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Contents

List of Figures

1 Introduction

Prediction markets have enjoyed a surge in popularity around the betting markets on who will win the 2024 US Presidential Election, with the highest volume dominated by Polymarket, despite its banned status as of the time of writing, as well as US-based Kalshi, attracting volumes of ...

2 Theoretical Framework

2.1 Prediction Markets

Prediction markets are financial markets designed to forecast future events. Participants of prediction markets trade state-contingent claims whose payoff depends on how those future events unfold. While different types of prediction markets have been designed, the scope of this thesis is limited to winner-take-all prediction markets. These markets are typically structured in the following way: a claim costs $\$p$ today and pays \$1 if and only if the stated event occurs, and \$0 otherwise. This structure implies two participants agreeing on the price $\$p$ which one of the participants pays, the other putting up $\$(1-p)$, with the winner receiving "all" of the dollar put up in collateral as their payoff. [**wolfers˙prediction˙2004**].

Through price discovery, traditional financial markets aggregate information about the value of assets. Prediction markets' primary purpose is leveraging this role of markets for forecasting. Under the Efficient Markets Hypothesis, the market price on prediction markets should reflect the risk-neutral probabilities of the event in question, encompassing all available information. [**berg˙prediction˙2008**]

This efficiency and predictive power of prediction markets has been the topic of vast existing literature, especially in the context of forecasting elections, such as in [**berg˙prediction˙2008**] [**erikson˙are˙2008**], who have found that .... This has also been tackled analytically, where [**wolfers˙interpreting˙2006**] derived two economic models which describe sufficient conditions under which prediction markets prices correspond with participants' mean beliefs.

However, little research has been done examining the world's largest prediction market as of 2025, Polymarket. This is thesis aims to provide empirical research into the market efficiency of winner-take-all prediction markets in the context of markets focusing on the interest rate decisions of the US Federal Open Market Committee's (FOMC) following their scheduled meeting.

