

Out of box feature engineering



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

Got it! Let's carefully break this down for `construction_cost_index` and its relationship with `vacancy` in a real estate context, especially for quarterly market-level data like Moody's dataset.

1 What is `construction_cost_index` (CCI)?

- The **Construction Cost Index (CCI)** measures the **relative cost of construction** over time.
- It usually combines **materials, labor, and equipment costs** required to construct new buildings.
- A higher CCI → construction is more expensive; a lower CCI → construction is cheaper.
- Since your dataset is **quarterly**, the index likely **changes every quarter** reflecting cost trends.

Important: The CCI doesn't tell you about the number of buildings being constructed directly — it's about **cost per unit of construction**, not the volume.

2 How does `construction_cost_index` impact vacancy?

Vacancy refers to the **percentage of unoccupied real estate space** in a market.

The connection is nuanced:

Concept	Mechanism	Effect
High CCI	Construction becomes more expensive	Developers may delay or reduce new construction , limiting supply
Reduced Supply	Fewer units enter the market	Vacancy may fall if demand remains stable
Low CCI	Construction is cheaper	More projects start

Additional notes:

- The effect is **lagged**. A spike in CCI today might **affect vacancy 2-4 quarters later**, because construction takes time.
- The relationship is **nonlinear**. Extremely high CCI may deter construction entirely, while moderate changes may have minimal effect.
- Market type matters. For example:
 - **Multifamily apartments:** sensitive to material/labor cost increases.

- **Industrial warehouses:** may be more sensitive to demand trends than construction costs alone.

3 Feature engineering ideas for construction_cost_index in quarterly real estate data

To make the feature more predictive of **vacancy**, consider creating:

1. Quarterly change

```
ini
CCI_change = CCI_current_quarter - CCI_previous_quarter
```

→ Captures **momentum in construction costs**, which can signal upcoming supply constraints.

2. Rolling averages / trends

```
ini
CCI_4q_avg = average(CCI_last_4_quarters)
```

→ Smooths out volatility and captures **trend over a year**, which is often more predictive than a single quarter.

3. Lagged features

```
ini
CCI_lag2 = CCI from 2 quarters ago
```

→ Realistic because construction delays mean vacancy responds **after a few quarters**.

4. Cost-adjusted construction activity

```
nginx
construction_units / CCI
```

→ Normalizes construction volume by cost to understand **effective supply** entering the market.

5. Relative CCI vs. historical baseline

```
ini
CCI_diff = CCI_current - CCI_mean_last_8q
```

→ Captures whether construction is unusually expensive, which can deter projects.

4 Real-world intuition

- In booming markets (high demand), even high CCI may **not stop construction** entirely, so vacancy might not change much.
- In slow markets, small rises in CCI can **significantly delay projects**, reducing supply, and lowering vacancy.
- This means **CCI-vacancy relationship can differ across markets**, which is important for Moody's multi-market dataset.

✓ Key takeaway:

`construction_cost_index` affects vacancy mainly **through its impact on future supply**, with **lags and market-specific sensitivity**. It's most useful when combined with **construction volume, trend features, and lagged values**.

If you want, I can **draw a quick schematic showing how CCI flows into vacancy over time with lags**, which makes it much easier to visualize for your model.

Do you want me to do that?



Help with out of box features engineering for this column.

Perfect! Let's go **beyond the usual lagged/trend features** for `construction_cost_index` and create some **"out-of-the-box" real estate industry features** that are realistic and predictive of **vacancy**. I'll focus on things that top analysts and modelers actually use in Moody's-type datasets.

1 Market Sensitivity Features

Idea: CCI impact on vacancy isn't uniform across markets. Capture **relative cost pressure** for each market.

- **CCI premium vs market average**

```
ini
```

```
CCI_premium = CCI_current_quarter / CCI_market_mean_last_8q
```

→ Shows if the market is **expensive compared to its own history**, not just absolute cost.

- **CCI deviation vs regional peers**

```
ini
```

```
CCI_vs_region = CCI_current_quarter / CCI_region_avg_last_4q
```

→ Highlights **competitive disadvantage or cost advantage** across neighboring markets.

- **CCI volatility**

```
ini
```

```
CCI_vol_4q = std_dev(CCI_last_4q)
```

→ High volatility may signal **uncertain construction costs**, which can delay projects and affect vacancy.

2 Supply-Demand Interaction Features

Idea: Combine CCI with **construction activity** to model effective supply.

- **Cost-adjusted new construction**

```
nginx
```

```
construction_units / CCI
```

→ Measures how much construction “value” enters the market, normalized by cost.

- **CCI × construction growth interaction**

```
nginx
```

```
CCI_current_quarter * growth_rate_construction_last_2q
```

→ Captures **stress on vacancy from both high costs and construction momentum**.

3 Trend / Inflection Features

Idea: Capture **turning points** rather than raw values.

- **CCI acceleration**

```
ini
```

```
CCI_accel = (CCI_current - CCI_lag1) - (CCI_lag1 - CCI_lag2)
```

→ Identifies **sharp changes in construction costs**, which often predict sudden supply delays.

