

The Apocalypse Model, Rerun

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In February the American Economic Review published “Work from Home and the Office Real Estate Apocalypse” by Arpit Gupta, Vrinda Mittal and Stijn Van Nieuwerburgh, an update to their working paper from 2022.¹ The “apocalyptic” headline numbers have been widely quoted over the last four years: New York office values down 46.7 percent from 2019, \$556.8 billion of value destroyed across the United States, a decline driven by a dramatic transition to remote work continuing until 2027.

I have spent my career (primarily) in New York office real estate and my own work argues the other side. In April 2020 I wrote that a shift to 20 percent of workdays at home would cut office demand by about five percent, a thesis driven in large part by the fact that space is sized to the peak day and tenants give up desks at thresholds, not in proportion to attendance.² Since we now know what actually happened for a good part of that period, it is worthwhile to rerun their model and compare it with the market data.

The paper’s model has one crucial setting that cannot be observed: the parameter p . The p parameter determines the duration of the remote work state, and through that sets the leasing and rent assumptions in a remote work future.

The paper estimates p from one year’s return on three REIT stocks and gets eight years. That one estimate is what turns a 2020 write-down into values still falling in 2027. This article reruns their model with one change. For 2024 through mid-2026, instead of the reduced leasing and rents of the remote-work state, the model is given what Manhattan actually recorded: occupancy rising about two points a year, which the model reproduces with leasing at about 93 percent of normal, and real rents flat and then up. On those inputs the office stock is worth 78 percent of its 2019 value at the end of 2026, against the paper’s 47 percent, and 78 percent is not an apocalypse.



¹ Arpit Gupta, Vrinda Mittal and Stijn Van Nieuwerburgh, “Work from Home and the Office Real Estate Apocalypse,” *American Economic Review* 116, no. 2 (February 2026): 674 to 709.

² Michael Colacino, “Office Demand and Remote Work: Analysis and Projection,” *Haiku Partners*, April 2020.

Leasing recovered for a reason the model cannot express. My reading is that tenants reduced their space once, at the first lease expiry, so the decline was a one-time step, not an ongoing decline; the paper's own data on tenants show the size of that step by kind of tenant. The authors sort about 3,000 firms by the number of days required in the office and compare the space each leased in 2023 with 2019: firms requiring four or five days took one percent more space, firms at two to three days took nine percent less, and firms at one day or fully remote took 41 percent less.

The sections that follow derive each of these numbers: Section 1 describes the model, Section 2 compares the paper's forecast with Manhattan's record, Section 2.1 reports the paper's evidence on tenants, Appendix A shows how p was estimated, Appendix B gives the leasing and rent inputs by state, and Appendix C gives the city's valuation of the stock.

1. What the model is

The authors' replication package, released this summer, contains the model. It works like this.

There is a stock of office space. Each year about twelve to fourteen percent of leases expire. Expiring tenants renew at some rate; vacant space leases up at some rate; market rents grow at some rate. Those three rates depend on which of four states the model's economy is in that year.

Two of the four states are the ordinary business cycle: expansion and recession. The other two are the same cycle inside what this article calls the **remote-work state** (labeled WFH-E and WFH-R). The remote-work state is a switch: on, the market has converted to extensive work from home; off, it has not. The model turns this state on in 2020, and for as long as it is on, renewal and lease-up run at a fixed fraction of their historical rates and rent growth is set lower. The business cycle carries on inside it, so a year can be a remote-work expansion or a remote-work recession; 2020 is defined as a remote-work recession. When the switch turns off, leasing returns to its historical rates from whatever occupancy has been reached.

How long each state lasts is set by fixed probabilities: each year the state either continues or changes. For the two business-cycle states those probabilities are frequencies counted from the NBER's dating of every year since 1926. In the NBER years that were expansions, 88 percent were followed by another expansion year; of the recession years, 44 percent were followed by another recession. An expansion therefore lasts about eight years on average, and a recession under two.

The remote-work state has one probability of its own, the persistence parameter p : once the switch is on, it stays on for another year with probability p and turns off with probability $1 - p$.

minus p . The paper's derived p is 0.875, an expected length of eight years ($1 / 0.125$). The count starts with 2020, the first remote-work year, so eight years runs 2020 through 2027; that is the “until 2027” of the paper's headline. Occupancy in the model declines as long as the remote-work state lasts. The value of a building is the discounted sum of its expected cash flows over every future path of the chain, so a higher p means a longer expected remote-work state and a lower building value today.³

The probabilities decide how many years the economy spends in each state. What leasing and rents do inside each state is set by the historical renewal, lease-up and rent-growth rates for expansions and recessions. In the remote-work state the leasing rates are those historical rates multiplied by one estimated number per calibration, the remote-work factor: 0.53 for the whole market and 0.77 for trophy space (which the paper calls A+); rent growth is set separately. Appendix B gives the rates and the estimation. There is no measure of remote work in the model at all. No share of days, no share of workers. The two factors were chosen to fit the path of office occupancy from 2020 through 2023, and p was chosen to fit a group of REIT stock prices.

