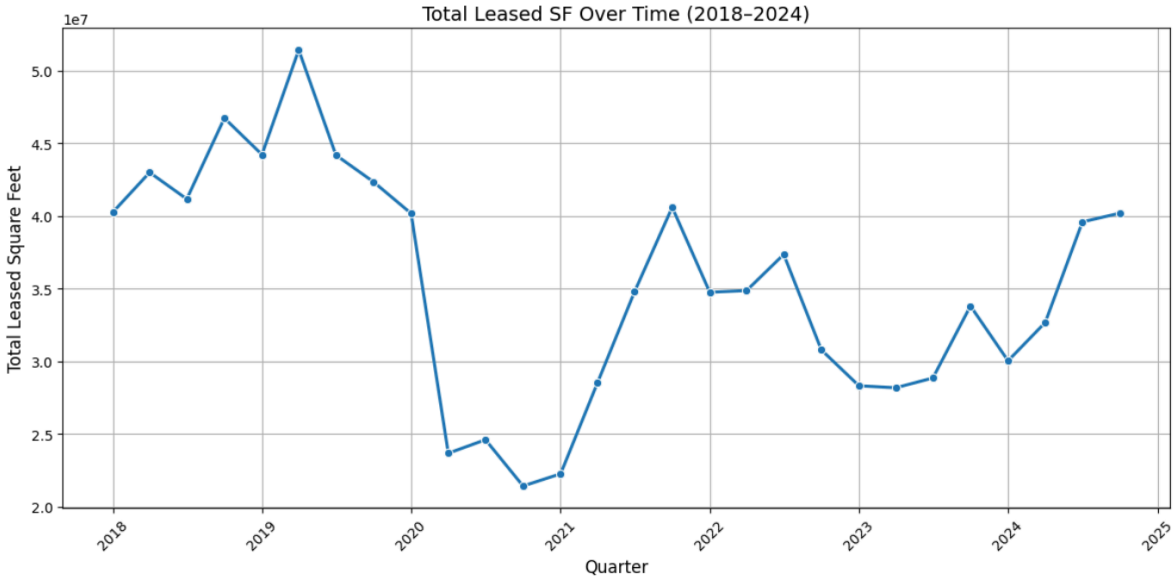
Part1:

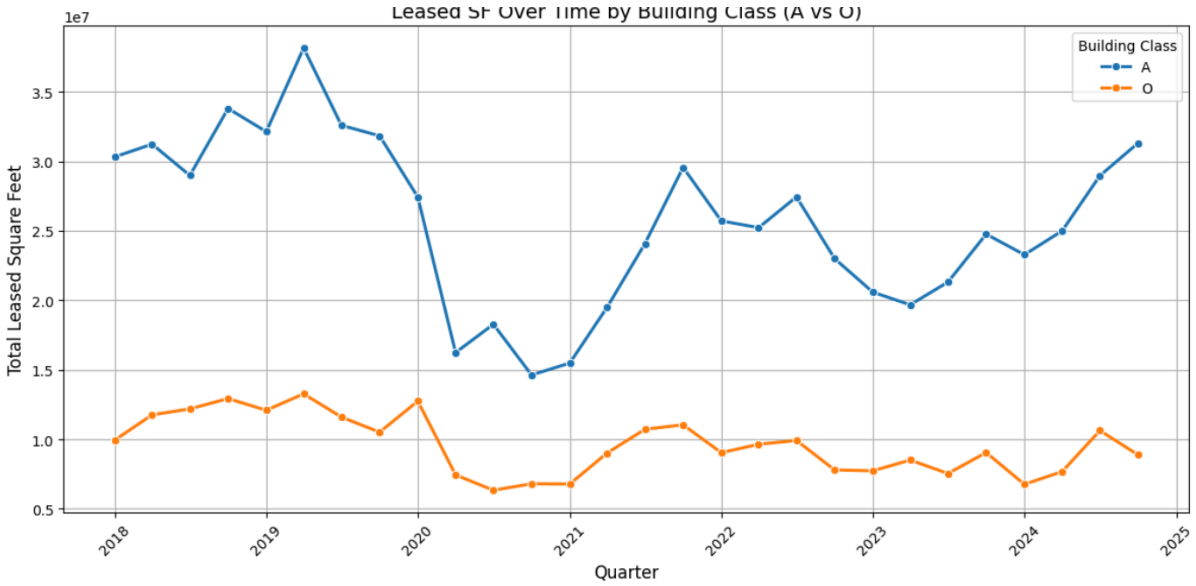


A clear **drop in leasing volume during 2020** (COVID onset)

A **rebound starting in 2021**, peaking mid-2022

A **second dip** in late 2022/early 2023

A **strong resurgence in 2024**



Class A Buildings:

- **Dominated leasing volume** throughout the period.

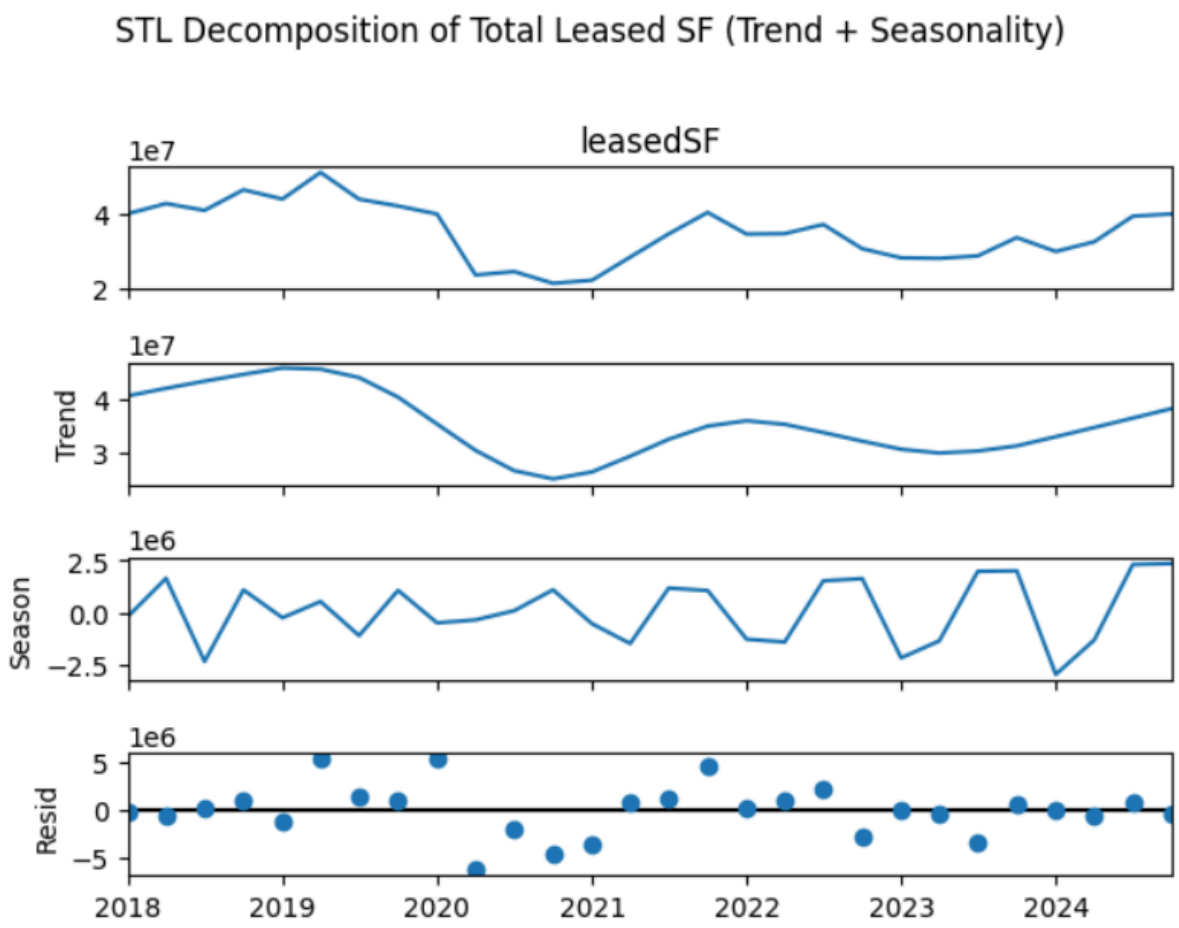
- Experienced a sharp **drop in 2020** (COVID onset).
- Rebounded **strongly from 2021 onward**, approaching pre-COVID levels by 2024.
- This rebound is particularly visible **after Q1 2023**, showing a likely "return to premium."

📉 Class O Buildings:

- Leasing was always **lower and more stable**, but:
- Also dropped in 2020 (though less steep).
- **Did not rebound as strongly** — may suggest that companies prioritized quality over quantity during recovery.
- **Flight to quality** after COVID: premium office space demand **came back stronger**.
- May suggest confidence in long-term in-person/hybrid work among larger firms.
- Class O demand remained **steady but secondary** — cost-conscious but not growing.

