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Tail Risk for Banks Posed by Investments in Generative Artificial Intelligence

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Financial Economics

Generative artificial intelligence (AI) has the potential to significantly increase our productivity and alter how we work and live in many ways. Because of this potential—and the related financial gain—there has been an enormous investment influx across the AI value chain. Commercial loans, underwritten by banking institutions, have been one of the mechanisms fueling this increase in capital expenditure. In this article we explore the ways banks are directly exposed to AI-adjacent investments and discuss the possible AI bubble tail risk—or the risk of losses due to extremely rare events, at the left tail of a probability distribution curve (more than three standard deviations from the mean).

Generative AI emerged as a transformative technology in 2022 with the release of OpenAI's popular generative pre-trained transformer (GPT) 3.5 model and associated chat tool, ChatGPT. AI is seen by many as a technology that may result in productivity leaps not seen since the Industrial Revolution. Looking ahead, companies across industries are expected to continue to invest heavily in AI projects, with S&P Global estimating AI information technology (IT) spending at $430 billion in 2025 and possibly exceeding $1 trillion by 2029. The AI spending surge has fueled fears of a bubble among institutional investors according to a Bank of America survey, with 45% of respondents noting an AI bubble was their top tail risk.

This article provides a brief snapshot of large bank[1] commercial lending to AI-adjacent borrowers. AI-adjacent lending consists of commercial & industrial (C&I) and commercial real estate (CRE) bank loans made to AI software companies and AI infrastructure companies, as well as loans for the construction of data centers and loans that are secured by these centers. Generally, large bank debt makes up a fraction of overall AI-adjacent debt; for instance, it made up around $450 billion in commitments ($150 billion of which was outstanding) in C&I exposure in late 2025.[2] In contrast, JPMorgan Chase & Co. analysts estimate AI-company-issued debt to be around $1.2 trillion alone—over double the large bank C&I commitments and eight times the outstanding balance of such commitments. For data centers, MSCI Real Capital Analytics estimated $14.9 billion of bank lending in the one-year period through the third quarter of 2025. In addition, Federal Reserve supervisory data show that banks have been increasingly involved in providing financing over the past year for AI-adjacent borrowers and data centers, with notable exposures in some of the largest transactions.



Direct bank outstanding exposure to AI-adjacent industries is generally considered relatively low—with the average bank outstanding amount to AI-adjacent industries at around 0.8% of bank total assets, according to our estimate. In addition, the average bank delinquency rate[3] for AI-adjacent industries remains in line with that for the overall portfolio. However, there is notable tail risk. In a tail risk event, stress in one AI-adjacent industry can spill over to multiple interconnected AI-adjacent industries. For example, if software companies are stressed and unable to maintain their infrastructure spending levels, semiconductor manufacturers, energy companies, and data centers may be affected, impacting their ability to repay their debts to commercial banks. Banks most likely have additional exposure to AI-adjacent industries through lending to nonbank financial institutions (NBFIs). For example, a bank may lend to a private credit institution providing funding for a data center or lend to an investment fund that specializes in AI investments, and stress in the underlying companies may lead to stress in the NBFI borrowers. Given these indirect channels are difficult to quantify with regulatory data, we will focus on direct lending to these AI-adjacent industries. We explore each segment of commercial lending and the potential associated tail risk in more detail.

Commercial & industrial loan exposures

AI-adjacent C&I exposures for large banks are identified through the industries of the borrowers of the commercial loans. The industries highlighted in this section—namely, the software,[4] energy,[5] and semiconductor[6] industries—are particularly notable within the C&I segment because of their more direct exposure to AI models, such as OpenAI's GPT models or Anthropic's Claude models. Despite being a relatively small part of the overall AI debt market, large banks have increased their concentration of C&I commitments to AI-adjacent industries from around 9% of total commitments across firms (around $250 billion) in 2015 to 13% (around $450 billion) in late 2025.[7]