2. What the model says happens next, and what happened

At $p = 0.875$ the model's New York office market stays in the remote-work state through 2027 at the reduced leasing rates of Section 1; in the A+ calibration occupancy goes from 95 percent in 2019 to 87 percent in 2026 and is still falling.

	Model, 2024 to 2026	Manhattan, 2024 to 2026
Renewals and new leasing	Depressed, at 53 to 77 percent of normal	2025 leasing 43 million square feet, the most since 2019; first half of 2026 the strongest since 2019
Vacant space	Fills slowly	Availability down from 18.2 percent in February 2024 to 13.0 percent in June 2026
Net absorption	Negative every year	Positive in 2024 for the first time since 2019
Rents	Flat in real terms	Constant-quality rents flat in 2024, then up 8.5 percent in real terms in 2025 and another 5 in the first half of 2026; concessions back to 2019 levels
Occupancy	Falling through 2026	Rising since early 2024

³ Discounting is by state prices, calibrated so that the model reproduces real T-bill and stock returns in expansions and recessions, 1926 to 2019. There is no interest-rate state; discount rates move only when the economy switches between expansion and recession.

The table sets that A+ path against Manhattan since the beginning of 2024.⁴

The model assumes a long period of depressed renewals and rents. For the last two and a half years the opposite has been true. In the model's own terms, the leasing rates went back to normal around the start of 2024, which is a transition of about four years, not eight.

What is that worth? The paper's 2020 write-down is a price set on one day under an expectation, and nothing that happened afterwards can change it: at $p = 0.875$ the model marks the New York stock down 47 percent in 2020 whether the remote-work state then lasts four years or twenty. The realized length shows up later, as recovery or its absence. The next table gives the model's own value of the New York office stock, in the whole-market calibration, as a ratio to its value in December 2019 and in real terms, along five paths.⁵

Remote-work state	2020	2023	2026	2027
Persists through 2027 (the expected length at $p = 0.875$)	0.53	0.54	0.47	0.45
Ends at the start of 2024	0.53	0.54	0.83	0.86
Ends at the start of 2023	0.53	0.80	0.90	0.94
Ends at the start of 2024, at Manhattan's actual leasing and rents through mid-2026, then normal	0.53	0.54	0.78	0.81
Never starts: an ordinary recession	0.74	1.01	1.14	1.19

One caution. The second row's 0.83 rests on the model's own real rent growth of 6.3 percent a year in expansions compounding from 2024, which is its arithmetic rather than a forecast. The fourth row replaces that assumption with the Manhattan column of the first table: leasing at about 93 percent of normal and the constant-quality rent index, from 2024 through the first half of 2026.⁶ On those inputs the market is 22 percent below (the table's 0.78) at the end of 2026, which is 1.66 times the 0.47 on the persisting path. Figure 1 draws the first

⁴ Availability and concessions: Colliers, *Manhattan Office Market Report, 2Q 2026*. Leasing and absorption: Newmark Research, *Manhattan Office Market Report, 2Q 2026*. Rents: Columbia CompStak Rent Index, *Manhattan office* (SSRN working paper 5841322), deflated by CPI-U.

⁵ The paper's all-New-York calibration, walked along a fixed sequence of states: remote-work recession in 2020, remote-work expansion to the exit year, ordinary expansion after. The 2020 decline reproduces the paper's 46.73 percent. The paper's own path averages over random futures; the table fixes them so the exit year can be read off.

⁶ Leasing for 2024 to 2026 is set at 93 percent of the normal-expansion rates, which reproduces Manhattan's occupancy recovery of about two points a year. Real rent growth is from the Columbia CompStak index: minus 1.4 percent in 2024, plus 8.5 in 2025, plus 4.7 in the first half of 2026. Later years use the model's normal-expansion rent growth, so the row is a ceiling.

and fourth rows of the table: the same drop in 2020, one line until 2023, then the fork at 2024.