2.2 Polymarket

2.2.1 Terminology

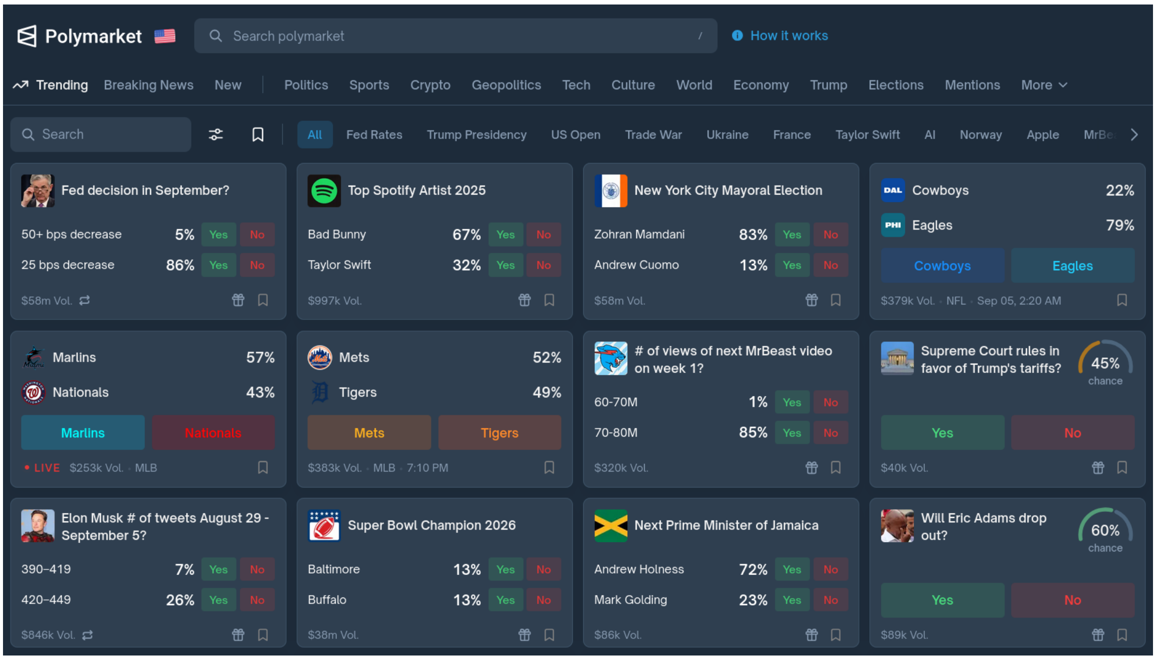

Figure 1: The Polymarket front page as of September 3rd, 2025. While sports and politics events drive the highest volume, there are various events related to popular culture (# of views of next MrBeast video, Top Spotify artist of 2025)

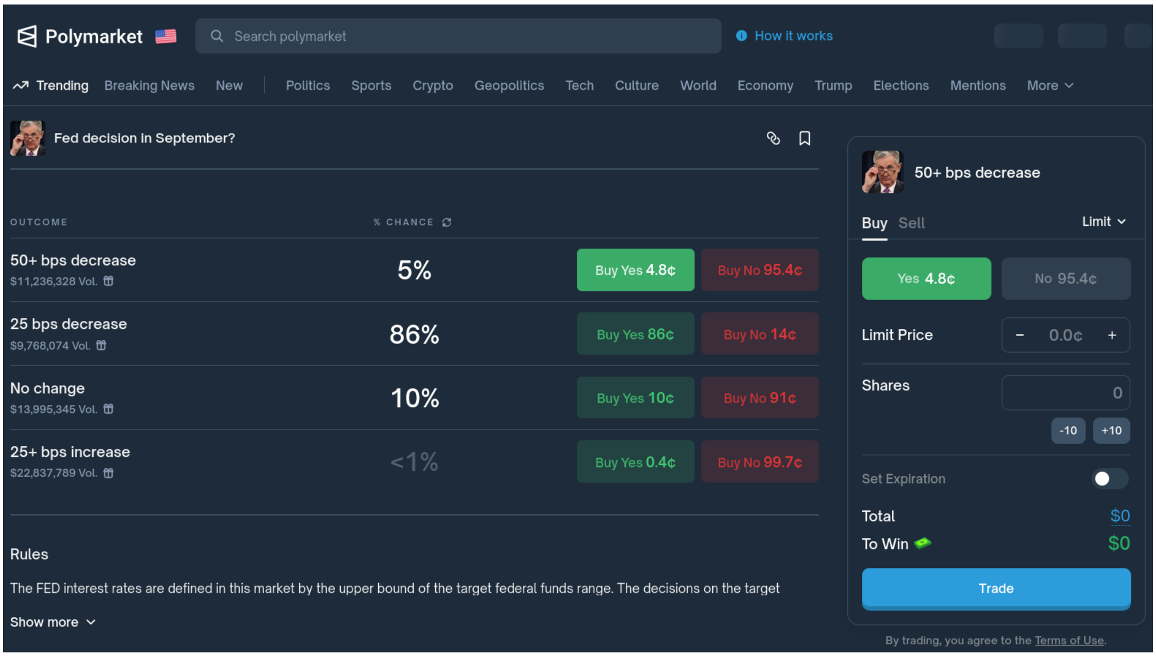

Figure 2: September FOMC event on Polymarket as of September 3rd, 2025

Each market related to possible interest rate decisions (50+ bps increase, 25 bps decrease, No change, 25+ bps decrease) for the September FOMC meeting is grouped into its own event, making it easier for traders to compare prices. While buying both Yes and No shares is possible, shorting is not an option on Polymarket, which is why the cost of all the ‘Yes‘ claims exceeds $1, and the cost of all ‘No‘ claims exceeds $3.

