

# DPI and vacancy relationship



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 Disposable\_Personal\_Income and response vacancy. Help me understand how it works

Excellent — let's break this down clearly and deeply so you can understand **how Disposable Personal Income (DPI)** interacts with **vacancy** in a **real estate context**, especially when working with a quarterly dataset like Moody's.

## 🧩 Step 1: What is Disposable Personal Income (DPI)?

### Definition:

Disposable Personal Income = Personal Income – Taxes

It represents the **amount of money households have left to spend or save** after paying direct taxes. So it reflects **purchasing power** at the consumer level.

In simpler terms — it's the “real money in people's pockets” available for **consumption, savings, or investment**.

## 🏠 Step 2: Why DPI matters in real estate

In real estate, DPI affects **demand for property** — both **residential** and **commercial** — because higher disposable income enables:

- More **spending on housing**, rent, or property ownership
- Higher **consumer spending**, which strengthens **retail and office demand**
- Increased **confidence** in the market (lower vacancy, higher absorption)
- In the opposite direction, lower DPI → **reduced affordability** and **higher vacancy**

## 📈 Step 3: Conceptual relationship with vacancy

Let's think of vacancy as a **supply-demand outcome**:

Scenario	DPI Trend	Expected Demand	Vacancy Effect
● DPI rising	People earn more → more spending → stronger tenant demand	↓ Vacancy	
● DPI falling	People earn less → spending cutbacks → weaker tenant demand	↑ Vacancy	

Scenario	DPI Trend	Expected Demand	Vacancy Effect
● DPI stable but prices rising	Incomes lag cost of living → affordability worsens	↑ Vacancy (especially residential)	

However, the **strength and direction** of the relationship can vary by property type and market:

#### a. Residential (Apartments, Single-Family)

- Higher DPI → More buying power → Some renters buy homes → mixed effect (short-term vacancy up, long-term stable)
- Lower DPI → More renters → vacancy drops (counterintuitive short-term effect)

#### b. Retail

- Strong DPI → More consumer spending → retailers expand → lower vacancy
- Weak DPI → Retail contraction → higher vacancy

#### c. Office / Industrial

- Indirect link — higher DPI → stronger economy → business growth → more office/industrial space demand → lower vacancy

### Step 4: How to analyze DPI-Vacancy relationship in your quarterly Moody's data

Let's talk analytics:

#### 1 Lag effects

Real estate responses lag income changes.

Try **lagged features**:

- **DPI\_lag\_1** (previous quarter)
- **DPI\_lag\_2** (two quarters ago)
- Moving averages (to smooth short-term volatility)

These lags can reveal **causal timing** — income increases might take 1–2 quarters to affect vacancy.

#### 2 Growth rates

Work with *rate of change* rather than absolute values:

```
python

DPI_Growth = (DPI_t - DPI_t-1) / DPI_t-1
```

This shows whether income acceleration/deceleration aligns with changes in vacancy.

#### 3 Real (Inflation-adjusted) DPI

If CPI data is available, use **Real Disposable Personal Income** =  $\text{DPI} / \text{CPI}$ .  
That shows **true purchasing power** trends rather than nominal ones.

#### 4 Normalization

Compare DPI per capita or per household for fair comparison across markets:

```
python

DPI_per_capita = DPI / Population
```

#### 5 Interaction features

Income interacts with affordability and market pricing:

- $\text{DPI\_to\_Rent\_Ratio} = \text{DPI} / \text{Average\_Rent}$
  - $\text{DPI\_to\_Housing\_Price\_Ratio} = \text{DPI} / \text{Median\_Home\_Price}$
- These show **affordability pressure**, which directly impacts occupancy.

### Step 5: Interpretation in your model context

If your model shows:

- **Negative coefficient (DPI  $\uparrow$   $\rightarrow$  Vacancy  $\downarrow$ ):** healthy demand signal — typical of expanding markets
- **Positive coefficient (DPI  $\uparrow$   $\rightarrow$  Vacancy  $\uparrow$ ):** might indicate displacement (e.g., renters moving to ownership, or supply overshooting)
- **Weak relationship:** suggests income changes don't fully drive vacancy — possibly dominated by supply or construction trends

### Step 6: Out-of-the-box ideas (industry-level insights)

To reach “top real estate analysis” level:

- Examine **income elasticity of demand** for each market and property type
- Compute **DPI momentum indicators** (rolling % change trends)
- Compare **DPI growth vs vacancy growth correlations** quarterly
- Build **market cluster profiles** (e.g., “high-DPI-high-demand” vs “low-DPI-stable”)
- Combine DPI with **Consumer Confidence Index** for behavioral interpretation

Would you like me to show you **advanced feature engineering ideas** for `Disposable_Personal_Income` (like interaction ratios, elasticities, and lag transformations) just like we did with other features?  
That would take your model a step deeper into how real estate pros interpret DPI's impact.



Help with out of box features engineering for this column.

Perfect 👍 — since you're working on **Moody's quarterly real estate dataset** and analyzing how **Disposable\_Personal\_Income (DPI)** relates to **vacancy**, let's go *beyond the basics* and explore **industry-grade, out-of-the-box feature engineering ideas** used by leading firms like CBRE, Moody's Analytics, or JLL.