Statistical Analysis:
A Kruskal-Wallis test showed a significant difference in leasing volume across periods ($H = 55.750$, $p < 0.00001$), confirming that the COVID-19 pandemic had a statistically disruptive effect on commercial real estate leasing."

A vs O
A Kruskal-Wallis test confirmed significant leasing behavior shifts across COVID periods for both premium (Class A) and ordinary (Class O) office spaces ($p < 0.00001$).
This statistically validates the visible leasing dip in 2020–2021 and the rebound starting in 2022–2024.



Interpretation of Each Panel

1. Original Series (Top Panel: `leasedSF`)

- Reflects the total leased square footage per quarter (what you plotted earlier).
- You can clearly see the **sharp COVID drop in 2020–2021**, followed by a rebound.

---

2. Trend (2nd Panel)

- Smoothed out trajectory of leasing activity over time.
- Shows a **clear U-shaped dip**:

- Peak around **2019**
- **Low point in mid-2021**
- **Steady recovery through 2024**

✅ This validates your main narrative: leasing slowed significantly during COVID and has since recovered.

---

3. Seasonality (3rd Panel)

- Shows **quarterly fluctuations** in leasing behavior.
- There's a **cyclical up-and-down pattern**, especially from 2021 onward:
  - Suggests that some quarters (like Q1 or Q4) might regularly be lower or higher.
  - Could be linked to **corporate fiscal cycles, move-in dates, or market patterns**.

This gives you a neat **"cyclical leasing behavior"** angle to mention.

---

4. Residual (Bottom Panel)

- What's left over after removing trend + seasonality.
- Mostly centered around zero → model fits well.
- A few moderate residual spikes, likely due to **outlier lease quarters or data noise**.

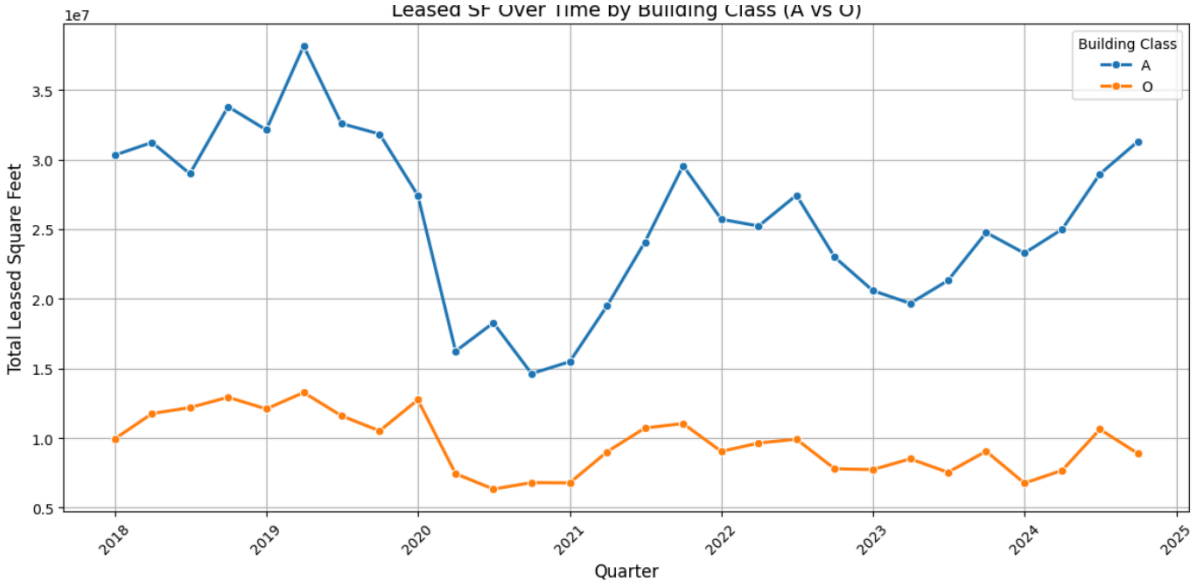
🎯 How to Use This in Slides or Report

> "STL decomposition of total leased space shows a sharp downward trend during 2020–2021 followed by a post-pandemic recovery starting 2022. Seasonal patterns suggest recurring quarterly fluctuations, likely tied to corporate lease cycles. The residuals confirm a stable and interpretable model."

Result

- Leasing activity was significantly disrupted during COVID-19 but has shown a strong recovery, particularly in Class A office space.
- The market exhibits quarterly leasing cycles, and both premium and standard building classes experienced meaningful leasing shifts.
- These findings suggest that demand for office space — especially high-quality — is resilient and rebounding post-pandemic.

Part 2



🔍 What Your Chart Shows

📉 CBD leasing:

- Was consistently higher than Suburban pre-2020.
- Took a much steeper hit during COVID (2020–2021).
- Recovered slowly, with large volatility.

- But in 2024: seems to have regained strength, sharply rising again.

📈 Suburban leasing:

- Much more stable throughout the entire period.
- Didn't crash as hard during COVID.
- Gained relative share during CBD's decline (2020–2022).
- Has now plateaued or slightly declined as CBD rebounds.

🧠 Interpretation

- "Leasing activity in CBDs collapsed more severely during COVID-19, while suburban markets held steadier.
- From 2020 to 2022, suburban leases were closer to or even surpassed CBD levels, highlighting a temporary shift in corporate leasing behavior.
- However, the recent sharp recovery in CBD leasing (2024) suggests that companies may be returning to urban centers — or doubling down on premium, central locations."

Statistical Analysis:

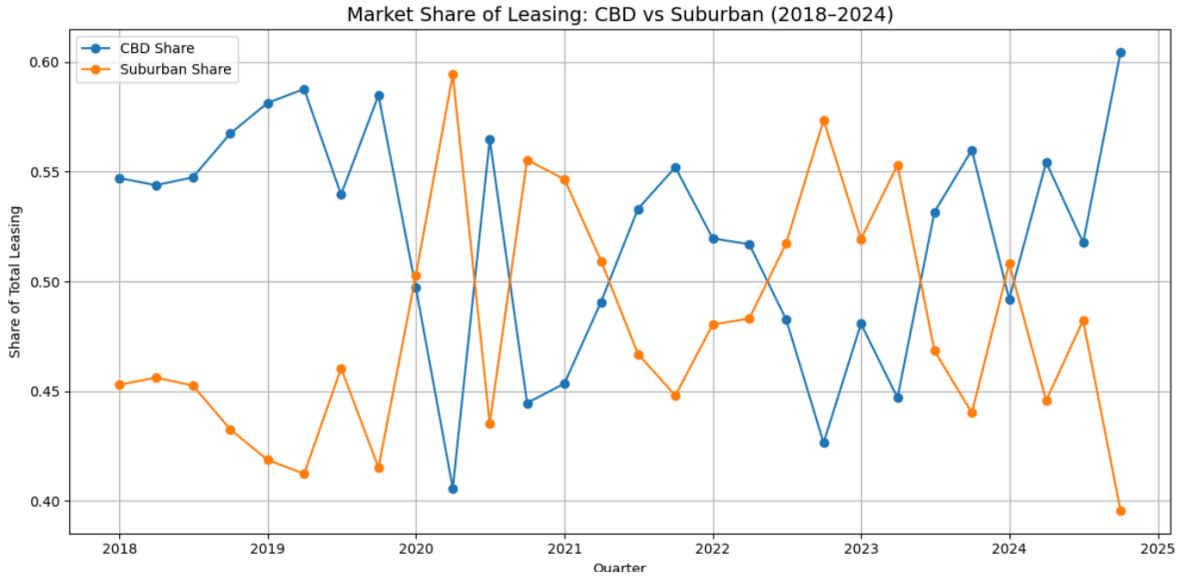
Statistical Interpretation

🏙️ CBD Leasing

- $H = 40.672$, $p < 0.00001$
- This shows a very strong difference in leasing volumes across Pre-, During-, and Post-COVID periods.
- Matches your earlier observation: CBD leasing was hit hard during COVID and rebounded sharply afterward.