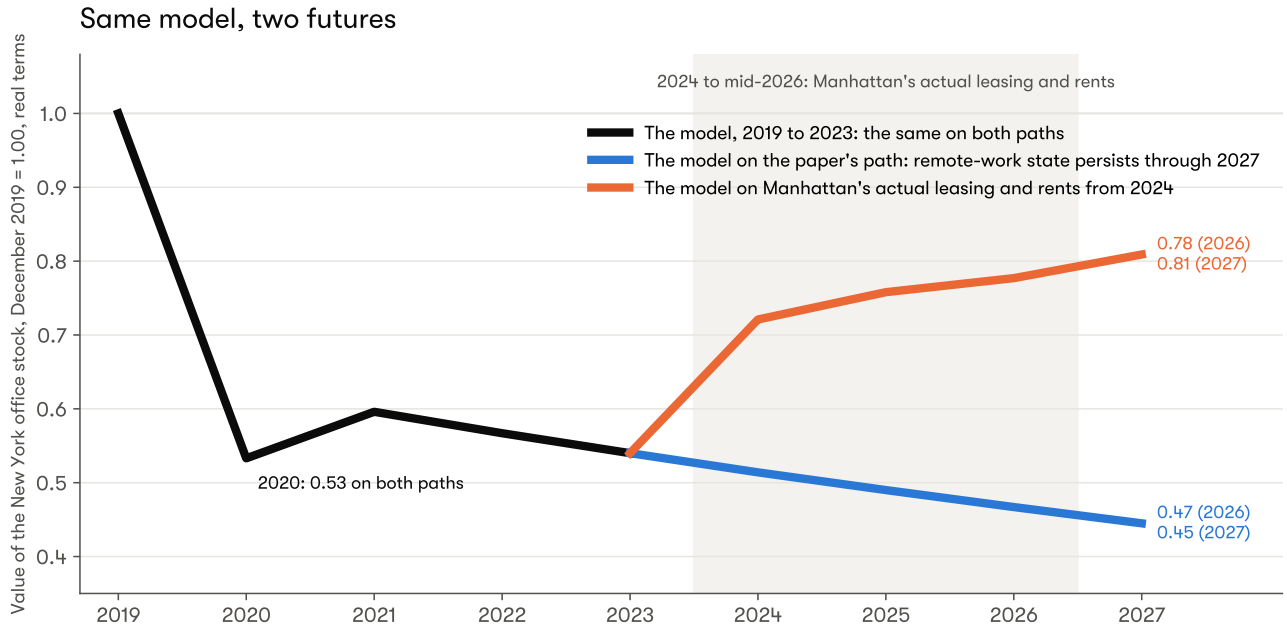
2.1 What the tenants did

The remote-work state reduces renewals and new leasing by one factor, the same for every tenant; the paper's own tenant evidence says otherwise. That evidence is the paper's best section, and it supports a different model. Using Scoop's Flex Index to sort 3,000 firms by required days in the office and CompStak to measure their leased space between 2019 and 2023, the authors find that the decline in space rose with days at home: the firms requiring four or five days added one percent, the two-to-three-day firms gave up nine percent, and the one-day and fully remote firms gave up 41 percent.⁷ This is the paper's direct measurement of what remote work did to demand. It is also the measurement my April 2020 thesis called for: a cut in space smaller than the reduction in days at home, and different from one kind of tenant to the next. For the hybrid class the cut is about a fifth of proportionate, nine percent of space for roughly half of the days at home, against the quarter I wrote down in 2020, five percent of demand for 20 percent of days at home.

A better description than a persistent decline would be a step function. Each tenant would adjust once, at its first lease roll, by an amount set by how remote it is: hybrid firms, which are most of the Manhattan tenant base, keep nearly all their space because they still need it on the peak day, and the large cuts are concentrated in the fully remote class. The paper acknowledges this in a sentence: the implications of hybrid work for office demand "are less clear than for fully remote positions." The model instead treats the 2020 to 2023 decline as the front edge of a bleed and continues it for as many years as a stock price implies.

The two readings agree about 2020 to 2023 and differ on what ends the decline. In the paper nothing ends it but chance: each year the remote-work state stops with probability $1 - p$. In the step reading it ends on a schedule, when the tenants who wanted less space reach their first lease expiry, most of them in 2024 to 2027 on the paper's average lease term of 7.3 years. The paper notes that 67.35 percent of the New York leases in force at the end of 2019 had still not expired by the end of 2023, and expects vacancy to rise as they do. The step reading expects the opposite, because the large reductions belong to the fully remote class, a small part of the Manhattan tenant base, and the hybrid majority gives up little at any expiry. What happened fits the step reading: occupancy began rising at the start of 2024 with two thirds of the 2019 leases still to roll. The paper's model gave the remote-work state only a 41 percent chance ($1 - 0.875^4$) of ending in 2024, but in fact the leasing data shows that it did end.

⁷ Gupta, Mittal and Van Nieuwerburgh, Figure 5, panel A.



Model values: the paper's all-New-York calibration at $p = 0.875$ (Section 2 table, rows 1 and 4); both paths share the 2020 write-down and run together until the end of 2023.

Figure 1. Value of the New York office stock, December 2019 = 1.00, real terms. Black: the model from 2019 to 2023, the same on both paths. Blue: the paper's path, remote-work state through 2027. Orange: the same model on Manhattan's actual leasing and rents from 2024. Rows 1 and 4 of the table above.

