Capital Market Consequences of Generative AI: Early Evidence from the Ban of ChatGPT in Italy

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Abstract

On March 31, 2023, the Italian data protection authority found that ChatGPT violated data protection laws and banned the service in Italy, providing a natural experiment to assess the economic consequences of generative AI. Italian firms with greater exposure to the technology exhibit an underperformance of around 9% compared to firms with lower exposure during the ban period. We observe a more significant negative impact on stock value for smaller and newly established companies, supporting a linkage to creative destruction. We also document that the ban affected the information environment. Analysts located in Italy issue fewer forecasts than foreign analysts covering the same Italian firm. Further, bid-ask spreads widen during the ban, particularly for firms with fewer institutional investors, limited analyst coverage, and a lower presence of foreign investors. Our findings collectively suggest a dual role of Generative AI in enhancing firm productivity and information processing.

Keywords: *AI, Generative, ChatGPT, privacy, disruption, innovation*, *information processing capacity.*
JEL Codes : O00, O33, O38, E44, E65, G10, G14.

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"*ChatGPT is a development on par with the printing press, electricity and even the wheel and fire*"

—— Lawrence H. Summers, former US Treasury Secretary

I. Introduction

The advent of generative AI has revolutionized access to productivity tools, enabling a widespread utilization that was once unimaginable. Leading contenders in this field, such as Google's Bard and OpenAI's ChatGPT, have offered businesses across the globe the opportunity to automate tasks that previously required trained individuals and significant infrastructure, presenting a powerful force for accelerated creative destruction (Schumpeter, 1942). However, the many applications of the technology make it challenging to characterize and analyze its economic value across a broad array of economic tasks. To assess economy-wide impacts, an ideal randomized experiment would be necessary: such an experiment would randomly treat a sample of representative firms with plausibly exogenous factors affecting access. Unfortunately, observing such an experiment, which would deprive businesses of potentially important benefits, seems improbable.

Yet, on March 31, 2023, due to concerns over consent and privacy of personal data, Italy banned ChatGPT within its geographic boundaries, prompting the shutdown of access to servers for all IP addresses originating from Italy. After nearly a month of discussions and improvements, Italian regulators re-authorized the service on April 28, 2023.

This natural experiment presents a remarkable setting to assess the effect of generative AI on an entire economy. First, the ban was enforced by a regulatory agency to uphold privacy laws rather than being a response to economic factors tied to ChatGPT, such as perceived productivity gains or lobbying efforts from professions directly impacted by the technology. Second, there was no forewarning from Italian regulators about their intention to impose the ban, nor was there an ongoing public discourse with OpenAI, implying that the ban came as a surprise to financial

markets. Further, the abrupt nature of the ban in terms of time and geography allows us to better control for trends toward the adoption of related technologies correlated to the use of Generative AI. Third, the ban took effect after ChatGPT had already been widely utilized throughout Italy. This provides a unique opportunity to observe the direct effects of the technology across a range of companies and other market participants.

Drawing on Acemoglu et al. (2018), our approach in assessing the impact of the ChatGPT ban is to examine its effects on the stock market valuation of different firms. This approach allows us to estimate the value of generative AI by analyzing changes in the relative stock market valuations of firms with varying levels of exposure (Eloundou et al., 2023; Eisfeldt et al., 2023).[1] On the one hand, greater exposure implies that certain tasks within a firm's operations can be automated or facilitated. Consequently, a ban is likely to result in a relative reduction in productivity for these firms.[2] On the other hand, exposure may facilitate replacing or disrupting outdated business models while new businesses emerge (Caballero et al., 1998, 2001, 2005; Acemoglu and Restrepo, 2018). From this perspective, the ban's impact on market values could depend on the nature of their businesses because the ban may either protect or impede pre-existing operations through its effect on creative destruction.

[1] In a supplementary appendix, we find that the ban leads to insignificant change in the aggregate Italian equity market value. One possible explanation is that listed firms are larger on average and, therefore, the ChatGPT ban, reducing creative destruction targeted toward larger incumbents, marginally benefited larger (more likely to be traded) incumbents (Caballero et al., 2008) at the expense of smaller private rivals. Unfortunately, there are significant conceptual and empirical challenges in measuring the expected return of an entire economy in an event study, so we cannot accurately estimate a benchmark counter-factual market return if the ban had not taken place. Consequently, we follow Acemoglu et al. (2018) and focus on firms with different levels of exposure in our main tests and examine different methodologies to correct for market-level return in a supplementary appendix.

[2] As an illustrative example, we show in Figure A1 how the stock price of Expert.AI, a listed firm on the Milan Stock Exchange, responded to the ChatGPT ban. Expert.AI specializes in providing organizations with data analysis and business solutions. In its 2022 annual report, Expert.AI emphasized the importance of technologies such as "GPT," "Machine Learning," "Natural Language Processing," "Artificial Intelligence," "Machine Translation," and "Speech Recognition," mentioning the keywords more than 40 times. Additionally, on February 15, 2023, Expert.AI announced the launch of its Hybrid AI Platform that integrates GPT, highlighting its reliance on Generative AI (source: Refinitiv/PR Newswire). The stock price of Expert.AI declined by approximately 8% on the announcement day of the ChatGPT Ban in Italy.

To analyze the potential impact of creative destruction, we adopt the generative AI exposure measure proposed by Eisfeldt et al. (2023), which assesses the level of exposure to ChatGPT by examining its ability to perform specific tasks.[3] We build value-weighted long portfolios consisting of industries with high exposure to AI, specifically firms in the Professional, Scientific, and Technical Services (54) and Information (51) sectors. Simultaneously, we short value-weighted portfolios of industries with low exposure. Figure 1 shows that the long-short portfolio strategy results in a negative cumulative return of 1.50% over three days following the announcement of the ChatGPT ban in Italy on March 31, 2023. Over the entire ban period, the long-short portfolio experiences a negative cumulative return of 5.48%, suggesting that the ban leads to a reduction in the market value of exposed firms.[4]

An alternative explanation is that the underperformance of ChatGPT/AI-exposed firms reflects the overall trends of AI-related industries rather than the ban.[5] To alleviate this concern, we construct a matched sample based on European listed firms with similar size, return on assets (ROA), and from the same industry. Using a difference-in-differences research design, our results in Table 2 suggest that Italian firms with greater exposure to ChatGPT exhibit a reduction in the firm value of around 9% during the entire ban period.

Another possibility is that the exposure measure developed by Eloundou et al. (2023) and Eisfeldt et al. (2023) captures systematic risk exposure to the economy, given that the technology sector is cyclical. To alleviate this concern, we conduct a falsification test utilizing Italy's negative

[3] Eisfeldt et al. (2023) use ChatGPT to evaluate whether the tasks performed by different occupations can be executed or improved by ChatGPT's capabilities. This measure captures the potential of generative AI to enhance or replace tasks performed by pre-existing labor.

[4] In Figure A2, we find that there is no notable reversal in the market value of high AI-exposed firms in the two months following the reactivation of ChatGPT on April 28, 2023. The absence of reversal suggests that the short-term ban could have damaged investors' confidence in the long-run prospects of AI-exposed firms in Italy, perhaps due to uncertainties about regulations on data privacy. Investors may still remain uncertain about the temporary nature of the reactivation and refrain from making significant changes to their investments.

[5] For example, there could be increased regulatory scrutiny on AI-related industries in EU, leading to a decline in the stock prices of these industries in the entire EU.

sovereign rating outlook issued by Moody's on August 6, 2022. If the underperformance of firms with higher exposure to ChatGPT is solely driven by an unmodeled greater country-level risk exposure, we expect to find similar effects. Our findings are inconsistent with this alternative interpretation.

We then explore an alternative approach to measure ChatGPT exposure by assessing shareholders' search behavior regarding AI-related information. This method enables us to capture investors' perceptions of the significance of the technology and its impact on companies. We find that the ban significantly decreases the stock value of firms with greater attention. We further define firms with high exposure if their number of mentions of AI topics in the most recent earnings conference call is above the median. This measure seeks to capture the exposure to AI using firms' disclosure. Italian firms with high attention (more mentions of AI topics) experience a negative return of 6.8% (8.7%) during the whole ban period.

Lastly, firms at different stages of their development may be differentially affected. On the one hand, larger firms and firms with extensive operating experience may experience higher returns from adopting new data-based technology (Farboodi et al., 2019; Babina et al., 2022; Chen and Srinivasan, 2023), making them more vulnerable to the ban's negative effects. On the other hand, different from other AI technologies, ChatGPT enables smaller and new firms to leverage non-rivalrous information production from OpenAI, helping them reduce the information advantages held by larger incumbent firms. Our finding supports the latter hypothesis of a more significant effect on newer and smaller firms. These findings suggest that ChatGPT may differ from prior data-based technologies and enable new and smaller firms to narrow the competitive gap. The ban may hinder the adoption of this new technology, depress creative destruction, and negatively affect smaller and new firms (Caballero et al., 2008; Acemoglu and Restrepo, 2018).

The ChatGPT ban may also broadly impact information users and producers in the capital market. Accessing relevant textual and financial information, and analyzing it to make informed investment decisions may become more complex and time-consuming without ChatGPT (e.g., Li, 2008; Dong et al., 2016; Blankespoor et al., 2019). To precisely identify this effect of ChatGPT on information processing capacity, we first focus on financial analysts, who are an essential set of information producers and may potentially be affected by the ban. We employ a novel identification strategy to isolate the ban's effect on analysts' information processing capacity and their forecasting behavior while holding fixed the firm fundamentals. Specifically, we use the country codes of analysts' office phone numbers to infer their locations and therefore identify treated analysts located in Italy. We then compare analysts located in Italy with those in other countries but covering the same firm. Since the ban may diminish the information processing capabilities of analysts located in Italy, we expect these analysts to issue fewer forecasts during the ban period, compared with their peers. We document a significant decrease in the number of forecasts by analysts located in Italy relative analysts located in other countries but covering the same firm. Our results thus provide early evidence of the effect of AI on information intermediaries.

The utilization of ChatGPT can affect the informational attributes of the capital market by changing a broad set of investors' information processing capacity (Blankespoor et al., 2020). ChatGPT transforms this landscape by providing different investors, especially small local investors, a conversational and interactive platform to gather insights and navigate the complexities of financial markets. Consistent with this conjecture, we show that Italian stocks experience a significant increase in bid-ask spreads during the ban. We anticipate and confirm that firms with fewer institutional investors and lower analyst coverage experience a more significant increase in bid-ask spreads. In addition, since the ban is limited to Italian geographic boundaries, foreign investors should not be affected. We find that firms with a higher proportion of foreign

investors exhibit a smaller increase in bid-ask spreads during the ban. Taken together, our findings support the conclusion that the ban leads to higher information acquisition costs, resulting in increased information asymmetry (Verrecchia, 1982).

Our research contributes to multiple strands of literature. First, we add to the literature on measuring the impact of disruptive technologies on firm value. Earlier work examines how technological advances affect firm valuations both analytically and empirically, such as investment-specific technological changes (Papanikolaou, 2011; Kogan and Papanikolaou, 2014), routine-biased automation (Zhang, 2019), and artificial intelligence (Babina et al., 2022, 2023).[6] Recent work by Eisfeldt et al. (2023) measures US public firms' labor force exposure to ChatGPT following Eloundou et al. (2023) and documents that firms in the highest exposure quintile outperformed those in the lowest quintile by 0.4% on a daily basis following the release of ChatGPT in Nov. 2022.