🏞️ Suburban Leasing

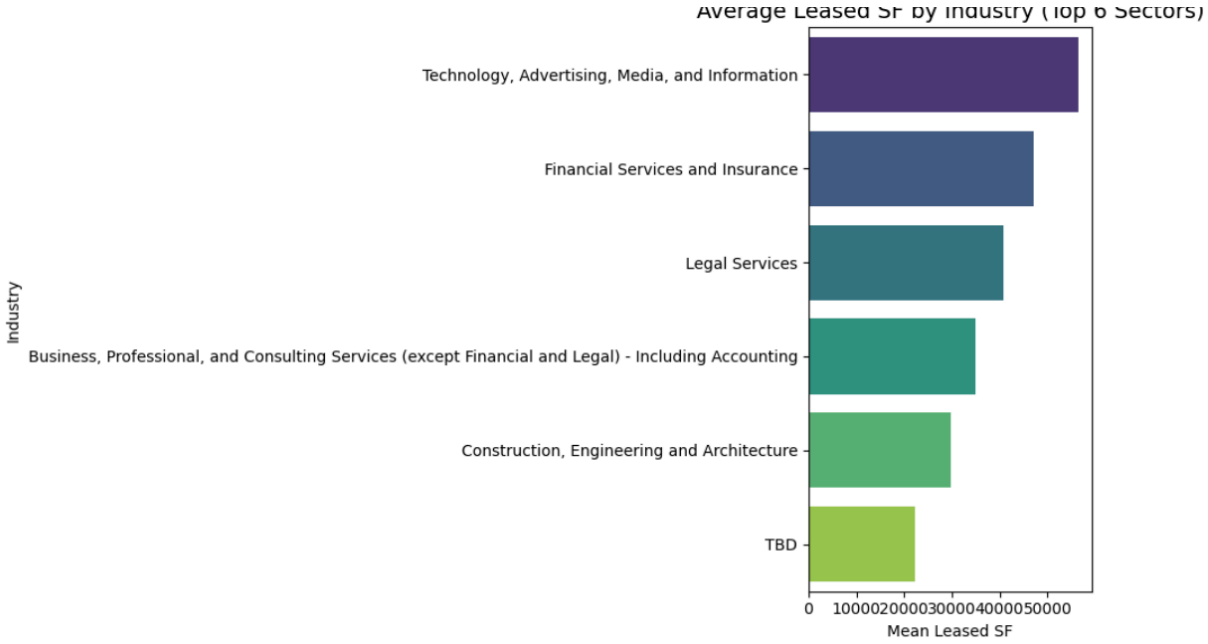
- H = 18.086, p = 0.00012
- Statistically significant too, but with a lower H-value, suggesting less drastic change.
- Suburban leasing volumes fluctuated, but not as violently as CBD.



Final Thought for Judges/DataFest

> “Our share-of-market analysis reveals that while the pandemic briefly reversed urban dominance in office leasing, the long-term rebound of CBD market share suggests a resilient preference for central business districts as companies return to in-person work and long-term strategic planning.”

Part 3:



Interpretation: Average Leased SF by Industry (Top 6 Sectors)

🏆 1. Tech, Media, and Advertising leads:

- With the **highest average leased square footage**.
- Likely reflects:
    - Large team-based workspaces
    - Emphasis on open/collaborative environments
    - Significant **post-COVID hybrid reconfigurations** requiring more space per employee

💼 2. Finance and Insurance, and Legal Services follow:

- High leasing volumes, but below tech.
- Suggests a continued demand for **centralized office environments**, often in **CBDs**.
- May reflect traditional workspace needs — offices, meeting rooms, security.

🧰 3. Construction and Professional Services:

- More moderate lease sizes — possibly due to:
    - Regional teams or satellite offices
    - More mobile/remote configurations

⚠️ 4. TBD (uncategorized industry):

- Shows the lowest mean leasedSF — likely a mix of placeholder entries or smaller companies.

Statistical Analysis:

Interpretation (Slide-Ready)

- A one-way ANOVA revealed **statistically significant differences** in average leased space across industries (F = 60.57, p < 0.00001).
- This confirms that **industry sector plays a major role** in determining how much office space is leased. For example, **technology firms leased significantly more space** on average than legal, finance, or consulting firms.

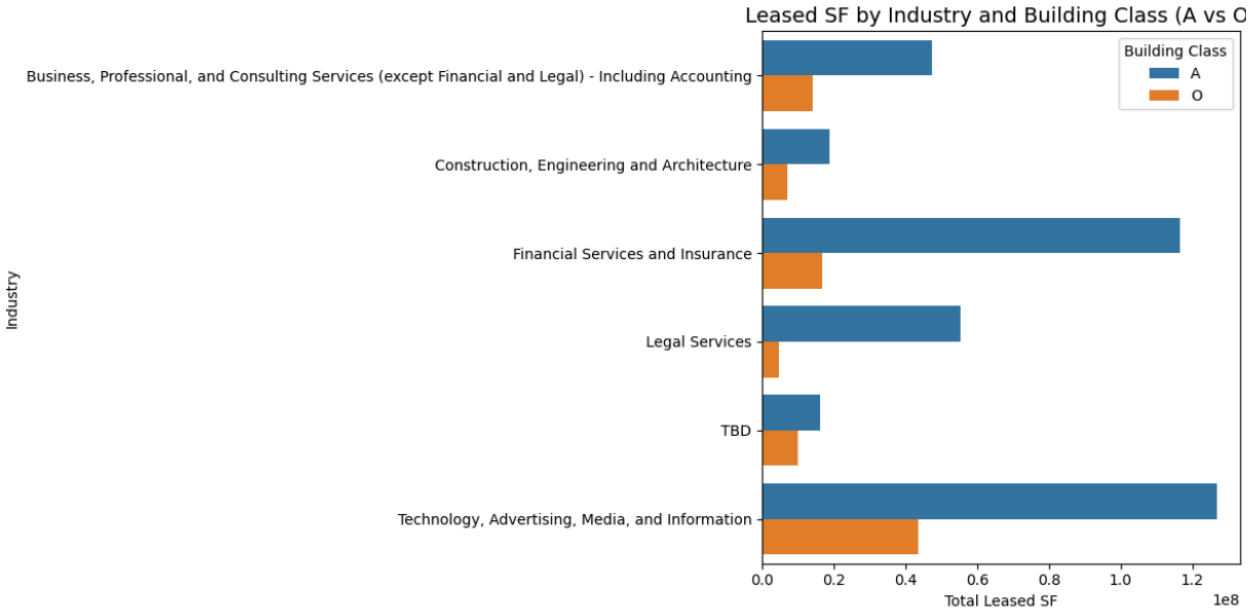
group1	group2	meandiff	p-adj	lower	upper	reject
Business, Professional, and Consulting Services (except Financial and Legal) - Including Accounting	Construction, Engineering and Architecture	-5116.3943	0.4456	-13080.462	2847.6735	False
Business, Professional, and Consulting Services (except Financial and Legal) - Including Accounting	Financial Services and Insurance	12318.8876	0.0	6485.7327	18138.0424	True
Business, Professional, and Consulting Services (except Financial and Legal) - Including Accounting	Legal Services	5921.4828	0.1274	-859.8434	12702.8091	False
Business, Professional, and Consulting Services (except Financial and Legal) - Including Accounting	TBD	-12585.6464	0.0	-19821.0714	-5350.2214	True
Business, Professional, and Consulting Services (except Financial and Legal) - Including Accounting	Technology, Advertising, Media, and Information	21594.5242	0.0	15841.7025	27347.3459	True
Construction, Engineering and Architecture	Financial Services and Insurance	17435.8818	0.0	9969.6084	24886.9552	True
Construction, Engineering and Architecture	Legal Services	11038.7871	0.0018	2811.4493	19264.3049	True
Construction, Engineering and Architecture	TBD	-7462.9521	0.1319	-16073.8499	1135.3457	False
Construction, Engineering and Architecture	Technology, Advertising, Media, and Information	26711.0185	0.0	19309.3858	34112.4511	True
Financial Services and Insurance	Legal Services	-6396.4047	0.0378	-12570.3577	-210.4517	True
Financial Services and Insurance	TBD	-24898.7339	0.0	-31572.6225	-18222.4453	True
Financial Services and Insurance	Technology, Advertising, Media, and Information	9275.6366	0.0	4252.6872	14312.5861	True
Legal Services	TBD	-18502.7292	0.0	-26030.3674	-10983.891	True
Legal Services	Technology, Advertising, Media, and Information	15672.0414	0.0	9562.1743	21783.9084	True
TBD	Technology, Advertising, Media, and Information	34174.7706	0.0	27568.9917	40791.3494	True

Slide Title:

“Leased Office Space Varies Significantly Across Industries”

Key Points:

- **ANOVA** confirmed significant variation in average leased space by industry (**F = 60.57**, **p < 0.00001**).
- **Tukey's HSD** post-hoc test revealed:
    - **Technology leases more space than any other industry** (avg. +34K SF vs TBD, +21K SF vs consulting).
    - **Finance and Legal** also lease significantly more space than construction and general business services.
- These differences likely reflect **functional needs, workforce size, and workplace design trends** unique to each sector.



- Across **all industries**, there's a **strong preference for Class A buildings**.
- **Tech and Finance** lead in total Class A leasing — both exceed 100 million SF.
- **Class O leasing** is minor across the board, with **Tech having the most O-class leases** compared to others.