Polymarket is the world’s largest prediction market-hosting platform, hosted on the website www.polymarket.com, and depicted in Figure **??**. On Polymarket, prediction markets are grouped into ‘events‘, which contain different ‘markets‘ related to a single topic/occasion. While anyone can propose an event through social media channels such as Discord and Twitter/X, Polymarket retains the right to create events themselves. Each ‘market‘ is a winner-take-all market as outlined in Section **??**, and concerns itself with exactly one ‘question‘ regarding the outcome of the event it is a part of. Market participants can trade on these questions by buying or selling existing shares in binary ‘Yes‘ and ‘No‘ claims i.e. $C \in \text{Yes}, \text{No}$ (called ‘outcomes‘ or ‘outcome shares‘), with prices for each of these shares, $P(C) \in \$[0, 1]$. When an event concludes, its markets are ’resolved’, meaning the claims of the outcome which realised in the world C^* in each market can be converted to $1 per claim, with claims in the opposite outcome, C', realising a $0 payoff. This resolution happens according to ‘rules‘ stipulated for every event, which are designed to provide clarification on the markets’ questions, in order to avoid situations where no market could resolve to a ‘Yes‘ outcome, despite being designed in such way. [**PMDocs**]

Figure **??** depicts the FOMC interest rate decision event for September, 2025, which features 4 markets regarding the potential interest rate decisions. These markets are non-overlapping and exhaustive, meaning one and only one of the markets will resolve to ‘Yes‘, while the other markets resolve to ‘No‘. This is ensured by the rules, which for this market are:

> The FED interest rates are defined in this market by the upper bound of the target federal funds range. The decisions on the target federal fund range are made by the Federal Open Market Committee (FOMC) meetings. This market will resolve to the amount of basis points the upper bound of the target federal funds rate is changed by versus the level it was prior to the Federal Reserve’s September 2025 meeting. If the target federal funds rate is changed to a level not expressed in the displayed options, the change will be rounded up to the nearest 25 and will resolve to the relevant bracket. (e.g. if there’s a cut/increase of 12.5 bps it will be considered to be

25 bps) The resolution source for this market is the FOMC's statement after its meeting scheduled for September 16 - 17, 2025 according to the official calendar: https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm.

The level and change of the target federal funds rate is also published at the official website of the Federal Reserve at https://www.federalreserve.gov/monetarypolicy/openmarket.htm.

This market may resolve as soon as the FOMC's statement for their September meeting with relevant data is issued. If no statement is released by the end date of the next scheduled meeting, this market will resolve to the "No change" bracket.