Second, we add to the information processing literature reviewed by Blankespoor et al. (2020) by exploiting exogenous variations resulting from the ban. We further contribute to the recent literature in finance and accounting demonstrating the capacity of technologies such as ChatGPT to extract information from unstructured sources, such as determining the sentiment of news headlines (Lopez-Lira and Tang, 2023), predicting future earnings-per-share (Li et al., 2023), forming economic expectations based on news articles (Bybee, 2023), enhancing the readability of management disclosures and conference calls (Frankel et al., 2022; Kim et al., 2023), quantifying new information conveyed by managers in conference calls (Bai et al., 2023), measuring managers' anticipated future capital expenditure (Jha et al., 2023), measuring business

[6] In addition to firm value, the literature has examined the economic effects of revolutionary technological advancements. As examples, prior studies estimate the impacts of the printing press in European cities from 1450 to 1600 (Dittmar, 2012), the telegraph in China's banking industry during the 19th century (Lin et al., 2021), the extension of high-speed transportation (Chen et al., 2022) and, recently, the expansion of 3G in the US (Fang et al. 2023). Bloom et al. (2021) examine the diffusion of 29 disruptive technologies across firms and geographical locations in the U.S.

complexity (Bernard et al., 2023), and predicting innovation success using patent textual information (Yang, 2023).[7] Our results provide evidence of how disruptive AI technology adoption affects capital market participants' information processing capacity.[8]

II. Institutional Background and Data

2.1. Background on Ban and Restoration in Italy

OpenAI is a non-profit laboratory founded in 2015 with the mission to promote the development of AI. The organization first released GPT-1 on June 11, 2018, and GPT-2 on February 14, 2019, in open source (Radford et al. 2018, 2019) to universal acclaim. GPT-1 and GPT-2 were designed primarily as chatbots with capabilities for text generation rather than as reliable productivity tools or for accurate research or problem-solving. On November 30, 2022, OpenAI released ChatGPT, built on the GPT-3 architecture, making it initially available to selected beta testers and then to the general public on January 30, 2023. The increased size of GPT-3, approximately 100 times the size of GPT-2, allowed GPT-3 to be highly versatile at performing a wide range of complex natural language tasks. GPT-4 was released on March 14, 2023, with about 1,000 times the number of parameters of GPT-3 with vastly improved capabilities to perform complex tasks (OpenAI 2023).

[7] In addition to text analysis, ChatGPT can potentially complete a broader range of tasks. For example, an emerging literature shows that ChaGPT can assist in auditing (Emett et al., 2023; Eulerich and Wood, 2023; Gu et al., 2023), test-taking (OpenAI, 2023; Eulerich et al., 2023; Katz et al., 2023), answering common and accounting questions (Wood et al., 2023; O'Leary, 2023a, 2023b), and conducting research (de Kok, 2023; Korinek, 2023).

[8] To our knowledge, Kreitmer and Raschky (2023) is the only other study that examines the impact of an exogenous shock to generative AI, and it also examines the context of the Italian ban. Kreitmer and Raschky (2023) find a short-term effect of the ban on the output of coding engineers. They also document that this sophisticated user base quickly found remedial strategies, as evidenced by a recovery of coding activity after a few days and an increase in search for proxy servers (VPN). Italian businesses could, in principle, use VPN to bypass IP restrictions. However, not all employees would want to set up a VPN, which might lower connection speed, or would be allowed to do so from their company network, especially for public firms with network security restrictions. In contrast, many coding engineers contributing open source code are self-employed or work independently or for smaller private firms, which might involve fewer restrictions.

On March 20, 2023, OpenAI paused the service for four days after discovering a security vulnerability allowing some users to access the chat history and personal information of other users, over a nine-hour window. Although OpenAI patched the vulnerability, the Italian data protection authority (Garante per la protezione dei dati personali) determined that OpenAI violated Italian and EU privacy laws shortly after the breach. On March 30, Italian regulators issued a first decision (Registro dei provvedimenti n. 112), requiring "temporary limitation of the processing of personal data of data subjects established in the Italian territory" (translated from Italian) and then clarifying this decision on a statement dated March 31, noting that "It will have to notify the Italian SA within 20 days of the measures implemented to comply with the order, a fine of up to EUR 20 million EUR or 4% of worldwide sales may be imposed."

The decision prompted OpenAI to cease its service to IP addresses originating from Italy on March 31, 2023. This decision was largely unexpected and came without any prior press article indicating a looming ban. The news received mixed responses, with Deputy Prime Minister Matteo Salvini stating: "This is a work tool that many young people, many companies, many start-ups were using and I hope that they can use it again as soon as possible, because otherwise Italy will have a gap compared to all other European countries" (Reuters, April 4, 2023). As OpenAI met with Italian regulators, it was widely expected that a reactivation would occur, but no timeline was set in advance (AP News "OpenAI to offer remedies to resolve Italy's ChatGPT ban," April 6).

On April 28, The service was reactivated after OpenAI introduced age verifications to prevent users below 13 years of age and allow users to exercise their right to object to the training of models with their personal data ("ChatGPT: OpenAI reopens the platform in Italy, guaranteeing more transparency and more rights for European users and non-users," press release, April 28, 2023). However, while the service has been uninterrupted since its reactivation, there are still concerns about the long-term regulation of AI in the European Union: the competing service

Google Bard was unavailable in Europe as of May 31 2023 (it eventually launched on July 13) and EU regulators have been revising laws regulating use of AI ("EU lawmakers vote for tougher AI rules as draft moves to final stage", Reuters, June 14, 2023).

2.2. Data Sources and Variable Construction

Stock returns, trading, and ownership information of companies in the European Union and the United Kingdom is obtained from the Refinitiv Eikon and Datastream database. Given that the first decision was released on March 31, we define the ban period from March 31 to April 28 (the restoration date). Table 1 presents variable definitions and summary statistics.[9] A typical firm in our sample has a median monthly return of 0.9%, book-to-market ratio of 0.60, market cap of 315 millions in EUR, and ROA of 0.05. As reported in Table A1 Panel A, the average market cap is 2.26 billion EUR for Italian stocks and 1.97 billion EUR for matched Euro stocks and the average ROA is 0.04 for both Italian and matched firms. There is no statistical difference between Italian and matched firms in terms of market cap and ROA.

III. The Impact of ChatGPT Ban on Firm Value

3.1. The Heterogeneous Impacts of ChatGPT Ban Across Firms

We assess the value of ChatGPT by estimating changes in the relative stock market valuation of firms with different levels of exposure. The impact of the technology on different business models varies significantly. For example, adopting generative AI in information and

[9] We check the accuracy of the stock returns data obtained from Refinitiv by comparing it with Yahoo Finance's stock prices. Specifically, we randomly select 200 European securities in our sample. We download the data on adjusted closing prices from Yahoo Finance and calculate the daily stock returns. The absolute value of stock return difference between Refinitiv and Yahoo Finance is 0 for over 90% of the sample and is less than 1.3% for 98% of the sample. After checking the data quality, we follow Ince and Porter (2006) and Amihud, Hameed, Kang, and Zhang (2015) to address return outliers. We set daily returns as missing if they are above 200% or if $(1 + r_{i,t}) \times (1 + r_{i,t+1}) - 1 \leq 50\%$ and either $r_{i,t}$ or $r_{i,t+1}$ is above 100%, where $r_{i,t}$ is the return of stock i on day t.

professional services industries may offer more benefits, including improved efficiency, cost reduction, and enhanced customer satisfaction (Eisfeldt et al., 2023). These advantages can emerge as a creative destruction, whereby less productive processes are phased out and replaced by more productive ones (Caballero et al., 1998, 2001, 2005; Acemoglu and Restrepo, 2018). This dynamic restructuring drives productivity gains and contributes to these industries' overall growth and competitiveness. Our first focus is on stock returns, since it is a forward-looking metric. By doing so, we can capture market perceptions about the current and future of the technology.

One important first step is to identify the generative AI exposure of each industry. Eisfeldt et al. (2023) first measure each occupation's exposure to ChatGPT based on the occupation's task descriptions. Then, they aggregate the occupation's exposure to the firm level using firm-occupational employment data. Along the same line, Eisfeldt et al. (2023) further develop industry-level exposure to ChatGPT for 2-digit NAICS industries. Since we seek to identify a similar creative destruction effect, we follow their approach to divide the sample based on this task-based ChatGPT exposure. In particular, we obtain Industry-level (2-digit NAICS) exposure to generative AI from Eisfeldt et al. (2023). The industries with the highest exposure are Finance and Insurance (52), Professional, scientific, and technical services (54), Management of companies and enterprises (55), and Information (51). There are no Italian firms in our sample in the Management of companies and enterprises (55). We exclude the Finance and Insurance industry for our baseline analysis due to its unique characteristics and the possible influence of overall instability in the EU financial market in early 2023.[10]

Following Eisfeldt et al. (2023), we form value-weighted portfolios of high exposure (i.e., firms from Professional, scientific, and technical services (54) and Information (51)) versus low

[10] https://www.bloomberg.com/news/articles/2023-03-15/credit-suisse-is-fueling-a-broader-rout-in-european-bank-stocks.

exposure industries (all other industries except Finance and Insurance). We plot the cumulative return over the ban period for high and low-exposure portfolios and a portfolio that is long high exposure and short low exposure. Figure 1 shows that high-exposure industries (the red line) underperform the low-exposure industries (the green line) during the ban period. The long-short portfolio (the blue line) has a negative cumulative return of 1.5% over three days after the announcement and 5.48% over the entire ban period, suggesting a drift after the announcement as more investors price in the ban's effect. Our results suggest that industries that potentially benefit the most from adoption are harmed the most after the ban was announced.

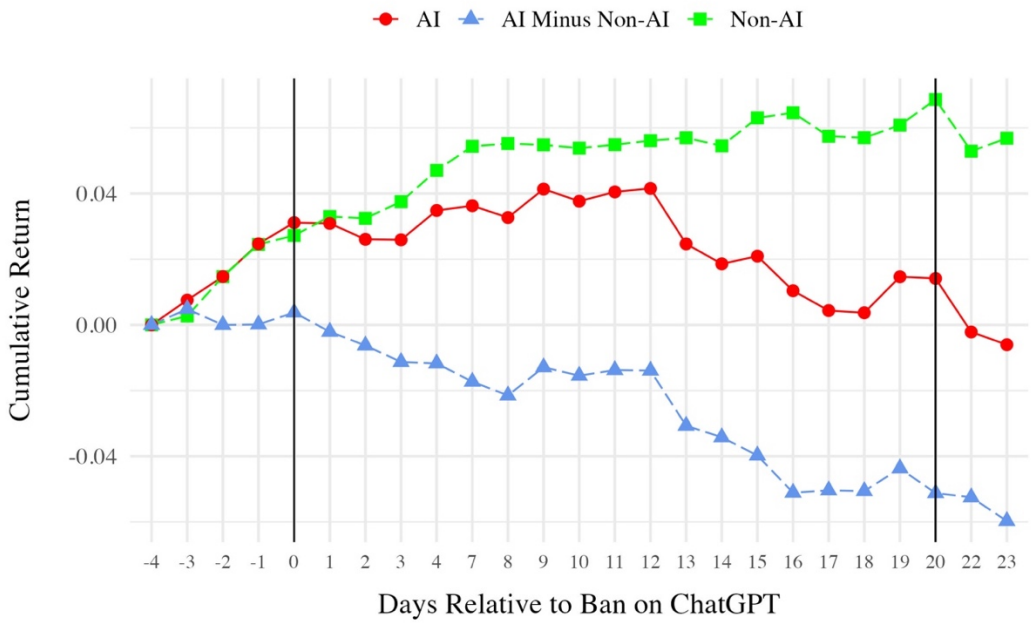

Figure 1: Value-weighted cumulative return for portfolios of Italy stocks in high generative AI exposure and low exposure industries, and a long-short portfolio that longs high exposure and short low exposure stocks. Day 0 (20) is the day of the ban (restoration) of ChatGPT in Italy.

One identification concern is that the ban may primarily reflect growing public concern within the European Union (EU) regarding the data privacy issues associated with AI-related industries. From this perspective, the decline in market value observed in exposed industries could be driven

by the public's apprehension about data privacy issues instead of concerns about the inaccessibility of the productivity gain brought by the technology. To alleviate the concern, we employ propensity score matching to construct a set of control firms.[11] Each Italian stock is matched to a non-Italian stock based on industry, classified by a 2-digit NAICS code, market capitalization, and profitability measured by return on assets (ROA) without replacement.

We construct the matched sample to compare Italian firms with non-Italian firms with similar fundamentals. The market capitalization for each firm is calculated as of March 24, 2023 (i.e., one week before the ban). After matching, Italian and matched firms have insignificant differences across market cap and ROA. We also require firms to have non-missing value on returns from March 24 to March 31.