- **CCI momentum index**

```
ini
```

```
CCI_momentum = sum(sign(CCI_diff) for last 3 quarters)
```

→ Indicates whether costs are consistently rising/falling, rather than just the numeric value.

4 Cross-Sector / Macro Interaction Features

Idea: Real estate is sensitive to the broader **construction/industrial economy**.

- **CCI × manufacturing_employment**
→ High costs + high industrial demand can signal **higher construction pressure**, affecting vacancy.
- **CCI / interest_rate_index**
→ Captures how expensive construction is relative to **borrowing costs**, which affects project feasibility.
- **CCI × material price index** (steel, lumber, concrete)
→ Highlights whether **local material costs** are driving CCI, rather than labor.

5 Nonlinear / Bucketed Features

Idea: Vacancy response may be nonlinear.

- **CCI buckets:** low / medium / high (based on quartiles)
- **CCI spike flags:** boolean feature if

```
yaml

CCI_current > CCI_4q_avg + 2*CCI_std_4q
```

→ Captures extreme events that often halt construction.

- **CCI trend reversal flag**
→ 1 if cost was rising last 2 quarters but dropped this quarter → could trigger **late construction starts**, affecting vacancy.

6 Temporal/Quarterly Seasonality Features

- **CCI seasonal index:**

```
nginx

CCI_current / avg_CCI_same_quarter_last_5y
```

→ Adjusts for regular seasonal patterns in construction costs.

- **Quarter-over-quarter ratio:**

```
ini

CCI_qoq_ratio = CCI_current / CCI_last_quarter
```

→ Highlights abrupt cost changes, often leading to **delayed project completion**.

If you want, I can **create a full feature table with 15-20 out-of-the-box CCI features**, ready to plug directly into your vacancy model, including formulas and lags.

Do you want me to do that?



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

Ah! You want **high-end, industry-standard “top-notch” feature engineering** for **construction_cost_index** like the real estate analytics teams at Moody’s, CBRE, or CoStar would actually use for predicting vacancy. Let’s go beyond simple lags and trends, focusing on **sophisticated, realistic features** that reflect **market dynamics, construction economics, and demand-supply interactions**.

1 Market Relative Pressure Features

Top analysts rarely use raw CCI—they contextualize it relative to market, region, or property type.

1. CCI vs historical baseline

```
ini

CCI_rel_baseline = CCI_current / rolling_mean(CCI_last_8q)
```

- Captures whether current construction costs are unusually high/low compared to the market’s own history.
- Helps predict developer hesitation, which can influence vacancy 1–3 quarters ahead.

2. CCI gap vs peer markets

```
ini

CCI_gap_region = CCI_current - avg(CCI_peers_last_4q)
```

- Highlights cost competitiveness across neighboring markets.
- Used to anticipate **capital flow shifts** or **construction delays**.

3. CCI volatility index

```
ini

CCI_vol_4q = std_dev(CCI_last_4q)
```

- High volatility often signals uncertainty → delays in new construction → potential impact on vacancy.

2 Lagged and Lag-Weighted Features

Vacancy responds with **delays**, not instantly.

1. Lagged CCI

```
CCI_lag1, CCI_lag2, CCI_lag4
```

- Industry practice: model multiple lags simultaneously to capture delayed supply effects.

2. Weighted rolling CCI

```
ini
```

```
CCI_weighted = 0.6*CCI_lag1 + 0.3*CCI_lag2 + 0.1*CCI_lag3
```

- Emphasizes more recent costs, reflecting how developers prioritize current construction prices.

3 CCI × Construction Activity Interactions

Vacancy is affected by **how much construction is actually happening relative to cost**.

1. Cost-adjusted supply

```
nginx
```

```
construction_units / CCI
```

- Measures “effective construction volume” entering the market.

2. CCI × construction growth

```
scss
```

```
CCI_current * (construction_units_growth_last_2q)
```

- Captures **market stress from high costs + rapid construction**.

4 Nonlinear / Extreme Event Features

Top models capture **nonlinearities** instead of assuming linear relationships.

1. CCI spike flag

```
scss
```

```
1 if CCI_current > rolling_mean(CCI_last_4q) + 2*std_dev(CCI_last_4q) else 0
```

- Captures extreme cost increases that could **halt or slow construction**.

2. CCI percentile rank

```
ini

CCI_pct_rank = percentile_rank(CCI_current, last_20_quarters)
```

- Helps quantify whether the cost is unusually high/low relative to history.

3. CCI acceleration

```
ini

CCI_accel = (CCI_current - CCI_lag1) - (CCI_lag1 - CCI_lag2)
```

- Detects **sharp trend changes** in construction cost, often predicting sudden changes in vacancy.

5 Macro and Sector Interaction Features

Real estate doesn't exist in isolation—construction costs interact with **macro and sector trends**.

1. CCI × interest rate

```
nginx

CCI / borrowing_cost_index
```

- Expensive construction + high borrowing costs → potential slowdown → lower vacancy growth.

2. CCI × employment in construction-related sectors

```
nginx

CCI * construction_employment
```

- Indicates **supply-side constraints** due to labor pressure.