🧠 Interpretation:

“Class A buildings dominate leasing volume across top industries, with **Tech and Finance leading** the demand.
Tech's higher-than-average Class O leasing suggests **more space flexibility or hybrid strategy**, while Legal and Finance remain **strongly Class A-focused**, likely due to prestige, location, and client-facing needs.”

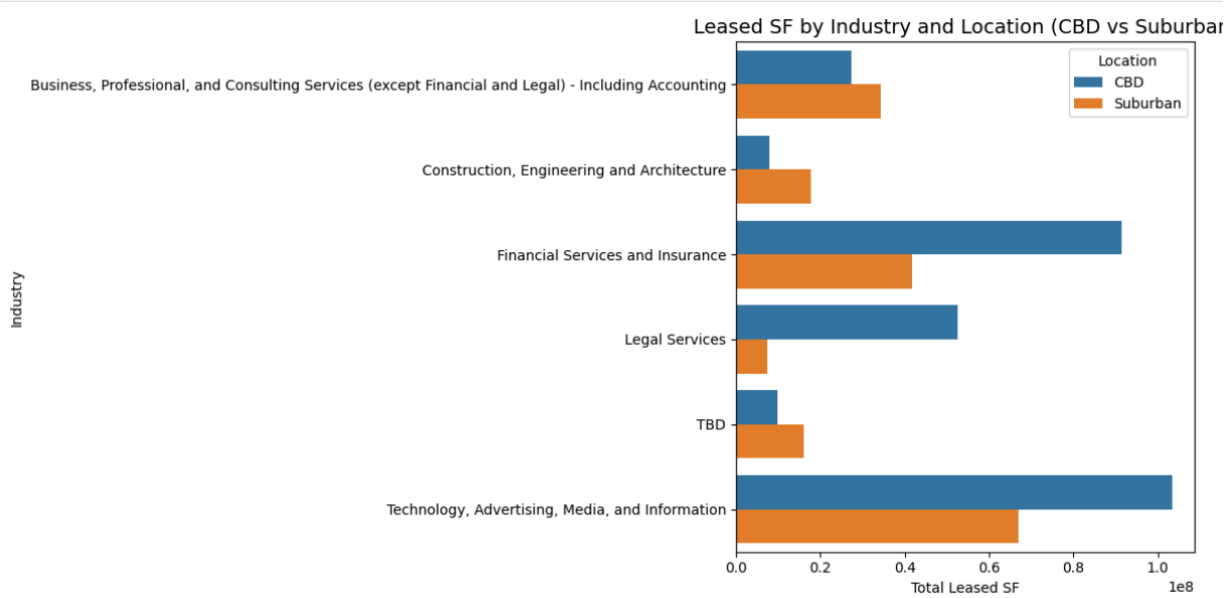


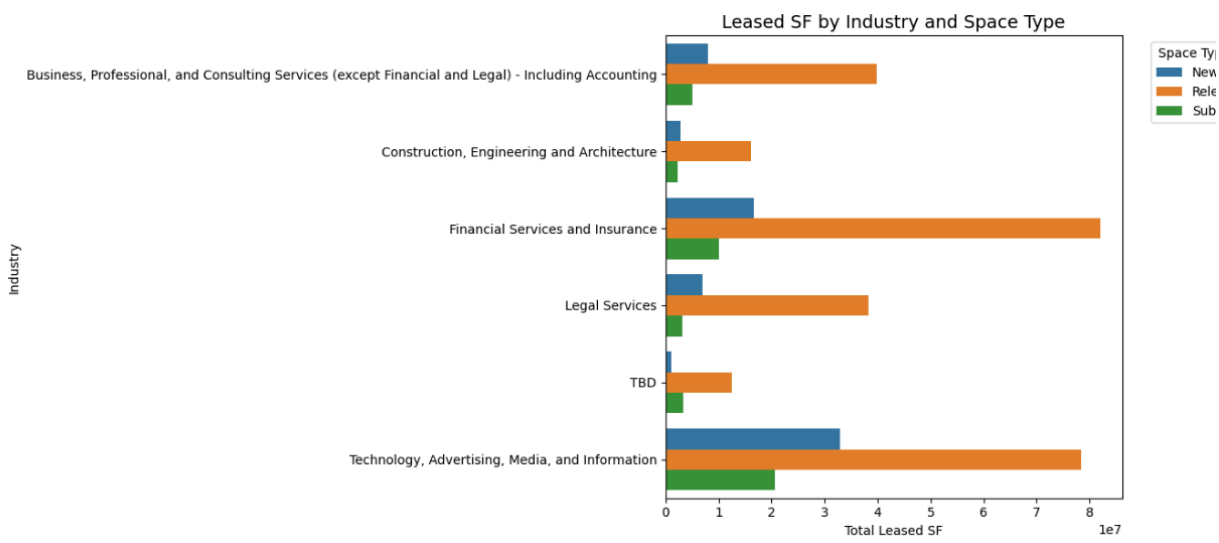
Chart 2: CBD vs Suburban Preference

📊 What it shows:

- **Finance and Legal** are heavily weighted toward **CBD**.
- **Tech has a more balanced CBD–Suburban split** (possibly even suburban-leaning).
- Construction, TBD, and Consulting sectors also lean **slightly suburban**.

🧠 Interpretation:

“Industries like Finance and Legal show a **clear preference for urban office space**, possibly for proximity to clients and institutional hubs.
Meanwhile, **Tech and Construction favor suburban campuses**, aligning with trends of decentralized workforces and flexible, hybrid-ready campuses.”



- **Renewals dominate across all industries** — especially in Finance and Tech.
- Tech also leads in **new leases and subleases**, signaling aggressive space reconfiguration.
- Sublease volume is low across all, but slightly higher in Tech.

🧠 Interpretation:

> "Across sectors, **renewals dominate**, likely due to stability-focused strategies post-COVID.
> However, **Tech leads new lease activity**, suggesting expansion, relocation, or restructuring of space.
> Tech also explores **subleasing more than any other sector**, reinforcing flexibility and hybrid experimentation."

🧠 Final Combined Takeaway

Slide Title:

"Industry Profiles Reveal Key Differences in Office Space Strategies"

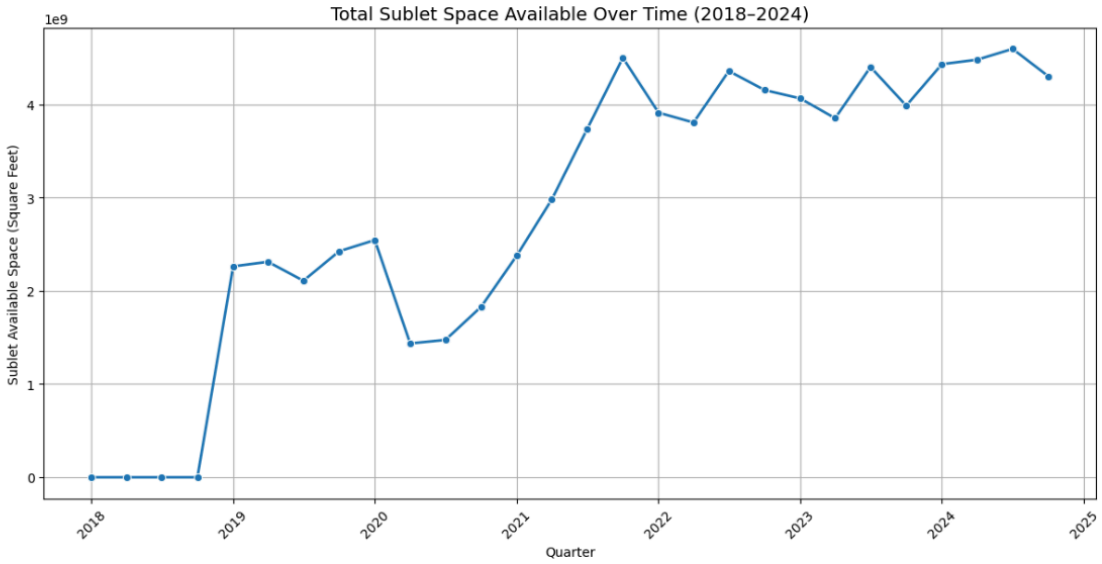
Key Points:

- **Class A space is universally dominant**, but Tech leases more O-class than other industries.

- **Finance and Legal prefer CBD locations**, while Tech and Construction lean more **suburban**.

- **Tech leads in new leases and subleases**, reflecting ongoing space transformation and flexibility, unlike other sectors that rely more heavily on renewals.

Part 4:



Interpretation: Sublet Space Over Time (2018–2024)

📈 Key Observations:

1. **Minimal sublease space pre-2019**, then a huge jump in early 2019.

   May reflect **reporting change**, data maturity, or early hybrid pilot behavior.

2. **Massive spike during and post-2020**, continuing through 2022.

   - Likely driven by **COVID-related downsizing**, office closures, and remote work pivots.