For our primary analysis, we use a control sample with firms in the European Union (excluding Italy) and the United Kingdom, which leads to a sample of 228 Italian firms and 228 matched Europe firms.[12] It is conceivable that the market may have anticipated other European countries to ban ChatGPT, as evidenced by announcements of investigations in France (April 11), Spain (April 13), and Germany (April 24), muting the documented effect if control firms are also treated. To alleviate this concern, we show in Table A6 that our results are similar using a matched control sample with only UK firms.[13]

Based on the matched sample, we test whether the ban impacts firms with different levels of exposure with a multivariate regression to control for other confounding factors. We form a sample

[11] Our results are robust to using different matching methods such as matching each Italian firm to three control firms, matching based on Mahalanobis distance matrix, or matching using Coarsened Exact Matching (CEM). Details of alternative matching methods are reported in Table A1.

[12] The total market capitalization of Italian firms in our sample is 514.8 billion EUR, approximately 73% of the total Italian market capitalization in February 2023 estimated by CEIC (Source: https:// www.ceicdata.com/en/italy/market-capitalization/market-capitalization-total).

[13] Except for the turnover result which is no longer statistically significant.

of Italian firms and their matched counterparts and examine the effect of exposure by estimating the following equation:[14]

$$Return_{i,t} = \beta_1 Italy_i \times D_i + \beta_2 D_i + \beta_3 Italy_i + X_{i,t-1} + Industry\ FE + \epsilon_{i,t}, \quad (1)$$

where *Italy* equals one for all Italian stocks and zero for the matched non-Italian stocks. D_i is a dummy variable that equals one for either firms with high levels of exposure, new firms, or small firms. We use three definitions of exposure. First, as mentioned above, firms are classified as having high exposure if they are in the professional, scientific, and technical services industry and information industry (Eloundou et al., 2023; Eisfeldt et al., 2023).

Second, we define firms with high exposure if their shareholders' attention to ChatGPT is above the median value (High AI Att). This alternative definition intends to capture investors' perceptions of the importance of AI on firm value. To construct firm-level AI attention, we first download from Refinitiv a country-level breakdown of the shareholder base for all firms in our sample. We then identify investor attention to ChatGPT based on a country-level Google search volume (GSI) of AI/ChatGPT from December 1, 2022 (i.e., after the release of ChatGPT) to March 24, 2023 (i.e., one week before the ban). As mentioned by Google Trends and other research papers using GSI (Eichenauer, et al., 2022; Carrière, et al., 2013), an important characteristic of the data is that Google employs a sampling procedure that introduces substantial sampling variation, affecting the results. In order to address this issue, we draw 50 random samples of GSI data and average the outputs. After obtaining the average country-level attention, we calculate the firm-

[14] All the regressions using stock return as the dependent variable are estimated by weighted least squares where the weight is the market cap of the stock on March 24, 2023 (one week before the announcement of the ban). In doing so, the regression estimates resemble the value-weighted portfolio returns and better capture the economic significance.

level ex-ante investor attention by taking the country-level Google search index average weighted by the percentage of shares held by the investors from each country.[15]

We examine if ChatGPT, a low-cost technology, is a force of creative destruction and levels the playing field for smaller and younger firms by augmenting their capabilities and narrowing the competitive gap with their larger and more established counterparts. We posit that if ChatGPT accelerates creative destruction, the ban's impact would be more pronounced for younger firms. These firms are disproportionately affected as they are hindered from using ChatGPT to bridge the resource gap between themselves and incumbents. We identify younger firms as those with age below the median value within the industry (New).[16]

Last, we classify firms as small if their market capitalization on March 24 (i.e., one week before the ban) is below the median value within the industry and large otherwise (Small Mkt.). $X_{i,t-1}$ consists of lagged book-to-market ratio (Book-to-Market), idiosyncratic volatility (Idio Vol), market capitalization (Market Cap), and the stock return in the last month (Lag Return). We control for industry fixed effects to account for time-invariant industry-level pricing effects, and robust standard errors are reported in parentheses.

In Table 2, we find that firms with higher exposure to generative AI underperform across three definitions of exposure during the ban period. In particular, the estimated β_1 in Column 1 indicates that Italian AI stocks experience an average negative return of 8.7% relative to the matched European stocks. Consistent with the finding in Eisfeldt et al. (2023) that AI industries benefit

[15] We require the sum of country-level ownership to be above 80% to ensure reasonable coverage of the country-level ownership data and below 110% to eliminate obvious errors.
[16] We calculate firms' age by taking the difference between 2023 and each firm's founding year. We manually collect the data on firms' founding years from various public sources.

from the introduction of ChatGPT, the estimated β_2 in Column 1 implies that European AI stocks outperform non-AI stocks by 4.7%.[17]

The incremental decline in firm value is between 6.8% and 9.2%, across specifications. This result is consistent with investors perceiving the ban as a more significant reduction in productivity for firms with higher exposure. Young (small) firms underperform by 6.8% (7.1%) during the ban period than old (large) firms. This finding suggests that the ban benefits incumbent firms, which are more likely to be older and larger, by hindering rivals' access to productivity tools.

3.2. Alternative AI Exposure Measure using Corporate Disclosure

Corporate disclosure plays an essential role in revealing individual firms' AI exposure. We follow Acemoglu et al. (2022) to develop the list of AI-related keywords (See Table A7 and A8 for more details) and analyze Italian firms' 2022 annual reports to identify firms with the number of AI-related keyword mentions above the median value. Consistent with the notion that corporate disclosure enhances the pricing effect, in Table 3, we find similar results suggesting that firms with a higher number of AI-related keyword mentions experience a price decline during the ban period.

3.3. Additional Analysis and A Placebo Test

We investigate whether the effect of the ChatGPT on stock returns differs across firms with different investor bases. Utilizing detailed Italian firms' ownership data from Refinitiv, Table A3 highlights significant differences in stock market reactions across different types of investors, consistent with our findings that market-wide returns remain largely unaffected. First, Italian firms

[17] Furthermore, we re-run Column 1 using four other matching methods and the results are consistent (see Figure A4).

with higher government (domestic/insider) ownership show a positive (negative) return. Second, we do not observe significant return patterns related to retail or institutional ownership.

A valid concern when interpreting the cross-sectional tests is that firms with a higher exposure could be more exposed to market risk and associated with magnified market returns changes. Consequently, the underperformance could be due to their market risk exposure rather than the ban. Unfortunately, since the ban affected the entire Italian market, it is not feasible to adjust firm returns based on the market return of Italian firms without controlling away the ban's effect. To address this concern, we demonstrate in Figure A3 and Table A2 that the underperformance of AI industries in Italy is qualitatively similar when using returns adjusted for market performance in other EU countries excluding Italy. Second, we conduct a placebo test in Table A4 utilizing Moody's lowering of Italy's sovereign rating outlook from stable to negative on August 6, 2022. If our results are driven by AI industries being more responsive to a country-level market shock, we expect exposed industries to respond more strongly to the sovereign rating downgrade. However, we do not find any underperformance for firms with high exposure relative to low exposure.

3.4. The Impact of ChatGPT Ban on Market-wide Valuations

Last, we examine the impact of the ChatGPT ban on Italian market-wide stock responses. The market-wide stock response test is a joint test of a) whether investors paid attention to the announcement of the ban and its restoration, b) whether investors perceive ChatGPT as a productive tool, c) whether investors agree on the value of ChatGPT adoption on firm value. Even if all three conditions are met, we still might not see a significant market-wide price reaction since ChatGPT could benefit a subset of firms while harming the value of other firms. For example, we find that Italian firms with higher AI exposure significantly underperform firms with lower AI

exposure. The heterogeneous effects of the ChatGPT ban across firms might cancel out and lead to an insignificant market-wide response.

Table B1 and Figure B1 document insignificant Italian market-wide stock response to the ChatGPT ban for different time windows after the announcement date. There is no significant market-wide reaction from the ChatGPT restoration date to one day after (i.e., [+20, +21]) and three days after (i.e., [+20, +23]). We further show that this finding is robust to: a) comparing the difference between Italian stock return and the matched European stock return over the ban period (Figure B2), b) using five different matched samples (Figure B3), and c) testing the return difference using a multivariate regression that controls for other risk factors and industry fixed effects (Figure B4).

IV. The Impact of the ChatGPT Ban on the Information Environment

In this section, we first examine the effect of the ban on the information environment. First, we examine analysts' forecasting behaviors to assess how the ban influences information production. Second, we use the bid-ask spread to assess whether the ban constrains investors' information processing capabilities, increasing information asymmetry. Third, to further explore the impact of the ban on investors' response to public information, we study the market reaction to earnings announcements during the ban period.

4.1. The Impact of the ChatGPT Ban on Analysts' Information Production

We examine whether the ban affects information production by financial analysts. On the one hand, prior research shows generative AI's potential to assist financial market participants' information processing and content creation (e.g., Li et al., 2023). On the other hand, the impact of the ban on analysts may be negligible for multiple reasons. First, the treatment effect depends

on how widely adopted ChatGPT has been by analysts before the ban. Second, analysts potentially have more resources (e.g., VPN) to surpass the ban and process information via ChatGPT. Therefore, our results on financial analysts may capture a lower bound of the ban's impact on information production.

The first empirical challenge arises from the direct impact of the ban on economic fundamentals, as outlined in our earlier section (Table 2). Consequently, the change in analysts' behavior results from changes in information processing costs and firm fundamentals. To alleviate this concern, within the group of analysts covering a particular Italian firm, we compare those based in Italy with their counterparts in other countries. This research design allows us to control for changes in firm fundamentals, ensuring that differences in forecast likelihood and frequency can be attributed to the ban. We identify analysts' location using the country code of their phone number to determine their office address.

We obtain data on analysts' names[18] and their forecasts on European firms from the I/B/E/S international file. The forecasts are matched to Italian firms using stock ticker.[19] This procedure yields a sample of 177 analysts covering 112 Italian firms, and a third of the analysts are likely based in Italy based on their office numbers' country code. We hypothesize that analysts in Italy will be less inclined to issue forecasts or decrease the frequency of their forecasts compared to analysts in non-Italian countries who cover the same firm. To test this hypothesis, we estimate the following specification:[20]

$$Forecast_{i,g,t} = \beta_1 Italy\ Analyst_{i,g} \times Ban_t + \beta_2 Italy\ \ Analyst_{i,g} +$$

[18] While the identity of analysts is masked in I/B/E/S Detail History file, I/B/E/S recommendation file provides the surname and the first letter of the given name of the analysts.
[19] Given that tickers can be reused and may overlap with each other across different stock exchanges, we manually check the matching accuracy and delete incorrect matches.
[20] The baseline regressions are estimated using OLS. In untabulated supplementary analyses, we use Poisson regressions either with or without fixed effects to avoid biased estimates and find similar results.

$$Firm \times Month\ FE + \epsilon_{i,g,t}, \quad (3)$$

where $Forecast_{i,g,t}$ is the forecast outcomes of analyst group *g* covering firm *i* in month *t*. We focus on three different measures of forecast quantities at the firm-group-month level and include: a) a dummy variable set to 1 if at least one forecast is issued by group *g* covering firm *i* in month *t,* and 0 otherwise (forecast likelihood); b) the number of forecasts by each group *g* covering firm *i* in month *t* (forecast frequency); c) the number of forecasts scaled by ex-ante (i.e., pre-ban period) number of analyst coverage for each group *g* covering firm *i* in month *t* (forecast frequency per analyst).[21] The first two outcomes shed light on the extensive and intensive margin of the impact of the ChatGPT ban. The third measure captures the average number of forecasts per analyst. *Ban* is a time dummy that equals one for the ban period and zero for the pre-periods, i.e., January, February, and March (before March 31). Our data's three-dimensional (firm-group-month level) nature allows us to control for firm-by-month fixed effects.