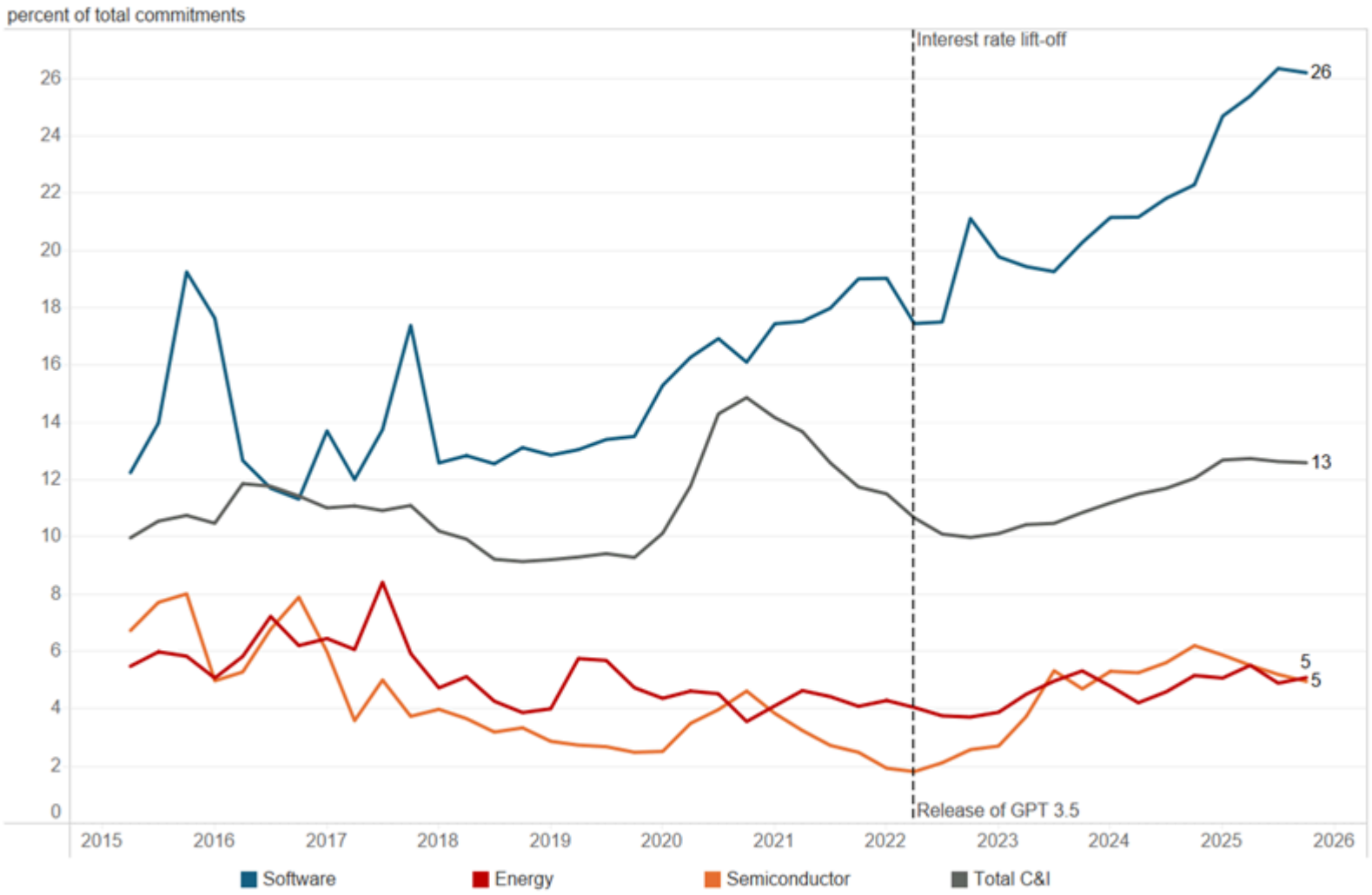
Across large banks, C&I outstanding exposure to AI-adjacent industries averages 9% of tier 1 capital (T1C)—which is a bank's core capital (including common stock and reserves) that often serves as a measure of its ability to absorb losses.[8] However, average bank committed exposure to AI-adjacent industries is closer to 25% of T1C. A tail risk scenario could lead to borrowers drawing on their lines of credit before becoming delinquent, resulting in losses above the current outstanding concentration of 9% of T1C.

