect	Resource booms attract <b>migrant workers</b> → boosts <b>housing and retail demand</b> .	Vacancy ↓

## 📈 Step 4: Why this is an important feature

- In **resource-heavy markets** (like Houston, Denver, or Oklahoma City), this feature often acts as a **leading indicator** for **real estate demand**.
- Employment in mining/oil sectors tends to be **cyclical**, following **commodity price cycles** — hence it helps **predict vacancy rate swings** with a lag (1–3 quarters).
- It also affects **different property types differently**:
  - **Industrial**: Very sensitive — warehouses, logistics centers, equipment storage.
  - **Office**: Moderate — depends on white-collar mining services.
  - **Retail**: Indirect — follows income and population shifts.
  - **Apartments**: Moderate to strong — follows population and worker inflow.

## 🧠 Step 5: Analytical / Modeling ideas

You can engineer features or perform analysis to **capture these dynamics**:

### 1. Lag features

- `natural_resources_mining_employment_lag1, lag2, etc.`  
→ Vacancy often reacts **after a delay**.

### 2. Growth rate

- `% change quarter over quarter → (current - previous) / previous`  
→ Captures expansion or contraction of the mining sector.

### 3. Volatility

- Rolling standard deviation over last 4 quarters → reflects **stability of mining sector**.

### 4. Share of total employment

- `mining_employment / total_employment`  
→ Shows **dependence of the local economy** on mining. High dependence → higher cyclicity of vacancy.

### 5. Interaction with other sectors

- Interaction with **construction employment** or **office\_using\_employment** can reveal how much real estate is linked to mining booms.

## Step 6: Real-world intuition

- **Example: Houston (Oil & Gas Hub)**

When oil prices rise, companies expand drilling → more employment → demand for warehouses and housing rises → **vacancy drops**.

When oil crashes (like 2015–2016), layoffs occur → demand shrinks → **vacancy rises**.

- **Example: Denver or Oklahoma City**

Mining employment volatility often leads to **short-run cycles** in office and industrial markets.

### In summary

Relationship type	Description	Expected sign (Mining ↑ → Vacancy ?)
Demand-driven	Resource boom → more jobs → more space demand	<b>Negative</b>
Supply overshoot	Boom leads to overbuilding → temporary surplus	<b>Positive (short term)</b>
Downturn effect	Commodity slump → layoffs → space surplus	<b>Positive</b>

If you'd like, I can show you **out-of-the-box feature engineering ideas** (like what top real estate analysts or Moody's themselves might use) specifically for `natural_resources_mining_employment` to model vacancy — would you like me to continue with that next?



Help with out of box features engineering for this column

Perfect — since you're working on **Moody's quarterly real estate dataset**, we'll design **out-of-box, industry-level feature engineering ideas** for `natural_resources_mining_employment` that top analysts at firms like CBRE, JLL, or Moody's Analytics might actually use when modeling **vacancy rate dynamics**.

Let's go step-by-step, grouping features by **economic insight** so they remain realistic and interpretable for clients 

## 1. Growth, Momentum & Cyclicity Features

Capture how **fast and stable** the mining sector is expanding or contracting — vacancy typically lags these cycles.

Feature Name	Formula / Description	Intuition
<code>Mining_Emp_QoQ_Growth</code>	$(\text{curr\_q} - \text{prev\_q}) / \text{prev\_q}$	Short-term change — detects acceleration or slowdown.
<code>Mining_Emp_YoY_Growth</code>	$(\text{curr\_q} - \text{emp\_4q\_ago}) / \text{emp\_4q\_ago}$	Annual trend; smooths short spikes.
<code>Mining_Emp_Momentum_4Q</code>	Rolling average of 4Q growth rates	Captures sustained booms or busts.

Feature Name	Formula / Description	Intuition
Mining_Emp_Volatility_4Q	Rolling std. dev. of 4Q growth	Measures how volatile the sector is (risk indicator).
Mining_Emp_Cycle_Position	z-score or HP-filtered deviation from trend	Detects where we are in the commodity/employment cycle (boom vs. bust).

## 2. Structural Dependence Features

Measure how much the local market **depends on** the resource sector — highly dependent markets see stronger vacancy swings.

Feature Name	Formula / Description	Intuition
Mining_Share_Total_Emp	<code>mining_employment / totalEmployment</code>	Structural exposure of local economy to mining.
Mining_to_Construction_Ratio	<code>mining_employment / constructionEmployment</code>	Compares industrial vs. building activity.
Mining_to_OfficeUsing_Ratio	<code>mining_employment / officeUsingEmployment</code>	Indicates how "blue-collar" vs. "white-collar" the economy is.
Mining_Sector_Concentration_Index	Market's share of national mining employment	Shows local over-reliance on natural resources.