2.2 Where my critique is weakest

The head count of fully remote workers has not gone away. The American Community Survey counts workers who usually worked from home in the survey week: 13.3 percent in 2024, down every year since 2021 but still more than double 2019. It is the subset of occupiers in the paper's Figure 5 whose employers took 41 percent less space, and that space is not coming back. Where that class dominates a market, as in San Francisco, which the paper reports at 34.5 percent availability in mid-2024, the apocalypse reading still fits.

The paper's main flaw remains: its model misses the step-function nature of space demand and does not distinguish hybrid from fully remote tenants, and so overstates the demand reduction caused by remote work.

3. Conclusion

The paper and this rerun use the same model and arrive at the same 2020. They differ only in what happens after 2023. On the path of the paper's expected eight years, the remote-work state continues through 2027, and the New York office stock is worth 47 percent of its 2019 value at the end of 2026 and still falling. Given the leasing and rents Manhattan actually recorded from 2024 through mid-2026, the same model puts the stock at 78 percent of its 2019 value at the end of 2026. The gap between 47 and 78 percent is that assumption of persistence, and it rests on one estimated number, p , which is too fragile to support it.

Appendix A shows how little it takes to move the estimate: one point of REIT return, or one more REIT in the set, changes the expected length of the remote-work state by years. The tenants, in the paper's own data, cut their space by attendance policy; my inference is that they cut it once, which is why leasing recovered in 2024 while the model has it still falling.

Testing the paper's valuation function directly on the mid-2026 market, using the Columbia CompStak index deflated by CPI-U (real rents 12.7 percent below December 2019) and occupancy three to six points lower than 2019, results in a square foot worth around 89 percent of its 2019 value and around 15 percent **more** in nominal dollars.⁸

The city's own valuation of the stock agrees. The Department of Finance capitalizes the income of every office building in Manhattan each year. Its latest roll, on 2024 income, values the office buildings at 129.6 billion dollars against 133.3 billion on the last roll before the pandemic, on 2018 income: 2.8 percent less in nominal dollars and 23 percent less in real terms, where the paper's persisting path has the stock 49 percent below its 2019 value at the end of 2024. Trophy buildings gained 11.5 percent and Class B and other office buildings lost seven to eleven percent in nominal terms: a loss concentrated at the bottom of the stock, not a collapse. Appendix C gives the series and its limits.

If the question is how much demand remote work removed, the right measure is the lease roll, not a stock price in the worst year of a pandemic. Take the cohorts of leases expiring in 2024, 2025 and 2026, sort the tenants by their stated office policy, and measure the square feet they renewed against what they gave up. The paper's authors have the CompStak data to do this and have already done it once, for 2019 to 2023. Doing it again for the years since would settle whether the step was taken once or is still being taken. My expectation is a number near the five percent I wrote down in 2020 for hybrid tenants and a larger one for the fully remote class. The market's own total already points that way. Colliers observed about ten percent of the Manhattan office stock as available at the end of 2019 and about

⁸ The paper's valuation function in its ordinary expansion state at the observed mid-2026 occupancy and real rent; 89 percent is the midpoint of 86 to 92. Nominal figures use the CPI-U ratio of June 2026 to December 2019, 1.286.

thirteen percent in June 2026.⁹ About three points more availability, less the two percent by which deliveries net of conversions grew the stock over the same years,¹⁰ is a reduction in occupied space of between one and three percent from 2019: the order of that five percent, and if anything below it.

In my long career New York City has been pronounced dead several times. In each case the reports of its death have been highly overstated. The leasing of the last two and a half years says this case is no different.

9 Colliers: 52.24 million square feet available at the end of 2019 (Brennan Yerman, Colliers Knowledge Leader, 2026) and 68.10 million, 13.0 percent, in the second quarter of 2026 (Manhattan Office Market Report, 2Q 2026); ten percent is derived from those figures.

10 Newmark Research, Manhattan Office Market Report, 2Q 2026: about fourteen million square feet delivered in 2020 through 2023 and half a million since, less 3.9 million converted to residential, about eleven million on an inventory of 450 to 524 million, or about two percent.

Appendix A. Where p comes from

The persistence parameter p (Section 1) is not observed and cannot be. The authors identify it from one number: the unlevered return of three New York office REITs, SL Green, Vornado and Empire State Realty, over the single year from December 2019 to December 2020, which was minus 22.75 percent. Unlevered means the stock return with debt taken out.

The model is built to produce a one-year total return on A+ office space, in four steps.

First, the starting point. The model is valued at the end of 2019; its occupancy at that date is the model's own, 95.1 percent, against the 93.5 percent NAREIT recorded for office REITs. Starting the model at the recorded 93.5 instead moves p from 0.875 to 0.873, so the level hardly matters. Call that value 100.