We'll structure this into five tiers — from intuitive transformations to advanced economic indicators — each designed to extract *economic signals* that might affect **vacancy dynamics**.

## 1 Foundational Transformations (baseline signals)

These capture direct income growth and volatility.

Feature Name	Formula / Description	Economic Meaning
DPI_QoQ_Growth	$(DPI_t - DPI_{t-1}) / DPI_{t-1}$	Short-term income growth, linked to near-term spending
DPI_YoY_Growth	$(DPI_t - DPI_{t-4}) / DPI_{t-4}$	Annualized income growth; better for smoothing
DPI_MA_4Q	4-quarter rolling mean	Income trend stability
DPI_Volatility_4Q	Std deviation of last 4 quarters	Measures income uncertainty; high volatility → demand instability
DPI_Lag1, DPI_Lag2	Previous quarters' DPI	Captures lagged demand effects (real estate reacts slowly)

## 2 Affordability & Purchasing Power Features

These integrate DPI with **cost-side variables** to measure true consumer strength.

Feature Name	Formula / Description	Why It's Valuable
Real_DPI	$DPI / CPI$	Adjust for inflation to see <i>real</i> purchasing power
DPI_per_Capita	$DPI / Population$	Makes cross-market comparisons fair
DPI_to_Rent_Ratio	$DPI / Avg\_Rent$	Measures how easily renters can afford housing
DPI_to_Price_Ratio	$DPI / Median\_Property\_Price$	Indicates housing affordability
DPI_to_Vacancy_Ratio	$DPI / Vacancy\_Rate$	Shows how much income supports occupancy strength
Disposable_Savings_Rate	$(DPI - Consumption\_Expenditure) / DPI$	High rate → potential future demand (people can spend later)

## 3 Momentum, Elasticity & Sensitivity Features

These capture *behavioral and dynamic effects* rather than static income levels.

Feature Name	Description	Insight
DPI_Momentum_Trend	Rolling average of <b>DPI_QoQ_Growth</b>	Indicates acceleration or slowdown in income
Income_Vacancy_Elasticity	$\Delta \text{Vacancy}\% / \Delta \text{DPI}\%$	Measures how sensitive vacancy is to income changes
DPI_Shock_Index	Z-score of quarterly DPI changes	Detects income shocks → predict sudden vacancy jumps
DPI_Acceleration	$\text{DPI\_Growth}_t - \text{DPI\_Growth}_{t-1}$	Income growth acceleration or deceleration
DPI_Trend_Deviation	Current DPI – long-term moving average	Deviation from long-term income equilibrium



## 4 Cross-Market & Relative Position Features

If you have multiple markets (e.g., Atlanta, Austin, New York), create **relative or comparative income measures**.

Feature	Description	Why it's useful
DPI_vs_National_Avg	$(\text{Market\_DPI} - \text{National\_DPI}) / \text{National\_DPI}$	Measures local income strength vs national trend
DPI_Rank_Percentile	Percentile rank among markets in that quarter	Helps explain which markets lead/lag income trends
DPI_Gap_to_Top_Market	Difference between market DPI and max DPI	Proxy for competitiveness / migration potential
Regional_DPI_Disparity	Std deviation of DPI across neighboring markets	Identifies regional income inequality → housing shifts



## 5 Economic Interaction Features (advanced, “institutional-grade”)

Combine DPI with **macroeconomic or behavioral drivers** for richer context:

Feature	Formula / Concept	What it captures
DPI_x_Employment	$\text{DPI} * \text{Employment\_Rate}$	Joint signal of income + job stability
DPI_x_Confidence_Index	$\text{DPI} * \text{Consumer\_Confidence}$	Spending willingness
DPI_x_Housing_Starts	$\text{DPI} * \text{Housing\_Starts}$	Income-driven housing demand
DPI_to_InterestRate_Ratio	$\text{DPI} / \text{Ten\_Year\_Treasury\_Rate}$	Captures affordability relative to borrowing cost
DPI_RealEstate_Demand_Potential	$\text{DPI\_per\_Capita} * \text{Population\_Growth}$	Proxy for potential space absorption
DPI_Distress_Index	$1 / (\text{DPI} * \text{Employment\_Rate})$	Signals market stress (high → riskier vacancy outlook)



## 6 Bonus: Temporal Decomposition Features

Use time-series decomposition on DPI (trend, seasonal, residual):

- **DPI\_Trend\_Component** → long-term structural income path
- **DPI\_Seasonal\_Component** → cyclical income effects
- **DPI\_Residual\_Shock** → unexpected deviation → may precede vacancy shifts

## How to use them effectively

1. Test both **level** and **growth-based** features.
2. Use **lagged** versions (1Q–4Q) to capture delayed real estate responses.
3. Normalize income-related ratios by **median rent, home price, or GDP** to control for scale differences.
4. Check **correlation stability** over time — if relationship flips, segment analysis by market or property type.

Would you like me to generate a **Python-ready feature engineering template** (with formulas + code snippets for lags, growth rates, interactions, etc.) for **Disposable\_Personal\_Income**?  
It'll be tailored for quarterly panel data (multiple markets × time).