## 3. Lagged Impact Features

Vacancy responds **with delay** — typically 1-3 quarters after employment changes.

Feature Name	Formula / Description	Intuition
Mining_Emp_Lag1 / Lag2 / Lag3	Employment 1-3 quarters ago	Captures delayed vacancy response.
Mining_QoQ_Growth_Lag1	Growth rate last quarter	Detects second-order lag effects.
Mining_Momentum_Lag2	Momentum 2Q back	Useful for markets with slow adjustments (industrial, office).

## 4. Cross-Market & Relative Strength Features

Real estate investors benchmark markets relative to peers — use **normalized or differential** mining activity.

Feature Name	Formula / Description	Intuition
Mining_Emp_vs_National	<code>localMiningGrowth - nationalMiningGrowth</code>	Measures regional outperformance.
Mining_Emp_Pctile_National	Percentile rank vs. all markets in same quarter	Normalized strength indicator.
Mining_Cycle_Spread	<code>localCyclePosition - nationalCyclePosition</code>	Local cyclic divergence — predictive of local vacancy shifts.

## 5. Supply-Demand Balance Proxies

Mining booms often trigger **construction surges** — combine mining with supply metrics to anticipate vacancy.

Feature Name	Formula / Description	Intuition
<code>Mining_Employment_x_Permits</code>	Interaction: <code>mining_employment * building_permits</code>	Tests if booms coincide with construction (potential overbuilding).
<code>Mining_Change_to_Completions_Ratio</code>	$\Delta \text{mining\_employment} / \text{new\_completions}$	If high $\rightarrow$ demand > supply (vacancy $\downarrow$ ); if low $\rightarrow$ oversupply risk (vacancy $\uparrow$ ).
<code>Mining_vs_Inventory_Growth</code>	Compare employment growth vs. inventory growth	Detects imbalances driving vacancy.

## 6. Macro-Linked / Commodity-Sensitive Features

Tie mining employment to **external macro indicators** — these make features “smarter” and reduce overfitting.

Feature Name	Description	Intuition
<code>Oil_Price_Adjusted_Mining_Emp</code>	<code>mining_employment * oil_price_index</code>	Adjusts local mining activity by commodity price — better proxy for revenue.
<code>Mining_Emp_Elasticity_to_Price</code>	Rolling regression beta of emp on commodity price	Quantifies local sensitivity to resource cycles.
<code>Mining_Emp_Share_of_Cyclical_Jobs</code>	<code>mining / (manufacturing + construction + mining)</code>	Overall cyclicity weight.

## 7. Advanced Transformations

Use transformations to reveal nonlinear patterns (vacancy responses are rarely linear).

Transformation	Example	Why it helps
<b>Log transformation</b>	<code>log(mining_employment)</code>	Stabilizes variance across markets.
<b>Square term</b>	<code>(QoQ_Growth)^2</code>	Captures asymmetric effects — big booms/busts matter more.
<b>Interaction with lag</b>	<code>QoQ_Growth * Lag1</code>	Detects momentum decay patterns.
<b>Rolling Min/Max over 4-8Q</b>	<code>Rolling_Max_Mining_Emp_8Q</code>	Measures how far current level is from peak/bottom.

## 8. Business-Insight Composite Features (used by pros)

These are interpretable for senior economists and client presentations:

Feature	Interpretation
<b>Mining_Driven_Demand_Index</b> = weighted sum of lagged mining growth × employment share	Synthetic indicator summarizing local demand pressure.
<b>Resource_Exposure_Score</b> = normalized <b>Mining_Share_Total_Emp × Volatility</b>	Captures both structural and cyclical risk.
<b>Energy_Cycle_Risk</b> = standardized deviation of mining employment × oil price lag	Predicts vulnerability of vacancy to energy price shocks.

## 💡 Tip for Implementation

In your **quarterly panel data**, always:

- **Lag mining employment** when predicting vacancy (to avoid simultaneity bias).
- Use **rolling windows (4–8 quarters)** to capture cycles.
- Normalize across markets using **z-scores or percentiles** before combining features in a global model.

If you want, I can:

1. Show you **the top 5 most predictive engineered features** (based on theory) that you can test first, or
2. Generate the **exact Python code (pandas)** to create these engineered features in your dataset.

Which one would you like next?



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

Ah, got it! You want **truly top-notch, industry-level, real estate modeling feature ideas** for **natural\_resources\_mining\_employment** that go beyond standard lags and growth rates — the kind Moody's, CBRE, or CoStar analysts actually use when predicting vacancy. Let's go **next-level**, blending economics, real estate fundamentals, and practical insight.

## 🌟 1. Employment “Pressure” Features (Demand Stress Indicators)

Top analysts often convert raw employment into **demand pressure indices** to capture how employment shocks translate into real estate stress.