Second, the year 2020. The model is moved forward one year with 2020 in the remote-work recession state, which means the leasing rates in that column of the table in Appendix B: 48.2 percent of expiring tenants renew, 14.2 percent of vacant space is leased, and real market rent falls 7.5 percent. Occupancy ends the year at 91.1 percent, and the net cash flow for the year, rent collected less operating costs and leasing commissions, comes to 4.50. A value and a year's cash flow are in the same units, dollars, and both are stated here per 100 dollars of 2019 value: the 4.50 is the dividend on a share bought for 100. None of this yet depends on p ; it reflects the remote-work recession state the model assumes for 2020.

Third, the value at the end of 2020. The model is valued again using end-2020 occupancy and rents, and now in the remote-work state with a grid of candidate values for p . This is the only place p enters. Each candidate implies an expected run of remote-work years ahead, with the rates in the remote-work expansion column of the table in Appendix B: renewals at 68.5 percent, lease-up at 8.3 percent and real rent growth of 1.2 percent; the longer the expected run, the smaller the discounted cash flows and the lower the value. At $p = 0.875$ the value is 72.75 and the 72.75 feeds into the next step.

Fourth, the return. A share bought for 100 at the end of 2019 paid 4.50 during 2020 and was worth 72.75 at the end of it: 72.75 plus 4.50 is 77.25 against 100, a return of minus 22.75 percent. That is the same value as the REITs' unlevered return, income plus the change in value over the starting value, and the authors' search over p yielded the number at which the two agree.

Path for 2020	Return on A+ office
Actual, three-REIT unlevered return (the paper's CRSP data)	minus 22.75 percent
Actual, recomputed from public data	minus 22.0 percent
Model, remote-work recession, $p = 0.875$	minus 22.75 percent
Model, remote-work recession, p near zero	minus 19.7 percent
Model, ordinary recession, no remote-work state	minus 21.7 percent

Rerunning the package returns the paper's 0.875. The first and third rows of the table confirm that the published number follows from the published code and data.

The sensitivity is significant. Had the REITs fallen one point less, p would be 0.83 and the transition six years; one point more, 0.91 and eleven years. Errors of that size are easy to find. The recomputation in the second row uses Yahoo Finance prices and NAREIT's published leverage and cost of debt, where the paper used CRSP prices and NAREIT figures it does not report; it comes to minus 22.0 percent, three quarters of a point from the paper's minus 22.75, and gives six years.¹¹ The model is also in real terms (its rents and discount rates are net of inflation) while the REIT return is in nominal dollars. Reducing the recomputed return by 2020's consumer price inflation, which the paper does not do, makes it minus 23.0 percent and the transition 8.6 years. The eight-year transition sits inside a band that one point of measurement moves by five years.

The model can also be asked a question the paper does not ask: what 2020 return does it produce with no remote-work state at all, only an ordinary recession? The last two rows of the table answer it.

An ordinary recession, with parameters estimated from the years before 2020, produces a 2020 drop of 21.7 percent. A remote-work recession with no persistence at all, one expected to end within the year, produces 19.7 percent, milder than the ordinary recession, because the A+ rent decline in a remote-work recession (7.5 percent in the table in Appendix B) is smaller than in an ordinary one (13.3). Adding eight expected years of persistence takes the model from 21.7 to 22.75. So of the 22.75 points the three REITs lost in 2020, the paper's own model attributes 21.7 to the ordinary recession and 1.05 to remote-work persistence, and every claim the paper makes about years, and therefore about value after 2020, rests on that 1.05. That 1.05 is roughly the same size as either of the two measurement differences just described, three quarters of a point from the data sources and a point from inflation.

Anything in the 2020 return that the recession does not produce is attributed to p : closed buildings, fears about rent collection, the liquidity panic in March and the vaccine rally in November all end up in that one parameter, each one read as a change in how long investors expected remote work to bleed office demand.

¹¹ Value-weighted equity return of SL Green, Vornado and Empire State Realty, December 2019 to December 2020, Yahoo Finance adjusted closes: minus 35.68 percent (the paper's CRSP figure is minus 36.16). Delevered with NAREIT T-Tracker office leverage at end 2019, 34.64 percent of market assets, and cost of debt, 3.83 percent: $(1 \text{ minus } 0.3464) \times (\text{minus } 35.68) + 0.3464 \times 3.83 = \text{minus } 21.99 \text{ percent}$.

There is a simpler test of how much rests on the paper's choice of SL Green, Vornado and Empire State as the three REITs whose 2020 return identifies p . BXP, the largest office REIT in the country and the owner of the kind of trophy space the A+ calibration describes, is not in the paper's set, presumably because only a quarter to a third of its income is from New York. Add it, at its market weight, and rerun the paper's own step.¹²

REITs in the 2020 return	Unlevered 2020 return, real	p	Expected transition
SL Green, Vornado, Empire State (the paper's set)	minus 23.0 percent	0.884	8.6 years
The three plus BXP	minus 20.7 percent	0.743	3.9 years
BXP alone	minus 18.3 percent	none	milder than an ordinary recession