3. CCI × commodity/material indices

```
nginx

CCI * lumber_index / steel_index
```

- Captures local material-driven construction stress.

6 Seasonal / Quarterly Adjusted Features

Seasonality is huge in construction:

1. CCI seasonal factor

```
nginx

CCI_current / avg_CCI_same_quarter_last_5y
```


- Adjusts for recurring seasonal fluctuations.

2. Quarter-over-quarter ratio

ini

```
CCI_qoq = CCI_current / CCI_lag1
```

- Detects abrupt cost jumps relative to the previous quarter.

✓ Industry Takeaways

- Top real estate models rarely use raw CCI directly—they **contextualize it across time, peers, supply, macro factors, and nonlinear thresholds**.
- They also incorporate **lags, volatility, and interaction effects**, since vacancy responds **with delays** and **nonlinear behavior**.

If you want, I can **prepare a full list of 20+ cutting-edge features** for `construction_cost_index`—all formulas, lags, and interactions included—ready to feed into your Moody’s real estate vacancy model.

Do you want me to do that?



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

Got it! Let's explore **completely fresh, realistic, and “out-of-the-box” feature engineering ideas** for `construction_cost_index` (CCI) that don't reuse any of the previous lag, trend, interaction, or volatility features we discussed. I'll focus on **what top real estate analysts would realistically consider**.

1 Market Pressure & Relative Cost Dynamics

1. CCI inflation-adjusted deviation

ini

```
CCI_inflation_adj = CCI_current - CPI_current_quarter
```

- Measures construction costs relative to general inflation. High values → construction is unusually expensive → potential supply slowdowns.

2. CCI premium vs historical high

ini

```
CCI_vs_peak = (CCI_current - max(CCI_last_8q)) / max(CCI_last_8q)
```

- Captures **how close costs are to all-time highs**, which can influence vacancy by deterring new projects.

3. CCI gap vs market capacity

ini

$CCI_gap_capacity = CCI_current / max_possible_CCI_in_market$

- Useful when certain markets have structural cost ceilings (e.g., labor scarcity).

2 Construction Feasibility Features

4. CCI-to-project-value ratio

ini

$CCI_per_unit_value = CCI_current / avg_project_value_last_4q$

- High ratio → projects may become economically unfeasible → delays → affects vacancy.

5. CCI elasticity indicator

ini

$CCI_elasticity = \% \text{ change in construction_units} / \% \text{ change in CCI}$

- Measures how sensitive developers are to cost changes. High elasticity → vacancy likely impacted more.

6. CCI cost-pressure index

ini

$cost_pressure = CCI_current / avg_wages_construction_sector$

- Combines material + labor pressures, reflecting **true economic burden** on developers.

3 Timing & Project Cycle Features

7. Lead-time adjusted CCI

ini

$CCI_projected = CCI_current * expected_construction_duration_quarters$

- Accounts for how current costs affect projects still under construction.

8. CCI relative to approved permits

```
ini
```

```
CCI_per_permit = CCI_current / construction_permits_last_4q
```

- Signals whether upcoming supply is **cost-constrained**, influencing future vacancy.

9. CCI season-adjusted slope

```
ini
```

```
CCI_slope_season = (CCI_current - avg_CCI_same_quarter_last_5y) / number_of_quarters
```

- Detects **quarterly cost acceleration**, not just trend, accounting for seasonality.

4 Market Sentiment & Investor Pressure Features

10. CCI vs funding index

```
ini
```

```
CCI_funding_ratio = CCI_current / construction_funding_index
```

- Captures whether construction costs are high relative to available financing.

11. CCI risk-adjusted cost

```
ini
```

```
CCI_risk_adjusted = CCI_current * (1 + regional_market_volatility)
```

- Adjusts construction cost by **market uncertainty**, common in Moody's forecasting.

12. CCI stress index

```
ini
```

```
CCI_stress = CCI_current / avg_vacancy_last_4q
```

- High cost + already high vacancy → indicates potential **supply slowdown or project cancellations**.

5 Cross-Market & Property Type Features

13. CCI dispersion index

```
ini
```

```
CCI_dispersion = std_dev(CCI_across_property_types_in_market)
```

- Captures cost imbalance between apartments, office, retail, and industrial; uneven costs affect vacancy dynamics differently.

14. CCI correlation with rental rates

```
ini

CCI_rent_corr = corr(CCI_last_8q, rental_rate_last_8q)
```

- High correlation → market may **pass costs to rents**, impacting leasing behavior and vacancy indirectly.

15. CCI affordability ratio

```
ini

CCI_affordability = CCI_current / median_income_local
```

- Especially relevant for multifamily markets; high cost relative to local income can **slow new project absorption**.

✓ Why these are realistic

- All features are grounded in **developer decision-making and market economics**, not just raw statistics.
- They consider **cost feasibility, project lead time, market risk, property type differences, and investor pressures**.
- These are exactly the kind of engineered features Moody's or CBRE analysts would use for vacancy modeling.

If you want, I can **compile a full ready-to-use feature table with 20–25 of these new CCI features**, complete with formulas and descriptive names, ready to plug into your vacancy model.

Do you want me to do that?