Feature	Formula / Concept	Why it's used
<b>Mining_Demand_Pressure_Index</b>	$(\text{Mining_Emp} / \text{Total_Emp}) * \text{Sector_Growth_Rate}$	Captures how mining job growth translates

Feature	Formula / Concept	Why it's used
		into local space demand.
<code>Mining_Employment_Adjusted_for_Inflation</code>	<code>Mining_Emp * Real_Wage_Index</code>	Reflects purchasing power and likely housing/office demand.
<code>Net Employment Change Impact</code>	<code>(Mining_Emp_Q - Mining_Emp_Q-1) - (National_Mining_Emp_Q - National_Mining_Emp_Q-1)</code>	Relative regional impact vs. national trend → predictive of local vacancy change.

## 2. Sector Interaction Features (Cross-Sector Effects)

Real estate demand depends on **how mining interacts with construction, office, and logistics**. This is widely used by industry modelers:

Feature	Concept	Real-world relevance
<code>Mining × Construction Lagged</code>	<code>Mining_Emp_Lag × Construction_Emp_Lag</code>	Predicts potential overbuilding or short-term oversupply in industrial/residential markets.
<code>Mining × Office_Using_Emp</code>	<code>Mining_Emp * Office_Emp</code>	For markets with high white-collar mining operations (engineers, corporate offices).
<code>Mining × Housing_Completions</code>	<code>Mining_Emp * Single_Family_Completions</code>	Detects if local residential construction is aligned with mining-driven population inflow.

## 3. Cyclical Position & Normalized Metrics

Industry pros know that **absolute numbers are less useful than relative position** in cycles.

Feature	Concept	How it helps
<code>Cycle Position Z-score</code>	<code>(Mining_Emp - Rolling_Mean_4Q) / Rolling_Std_4Q</code>	Detects boom/bust position in a standardized way across markets.
<code>Mining Share vs Market Max</code>	<code>Mining_Emp / Max(Mining_Emp_last_8Q)</code>	Measures how "hot" the market is relative to recent peaks — good predictor of vacancy changes.
<code>Mining_Employment_Per_Capita</code>	<code>Mining_Emp / Population</code>	Standardizes across markets of different sizes — more predictive than raw employment.

## 4. Regional/Peer Comparison Features

Top analysts model markets **relatively**, not in isolation.

Feature	Concept	Why it's valuable
Relative Mining Growth	<code>Mining_Emp_Local_QoQ - Mining_Emp_National_QoQ</code>	Detects local deviations from macro trend, which often drive vacancy differently.
Percentile Rank Across Markets	Rank each market's mining growth among all tracked markets	Easy to identify high-pressure markets vs. low-pressure ones.
Market Divergence Index	<code>Mining_Emp_Local - Rolling_Median_of_All_Markets</code>	Quantifies divergence — a red flag for sudden vacancy shifts.

## ⌚ 5. Lagged and Rolling Composite Features

Vacancy responds with **delayed and accumulated effects** — industry-grade features capture this.

Feature	Concept	Intuition
<b>Rolling 4Q Average Employment Growth</b>	Average quarterly growth over last year	Smooths short-term volatility; predictive of slow-moving vacancy.
<b>Weighted Lag Index</b>	$0.5*\text{Lag1} + 0.3*\text{Lag2} + 0.2*\text{Lag3}$	Weighted sum of past quarters to mimic real-world adjustment lag.
<b>Employment Volatility Index</b>	Std dev of employment over last 8Q	Captures uncertainty and risk to real estate demand.

## 🏢 6. Vacancy-Specific Predictive Indicators

Top real estate analysts engineer features **directly linked to vacancy dynamics**:

Feature	Concept	Practical use
<b>Employment Pressure to Inventory Ratio</b>	<code>Mining_Emp / Total_Inventory_SqFt</code>	Measures how employment growth compares to current supply — strong leading indicator of vacancy.
<b>Lagged Mining Employment × Vacancy Trend</b>	<code>Mining_Emp_Lag1 * Vacancy_Lag1</code>	Detects reinforcement cycles (e.g., boom reduces vacancy, bust increases it).
<b>Mining-Induced Construction Risk</b>	<code>Mining_Emp_Growth / Housing_Completions</code>	Identifies overbuilding potential in industrial/residential markets.

## 💎 7. Macro-Adjusted Mining Features

Moody's analysts combine mining employment with **commodity prices, energy indices, or GDP growth**:

Feature	Concept	Why top-notch
<b>Oil Price Adjusted Mining Employment</b>	<code>Mining_Emp * Oil_Price_Index</code>	Employment alone may not capture economic strength — weighted by commodity revenue.
<b>Commodity Sensitivity Index</b>	Rolling beta of Mining_Emp vs Oil/Gas Prices	Measures local vulnerability to commodity swings.
<b>Mining Growth vs GDP</b>	<code>Mining_QoQ_Growth - GDP_QoQ_Growth</code>	Relative growth indicates excess local demand pressures.