We report the results in Table 4. We evaluate the extensive margin of analyst forecast (forecast likelihood) in Column 1 of Table 4. The forecast likelihood decreases by 10.9% for the group of analysts located in Italy relative to analysts in other countries covering the same Italian firm during the ban period. As for the intensive margin, the number of forecasts and forecasts per analyst decrease by 0.29 and 0.14 (6.97% and 10.31% of the sample standard deviation) for analysts in Italy relative to their non-Italian counterparts, consistent with ChatGPT assisting analysts in their day-to-day operations. Note that we cannot identify from these tests how analysts use the technology because we only observe the occurrence of a forecast; in particular, it could be

[21]There are one treatment group and one control group for each firm – analysts in Italy and analysts in other countries. In addition to analyzing analyst forecasts at firm-group-month level, we perform a robustness check at firm-analyst-month level and find qualitatively similar results.

ChatGPT helps analysts process information, or assists them to better explain and present the forecast. Both channels are consistent with a reduction in the information available to investors.

4.2. The Impact of the ChatGPT Ban on Bid Ask Spread

We hypothesize that generative AI may help investors process and summarize unstructured information (e.g., Kim et al., 2023), leading to better information flows, more trading, and lower information asymmetry. To test this, we employ a difference-in-differences design by estimating the following equation:

$$Bid - ask_{i,t} = \beta_1 Italy_i \times Ban_t + \beta_2 Italy_i + X_{i,t-1} + Time/Industry\ FE + \epsilon_{i,t}, \quad (2)$$

where *Ban* is a time dummy that equals one for the ban period and zero for the pre-periods, i.e., January, February, and March (before March 31). We mainly focus on the bid-ask spread and the bid-ask spread adjusted by trading volume. We see from Table 5 that both the raw (column 1) and adjusted (column 2) bid-ask spread significantly increase by around 0.03, or roughly 1.5 times the standard deviation.[22] This result is consistent with the ban hindering information processing and increasing information asymmetry among investors.

We further conduct several cross-sectional tests on the adjusted bid-ask spreads (Table 6) to shed light on the mechanism driving the increased information asymmetry.[23] Firms with limited analyst coverage are more prone to information processing problems and suffer decreased liquidity during the ban. Firms with higher foreign ownership (column 2) have a lower increase in information asymmetry since the ban only applies to Italian geographic boundaries and does not affect foreign investors. Consistent with the notion that smaller and unsophisticated investors rely

[22] We show in Table A5 the results on stock return total volatility, idiosyncratic volatility, and turnover. Turnover declines significantly during the ban period for Italian stocks, consistent with our hypothesis.
[23] Our cross-sectional results remain consistent using unadjusted bid-ask spreads.

more on ChatGPT to parse through financial information than institutional investors, we find that firms with higher institutional ownership (High Institution, column 3) exhibit a smaller increase in the bid-ask spread. Overall, our results point to ChatGPT's role as a productivity tool that facilitates investors' information processing.

4.3. The Impact of ChatGPT Ban on Market Reaction to Earnings Announcements

We further look at the market reaction to earnings announcements during the ban period. The ChatGPT ban may reduce or amplify the stock market's reaction to earnings announcements. On the one hand, if the ban hampers investors' information processing capacity, they may struggle to digest earnings information efficiently during the ban period. This reduced capacity could lead to delayed or less accurate assessments of earnings reports, resulting in a delayed market response.

On the other hand, the ChatGPT ban may amplify the reaction to earnings announcements due to inefficient integration of news to stock prices before the earnings announcements. To illustrate this, consider the price movement of a hypothetical stock with and without prior information acquisition before an earnings announcement or another scheduled public news event. In an market where traders are able to collect private information, part of the information is acquired and integrated into the price before its public disclosure (e.g., Kyle 1985, Back 1992), muting the market reaction to earnings information. In contrast, without informed traders, no market participant is aware of the information content of the impending disclosure event. Thus, the immediate response of stock prices to earnings announcements is substantial. Another potential channel is that the ban results in fewer analyst forecasts leading to earnings announcements, as we document earlier. Consequently, there is a higher influx of information during earnings-announcement windows, potentially resulting in more pronounced market reactions (Ball and Shivakumar 2008).

In sum, the ChatGPT ban's impact on reactions to earnings announcements is ex-ante unclear, and we test these two opposing predictions empirically. We follow Livnat and Mendenhall (2006) and Mian and Sankaraguruswamy (2012) to calculate the unexpected earning *(UE)* which represents the unexpected part of the earnings announcement, as follows:

$$UE_{i,t} = \frac{Earnings_{i,t} - Earnings_{i,t-1}}{P_{i,t}}, \quad (4)$$

where $Earnings_{i,t}$ is the earnings per share of firm *i* in year *t* and $P_{i,t}$ the stock price two days before the earnings announcement date in year t to avoid the contamination effects of announcements on prices. We use firms' earnings in the last year ($Earnings_{i,t-1}$) as investors' expected earnings for year *t.* We also use the median value of analyst forecasts as the market's expected earnings and find similar results.[24] *UE* is winsorized at 1 percent and 99 percent to mitigate the impact of extreme values.[25]

We measure stock market's reaction to earnings announcements by regressing stock returns on unexpected earnings. In particular, we estimate the following regression:

$$Ret_{i,t} = \beta_1 Italy_i \times Ban_t \times UE_t + \beta_2 Italy_i \times Ban_t + \beta_3 Italy_i \times UE_t + \beta_4 Ban_t \times UE_t + \beta_5 UE_t + \beta_6 Italy_i + Time/Industry\ FE + \epsilon_{i,t}, \quad (5)$$

where $Ret_{i,t}$ is the cumulative abnormal return for firm *i* during three different time windows - three, five, or seven days centered on the earnings announcement dates.[26] *Ban* is a time dummy that equals one for the ban period and zero for the pre-periods, i.e., January, February, and March (before March 31).

[24] In untabulated results, we construct an alternative measure of *UE* by replacing $Earnings_{i,t-1}$ with a measure of analysts' expectation. We calculate analysts' expectations as the median of 1-year ahead forecasts in the 90 days prior to the earnings announcements. The results are qualitatively similar.

[25] We focus on annual earnings announcements because the data on quarterly earnings announcements is scarce for Italian firms.

[26] We take the difference between daily stock return and market return as daily abnormal return. Our results are robust to alternative measures of abnormal returns adjusted based on the CAPM model.

Table 7 shows that the market reaction to the earnings announcements is stronger for Italian firms during the ban period compared to matched non-Italian firms. With a one-standard-deviation (0.13) increase in unexpected earnings, Italian firms experienced an incremental increase in stock prices of 5.42 (0.13*0.417) basis points compared to their matched peers in a three-day window around the earnings announcements. The incremental increase is 11.71 and 12.26 basis points for the five- and seven-day windows around earnings announcement dates. As mentioned above, the ban can reduce market reaction by slowing investors' processing of earnings news, or increase reaction by impeding the incorporation of news into prices before earnings announcements. Our result is consistent with a net effect in favour of the second effect: the ban adversely affects investors' information integration before the annual announcements of corporate earnings when the information is publicly revealed.

V. Conclusion

Despite the overwhelmingly positive response to the availability of AI tools such as OpenAI's ChatGPT, a comprehensive assessment of the benefits of AI remains unclear. This study aims to contribute to this question by examining the capital market response to the ban of ChatGPT in Italy, which created a unique setting where access to the technology was hindered across a wide range of businesses. The ban's impact affected industries with higher exposure to AI as well as smaller and younger firms. These results are consistent with the redistributive effects of Generative AI via creative destruction, challenging incumbents to benefit smaller, younger, and more technology-oriented firms. Additionally, our findings suggest that AI may benefit trading, as evidenced by increased bid-ask spread during the ban, particularly for firms with fewer institutional investors, limited analyst coverage, and a lower presence of foreign investors. Our

analyses on financial analysts' behavior further confirm the benefit of AI in facilitating information processing.

Our results also come with limitations inherent to the nature of the event. Our findings primarily focus on Italian publicly traded firms, and caution should be exercised when generalizing these results to private firms or other countries. Moreover, the empirical setting relies on investor beliefs, which may not always align with actual outcomes. While our findings indicate a persistent underperformance of Italian exposed industries compared to counterfactuals, it is important to acknowledge that evaluating the long-term impact of the ban on the economy necessitates a broader timeframe and evidence derived from post-ban performance.

There are also caveats in our findings. First, Italian businesses could circumvent the ban by utilizing proxy servers with foreign IP addresses. To our knowledge, OpenAI does not have a policy in place to block IP addresses used by proxy servers and sophisticated users, who likely had the greatest use for ChatGPT's coding capabilities, exhibit greater use of proxy servers and quickly recovered within a few days of the ban (Kreitmeir and Raschky, 2023). In a counterfactual where the ban had been prolonged and extended to other countries, it is possible that a greater share of the user base may have moved to such services. ChatGPT users may also have switched to alternative services during the ban, especially considering that Google's Bard was launched shortly before the ban on March 21. However, Bard was initially limited to a select group of users who had made advance reservations on a waitlist. It was made widely available to the general public on May 10 and was launched in the European Union on July 13, after the period of the ban.

Second, if the market had anticipated a short-lived ban, we would underestimate the value destruction of a long-run ban. As a result, our results can only be interpreted to speak about the potential long-term costs of regulations causing limited access to Generative AI, rather than actual damages suffered by the Italian economy due to the ban. We also note that our results cannot

measure welfare and are only intended as inputs to policies about Generative AI. To begin with, market values do not capture the total social value created by private firms or the value appropriated by other stakeholders, such as consumers, governments, or employees. In addition, there may be trade-offs between privacy and economic efficiency, which governments are currently trying to address in evaluating approaches to regulating AI.

Finally, other interesting events may offer complementary evidence about the value of the technology. For example, OpenAI initially did not permit individuals to register in China, although it was not completely blocked and functioned in Mandarin. However, in February 2023, Chinese authorities took steps to restrict access by ordering social media platforms to remove workarounds and enforcing stricter controls on VPN access. The banning of ChatGPT in China is a significant event that may further expand our understanding of the benefits of AI.[27]

[27] The ban in China poses its own empirical challenges and would likely require a study exploiting the institutional features of this economy. First, since ChatGPT was never officially allowed in China, only a select group of users who used workarounds could access the service. These users faced the risk of enforcement actions, which likely limited the widespread adoption of the technology within the country. Second, the banning of ChatGPT in China was not a singular event with a specific date. Instead, it occurred gradually through various informal channels that closed down workarounds. This decentralized approach makes it difficult to pinpoint a precise moment when the ban took effect.

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Variable Definitions

Variable Name	Definition
Return	The monthly buy-and-hold stock return.
Market-Adj. Return	Mkt-Adj Ret is obtained by cumulating the daily abnormal return over a month. The daily abnormal return is adjusted based on the CAPM model: $R_t^{mkt\ adj} = R_t - \beta_t R_{MKT-RF,t}$, where β_t is estimated by running the following regression with daily returns ranging from [-252, -1]: $$R_t - R_t^f = \alpha_t + \beta_t R_{MKT-RF,t} + \varepsilon_t$$ where R_t^f is the risk-free rate and $R_{MKT-RF,t}$ is the value-weighted portfolio return of all stocks in EU plus UK excluding those in Italy in excess of the risk-free rate.
Volatility	The monthly standard deviation of daily raw return.
Idio Vol	The volatility of daily abnormal return calculated based the CAPM model over a month
Turnover	The monthly average of the ratio of traded shares to the total shares outstanding, multiplied by 100.
Bid-Ask	The monthly average of daily bid-ask spreads, which is the bid price minus the ask price divided by the closing price.
Bid-Ask Adj.	The monthly average of daily bid-ask spreads weighted by daily trading volume.
Book-to-Market Ratio	The book value of equity per share divided by the stock price at the month's end.
Market Cap	The market capitalization in EUR billions at the end of a month.
ROA	Earnings before interests and taxes (EBIT) divided by total assets
Forecast Likelihood	A dummy variable set to 1 if at least one forecast is issued by analysts in Italy (analysts in other countries) and 0 otherwise.
Forecast Frequency	The number of forecasts issued by analysts in Italy (analysts in other countries).
Forecast Frequency Per Analyst	The number of forecasts issued by analysts in Italy (analysts in other countries) scaled by the ex-ante number of analysts in the pre-ban period
Unexpected Earnings	Similar to Livnat and Mendenhall (2006) and Mian and Sankaraguruswamy (2012), we calculate the unexpected earning, UE, which represents the unexpected part of the earnings announcement, as follows: $$UE_{i,t} = \frac{Earnings_{i,t} - Earnings_{i,t-1}}{P_{i,t}},$$ where $Earnings_{i,t}$ is the earnings per share of firm i in year t and $P_{i,t}$ is the price per share two days before the announcement date of earnings in year t to avoid the contamination effects of announcements on prices. We winsorize the distribution of UE at 1 percent and 99 percent to avoid the impact of extreme values. We focus on annual earnings announcement due to data coverage issue. We also define UE as indicated by the above equation replacing with a measure of analysts' expectation based on analysts' forecasts. The measure of analysts' expectations is constructed as the median of 1-year ahead forecasts in the 90 days prior to the earnings announcements.