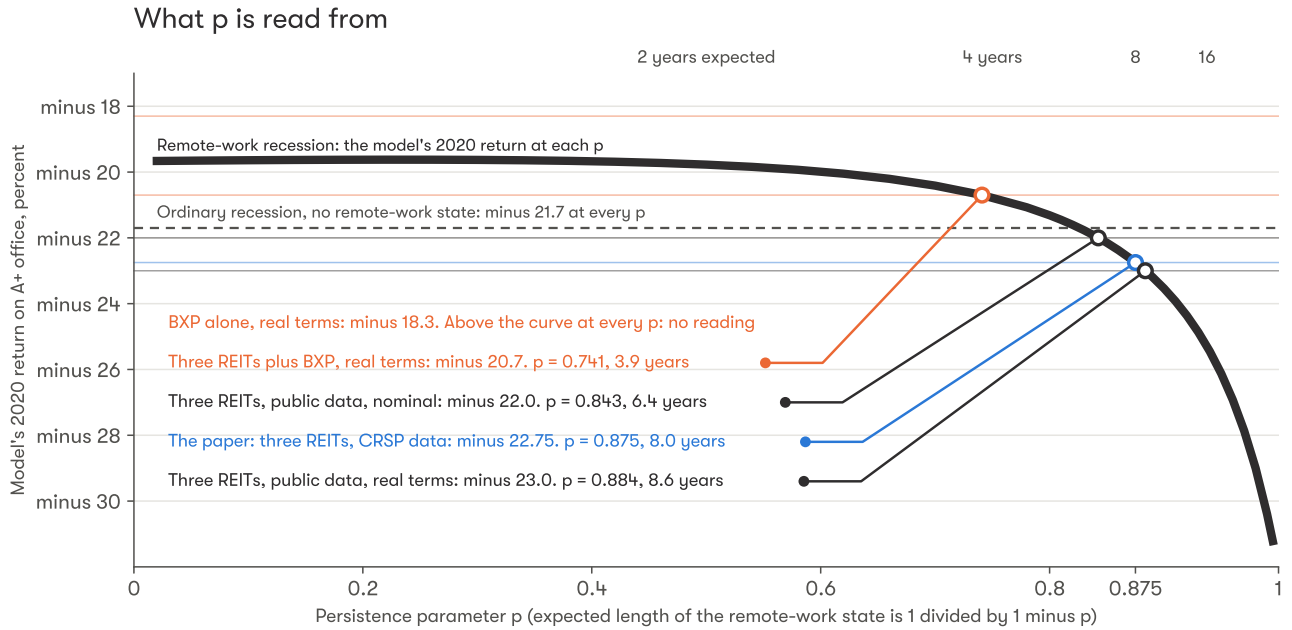
BXP fell 28 percent in 2020 against 36 for the other three, and at the end of 2019 it was worth as much as the three combined. Blended in, the 2020 return lands at a four-year expected transition, which is what the Manhattan leasing data in Section 2 show happened. BXP on its own fell less than the model's ordinary recession, so no length of remote-work state can be read from it at all. The eight-year transition is a property of three stocks, SL Green, Vornado and Empire State, and a fourth removes it. Figure 2 draws the whole mapping, the model's 2020 return at every value of p , with the returns from the two tables marked where they meet it. The curve is flat near minus 19.7 percent until p is about 0.6 and steep after; the paper's number sits on the steep part and BXP alone sits above the curve.

The authors read p from how far the model falls in 2020. After 2020 the model cannot fall again at any p , it only earns a small positive return each year the state continues,¹³ so the 2020 search cannot be repeated on a later year, even though the REITs fell again in 2022.¹⁴ The paper's footnote proposing to update p over time by the same method describes something the model cannot do.

¹² BXP from Yahoo Finance adjusted closes and 10-K share counts; end-2019 value weights BXP 0.48, Vornado 0.29, SL Green 0.17, Empire State 0.06; delevered as in footnote 11; deflated by CPI-U.

¹³ Total return along the path in which the remote-work state persists, A+ calibration: for 2022 and each later year between 4.1 and 5.4 percent across p from 0.02 to 0.995. The 2021 rebound is larger, 19 to 27 percent over the same range of p , and less sensitive to p than the 2020 drop, which runs from minus 20 to minus 31.

¹⁴ Real asset return of the three REITs for 2022, Yahoo Finance prices delevered with NAREIT office leverage and deflated by CPI-U: minus 29.0 percent, after minus 23.0 in 2020 and plus 4.7 in 2021, against the model's plus 4.1 to 5.4 (footnote 13). Over the longer window from December 2019 to December 2025 the REITs' real asset return is minus 29.6 percent, the model at $p = 0.875$ gives plus 11.4, and no p between 0.02 and 0.995 matches.



Curve: the replication package's model stepped into 2020 as a remote-work recession, solved at each p (Appendix A). Markers: the 2020 unlevered returns in the two Appendix A tables.