2.2.2 Order Matching

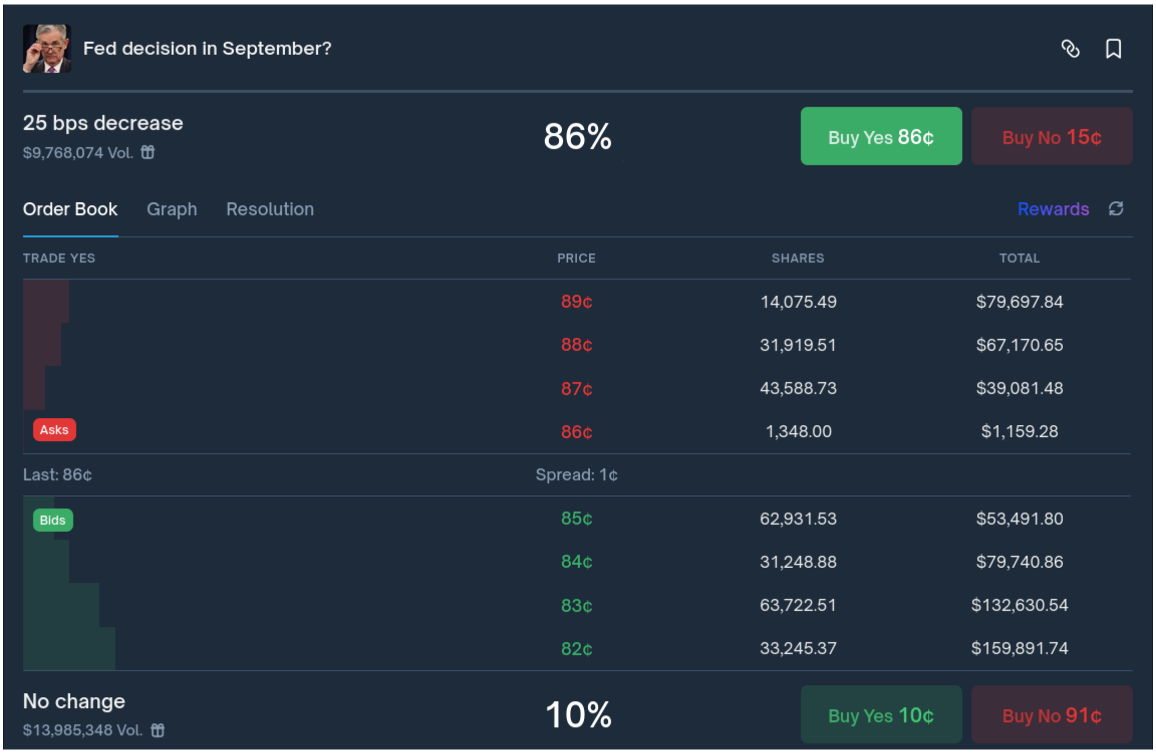

Figure 3: The Polymarket front page as of September 3rd, 2025. While there is a variety of events, sports and politics markets are among the most popular

SHARES	TOTAL	PRICE	SHARES	TOTAL
14,075.49	$79,697.84	89¢	33,245.37	$31,256.54
31,919.51	$67,170.65	88¢	63,722.51	$25,272.38
43,588.73	$39,081.48	87¢	31,248.88	$14,439.55
1,348.00	$1,159.28	86¢	62,931.53	$9,439.73
Yes Orders			No Orders	
62,931.53	$53,491.80	85¢	1,348.00	$188.72
31,248.88	$79,740.86	84¢	43,588.73	$5,855.25
63,722.51	$132,630.54	83¢	31,919.51	$9,685.60
33,245.37	$159,891.74	82¢	14,075.49	$11,233.90

As Figure **??** shows, market participants can submit limit or market orders to buy or sell Yes or No claims. While buying is allowed at any quantity, short selling is not permitted on Polymarket, and only owned shares can be sold. This results in some price-inefficiencies, such as in **??**, where despite the exhaustive set of markets, for each market i in the set of markets in that event, I, the bid prices exhibit $\sum_{i \in I} P(\text{Yes})_i \neq \$1$, $\sum_{i \in I} P(\text{No})_i \neq \$3$, as well as $\sum_{i \in I}(P(\text{Yes})_i + P(\text{No})_i) \neq \$4$. This, however, is not exploitable due to lack of short-selling. As explained in Section **??**, a trade is only possible if two individual market participants agree on a price, which is why on Polymarket, it is mechanically ensured that $\P(C) + P(C') = \$1$ for any two complementary claims (opposite outcomes). This guarantees that every pair of claims $(C, C') \in \text{Yes}, \text{No}$ is necessarily fully collateralised by $1, put up by the holders of the 'Yes' and 'No' shares, ensuring the successful resolution of the market. [**PMDocs**]

Trading on Polymarket takes form in a continuous double auction, with no halts in trading between a market's opening and its resolution. This is shown in Figure **??**, with resting bid and ask limit orders being displayed for 'Yes' outcome claims in the market for the FOMC meeting in September to conclude with a 25 bps decrease in the upper bound of the target federal funds range.