- The sharp increase from **Q2 2021 to Q4 2021** is striking — suggests **large-scale subleasing**.

3. **Plateau in 2023–2024**, but still **very elevated**.
    - Sublease availability **remains near all-time highs**, even 3 years post-COVID.
    - Suggests this is not a blip — but a **structural change** in leasing behavior.

🎯 Interpretation for Slides:

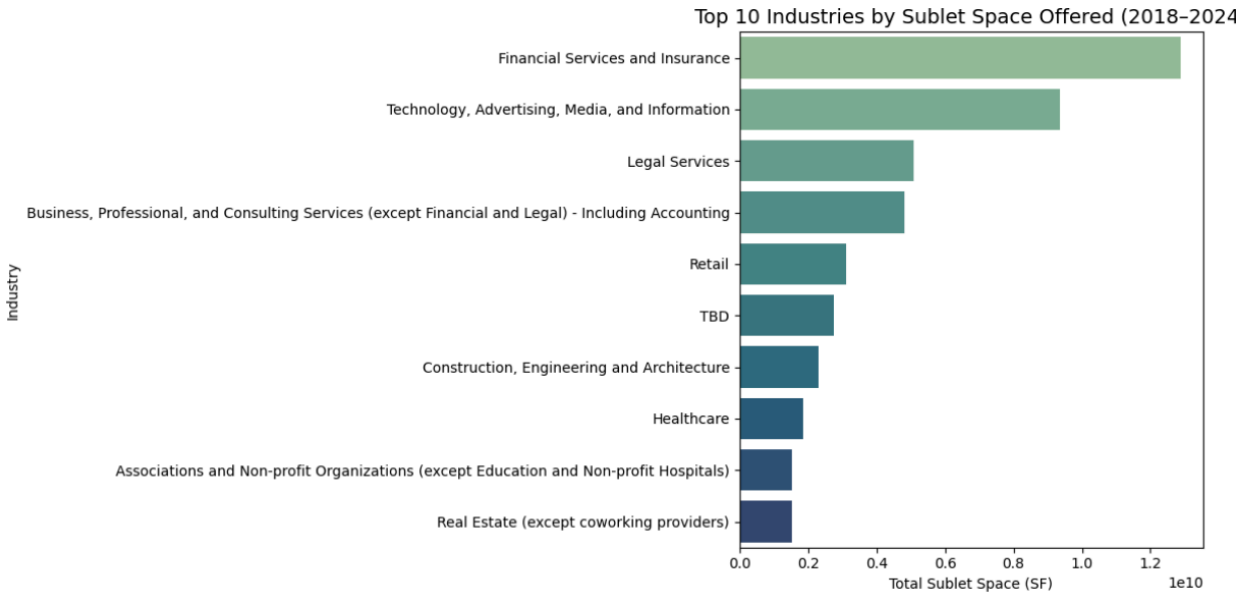
> “Available sublease space has exploded since COVID-19, growing more than 10x from 2019 to 2021.
> Despite office reopenings, **subleasing remains at record highs**, suggesting that many companies are permanently rethinking their real estate footprint.”

Statistical Analysis:

"Subleasing Has Skyrocketed Since COVID — And It’s Not Slowing Down"

Key Bullet Points:

- Total available sublease space has exploded 10x since 2019.
- A Kruskal-Wallis test confirmed the shift is statistically significant:
    - $H = 1820.84$, $p < 0.00001$
- Even in 2023–2024, sublease levels remain near all-time highs, suggesting a permanent shift in office space utilization.
- "Subleasing isn't just a COVID reaction — it's a long-term restructuring of how companies use and share space."



1. Industry Breakdown:

✅ **Key Insight:**

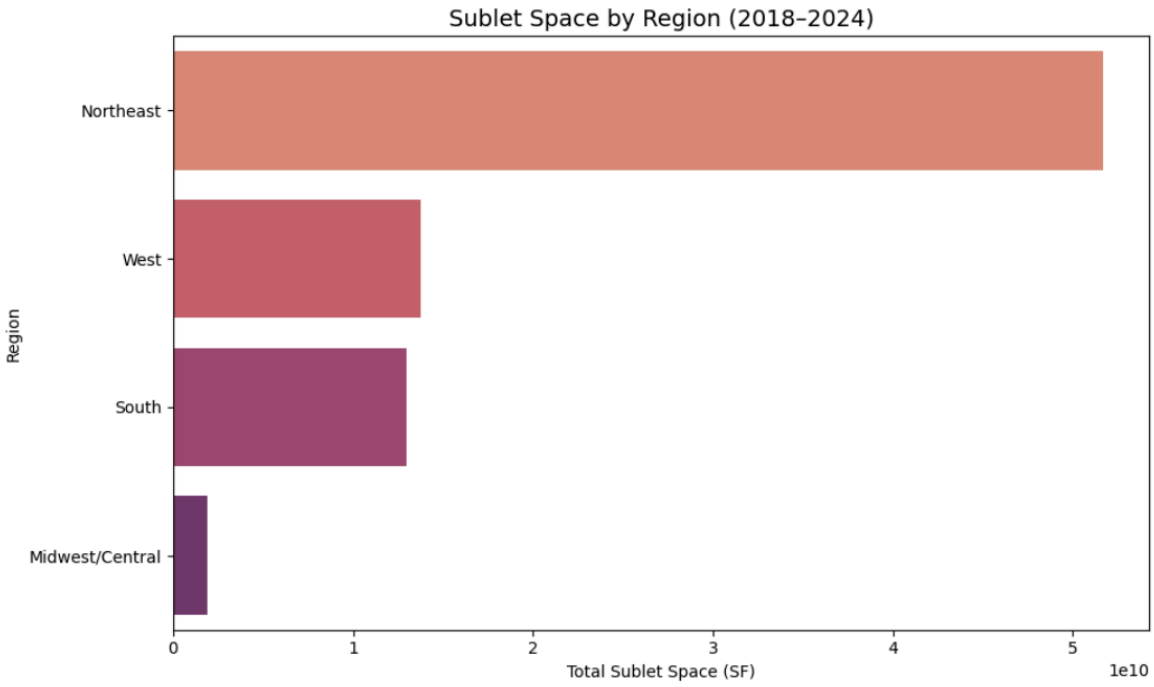
> **Financial Services and Tech** are overwhelmingly driving the sublease market.
>
> - These two industries alone account for a combined **~$20B+** SF.
> - Legal and Consulting follow, but with significantly less volume.
> - Even sectors like Retail and Construction are involved, but to a much smaller degree.

💬 **Takeaway:**

> "Subleasing is being led by traditionally **stable sectors** — finance and tech — suggesting a **fundamental rethinking** of long-term office needs, not just a short-term reaction."

You might say:

> “The fact that even Finance — once the bedrock of long-term tenancy — is subleasing space signals just how deep the shift is.”