Table 1: Summary Statistics

Variable	Obs.	Mean	St. Dev.	10%	25%	Median	75%	90%
Return	1824	0.020	0.113	-0.087	-0.038	0.009	0.064	0.132
Volatility	1824	2.169	1.349	1.085	1.387	1.844	2.477	3.439
Turnover	1814	19.322	25.014	2.290	5.074	11.351	23.625	41.269
Bid-Ask	1820	0.016	0.019	0.001	0.002	0.010	0.021	0.038
Bid-Ask Adj.	1810	0.016	0.020	0.001	0.002	0.009	0.020	0.040
Book-to-Market	1797	0.850	0.857	0.181	0.320	0.602	1.139	1.693
Idio Vol	1824	5.367	10.388	0.867	1.411	2.635	4.803	10.244
Market Cap	1824	2.019	4.776	0.019	0.081	0.315	1.577	5.305
ROA	1824	0.044	0.102	-0.011	0.016	0.051	0.088	0.127
Unexpected Earnings	233	0.001	0.13	-0.079	-0.021	0.003	0.018	0.054
			Analysts in Italy					
Forecast Likelihood	642	0.805	1.310	0.000	0.000	0.000	1.000	2.000
Forecast Frequency	642	0.408	0.492	0.000	0.000	0.000	1.000	1.000
Forecast Frequency Per Analyst	642	0.397	0.528	0.000	0.000	0.000	1.000	1.000
			Analysts in Other Countries					
Forecast Likelihood	642	0.671	1.507	0.000	0.000	0.000	1.000	2.000
Forecast Frequency	642	0.259	0.438	0.000	0.000	0.000	1.000	1.000
Forecast Frequency Per Analyst	642	0.256	0.481	0.000	0.000	0.000	0.000	1.000

This table shows the summary statistics of the variables in the ban period (i.e., 21 active trading days from March 31st to April 28th). Return is the monthly buy-and-hold stock return. Volatility is the monthly standard deviation of daily raw return. Turnover is the monthly average of the ratio of traded shares to the total shares outstanding, multiplied by 100. Bid-Ask is the monthly average of daily bid-ask spreads, which is the bid price minus the ask price divided by the closing price. Bid-Ask Adj. is the monthly average of daily bid-ask spreads weighted by daily trading volume. Book-to-Market Ratio is the book value of equity per share divided by the stock price at the month's end. Idio Vol is the volatility of daily abnormal return calculated using the 1-factor market CAPM model over a month. Market Cap is the market capitalization in EUR billions at the end of a month. Return on assets (ROA) is calculated as earnings before interests and taxes (EBIT) divided by total assets. UE is unexpected earnings. Forecast likelihood is a dummy variable set to 1 if at least one forecast is issued by analysts in Italy (analysts in other countries) and 0 otherwise. Forecast frequency is the number of forecasts issued by analysts in Italy (analysts in other countries). Forecast frequency per analyst is the number of forecasts issued by analysts in Italy (analysts in other countries) scaled by the ex-ante number of analysts in the pre-ban period. To minimize the effects of outliers, we winsorize all continuous variables at the 1st and 99th percentiles except for stock return.

Table 2: The Heterogeneous Effects of the Ban on Stock Returns

Dependent variable	**Ret**	**Ret**	**Ret**	**Ret**	**Ret**	**Ret**
Dummy (D) =	**ChatGPT-Industry**	**ChatGPT - Industry**	**High ChatGPT/AI Att.**	**High AI Mention**	**New**	**Small Mkt.**
Italy×D	**-0.087****	**-0.092*****	**-0.068*****	**-0.087****	**-0.068****	**-0.071****
	(0.036)	**(0.030)**	**(0.025)**	**(0.040)**	**(0.032)**	**(0.029)**
D	0.047*		0.039*	0.045	0.053*	0.038
	(0.026)		(0.022)	(0.029)	(0.030)	(0.024)
Italy	0.027*	0.028*	0.029	0.026	0.038**	0.022
	(0.016)	(0.017)	(0.018)	(0.020)	(0.017)	(0.017)
Lag B-to-M	0.0007	-0.004	-0.010	-0.011	-0.030**	-0.008
	(0.011)	(0.011)	(0.011)	(0.017)	(0.012)	(0.011)
Lag Idio Vol	0.0006	0.0006	0.0007*	0.0009	0.0009**	0.0006
	(0.0004)	(0.0004)	(0.0004)	(0.0006)	(0.0004)	(0.0004)
Lag Market Cap	0.002**	0.001*	0.001*	0.001	0.002***	0.001*
	(0.0007)	(0.0007)	(0.0007)	(0.0009)	(0.0007)	(0.0008)
Lag Return	0.042	0.037	0.014	0.061	-0.017	0.013
	(0.065)	(0.071)	(0.069)	(0.111)	(0.070)	(0.070)
Industry FE.	No	Yes	Yes	Yes	Yes	Yes
Observations	389	389	387	94	313	389
R^2	0.17	0.23	0.22	0.25	0.30	0.20
Within R^2	--	0.13	0.12	0.15	0.20	0.10

This table reports the heterogeneous effects of the Ban on stock returns. We exploit five ex-ante firm-level measures: AI industry, attention to ChatGPT, number of AI topics mentioned in conference call transcripts, age, and firm size. Firms are classified as having high AI exposure if they are in the professional, scientific, and technical services sector and information sector and low AI exposure otherwise. High AI Att. equals one for firms with above the median level ex-ante investor attention and zero otherwise. We calculate the firm-level ex-ante investor attention by taking the average of the country-level Google search index weighted by the percentage of shares held by the investors from each country. We require the sum of country-level ownership to be above 80% and below 110%. Firms are defined as new if the founding year of the firm is more recent than the median founding year within the industry. We download the incorporation date of each firm from Refinitiv and replace the missing value with manually-collected founding years of Italian firms from Wikipedia. Firms are defined as small if their market capitalization on March 24 is below the median value within the industry and large otherwise. Italy is a dummy variable set to 1 for Italian stocks and 0 otherwise. We include industry fixed effects in Columns 2 to 6. We report standard errors robust to heteroskedasticity.

Table 3: The Incremental Effect of Disclosure– AI Topics in Annual Reports

Dependent Var.=	**Ret**	**Market-Adj Ret**
Italy* × *ChatGPT-Industry* × *High AI Topic	**-0.109***	**-0.146*****
	(0.056)	**(0.053)**
ChatGPT-Industry × High AI Topic	0.036	0.058
	(0.047)	(0.041)
Italy × **ChatGPT-Industry**	-0.009	0.017
	(0.045)	(0.039)
Italy × High AI Topic	0.031	0.058*
	(0.030)	(0.031)
High AI Topic	-0.013	-0.030
	(0.026)	(0.025)
Italy	0.009	-0.011
	(0.020)	(0.019)
Other risk factors	Yes	Yes
Industry FE.	Yes	Yes
Month FE.	Yes	Yes
Observations	291	291
R^2	0.25	0.26
Within R^2	0.16	0.16

This table reports the heterogeneous effects of the ChatGPT Ban on stock returns. We measure Italian firms' exposure to ChatGPT by their mentions of AI topics in 2022 annual reports. Firms are classified as having high AI exposure if their frequency of mentioning the AI-related keywords is above the median. Italy is a dummy variable set to 1 for Italian stocks and 0 otherwise. Standard errors are robust to heteroskedasticity.

Table 4: The Effects of the ChatGPT Ban on Analyst Forecasts

Dependent Variable	Forecast Likelihood	Forecast Frequency	Forecast Frequency Per Analyst
Italy Analyst* × *Ban	-0.109**	-0.290**	-0.141***
	(0.050)	(0.108)	(0.024)
Italy Analyst	0.165***	0.140	0.174***
	(0.027)	(0.129)	(0.023)
Controls	Yes	Yes	Yes
Firm-by-Month FE.	Yes	Yes	Yes
Observations	856	856	856
(Pseudo)R^2	0.67	0.69	0.67
Within R^2	0.07	0.008	0.06

This table reports the effects of the ChatGPT Ban on analyst forecasts. The dependent variables are the forecast outcomes in group *g* covering firm *i* in month *t*, and include: a) a dummy variable set to 1 if at least one forecast is issued by group *g* covering firm *i* in month *t*, and 0 otherwise (forecast likelihood); b) number of forecasts by each group *g* covering firm *i* in month *t* (forecast frequency); c) number of forecasts scaled by ex-ante (i.e., pre-ban period) number of analyst coverage for each group *g* covering firm *i* in month *t* (forecast frequency per analyst). *Ban* is a time dummy that equals one for the ban period and zero for the pre-periods, i.e., January to March. We compare the outcome for the group of analysts located in Italy with those in other countries covering the same Italian firm, controlling for firm-by-month fixed effects. Standard errors are clustered by industry.

Table 5: The Effect of the ChatGPT Ban on Bid-Ask Spread

Dependent variable	Bid-ask spread	Bid-ask Adj
Italy×Ban	**0.028*** **	**0.031*** **
	(0.002)	**(0.002)**
Italy	0.004***	0.004***
	(0.001)	(0.0010)
Controls	Yes	Yes
Industry FE.	Yes	Yes
Month FE.	Yes	Yes
Observations	1,553	1,543
R^2	0.45	0.44
Within R^2	0.34	0.34

This table reports the effects of the ChatGPT Ban on the bid-ask spread. The sample period is from January to April 2023. Bid-Ask is the monthly average of the daily bid-ask spread, which is the bid price minus the ask price divided by the closing price. Bid-Ask Adj. is the monthly average of the daily bid-ask spread weighted by daily trading volume. We control for industry and month-fixed effects. Standard errors are clustered at the industry level.

Table 6: The Heterogeneous Effects of the ChatGPT Ban on Bid-Ask Spread

Dependent variable	**Bid-ask Adj**	**Bid-ask Adj**	**Bid-ask Adj**
Dummy (D) =	**More Analysts**	**High Foreign**	**High Institution**
Italy×Ban×D	**-0.016*** **	**-0.010*** **	**-0.010** **
	(0.002)	**(0.002)**	**(0.004)**
Italy×Ban	**0.039*** **	**0.035*** **	**0.036*** **
	(0.002)	**(0.002)**	**(0.003)**
Ban×D	1.75e-5	0.0001	-0.0001
	(0.0005)	(0.0007)	(0.0007)
Italy×D	-0.009***	-0.007**	-0.008***
	(0.003)	(0.002)	(0.002)
Italy	0.008***	0.007***	0.008***
	(0.002)	(0.001)	(0.002)
D	-0.0001	-0.0004	-0.0001
	(0.001)	(0.001)	(0.002)
Controls	Yes	Yes	Yes
Industry FE.	Yes	Yes	Yes
Month FE.	Yes	Yes	Yes
Observations	1,543	1,467	1,531
R^2	0.50	0.46	0.47
Within R^2	0.40	0.37	0.37

This table reports the heterogeneous effects of the ChatGPT Ban on the bid-ask spread. The sample period is from January to April 2023. Bid-Ask is the monthly average of the daily bid-ask spread, which is the bid price minus the ask price divided by the closing price. Bid-Ask Adj. is the monthly average of the daily bid-ask spread weighted by daily trading volume. More analysts is a dummy variable set to 1 if the ex-ante number of analysts covering the Italian firm in 2023 Q1 is above median and 0 otherwise. High foreign (institution) is a dummy variable set to 1 if the foreign (institution) ownership level of the Italian firm by the end of 2023 Q1 is above median and 0 otherwise. These dummies are the same for the matched firms as those for the Italian firm. We control for industry and month-fixed effects. Standard errors are clustered at the industry level.