Software industry

Software companies are exposed to AI either through direct spending on infrastructure supporting the creation of their own AI models or through their reliance on licensed AI technology from other companies. The software industry comprises software publishers; data processing, hosting, and related services; and computer systems design and related services. The largest tech companies' investments in AI has grown significantly since 2022, and this investment has been largely funded through capital injections;[9] however, debt financing has grown as well, with large bank C&I commitments to the software industry growing from $150 billion in early 2022 to $191 billion in late 2025. As of the third quarter of 2025, delinquencies for C&I loans to software companies at large banks were at relatively low levels, accounting for fewer than 50 basis points of T1C at each large bank. However, a significantly higher share of large bank commitments to software companies are rated B and below[10] (see figure 1)—at around 26% ($50 billion) of C&I commitments. For these companies, interest rate expenditures are substantive, and these firms have relied on investors to subsidize AI spending through additional capital injections given they are unprofitable.

A tail risk scenario for large banks with high concentrations of lower-rated software industry borrowers is capital injections in AI software companies decrease and interest rates remain at current levels, resulting in increased strain on the borrower to meet debt payments. This stress would likely further reduce investment, which would have negative knock-on effects on planned infrastructure spending by data centers, energy companies, and semiconductor manufacturers.

1. Share of commercial & industrial (C&I) commitments rated B and below for AI-adjacent industries and the overall portfolio



Notes: C&I commitments rated B and below are the contractually agreed-upon amount of money that a bank has agreed to provide to a highly speculative borrower with material default risk and a limited margin of safety. For more information on ratings, see FitchRatings' rating definitions. AI stands for artificial intelligence. GPT 3.5 refers to OpenAI's popular generative pre-trained transformer 3.5 model.
Sources: Authors' calculations based on data from the Federal Reserve, FR Y-14Q Schedule H (excluding asset-backed lending and unrated loans), and S&P Global.

Energy and semiconductor industries

Energy and semiconductor companies provide the infrastructure to power AI data centers. Energy companies (i.e., power generation, transmission, and distribution companies) are currently not as exposed to AI, as only about 8% of total U.S. power demand stems from data centers. However, some utility companies are entering into partnerships to provide power to data centers and are planning either acquisitions or large infrastructure projects to address future demand.[11] Semiconductor companies produce either the components for semiconductors or the semiconductors themselves. These companies rely heavily on the spending of a few major AI companies for the majority of their revenue—with NVIDIA and Broadcom noting high concentrations of sales and net revenue, respectively, from a few companies.[12]

Lending to semiconductor manufacturing and energy producers has generally included fewer commitments to lower-rated borrowers than the overall portfolio at large banks (see figure 1) and low delinquencies. The overall commitments for lending to the energy and semiconductor industries combined are around $275 billion. C&I commitments rated B and below within these two industries total $15 billion, which is below the lower-rated commitments detailed for the software industry. This trend also holds for delinquencies in the energy and semiconductor space, which accounted for fewer than 15 basis points of T1C at every large bank as of the third quarter of 2025. However, the tail risk drivers for these industries are uncertain profitability of investments and the possibility that borrowers could be left with surplus inventory because of a large reduction in demand. This reduction could occur in either of the following scenarios:

- There could be decreased software company spending due to either a decrease in new capital injections or reduced demand for software tools, leading to pullbacks in AI infrastructure spending.
- There could be notable increases in AI model efficiency, leading to a decrease in the demand for additional energy and semiconductors.[13]

In either of these scenarios, large portions of banks' exposure to the energy and semiconductor industries could come under stress at the same time as large portions of their exposure to the software industry do. The average current bank energy and semiconductor C&I outstanding exposure is around 1% and 4% of T1C, respectively. However, total C&I commitments to these two industries average around 16% of T1C and exceed 20% at around a third of banks.