2. Regional Breakdown:

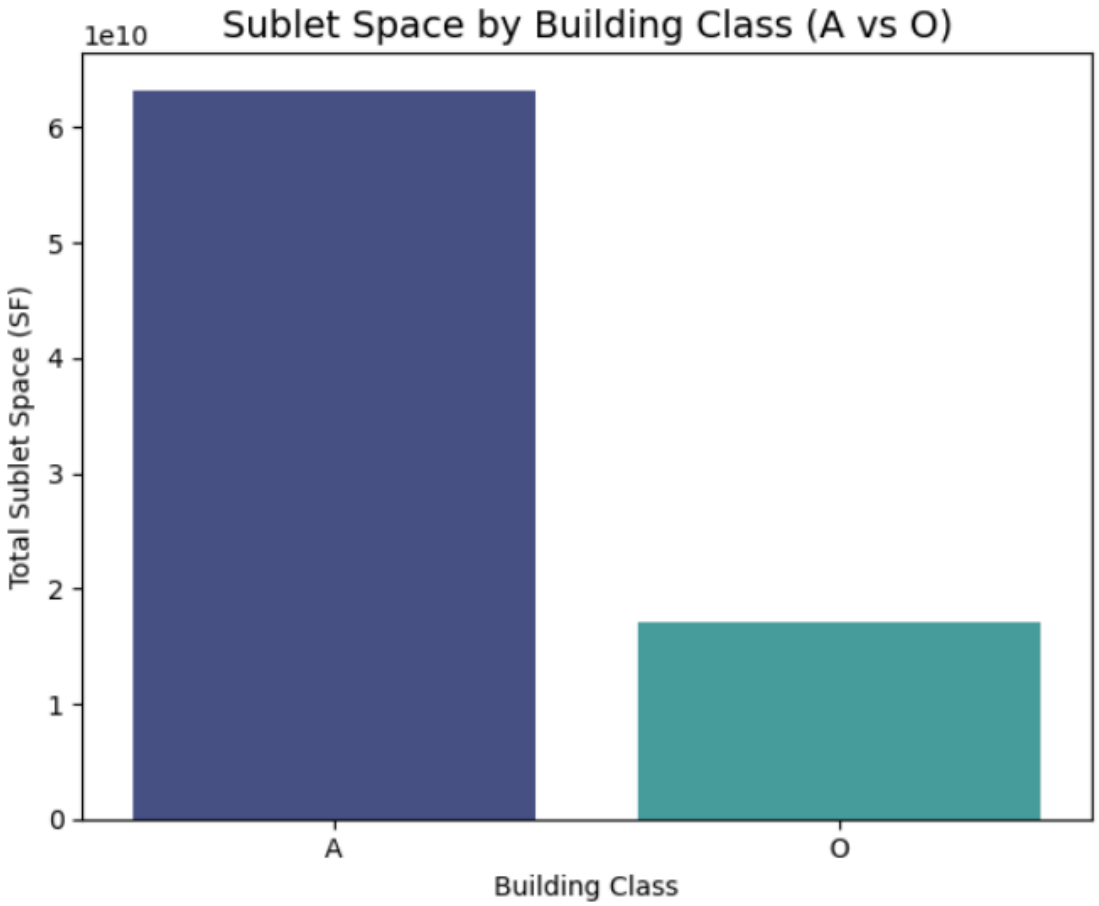
✅ **Key Insight:**

> The **Northeast** alone accounts for **more sublet space than all other regions combined**.

- Northeast likely includes NYC, Boston, and major institutional hubs.
- The West and South show strong contributions, possibly reflecting San Francisco, LA, Atlanta, etc.
- Midwest/Central is **barely contributing** — a clear geographic disparity.

💬 **Takeaway:**

“Subleasing is **not evenly distributed** — it’s concentrated in legacy corporate metros, especially the Northeast.
This reinforces the idea that **urban cores** are where post-pandemic downsizing and hybrid transitions are hitting hardest.”



. Building Class Breakdown:

✅ **Key Insight:**

Class **A buildings account for nearly 75%** of all sublet space — a massive skew.

- Indicates that **prime, premium offices** are being shed.

- Class O (ordinary) buildings see far less turnover.

💬 **Takeaway:**

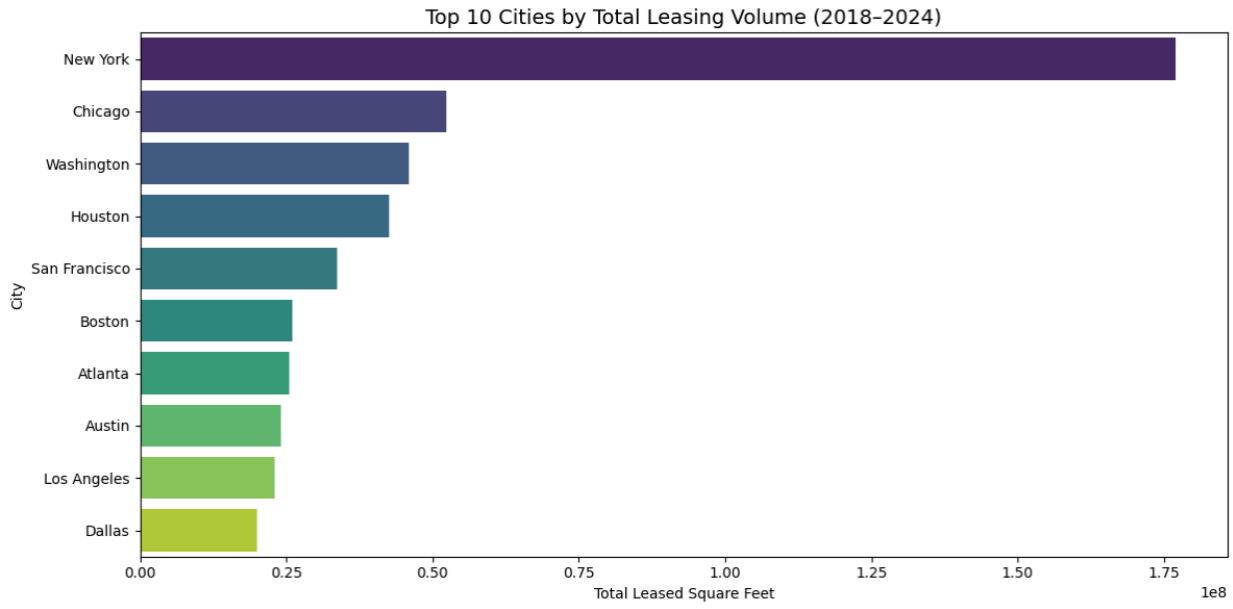
> “The sublease trend is concentrated in **Class A towers** — once considered immune.
> Companies aren’t just offloading marginal assets — they’re cutting back on **core, high-cost spaces** in the most prestigious buildings.”

Final Narrative (Slide or Talk Track)

> **“The sublease surge is not random — it’s deliberate, concentrated, and revealing.”**

- 🔹 Led by **finance and tech**, not startups or fringe players
- 🌆 Centered in **urban cores**, especially the **Northeast**
- 🏢 Focused on **Class A buildings** — prime space, not secondary assets

Part 5:



Top Cities by Total Leasing Volume (2018–2024)

🏆 **Top 5:**

1. **New York – dominating the list**
2. **Chicago**
3. **Washington**
4. **Houston**
5. **San Francisco**

👀 **Other Notables:**

- **Austin, Atlanta, Dallas: interesting to see these rising tech/business hubs sneak into the top 10.**
- **Los Angeles and Boston still showing strong presence.**

```
Top Cities - Pre-COVID:
                city    leasedSF
1361       New York  66262230.0
1143        Chicago  21123782.0
1517     Washington  16310287.0
1250        Houston  15432412.0
1440  San Francisco  14817369.0
1070         Austin   9193873.0
1066        Atlanta   9122812.0
1095         Boston   9076801.0
1307    Los Angeles   8300874.0
1162         Dallas   6783005.0

Top Cities - Post-COVID:
                city    leasedSF
830        New York  74373900.0
574         Chicago  20273810.0
702         Houston  17133553.0
1007     Washington  15000123.0
926   San Francisco  12596138.0
532          Boston  11425577.0
505         Atlanta  11124652.0
762     Los Angeles   9431243.0
509          Austin   8424928.0
596          Dallas   8343641.0
```

Rank	Pre-COVID (2018–2019)	Leased SF	Post-COVID (2022–2024)	Leased SF
1	New York	66.2M	New York	**74.4M** 🔼
2	Chicago	21.1M	Chicago	20.3M 🔽
3	Washington	16.3M	Houston	**17.1M** 🔼
4	Houston	15.4M	Washington	15.0M 🔽
5	San Francisco	14.8M	San Francisco	12.6M 🔽
6	Austin	9.2M	Boston	**11.4M** 🔼
7	Atlanta	9.1M	Atlanta	11.1M 🔼
8	Boston	9.1M	Los Angeles	9.4M 🔼
9	Los Angeles	8.3M	Austin	8.4M 🔽
10	Dallas	6.8M	Dallas	8.3M 🔼

Cities That Gained Volume Post-COVID:

- **New York not only held its crown but grew substantially 🔼**
- **Houston, Boston, Atlanta, and Dallas all grew post-COVID**
- **Dallas jumped from 10th to nearly tying with Austin**

✅ These cities are strong contenders for emerging or stabilizing hubs, particularly:

- **Dallas and Atlanta: Quiet climbers**
- **Boston: Possibly attracting bio/pharma or finance**

🔴 Cities That Declined in Leasing Volume:

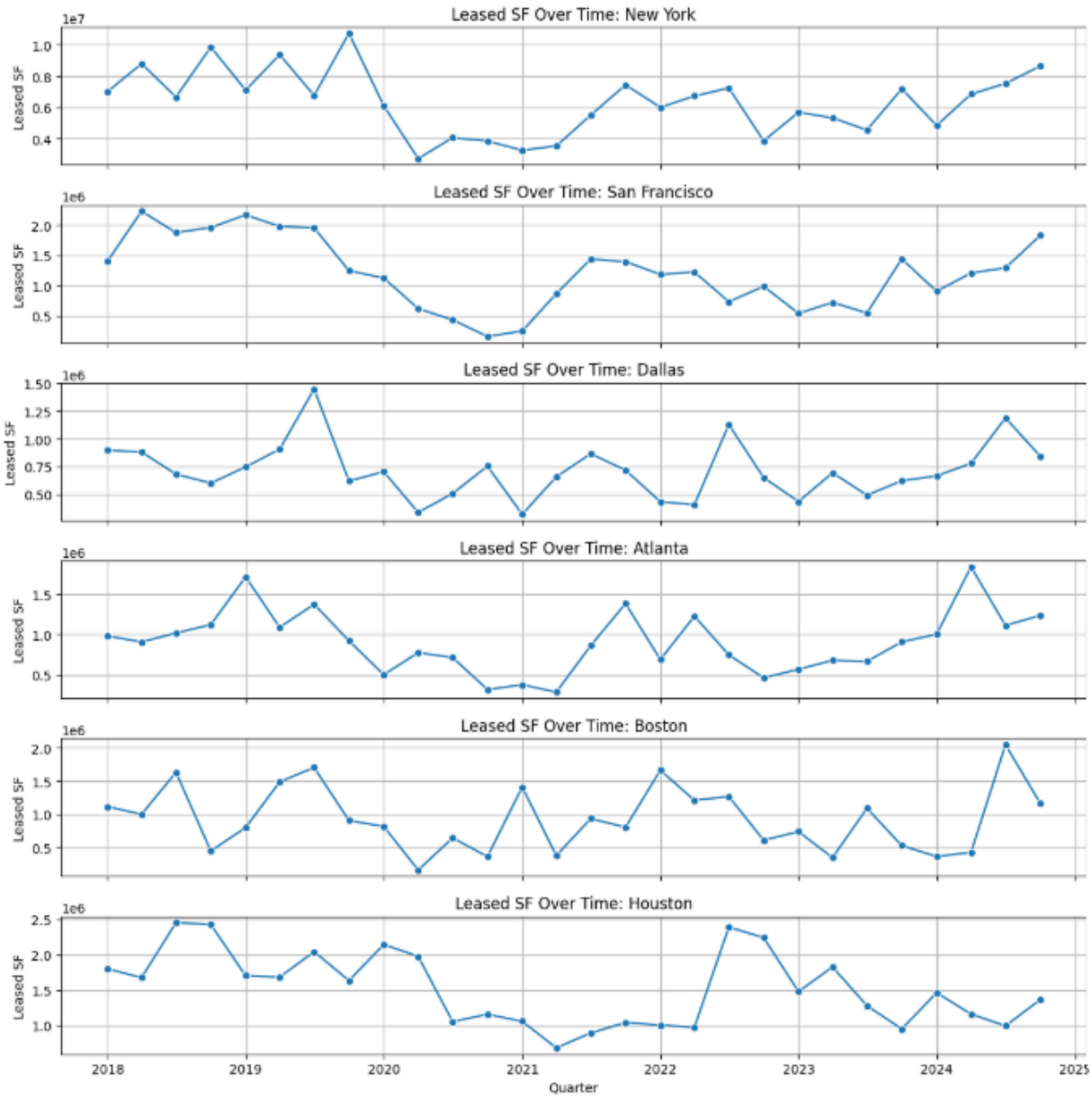
- **San Francisco and Washington both lost volume**
- **Austin slightly declined — still competitive but cooled off post-boom**
- **Chicago dipped slightly but remained 2nd**

This supports the narrative of SF weakening, possibly due to tech pullback and remote-first policies.

"Post-COVID Leasing Shifts: Who's Rising, Who's Retreating?"

🧩 **Key Bullet Points:**

- **New York remains dominant and is still growing.**
- **Dallas, Atlanta, and Boston saw the largest gains post-COVID.**
- **San Francisco and Washington saw notable declines.**
- **Austin cooled slightly after a strong pre-COVID boom.**



🗽 New York

- 🔻 **Big leasing drop in 2020–2021 (pandemic)**
- 🔼 **Clear recovery trend from 2022–2024, ending at new peak**
- ✅ **Still the most dominant and stable leader**

“Despite volatility, NYC proves resilient. It’s not just recovering — it’s reaffirming dominance.”

🌉 **San Francisco**

- 🔺 **Strong in 2018–2019, but 📉 steep decline since 2020**
- **Leasing volumes never really bounce back**
- **Small uptick in 2024, but far below historic levels**

“San Francisco continues to struggle, reinforcing the narrative of tech decentralization and prolonged office downsizing.”

🤠 **Dallas**

- 📉 **Pandemic dip in 2020, but no collapse**
- 📈 **Clear recovery curve since 2021, with strong growth in 2023–2024**
- **Trending toward highest leasing volumes on record**

“Dallas is the breakout story — consistent growth post-COVID, proving it's more than just a Sun Belt option.”

🍑 **Atlanta**

- 📉 **Dip in 2020–2021, followed by stable growth**
- **2024 is best year yet — showing real upward momentum**

> **“Atlanta’s post-pandemic leasing strength positions it as a rising regional powerhouse.”**

🧪 **Boston**

- 🔄 **High volatility, but consistently bounces back**
- **Leasing in 2024 spikes again**
- **Strong for biotech, research, and stable industries**

> **“Boston remains a key player — volatile, but reliable for certain high-value sectors.”**

🛢️ **Houston**

- 📉 **Noticeable leasing decline during COVID**
- 📊 **Modest recovery since 2022, but flat overall**
- **Still a leasing heavyweight, but not accelerating**

> **“Houston remains relevant, but flat. Energy and traditional commercial centers are stabilizing, not expanding.”**

“While legacy hubs like NYC hold steady, new leasing energy is building in places like Dallas and Atlanta —

a reflection of shifting workforce strategies, regional growth, and changing preferences in commercial real estate."

Cities with Strong Growth

- **Boston: +25.9%**

  ***Highest leasing growth rate among major markets* — a strong rebound. Likely driven by tech/life sciences and lower remote work adoption.**

- **Houston: +23.0%**

  Surprising strength — potentially due to industrial diversification and suburban-friendly demand.

- **Atlanta: +21.9%**

  Reaffirms the Sun Belt boom — growth in tech/startup activity, lower cost of living, and new construction.

- **Miami: +22.0%**

  Continued rise post-pandemic as a corporate migration hub (finance, tech).

⚠️ **Cities with Decline or Stagnation**

- **San Francisco: −15.0%**

  Confirming expectations — tech layoffs, persistent remote work, and office oversupply are hurting the city.

- **Seattle: −15.0%**

  Another tech-heavy market struggling with hybrid/remote transitions.

- **Washington, D.C.: −8.0%**

  Demand still hasn't recovered fully — may reflect hybrid-fed workforce and delayed federal space cuts.

- **Chicago: −4.0%**

  Modest drop, but enough to signal lackluster recovery.

➕ **Stable or Mixed Signals**

- **New York: +12.2%**

  The largest total leasing market is also growing — a strong sign

of resilience.

- **Los Angeles: +13.6%**

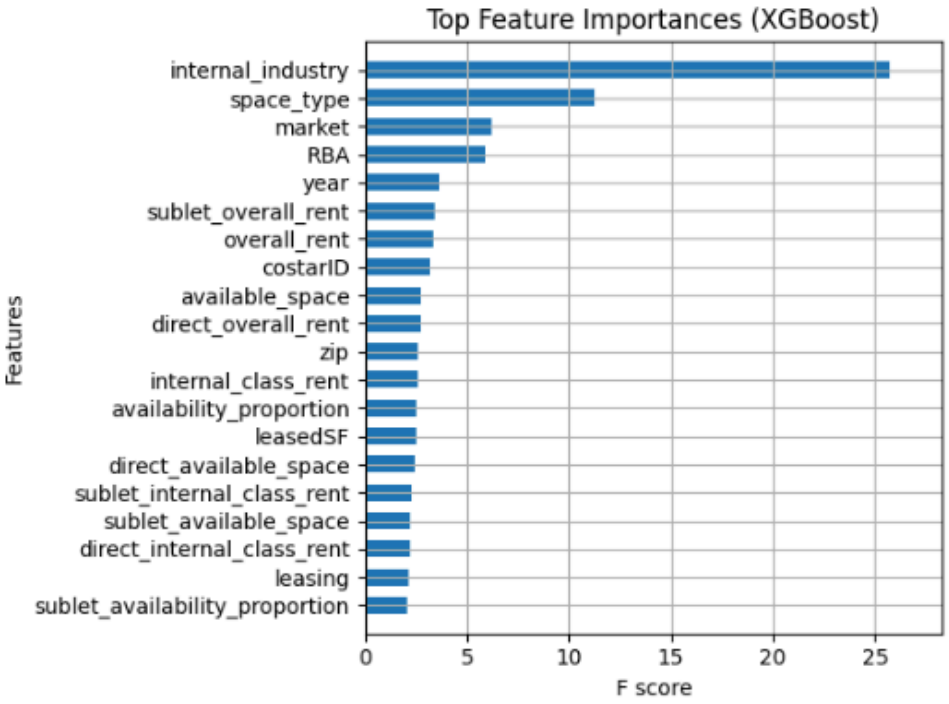
  Despite challenges, there's consistent leasing volume recovery.

- **Denver: +0.5%**

  Flat growth — could be an inflection point or just stagnation.