Table 7: The Effects of the ChatGPT Ban on the Market Reaction to Earnings Announcements

Dependent variable	Ret [-1,+1]	Ret [-2,+2]	Ret [-3,+3]
Italy*×*Ban*×*UE	0.417**	0.901***	0.943***
	(0.164)	(0.155)	(0.146)
Ban*×*UE	-0.152*	-0.285***	-0.305***
	(0.081)	(0.092)	(0.099)
Italy*×*UE	-0.037	-0.009	-0.071
	(0.052)	(0.082)	(0.127)
Italy*×*Ban	0.081**	0.105**	0.128***
	(0.036)	(0.041)	(0.035)
UE	0.070	0.078	0.104
	(0.061)	(0.069)	(0.097)
Italy	0.005	0.003	-0.0007
	(0.011)	(0.013)	(0.016)
Industry FE.	Yes	Yes	Yes
Month FE.	Yes	Yes	Yes
Observations	230	230	230
R^2	0.14	0.15	0.17
Within R^2	0.05	0.07	0.07

This table reports the effects of the ChatGPT Ban on market reaction to earnings announcements. *Ret* is the cumulative abnormal return for firm *i* during three different time windows - three, five, or seven days centered on the earnings announcement dates. Ban is a time dummy that equals one for the ban period and zero for the pre-periods, i.e., January, February, and March (before March 31st). We include industry and month-fixed effects, and the standard errors are clustered by industry.

A. Supplementary Appendix

Figure A1 An Illustrative Example of the ChatGPT Ban on Firm Value

Expert.AI, a listed firm on the Milan Stock Exchange headquartered in Modena, Italy, specializes in providing organizations with data analysis and business solutions. In its 2022 annual report, Expert.AI emphasized the importance of technologies such as "GPT," "Machine Learning," "Natural Language Processing," "Artificial Intelligence," "Machine Translation," and "Speech Recognition," mentioning the keywords more than 40 times. Additionally, on February 15, 2023, Expert.AI announced the launch of its Hybrid AI Platform that integrates GPT, highlighting its reliance on Generative AI (source: Refinitiv/PR Newswire). As an illustrative example, we examine the stock price reaction of Expert.AI to the ban announcement and find that its stock price experienced a decline of approximately 8% on the announcement day of the Ban.

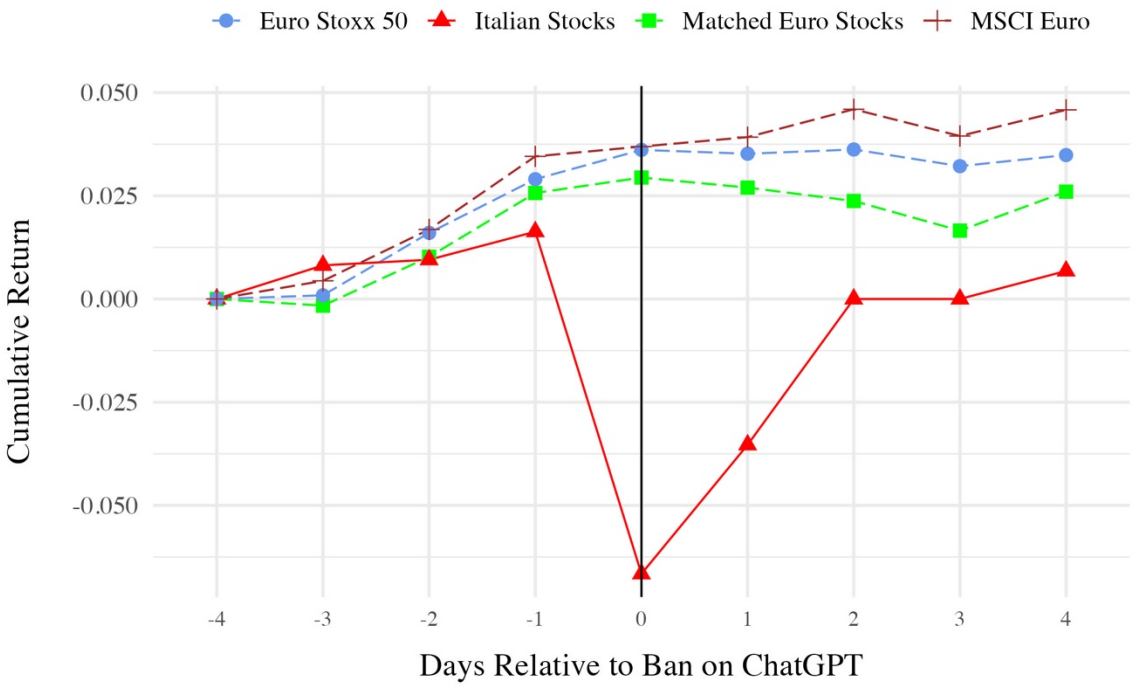

Figure A2: Value-weighted cumulative return for portfolios consisting of Italian stocks in AI industries and Non-AI industries, and a portfolio that longs Italian AI stocks and shorts Italian non-AI stocks. Returns are value-weighted. Day 20 is the day of the restoration of ChatGPT in Italy. Day 60 is about 2 months after the restoration of ChatGPT in Italy.

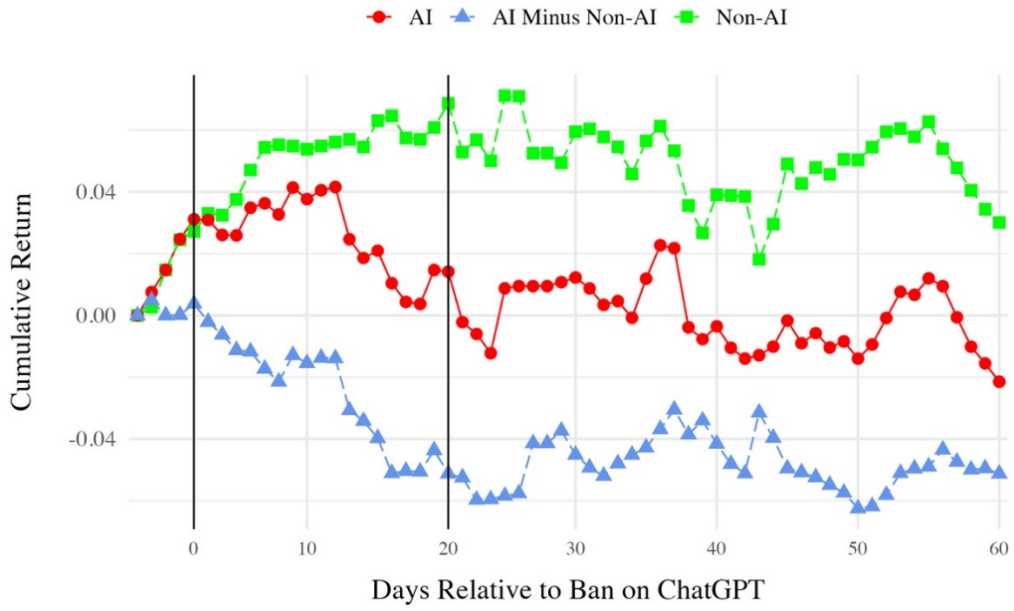

Figure A3: Value-weighted cumulative return for portfolios consisting of Italian stocks in AI industries and Non-AI industries, and a portfolio that longs Italian AI stocks and shorts Italian non-AI stocks. Returns are value-weighted and adjusted for the EU (excluding Italy) market factor. Day 20 is the day of the restoration of ChatGPT in Italy.

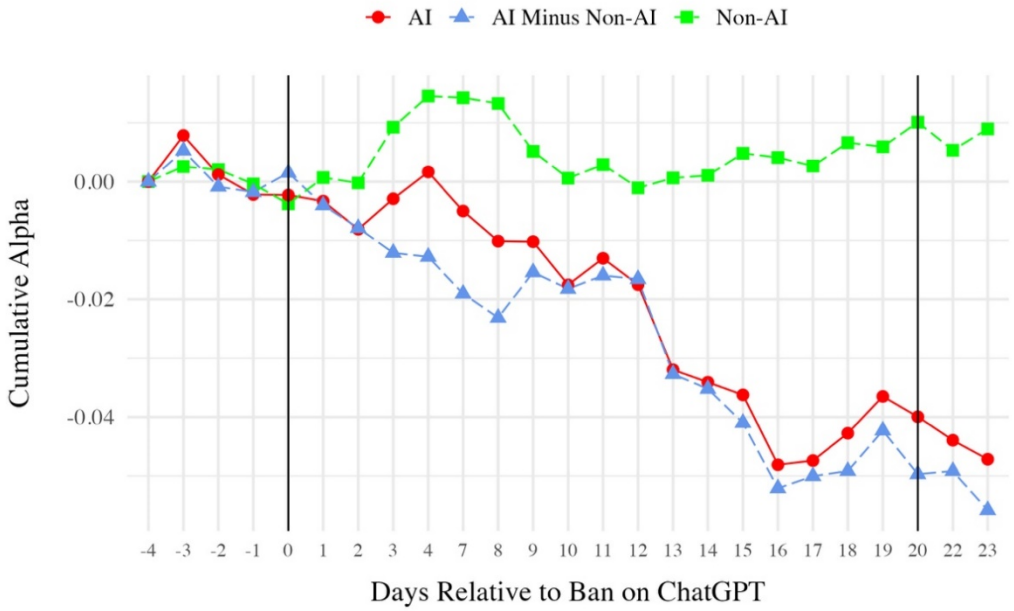

Figure A4: The effect of the Ban on the cumulative returns throughout the ban period, for Italian AI stocks versus non-AI stocks. We use four alternative matching methods for robustness, namely CEM, PSM 1-to-3, PSM Based on Mahalanobis Distance, and PSM using UK firms only. We examine the heterogenous effects across different firms by estimating the following equation using the four matched samples:

$$Return_{i,t} = \alpha_i + \beta_1 Italy_i \times AI_i + \beta_2 Italy_i + X_{i,t-1} + Industry\ FE + \epsilon_{i,t},$$

where *Italy* equals one for all Italian stocks and zero for the matched non-Italian stocks. AI_i is a dummy variable that equals one for firms in AI industries. We include industry fixed effects and a vector of controls. The dots represent the estimated value of β_1 and the bars correspond to 95% confidence intervals. Standard errors are robust to heteroskedasticity.