Figure 2. The model's 2020 return on A+ office at each value of the persistence parameter p , with the 2020 returns from the two tables above marked where they meet the curve. The dashed line is the ordinary recession with no remote-work state, minus 21.7 percent at every p . Top axis: the expected length of the remote-workstate, 1 divided by 1 minus p .

Backing an unobservable number out of a price is ordinary practice; implied volatility is read from option prices every day. What makes an implied number trustworthy is that other prices on the same day, and the same price on other days, give about the same answer. The paper's p fails both checks, and the paper reports it to four decimals with no interval around it.

Appendix B. The leasing and rent inputs by market state

The model's renewal, lease-up and rent-growth rates in each of its four states (Section 1) are built in three steps.

First, the historical expansion and recession inputs. No lease-level data on renewals or on the leasing of vacant space enter the model. The four leasing rates, renewal and lease-up in an ordinary expansion and in an ordinary recession, are set from four moments of an occupancy series, one series for each of the paper's two calibrations, whole market and A+ (Section 1): for the whole market, Cushman & Wakefield's Manhattan series from 1987 to 2019; for A+, NAREIT's office REIT series from 2000 to 2019. The two renewal rates are fixed so that occupancy settles at the series' maximum in a long expansion and at its minimum in a long recession, and the two lease-up rates are then chosen so that occupancy simulated by the model reproduces the series' mean and standard deviation. Rent growth in each state comes from CompStak's record of rents on newly signed leases. Those numbers are the first two columns of the table below.

Second, the remote-work factor. Nobody observes renewal or lease-up rates for a whole market; what is observed is occupancy, one number a quarter, and one number cannot fix two rates. The authors therefore assume that remote work cut renewals and new leasing in the same proportion, and estimate that one proportion from occupancy: Cushman & Wakefield's Manhattan series for the whole market, NAREIT's office REIT series for A+.

The second quarter of 2022 shows the calculation. Occupancy was 79 percent. About fourteen percent of leases expire in a year, so eleven percent of the stock was coming up for renewal and 68 percent was not. At the Expansion column's rates, 85 percent of the eleven renews and 18 percent of the 21 vacant leases up, together thirteen percent of the stock, and occupancy would have risen to more than 80 percent. It fell instead, two points at an annual pace, toward 77. The model also shrinks the stock 2.5 percent a year, which lifts the 68 that stay to 70 percent of the smaller stock, so leasing can have filled only seven points of the 77, not thirteen. Seven over thirteen, on the unrounded figures, is 0.53 for that quarter. The authors run the same comparison for each of the sixteen quarters from 2020 through 2023, with the Recession column for the four quarters of 2020, and take the single ratio that fits all sixteen best: 0.53 for the whole market and, by the same method on the NAREIT series, 0.77 for A+. ¹⁵

15 The function `estimate_s_nyc` in the package's `param_estimation.py`: a regression through the origin of the leasing needed to reach each quarter's observed occupancy on the leasing the historical rates would have produced. Rerun, it returns 0.5291.

Third, multiplication. The columns for “Remote-work expansion” and “Remote-work recession” are the historical leasing rates times the remote-work factor. In the rent growth rows (the third and the sixth rows) rent growth is not multiplied by a factor; it is estimated directly from CompStak’s rents for 2020 to 2023.

Per year	Expansion	Recession	Remote-work expansion	Remote-work recession	Remote-work factor
Whole market: expiring tenants who renew	85.0 percent	37.5 percent	45.0 percent	19.9 percent	0.53
Whole market: vacant space leased	17.9 percent	30.5 percent	9.5 percent	16.2 percent	0.53
Whole market: real market rent growth	plus 6.3 percent	minus 11.9 percent	minus 2.1 percent	minus 17.4 percent	set separately
A+: expiring tenants who renew	88.8 percent	62.5 percent	68.5 percent	48.2 percent	0.77
A+: vacant space leased	10.8 percent	18.4 percent	8.3 percent	14.2 percent	0.77
A+: real market rent growth	plus 7.3 percent	minus 13.3 percent	plus 1.2 percent	minus 7.5 percent	set separately

Reading across the first row: in an ordinary expansion 85.0 percent of expiring tenants renew, and 85.0 times the factor of 0.53 is 45.0 percent, the renewal rate in a remote-work expansion. Every other leasing rate in the last two columns is made the same way. “Normal” leasing, in the body of this article, means the expansion column.

One feature of the fitted rates should be noted. In both calibrations the share of vacant space leased in a year is higher in a recession than in an expansion: for A+ space, 18.4 percent against 10.8. The model assumes that vacant space leases faster in bad times than in good. The paper’s explanation is that less space is vacant in an expansion, so the same volume of leasing is a smaller share of it. That describes the arithmetic of the ratio, not any leasing market a broker would recognize, and because every remote-work rate is one of these fitted numbers times the remote-work factor, whatever the fit gets wrong is carried into every remote-work year of the forecast.