Commercial real estate loan exposures

Data centers provide the infrastructure to support AI capabilities, such as resources to satisfy significant computational power through specialized hardware, storage, and management of data, plus a high number of processors to train AI models. In addition, data centers demand infrastructures with high utility requirements because of substantial electricity needs and specialized cooling systems to address the heat produced by AI hardware. AI has primarily entered into bank CRE exposure through investments in data centers. Banks have been increasingly involved in providing financing for AI-adjacent borrowers and data centers, with notable exposures in some of the largest transactions. Although not solely financed by banks, these new data center transactions can be massive in scale—for example, Stargate recently reported that it is sourcing a $7.1 billion construction loan to build out a new data center as part of an overall plan to commit $500 billion to construct multiple data centers.

Technological advancements, evolving business models, and changing consumer behaviors around AI are driving rapidly increasing demand for data centers. One estimate indicated that data center asset value will triple in the next ten years. Data centers are considered an attractive investment because they are in high demand and play an essential role in the evolving tech and AI landscape. In addition, highly specialized computational power, land and construction costs, and the scarcity of materials and labor put additional constraints on the supply of data centers, further increasing their attractiveness to investors.

The fundamentals of the property type corroborate this positive perspective. As of the first half of 2025, the data center vacancy rate was at an all-time low of 1.6%, with a preleased rate of 74% for properties under construction. The top eight markets identified by CBRE Research (figure 2) have very low vacancies, ranging from 0.2% for Hillsboro, OR, to 7.1% for the New York tri-state area. These locations are experiencing high growth and high demand for new data centers because of a combination of factors, such as proximity to major fiber networks, relatively lower costs, access to power, and business-friendly environments.

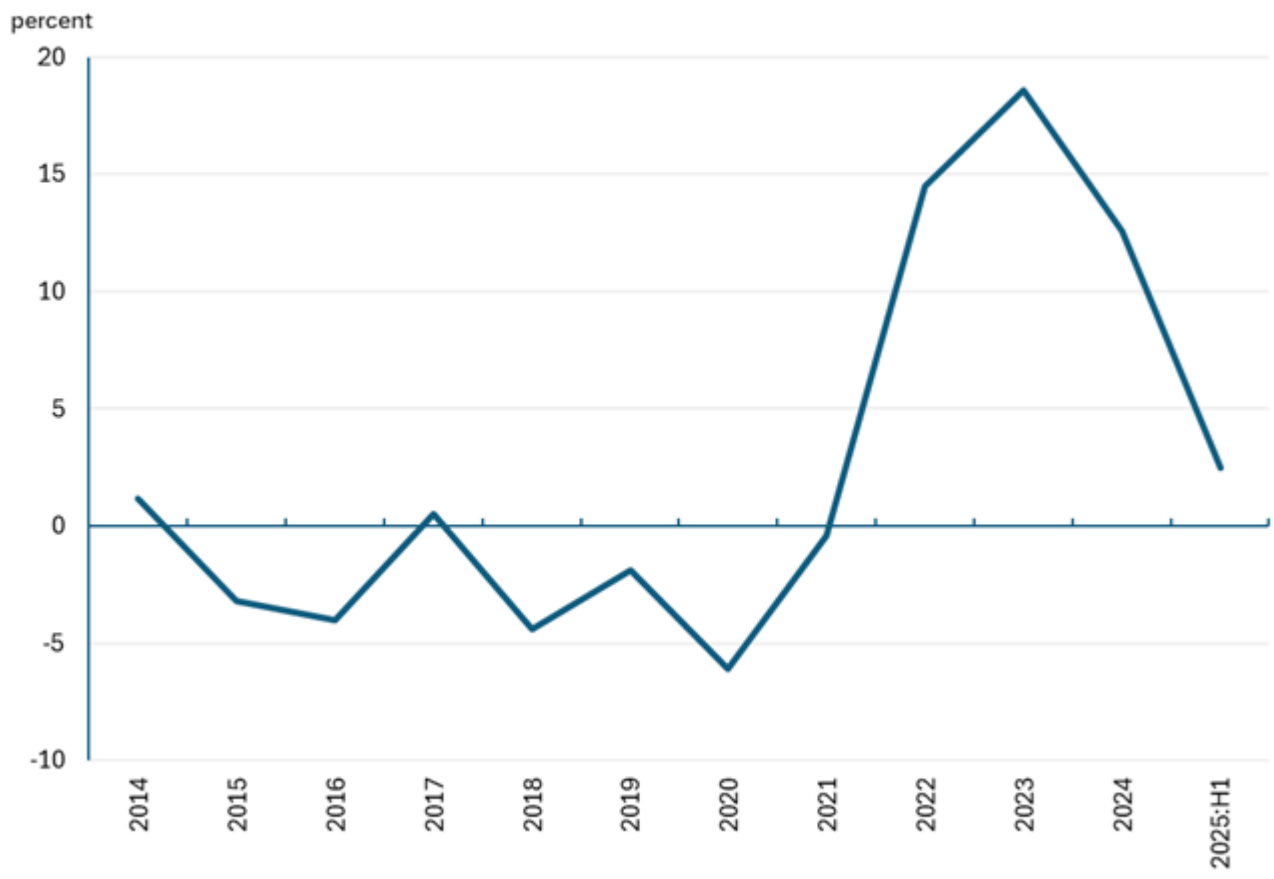
2. Fundamentals of the top eight markets for data centers, first half of 2025