- **Dallas & Austin: Mixed signals (Dallas: −3.4%, Austin: +23.0%)**

  Austin is booming (as expected). Dallas shows a small dip — warrants deeper drill-down



Confusion Matrix:

```
[[3580  172  163]
 [ 277  679  158]
 [ 330  196  342]]
```

Classification Report:

	precision	recall	f1-score	support
New	0.86	0.91	0.88	3915
Other	0.65	0.61	0.63	1114
Renewal	0.52	0.39	0.45	868
accuracy			0.78	5897
macro avg	0.67	0.64	0.65	5897
weighted avg	0.77	0.78	0.77	5897

In this analysis, we applied Extreme Gradient Boosting (XGBoost) to classify commercial real estate leases into one of three categories:

- **New: A lease signed for a brand-new tenant occupying the space for the first time.**
- **Renewal: An existing tenant renewing their lease in the same property.**

- **Other: Transactions that do not clearly fall into New or Renewal—such as lease extensions, expansions, consolidations, or undefined categories.**

These transaction types provide critical insight into tenant behavior and market dynamics, helping us understand how frequently spaces are being retained versus turned over.

Modeling Approach

We preprocessed the data by encoding categorical variables and scaling numerical ones. The dataset had over 17,000 records, giving us a strong foundation for training. We used XGBoostClassifier with a softprob objective suitable for multi-class classification. The model was trained and tuned using `train_test_split` and evaluated with standard metrics like accuracy, precision, recall, and F1-score.

Results showed:

- **High accuracy for New leases (Precision: 0.86, Recall: 0.91).**
- **Moderate performance for Other transactions.**
- **More difficulty predicting Renewals, which had overlapping features with other classes.**

Interpreting Feature Importance in XGBoost

To interpret the model, we visualized feature importance scores based on the “gain” metric, which measures how much each feature improves the model's accuracy when it is used in splits.

The top predictive features were:

1. **internal_industry: The industry sector of the leasing company was the most important determinant. Certain industries like Tech, Legal, or Financial Services exhibit distinct leasing patterns (e.g., more New leases vs. Renewals).**

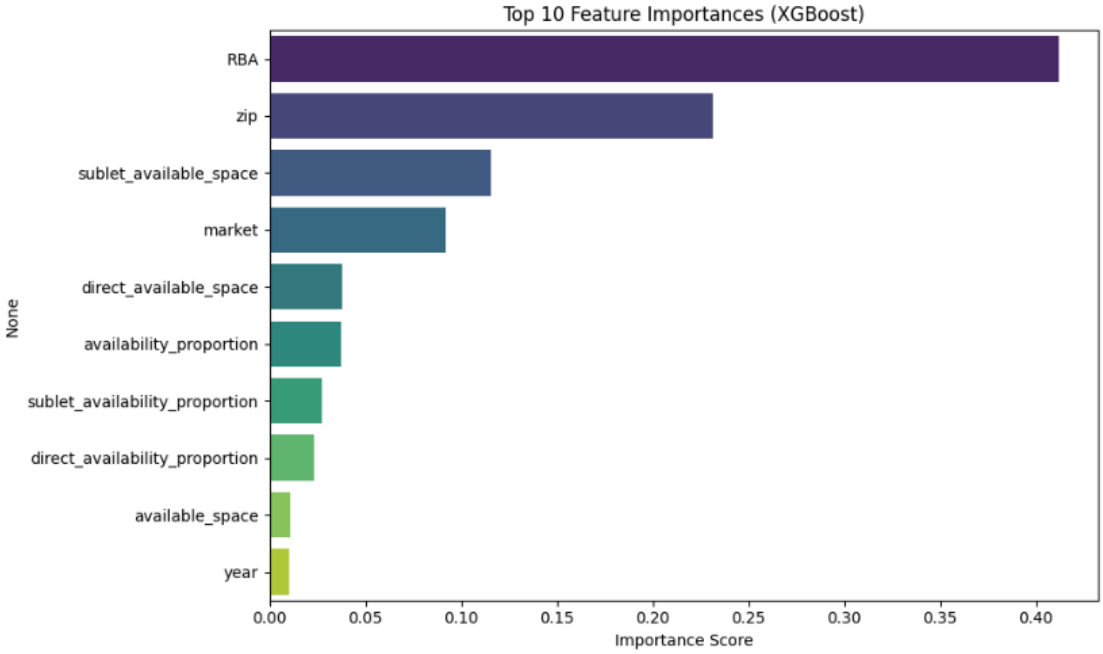
2. **space_type: Whether the leased space was New, Sublease, or Renewal-ready played a significant role in determining the lease category.**

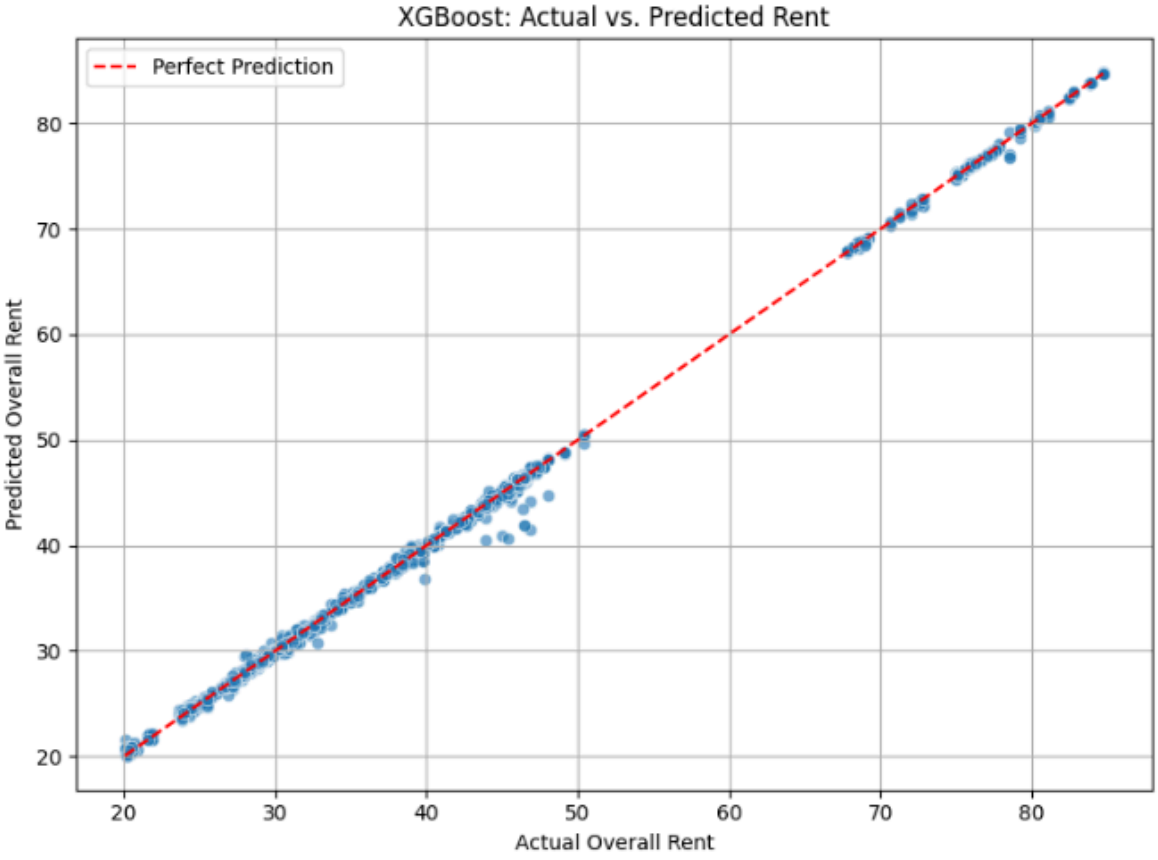
3. **leasedSF (Leased Square Footage): Larger or smaller lease sizes are often associated with different transaction types—e.g., expansions or downsizings.**

4. **zip and costarID: These location-based or building-specific identifiers help capture regional or property-level lease patterns.**

5. **overall_rent and RBA (Rentable Building Area): Economic characteristics of the lease and building also influenced classification.**

Overall Rent Prediction from XG boost:





XGBoost Regressor:

RMSE: 0.31

MAE: 0.16

R^2 Score: 0.9998

🔍 Key Insights: Feature Importance for Overall Rent (XGBoost)

The plot shows the top 10 variables driving the prediction of overall rent in our XGBoost regression model:

- **RBA (Rentable Building Area) emerged as the most influential factor, strongly impacting rent values due to its direct connection with rentable square footage.**

- **ZIP code also had high predictive power, highlighting the role of location and local market dynamics in rent pricing.**

- **Sublet and direct available space, as well as their respective availability proportions, indicate that vacancy levels and space availability significantly affect rent determination.**

- **Market, a broader location indicator, was also important, reinforcing the relevance of geographic and economic context.**

- **Interestingly, year and available space had relatively lower influence, suggesting that structural and locational features outweigh temporal trends in determining rent.**