Appendix C. The city's valuation of the stock

The New York City Department of Finance values every office building in Manhattan each year from its reported income, for property tax, and publishes the values by class in its assessment roll summaries.¹⁶ The income behind a roll is from the calendar year three years before the fiscal year: the FY2027 roll, published in January 2026, capitalizes 2024 income, and the FY2021 roll, the last before the pandemic, capitalizes 2018 income. The FY2022 roll was cut by judgment: in January 2021 the department reduced Manhattan office building values 17 percent, stating that the pandemic's effects on the market had been incorporated in its valuation approaches, before any pandemic-year income had been reported. And the capitalization rates it applies to Manhattan office moved by flat steps, plus 20 basis points on the FY2022 roll, plus 70 on FY2023, minus 70 on FY2024 and none since, so between FY2021 and FY2027 the rate change accounts for about two points of value and the rest is income.

The table gives the change from the FY2021 roll to the FY2027 roll by class, in nominal dollars and deflated by CPI-U between the two income years, December 2018 to December 2024, a ratio of 1.257.

Class	FY2021, \$ billion	FY2027, \$ billion	Nominal, total	Nominal, per square foot	Real, total	Real, per square foot
Trophy	27.9	31.1	plus 11.5 percent	plus 5.1	minus 11.3	minus 16.4
Class A	49.0	46.9	minus 4.3	plus 1.0	minus 23.8	minus 19.6
Class B	34.1	31.6	minus 7.2	minus 0.6	minus 26.1	minus 20.9
Other office	22.3	19.9	minus 10.8	minus 2.5	minus 29.0	minus 22.4
All office buildings	133.3	129.6	minus 2.8	plus 1.7	minus 22.7	minus 19.0

¹⁶ New York City Department of Finance, *Final Assessment Roll Summaries, fiscal years 2019 to 2027, Manhattan summary by property type*; office buildings are the sum of the trophy, Class A, Class B and other office rows, and condominium office is listed separately. The income year of each roll is from the department's press release of 15 January 2026, which states that the FY2027 tentative roll uses income and expense information for calendar year 2024. The FY2022 cut is from the press release of January 2021 on the FY2022 tentative roll ("the overall decrease in market values reflects pandemic effects on the market, which were incorporated in the valuation approaches used by the Department of Finance"); the capitalization-rate steps are from the Tax Class 4 page of each year's *Additional Statistical Distributions and Capitalization Rate Methodology*. CPI-U from FRED: December 2018, 252.8; December 2024, 317.6.

Office condominiums, 24.5 billion on the FY2021 roll and 29.4 on FY2027, are not in the table; with them the total is up 0.8 percent in nominal terms and down 19.8 in real terms. The square footage of office buildings fell 4.5 percent over the period, from 353 million to 338 million, as buildings were converted or demolished, which is why value per square foot held up better than the total. Along the way the series fell once, by 17.0 percent on the FY2022 roll, from 133.3 to 110.7 billion, and then rose on every roll: plus 8.3 percent on FY2023, 5.4 on FY2024, 1.1 on FY2025, 0.6 on FY2026 and 0.8 on FY2027.

The comparison with the article's figures is made at 2024, the latest income year the rolls cover, with every measure as a real ratio to its pre-pandemic level.

Measure, real, ratio to the pre-pandemic value	2024
The paper's whole-market path, remote-work state persisting (Section 2 table, first row)	0.51
The same model on Manhattan's observed leasing and rents (Section 2 table, fourth row)	0.72
Department of Finance, Manhattan office buildings, 2024 income against 2018 income	0.77
The three REITs, SL Green, Vornado and Empire State, real asset value with income reinvested, end 2024	0.79

The city's capitalization of every office building in Manhattan sits beside the rerun and the REITs, and 26 points above the paper's path.

The values lag income by two to three years and follow contract rent, so leases signed before 2020 and still running in 2024 hold the 2024 figure up, and the roll cannot see the leases signed since. That is the strongest objection to the series, and the FY2028 and FY2029 rolls, on 2025 and 2026 income, will test it. The values are the department's capitalization, not sale prices. And the series is a value index, while the REIT figure in the last row is a total return with income.

Note on replication

The code written for this project can be provided on request. Full replication requires the authors' replication package (openICPSR project 228041), which runs in Python 3.12 and supplies the model code together with the Cushman & Wakefield and NAREIT occupancy series and the CRSP market returns it is calibrated to. The package's CompStak lease data and Scoop Flex Index data are proprietary; it includes pseudo-data in their place, and the originals must be licensed from CompStak and Scoop. The additional inputs used here are public: Yahoo Finance prices, share counts from SEC filings, the NAREIT T-Tracker, consumer prices from FRED, the Columbia CompStak Rent Index, and the New York City Department of Finance assessment roll summaries and capitalization-rate methodology documents.