Market	Inventory (MW)	YoY change (MW)	Available (MW)	Vacancy rate (%)	YoY change (bps)	2025: H1 net absorption (MW)	YoY change (MW)	Rental rate ($ per kW/month)
Northern Virginia	3,480	869	25	0.7	−80	539	431	190–235
Atlanta	1,279	969	24	1.9	−690	281	267	160–180
Dallas	870	279	21	2.4	−200	279	238	140–175
Chicago	692	102	16	2.4	50	55	25	185–215
Phoenix	685	174	11	1.5	−180	83	−65	170–210
Silicon Valley	484	25	22	4.5	−190	21	−12	175–275
Hillsboro, OR	475	48	1	0.2	13	48	−123	150–155
New York tri-state	190	0	13	7.1	60	−1	−1.1	180–225

Notes: MW stands for megawatt; bps, basis points; and kW, kilowatt (1,000 kilowatts = 1 megawatt). YoY stands for year-over-year (comparing the first half of 2025 with the first half of 2024). In this context, net absorption means the net change in leased space, calculated by subtracting the total capacity vacated from the total capacity leased. Rental rates are quoted asking rates for 250-plus kW at *N* + 1/Tier III requirements, which ensure data center high availability (99.982% annual uptime, or Tier III annual uptime) through the provision of at least one extra component (+1) for every critical system (e.g., power or cooling) beyond what is needed to handle the maximum load (*N*). See CBRE (2025a) for additional context.
Source: CBRE Research.

Largely resulting from favorable vacancy trends, rental rates for data centers also continued to increase, though they've begun to moderate since their 2023 peak, per CBRE Research (figure 3). As of first half of 2025, average asking rent for the top eight markets increased by 2.5% since the second half of 2024 for data centers with 250-to-500-kilowatt (kW) requirements.

3. Average year-over-year asking rent growth for the top eight markets for data centers, 2014–25



Notes: The top eight markets are listed in figure 2. See CBRE (2025b) for additional context.
Source: Authors' adaptation of data from CBRE Research.

Loan performances for data centers are not currently directly observable because of regulatory data limitations. However, according to Federal Reserve data, the delinquency rate for the overall industrial property type that the majority of the data centers are part of was 1.6% as of the third quarter of 2025—which was one of the lowest among all property types. In addition, while there have been large data center transactions, large banks are not materially concentrated (as a percentage of tier 1 capital) in data centers. Despite the strong loan performances and property fundamentals, there are multiple tail risks from lending to this property type. Tail risks that could impact lenders such as banks include 1) high upfront capital investment and interconnectivity among companies the create concentration risks for lenders; 2) potential obsolescence of the equipment and technologies built inside these properties, resulting in loss of tenants or the need for further capital investment; and 3) exit risk due to the fact that data centers are often built in highly specialized ways and, therefore, tenant replacement may be difficult or infeasible.