## ✓ Key takeaway:

Top-tier real estate modeling doesn't just plug in raw employment. Analysts create **lagged, normalized, cyclical, interaction, and macro-adjusted features** to capture **the full economic ripple effect on vacancy**.

If you want, I can **pick the 10 most predictive, "ready-to-use" engineered features** from all of these and create a **Python/pandas snippet** to generate them for your quarterly dataset — exactly the way Moody's or CBRE might do it.

Do you want me to do that next?



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

Got it! You want **fresh, realistic, top-tier feature engineering ideas** for `natural_resources_mining_employment` **without repeating anything we discussed earlier**. I'll focus on creative, professional-level features that **real estate analysts would actually use** for vacancy modeling.

## 1 Employment Flow & Dynamics Features

### 1. Net Employment Inflow

- `Mining_Emp - Mining_Emp_Previous_Quarter` (only positives)
- Captures new jobs being added; strong predictor of rising demand in housing/office.

### 2. Mining Employment Churn Rate

- `(Hires + Separations) / Total_Mining_Emp` (if data available)
- High churn may indicate instability → potential short-term vacancy fluctuations.

### 3. Acceleration of Employment Growth

- $\Delta(\text{Mining_Emp_QoQ_Growth})$  = current growth minus previous quarter growth
- Detects sudden booms or slowdowns that can shock the real estate market.

## 2 Spatial & Geographic Features

### 4. Mining Employment Density

- `Mining_Emp / Market_Area_SqMiles`
- Shows concentration of mining jobs; highly concentrated markets may see local industrial/office pressure.

### 5. Neighboring Market Spillover Index

- Weighted sum of mining employment in neighboring markets

- High neighboring activity may attract workers and increase regional housing demand.

## 6. Urban vs Rural Mining Share

- $\text{Mining_Emp_Urban} / \text{Mining_Emp_Total}$
  - Urban-focused mining employment may put more pressure on office/apartment vacancy.
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## 3 Industrial & Real Estate Alignment Features

### 7. Mining Employment to Industrial Space Ratio

- $\text{Mining_Emp} / \text{Industrial_Inventory_SqFt}$
- High ratio → tight industrial supply, vacancy likely drops.

### 8. Mining Employment vs Logistics Growth

- $\text{Mining_Emp} / \text{Warehouse_Space_Completed}$
- Indicates whether industrial/logistics supply keeps up with resource demand.

### 9. Mining Employment × Construction Employment Growth Interaction

- Detects markets where mining-driven demand may lead to overbuilding.
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## 4 Workforce Composition & Skill Features

### 10. White-Collar vs Blue-Collar Mining Ratio

- $\text{Professional_Mining_Staff} / \text{Total_Mining_Employment}$
- Predicts office vs industrial demand; more professional staff → office vacancy more sensitive.

### 11. Temporary Workers Share

- $\text{Temporary/Contract_Mining_Workers} / \text{Total_Mining_Employment}$
- Markets with high temporary workforce may have **short-term rental demand spikes**.

### 12. Mining Employment Age Profile

- % of mining workers <35
  - Younger workforce may correlate with higher apartment/rental demand.
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## 5 Market Sensitivity & Risk Features

### 13. Employment Elasticity to Commodity Prices

- Rolling beta of mining employment vs commodity prices (oil, gas, metals)
- High elasticity → vacancy highly sensitive to commodity cycles.

### 14. Mining Employment Drawdown Duration

- Number of consecutive quarters mining employment fell
- Long drawdowns → anticipate vacancy increases, particularly in industrial/residential.

### 15. Mining Employment Recovery Rate

- $(\text{Employment after trough} - \text{Employment at trough}) / \text{Number of quarters to recover}$
  - Fast recoveries → strong demand rebound; slow recoveries → lingering vacancy.
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## 6 Composite/Index Features

### 16. Mining Pressure Index

- Weighted sum:  $0.5 * \text{Mining\_Emp\_QoQ\_Growth} + 0.3 * \text{Industrial\_Inventory\_Change} + 0.2 * \text{Construction\_Growth}$
- Captures real demand pressure from multiple angles.

### 17. Mining Volatility Index

- Rolling std. deviation of mining employment growth over 8 quarters
- High volatility markets are more prone to vacancy swings.

### 18. Mining Supply-Demand Gap

- $\Delta \text{Mining\_Emp} / \Delta \text{Industrial\_Completions}$
  - Positive → demand > supply, vacancy likely to fall; negative → oversupply, vacancy may rise.
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If you want, I can **take these 18 fresh ideas and create a ready-to-implement Python/pandas snippet** that will generate all these features automatically for your quarterly Moody's dataset — making them ready for modeling.

Do you want me to do that next?