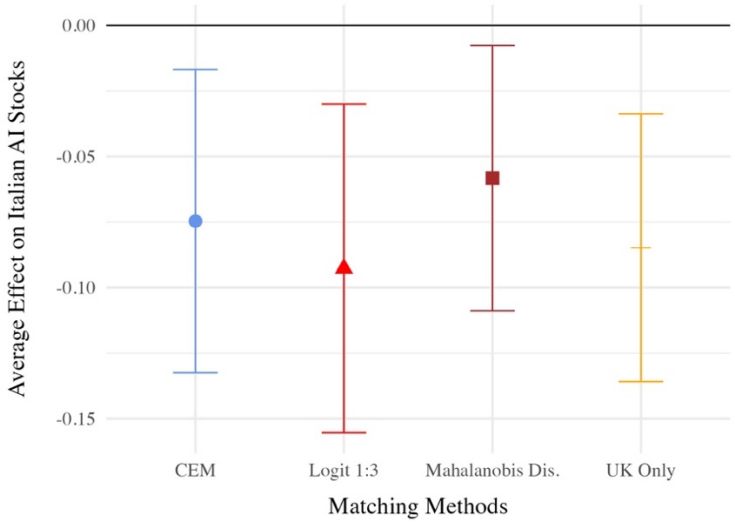

Table A1: Matching Accuracies for Different Matching Methods

Panel A: PSM (Logistic Link) – EU Plus UK			
	Italian Stocks (N=228)	Matched European Stocks (N=228)	Difference (Italy-Europe)
Mkt Cap	2258.04	1974.96	283.09
	(5.23)	(6.2)	(0.73)
ROA	0.04	0.04	0
	(4.09)	(3.48)	(0.94)

Panel B: PSM (Mahalanobis Distance) – EU Plus UK			
	Italian Stocks (N=217)	Matched European Stocks (N=217)	Difference (Italy-Europe)
Mkt Cap	2156.12	2066.78	89.34
	(5.24)	(5.34)	(0.16)
ROA	0.04	0.04	0
	(4.35)	(4.21)	(0.10)

Panel C: CEM – EU Plus UK			
	Italian Stocks (N=291)	Matched European Stocks (N=291)	Difference (Italy-Europe)
Mkt Cap	1586.12	1936.97	-350.85
	(5.47)	(6.64)	(-0.33)
ROA	0.04	0.03	0
	(4.33)	(3.86)	(0.33)

Panel D: PSM (Logistic; 1:3 Match) – EU Plus UK			
	Italian Stocks (N=228)	Matched European Stocks (N=677)	Difference (Italy-Europe)
Mkt Cap	2258.04	2042.12	215.93
	(5.23)	(7.44)	(0.67)
ROA	0.04	0.04	0
	(4.09)	(3.64)	(0.99)

Panel E: PSM (Logistic) - UK			
	Italian Stocks (N=260)	Matched UK Stocks (N=260)	Difference (Italy-Europe)
Mkt Cap	1829.98	2113.26	-283.27
	(5.64)	(5.87)	(-4.33)
ROA	0.03	0.03	0.01
	(3.92)	(3.7)	(0.9)

This table reports the matching accuracy between Italian stocks and stocks in the European Union and the United Kingdom, excluding Italy. We find a matched European stock in the same industry for each Italian firm with the closest market capitalization and ROA without replacement. In Panel A, we use the propensity score method to compute the distance between units as the absolute difference between the propensity scores of pairs of units. The propensity scores are estimated using logistic regression. Finally, we yield a sample of 456 firms in total (228 Italian stocks and 228 European stocks). In Panel B, we compute the Mahalanobis distance matrics from the covariates. In Panel C, we use coarsened exact matching (CEM). In Panel D, we follow the same method as in Panel A, except that each Italian stock is matched to 3 European stocks. In Panel E, we use the propensity score method to find a matched firm with the closest market cap in the same industry from the subsample consisting of only UK firms. Mkt Cap is in EUR millions. We report the t-values in parentheses.

Table A2: The Heterogeneous Effects of ChatGPT Ban on Market-adjusted Returns

D=	AI-Industry	High Attention	High AI Topic	New	Small Mkt.	Low Foreign	High Govern	High Insider
Italy×D	**-0.093*** **	**-0.074*** **	**-0.139*** **	**-0.070** **	**-0.067** **	**-0.079*** **	**0.074** **	**-0.058* **
	(0.032)	**(0.027)**	**(0.049)**	**(0.034)**	**(0.030)**	**(0.026)**	**(0.031)**	**(0.031)**
D		0.048**	0.071**	0.054*	0.043*	0.067***	-0.048*	0.038
		(0.022)	(0.029)	(0.031)	(0.023)	(0.022)	(0.029)	(0.029)
Italy	0.025	0.027	0.025	0.036*	0.019	0.036*	-0.029	0.025
	(0.019)	(0.020)	(0.023)	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	389	387	94	313	389	387	200	212
R^2	0.21	0.21	0.26	0.27	0.19	0.26	0.26	0.20
Within R^2	0.11	0.10	0.14	0.16	0.07	0.16	0.15	0.09

This table reports the heterogeneous effects of ChatGPT Ban on market-adjusted returns. We define the ban period as the period from the announcement date of the Ban to the announcement date of the Reactivation, namely [2023-03-31,2023-04-28]. We then set the benchmark period as January, February, and March. Ban is a dummy variable set to 1 if it is the ban period and 0 otherwise. Mkt-Adj Ret is obtained by cumulating the daily abnormal return over the whole ban period. The daily abnormal return is adjusted based on the CAPM model:

$$R_t^{mkt\ adj} = R_t - \beta_t R_{MKT-RF,t},$$

where β_t is estimated by running the following regression with daily returns ranging from [-252, -1]:

$$R_t - R_t^f = \alpha_t + \beta_t R_{MKT-RF,t} + \varepsilon_t$$

where R_t^f is the risk-free rate and $R_{MKT-RF,t}$ is the value-weighted portfolio return of all stocks in EU plus UK excluding those in Italy in excess of the risk-free rate. All control variables are lagged by one month. We control for industry and month fixed effects and standard errors are robust to heteroskedasticity.

Table A3: The Heterogeneous Effects of the Ban on Stock Returns Across Firms with Different Ownership Structures

D=	High Domestic	High Govern	High Insider	High Retail	High Institutional
Italy×D	**-0.078*** **	**0.062** **	**-0.065** **	**-0.034**	**0.015**
	(0.024)	**(0.029)**	**(0.031)**	**(0.034)**	**(0.030)**
D	0.063***	-0.044	0.038	0.018	-0.005
	(0.022)	(0.031)	(0.031)	(0.031)	(0.027)
Italy	0.039**	-0.018	0.036	0.035	0.005
	(0.018)	(0.020)	(0.022)	(0.024)	(0.024)
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE.	Yes	Yes	Yes	Yes	Yes
Observations	387	200	212	245	386
R^2	0.26	0.25	0.24	0.22	0.19
Within R^2	0.17	0.16	0.15	0.11	0.09

This table reports the heterogeneous effects of the Ban on stock returns. We exploit five ex-ante firm-level ownership measures - domestic, government, retail, institutional, and insider ownership. We download the ownership level of domestic, retail, government, institutional, and insider investors for each firm from Refinitiv. We set the dummy variables to one if the ownership level in March for a particular ownership type is above the median and 0 otherwise. Italy is a dummy variable set to 1 for Italian stocks and 0 otherwise. We include industry fixed effects and report standard errors robust to heteroskedasticity in parentheses.

Table A4: A Placebo Test using Italy's Outlook Downgrade by Moody's on Aug. 6 2022

Panel A: Announcement Effect on August 6, 2022

	Italian Stocks	**Matched**	**Difference**
[0, +1]	0.002	0.008**	-0.006
	(0.655)	(2.08)	(-1.15)
[0, +2]	-0.003	-0.003	-0.0005
	(-0.812)	(-0.870)	(-0.121)
[0, +3]	0.003	0.008*	-0.005
	(0.811)	(1.95)	(-0.941)

Panel B: Heterogeneous Effects on Stock Return

D=	**AI-Industry**	**High AI Att**	**High AI Topic**	**New**	**Small Mkt.**
Italy*×*D	-0.025	0.037*	0.096***	0.003	0.096***
	(0.017)	(0.019)	(0.020)	(0.021)	(0.020)
D		0.004	-0.038*	0.011	-0.029*
		(0.018)	(0.021)	(0.020)	(0.018)
Italy	-0.024**	-0.031***	-0.035***	-0.030***	-0.030***
	(0.010)	(0.010)	(0.012)	(0.011)	(0.010)
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE.	No	Yes	Yes	Yes	Yes
Observations	387	385	94	311	387
R^2	0.45	0.46	0.56	0.48	0.46
Within R^2	0.27	0.28	0.38	0.29	0.28

This table reports the announcement effects and heterogeneous effects of Italy's outlook cut by Moody's on stock returns. On August 6, 2022, Italy's sovereign rating outlook was lowered to negative from stable by Moody's. We expect the Italian market to respond negatively but without differential effects on firms with high vs. low AI exposures. In Panel A, we focus on the cumulative returns around the announcement window [0,+1], [0,+2], and [0,+3]. We focus on the cumulative returns in [0,+3] in Panel B and exploit five ex-ante firm-level measures - AI industry, attention to ChatGPT, AI topics mentioned in conference call transcripts, age, and firm size. Firms are classified as having high AI exposure if they are in the professional, scientific, and technical services sector and information sector and low AI exposure otherwise. High AI Att equals one for firms with above the median level ex-ante investor attention and zero otherwise. We calculate the firm-level ex-ante investor attention to ChatGPT by taking the average of the country-level Google search index weighted by the percentage of shares held by the investors from each country. To be conservative, we require the sum of country-level ownership to be above 80% and below 110%. Firms are defined as new if the founding year of the firm is more recent than the median founding year within the industry. We download the incorporation date of each firm from Refinitiv and replace the missing value with manually-collected founding years of Italian firms from Wikipedia. Firms are defined as small if their market capitalization on March 24 is below the median value within the industry and large otherwise. Italy is a dummy variable set to 1 for Italian stocks and 0 otherwise. All control variables are lagged by one month. We control for industry fixed effects in Panel B. We report standard errors robust to heteroskedasticity in both panels.

Table A5: The Effects of the ChatGPT Ban on Information Processing: Volatility and Turnover

Dependent Var.:	Volatility	Idio_Vol	Turnover
Italy×Ban	**-0.110**	**-0.142**	**-3.68****
	(0.117)	**(0.107)**	**(1.67)**
Italy	-0.220***	-0.212***	2.29
	(0.074)	(0.072)	(1.65)
Lag Book-to-	-0.023	-0.009	2.67
	(0.057)	(0.054)	(2.32)
Lag Idio Vol	0.046***	0.042***	0.527***
	(0.007)	(0.005)	(0.105)
Lag Market Cap	-0.032***	-0.036***	0.674**
	(0.008)	(0.011)	(0.267)
Lag Return	-0.287	-0.675	25.7***
	(0.629)	(0.451)	(6.61)
Industry FE.	Yes	Yes	Yes
Month FE.	Yes	Yes	Yes
Observations	1,557	1,417	1,547
R^2	0.20	0.22	0.13
Within R^2	0.15	0.17	0.08

This table reports the effects of the ChatGPT Ban on stock return volatility and turnover. Volatility is a monthly measure of the standard deviation of daily raw return. Idio_Vol is the standard deviation of daily abnormal return based on the CAPM model. Turnover is the monthly average of the ratio of traded shares to the total shares outstanding. We control for industry and month-fixed effects. Standard errors are clustered at the industry level.

Table A6: Information Processing Results using only UK firms as Matched Sample

Effects on Micro-Structure Outcomes					
Dependent Var.:	Bid-Ask	Bid-Ask Adj	Volatility	Idio_Vol	Turnover
Ban×Italy	**0.031*****	**0.034*****	**-0.188**	**-0.069**	**0.330**
	(0.002)	**(0.003)**	**(0.154)**	**(0.147)**	**(3.72)**
Controls	Yes	Yes	Yes	Yes	Yes
Industry FE.	Yes	Yes	Yes	Yes	Yes
Month FE.	Yes	Yes	Yes	Yes	Yes
Observations	1,776	1,775	1,792	1,454	1,779
R^2	0.61	0.60	0.44	0.44	0.44
Within R^2	0.15	0.14	0.15	0.12	0.09

This table reports the effects of the ChatGPT ban using matched UK firms. We define the ban period as the period from the announcement date of the Ban to the announcement date of the Reactivation, namely [2023-03-31,2023-04-28]. We then set the benchmark period as January, February, and March 2023. Ban is a dummy variable set to 1 if it is the ban period and 0 otherwise. Italy is a dummy variable set to 1 for Italian stocks and 0 otherwise. We control for industry and month-fixed effects, and standard errors are clustered at the industry level.