Conclusion

As discussed in this article, the current momentum around generative artificial intelligence, due to its potential to significantly boost our productivity, has continued to spur significant investments into the space. The fundamentals of the parties receiving the funding look appropriate as of now. That said, there are risks—which if they were to manifest could impact the standing of those borrowers and in turn the providers of their funding. Banks make up a part of those providers. As we've outlined here, from a C&I perspective, the average large bank has a committed exposure of 25% of tier 1 capital. Given data limitations, it is difficult to provide a percentage of committed exposure from a CRE perspective, but it is not material. The aforementioned committed amounts would be the maximum loss for large banks for the known direct AI exposure, but that is highly unlikely given that some recovery of losses would occur (albeit this is uncertain) and not all borrowers would default. To further explore banks' AI exposure, we must additionally investigate their indirect exposure to AI, and the data within the CRE space would likely provide us more perspective on the potential implications for large banks.

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Notes

[1] In this article, we define large banks as bank holding companies, covered savings and loan holding companies, and U.S. intermediate holding companies with $100 billion or more in total consolidated assets that file the Federal Reserve's FR Y-14Q Schedule H.

[2] Unless otherwise indicated, all U.S. dollar amounts and percentages reported throughout the article are from calculations by the authors based on FR Y-14Q Schedule H data (see also note 8). Committed balances refer to the legally binding promise from a lender to make funds available to a borrower. Outstanding balances refer to the portion of the committed funds that has already been borrowed by the borrower and is currently owed to the lender. AI has the ability to affect all industries within the FR Y-14Q Schedule H data, as companies invest in the technology. The industries included here are those with the most direct exposure to data centers, AI models, or AI software companies. As there is not an indicator of which companies focus on AI, not all companies in these industries have exposure to AI.

[3] Delinquency rate is defined as the percent of total outstanding debt that is at least 90 days past due or in nonaccrual status.

[4] In the 2017 North American Industry Classification System (NAICS), the software codes are 511210 (software publishers) and 518210 (data processing, hosting, and related services), plus the codes beginning with 5415 (computer systems design and related services).

[5] In the 2017 NAICS, the energy codes are the codes beginning with 2211 (electric power generation, transmission, and distribution) and 2212 (natural gas distribution).

[6] In the 2017 NAICS, the semiconductor codes are all the codes beginning with 3344 (semiconductor and other electronic component manufacturing).

[7] Given tail risk scenarios are discussed in this article, commitments are used as borrowers may draw on lines of credit in the event of extreme stress. All commitment trends discussed in the C&I section apply to outstanding exposure as well.

[8] All tier 1 capital and total asset metrics reported throughout the article are from calculations by the authors based on both FR Y-14Q Schedule H and FR Y-9C data.

[9] Capital injections include issuance of debt or investments by angel investors, venture capital, or investment funds for an equity stake. For public companies, issuance of stock can be used to raise additional capital. The government may also provide additional capital to struggling companies, if necessary.

[10] B and below borrowers are generally highly speculative borrowers with material default risk and a limited margin of safety. For more information on ratings, see FitchRatings' rating definitions. The sources of the ratings are Federal Reserve staff calculations based on data from the FR Y-14Q Schedule H (excluding asset-backed lending and unrated loans) and S&P Global.

[11] See, e.g., the NRG Energy, Inc. (2025), Hao (2025), and the Pacific Gas and Electric Company (2025).

[12] See NVIDIA Corporation (2025, p. 22), Broadcom Inc. (2025, p. 28), and Barth et al. (2025).

[13] For example, NVIDIA announced at the 2026 Consumer Electronic Show that their newest Rubin chips will not require the level of cooling that their previous chips required, leading to investor sell-offs of data center cooling system providers (Kopack, 2026).

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