Mechanically, this is realised on Polymarket's centralised limit order book (CLOB) which has a 'hybrid' organisation of off-chain order matching, and on-chain settlement. This entails that market participants' orders are submitted to the CLOB, hosted on Polymarket servers, where they are matched into trades. Once a trade has been recorded on the servers, the actual settlement, execution, and recording of transactions takes place on the Polygon blockchain. While an in-depth description of the blockchain mechanism is beyond the scope of this thesis, the key implication is that all trades on Polymarket are publicly available, with identifiable users. Internally, pairs of opposing outcome shares (C, C') are represented by pairs of 'binary outcome tokens', which are pairs of Yes and No claims in the same market, created upon being exchanged for and collateralised by the same nominal amount of 'USDC', the underlying currency for all exchange taking place on Polymarket. USDC is a cryptocurrency (a stablecoin), which is pegged to the United States dollar, and has been since 2021 accepted in transaction settlement by payment services provider Visa. [**hussain˙visa˙2021**]. For the purposes of this thesis, 'USDC' will be referred to in terms of US dollars (1 USDC = 1 USD), while the term 'outcome token' may be used to refer to digital assets representing a single share in a claim. The effects of Polymarket's internal mechanisms on data acquisition is elaborated on in Section **??**.

There are three distinct possibilities by which market participants' orders are matched:

Direct trade A marketable order (by a liquidity taker) in a given claim C matches resting liquidity providing (maker) orders in the same claim C. Here, one side is selling the claim C, while their counterparty in the trade is buying that same claim. Internally, settlement is a straightforward token-for-USDC swap at the matched price. This order-matching mechanism is essentially identical to the one familiar from traditional equities markets.

Minting new tokens Because a pair of opposite outcome tokens (C, C') are always backed by \$1 of collateral, two buy orders from opposite-token orderbooks can also be matched if they agree on the price. In this case, new sets of binary outcome tokens are created, a process referred to as 'minting', where each pair of outcome tokens (C, C') is backed by \$1 put up cumulatively by the counterparties of the trade. Terminologically it can also be said that each dollar of collateral is 'split' into a pair of outcome tokens. This happens when there exists a resting limit buy order (a bid) for the claim C with price $P(C) =: p$, which is then matched with an incoming marketable buy (another bid) of the same size for the opposite claim C' with price $P(C') = 1 - p$.

Burning tokens The reverse operation of minting, this operation eliminates a set of outcome tokens (C, C') from the market and releases the collateral which was used to back it. This happens when two sell orders in opposite tokens' orderbooks sum such that the number of pairs of outcome tokens matches the amount of USDC cumulatively demanded, for them, i.e. when a resting sell order (an ask) for C wishes to sell at price $P(C) =: p$, which is matched by an incoming marketable sell order of C' of the same size at price $P(C') =: 1 - p$. The set of tokens (C, C') are burned (or 'merged'), and each side receives the collateral that had been initially put up when the tokens were minted.

Visually, as shown in Figure **??**, limit orders in orderbooks of a pair of outcome tokens (C, C') are represented symmetrically, i.e. bids (resp. asks) in C will be shown as asks (resp. bids) in C', and vice versa. This follows the logic described above, since any of the three options for order matching appear the same to market participants. Each of these order-matching mechanisms work based on the necessary condition that $P(C) + P(C') = \$1$, which underlies winner-take-all markets. It is important to note that this is the only arbitrage-eliminating mechanism implemented internally, and that this only works on the level of markets, not events. Since events are just collections of markets, there is no internal mechanism to prevent arbitrage across markets, such as $\sum_{i \in I} P(\text{Yes})_i \leq \$1$, $\sum_{i \in I} P(\text{No})_i \leq \$N - 1$, as well as $\sum_{i \in I}(P(\text{Yes})_i + P(\text{No})_i) \leq \$N$, where i is a market in the set of markets for a given event I which contains N number of markets. [**PMDocs**, **saguillo˙unravelling˙2025**]

Additionally, the split/merge operations (minting and burning tokens) are not restricted to order matching. Users may themselves at any time during the market's lifetime split units of USDC into pairs of binary outcome tokens (C, C'), 'buying' each for \$0.50, or merge a pair of tokens to receive the underlying collateral. The former can be useful to market participants who wish to act as market makers, while the latter can be used to liquidate large positions over time without moving markets too heavily.