Table A7: Number of AI Topic Mentions in Italian Firms' Conference Call Transcripts

	Obs.	Mean	St. Dev.	50%	Max.
GPT	80	0	0	0	0
Machine Learning	80	0.013	0.112	0	1
Computer Vision	80	0	0	0	0
Machine Vision	80	0	0	0	0
Deep Learning	80	0	0	0	0
Virtual Agents	80	0	0	0	0
Image Recognition	80	0	0	0	0
Natural Language Processing	80	0	0	0	0
Speech Recognition	80	0	0	0	0
Pattern Recognition	80	0	0	0	0
Object Recognition	80	0	0	0	0
Neural Networks	80	0	0	0	0
AI Chatbot	80	0	0	0	0
Supervised Learning	80	0	0	0	0
Text Mining	80	0	0	0	0
Unsupervised Learning	80	0	0	0	0
Image Processing	80	0	0	0	0
Mahout	80	0	0	0	0
Recommender Systems	80	0	0	0	0
Support Vector Machines	80	0	0	0	0
Random Forests	80	0	0	0	0
Latent Semantic Analysis	80	0	0	0	0
Sentiment Analysis	80	0	0	0	0
Opinion Mining	80	0	0	0	0
Latent Dirichlet Allocation	80	0	0	0	0
Predictive Models	80	0	0	0	0
Kernel Methods	80	0	0	0	0
Keras	80	0	0	0	0
Gradient Boosting	80	0	0	0	0
Opencv	80	0	0	0	0
XGboost	80	0	0	0	0
Libsvm	80	0	0	0	0
Word2vec	80	0	0	0	0
Machine Translation	80	0	0	0	0
Sentiment Classification	80	0	0	0	0
Artificial Intelligence	80	0.138	0.443	0	2
Sum	**80**	**0.15**	**0.506**	**0**	**3**
Total Words	**80**	**8634.488**	**2844.527**	**8350**	**15001**

This table reports the frequency of Italian firms mentioning ChatGPT and AI in their earnings calls' transcripts in Q1 2023. We utilize a keyword list compiled by Acemoglu et al. (2022), which use the keywords to construct firm-level AI job vacancies. We include terms such as "GPT" in our analysis as well. We download Italian firms' earnings calls' transcripts from Refinitiv Eikon. We can retrieve the data for 80 firms. We translate the keywords to Italian for a small set of annual reports written in Italian and do the search.

Table A8: Number of AI Topic Mentions in Italian Firms' 2022 Annual Reports

	Obs.	Mean	St. Dev.	50%	Max.
GPT	264	0.034	0.342	0	5
Machine Learning	264	0.174	0.670	0	5
Computer Vision	264	0.015	0.150	0	2
Machine Vision	264	0.004	0.062	0	1
Deep Learning	264	0.030	0.211	0	2
Virtual Agents	264	0.008	0.123	0	2
Image Recognition	264	0.008	0.087	0	1
Natural Language Processing	264	0.008	0.087	0	1
Speech Recognition	264	0.011	0.137	0	2
Pattern Recognition	264	0.000	0.000	0	0
Object Recognition	264	0.000	0.000	0	0
Neural Networks	264	0.015	0.122	0	1
AI Chatbot	264	0.000	0.000	0	0
Supervised Learning	264	0.000	0.000	0	0
Text Mining	264	0.000	0.000	0	0
Unsupervised Learning	264	0.000	0.000	0	0
Image Processing	264	0.004	0.062	0	1
Mahout	264	0.000	0.000	0	0
Recommender Systems	264	0.000	0.000	0	0
Support Vector Machines	264	0.000	0.000	0	0
Random Forests	264	0.000	0.000	0	0
Latent Semantic Analysis	264	0.000	0.000	0	0
Sentiment Analysis	264	0.023	0.194	0	2
Opinion Mining	264	0.000	0.000	0	0
Latent Dirichlet Allocation	264	0.000	0.000	0	0
Predictive Models	264	0.042	0.251	0	3
Kernel Methods	264	0.000	0.000	0	0
Keras	264	0.000	0.000	0	0
Gradient Boosting	264	0.000	0.000	0	0
Opencv	264	0.000	0.000	0	0
XGboost	264	0.000	0.000	0	0
Libsvm	264	0.000	0.000	0	0
Word2vec	264	0.000	0.000	0	0
Machine Translation	264	0.004	0.062	0	1
Sentiment Classification	264	0.000	0.000	0	0
Artificial Intelligence	264	0.973	3.105	0	33
Sum	**264**	**0.705**	**3.864**	**0**	**42**
Total Words	**264**	**86361.655**	**79718.256**	**66404.5**	**559419**

This table reports the frequency of Italian firms mentioning ChatGPT and AI in their 2022 annual reports. We utilize a keyword list compiled by Acemoglu et al. (2022), which use the keywords to construct firm-level AI job vacancies. We include terms such as "GPT" in our analysis as well. We download Italian firms' 2022 annual reports from Refinitiv Eikon. We can retrieve annual reports for 264 firms. We translate the keywords to Italian for a small set of annual reports written in Italian and do the search.

B. Supplementary Appendix on Market-Wide Response

Table B1 Returns during the Announcement Window and the Whole Ban Period

	Italian Stocks	Matched	Difference
[0,+1]	0.006*	0.002	0.004
	(1.66)	(0.468)	(0.772)
[0,+3]	0.004	-0.0004	0.005
	(0.884)	(-0.098)	(0.961)
Ban Period [0, +20]	0.034***	0.018*	0.016
	(3.98)	(1.78)	(1.05)
[+20, +21]	-0.003	-0.005	0.002
	(-0.755)	(-1.36)	(0.317)
[+20, +23]	-0.012***	-0.006	-0.006
	(-3.12)	(-1.27)	(-1.05)

This table reports the cumulative returns of the portfolios of Italian stocks, matched European stocks, and their difference across different time windows. We report t-statistics adjusted for heteroskedasticity in parentheses.

Figure B1: Value-weighted announcement return around ChatGPT ban (March 31st) and restoration dates (April 28th) for Italy stocks versus EURO STOXX 50, MSCI Euro, or matched EU stocks

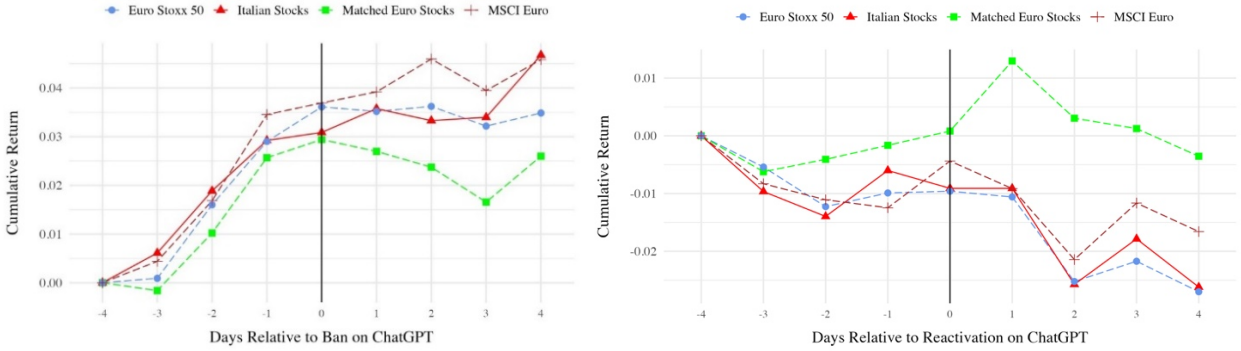

Figure B2: Italian stock return minus the matched European stock return over the ban period. The red line is the value-weighted cumulative returns difference. The grey lines represent 95% confidence intervals based on heteroskedasticity-robust standard errors.

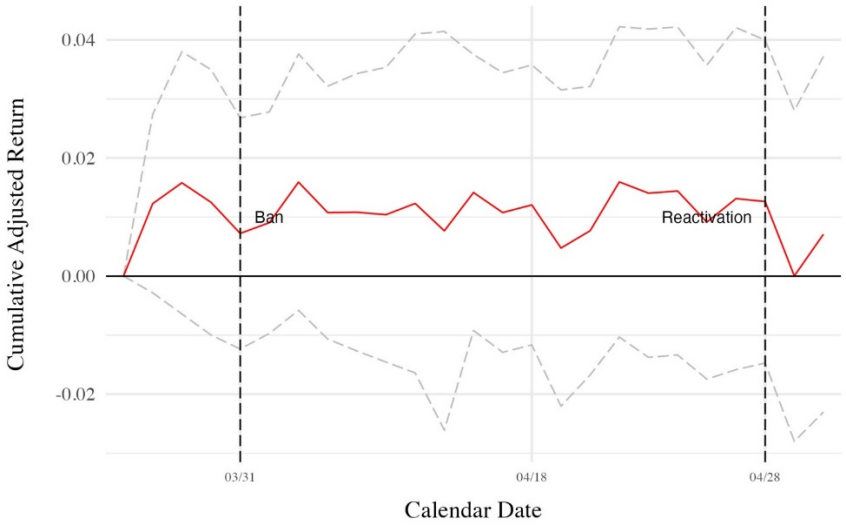

Figure B3: Cumulative return around the ban period, for Italian stocks versus matched EU stocks. We use four different matching methods for robustness. The first one is PSM using logistic regression to estimate propensity scores. Second, we match firms using the Mahalanobis distance matrix from the covariates. Third, we use Coarsened Exact Matching (CEM), a semi-parametric matching method. We conduct one-to-one matching for the first three methods to find a European stock in the same industry with the closest market capitalization and ROA. Forth, we use the PSM with 1-to-3 matching. Last, we use PSM to find a matched firm in the same industry with the closest size from a subsample of UK firms only.

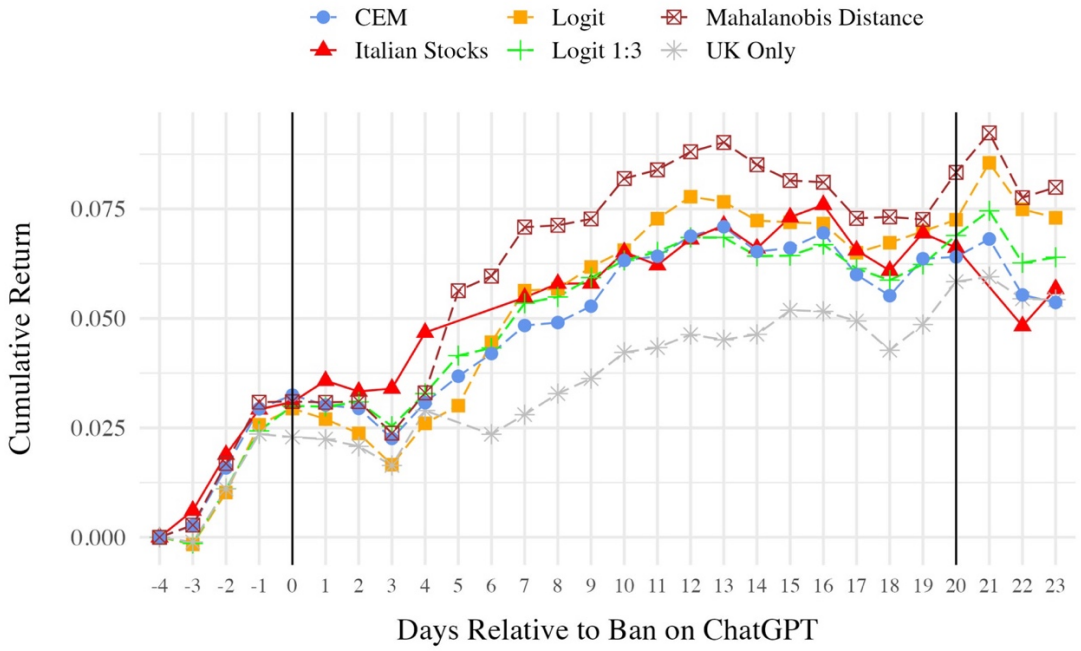

Figure B4: The effect of the Ban on the cumulative returns in the ban period, for Italian stocks versus matched EU stocks. We use four alternative matching methods for robustness, namely CEM, PSM 1-to-3, PSM Based on Mahalanobis Distance, and PSM using UK firms only. In Panel A, we examine the effects of the Ban on ChatGPT on Italian stock market by estimating the following equation using each of the five matched samples:

$$Return_{i,t} = \alpha_i + \beta_1 Italy_i + X_{i,t-1} + Industry\ FE + \epsilon_{i,t},$$

where *Italy* equals one for all Italian stocks and zero for the matched non-Italian stocks. We include industry fixed effects and a vector of controls. The dots represent the estimated value of β_1 and the bars correspond to 95% confidence intervals. Standard errors are robust to heteroskedasticity.