2.3 Federal Funds Rate futures

2.3.1 Effective Federal Funds Rate (EFFR)

The effective federal funds rate is the volume-weighted median interest rate on uncollateralised overnight loans of US dollar reserve balances between depository institutions in the United States. The Federal Reserve Bank of New York computes the EFFR and publishes it for the previous business day at approximately 9:00 a.m. New York time every day. This benchmark rate is the underlying asset of the Chicago Mercantile Exchange's (CME's) 30-Day Federal Funds futures. [**FED˙EFFR˙NY**]

2.3.2 Price quoting and the implied monthly average

CME 30-Day Federal Funds (ZQ) futures are quoted in IMM index terms, with price equal to 100 minus the market-implied arithmetic average of daily EFFR over the contract's calendar month. If the futures price for month T is P_t^T (percent), the implied expected monthly average is

$$\mathbb{E}_t[\bar{r}_T] = 100 - P_t^T$$

where $\bar{r}_T$ denotes the arithmetic average of daily EFFR realizations during month T. This mapping follows directly from the contract's price quotation and settlement definition.

2.3.3 High-level assumptions for extracting probabilities

To translate ZQ prices into probabilities of FOMC outcomes, the CME FedWatch methodology adopts three core assumptions.

First, rate changes occur in uniform 25-basis-point increments and the EFFR adjusts proportionally to the target change.

Second, within a meeting month, the EFFR is piecewise constant: it equals a pre-meeting level up to the decision's effective date, and a post-meeting level thereafter.

Third, anchor months without FOMC meetings pin down a month-end/start-of-next-month level that is used to propagate boundary conditions through adjacent months. Under these assumptions, ZQ prices encode a risk-neutral expectation of the path of EFFR that can be decomposed into before/after segments in meeting months and rolled across months via anchors.

2.3.4 Anchor months and boundary conditions

In any month with no scheduled FOMC meeting, the entire calendar month is governed by a single policy regime, so the ZQ-implied average equals the expected EFFR throughout the month. FedWatch uses these months as anchors: for an anchor month T,

$$\text{EFFR(End)}_{T-1} = \text{EFFR(Avg)}_T = \text{EFFR(Start)}_{T+1}$$

Operationally, one identifies the nearest full non-meeting month, reads $\text{EFFR(Avg)}_T = 100 - P^T$ from its ZQ price, sets the end of the prior month and the start of the following month to that level, and then propagates these boundary values backward and forward as needed when solving adjacent meeting months. This anchoring step provides the initial conditions for the system of month-by-month equations.

2.3.5 Meeting months and the time-weighting identity

Consider a meeting month T with m_T calendar days and k_T days before the policy change becomes effective. Let r_T^- denote the pre-meeting EFFR level and r_T^+ the post-meeting level. Because the futures price reflects the arithmetic monthly average, the implied average satisfies the time-weighting identity

$$\mathbb{E}_t[\overline{r}_T] = \omega_T \, r_T^- + (1-\omega_T)\,\mathbb{E}_t[r_T^+], \qquad \omega_T \equiv \frac{k_T}{m_T}$$

Solving for the expected post-meeting level gives

$$\mathbb{E}_t[r_T^+] = \frac{m_T\,\mathbb{E}_t[\overline{r}_T] - k_T\,r_T^-}{m_T - k_T}$$

When the following month $T{+}1$ is an anchor, $\mathbb{E}_t[r_T^+]$ is identified directly from EFFR(Avg)_{T+1}. On the other hand, if the prior month is an anchor, r_T^- is identified from EFFR(Avg)_{T-1}. In either case, the time-weighting identity links the observable ZQ-implied monthly average to the unobservable post-meeting level and enables sequential solution across the term structure.

2.3.6 Probability calculations via the characteristic–mantissa method

Define the expected change in EFFR over the meeting month as $\Delta_T^* \equiv \mathbb{E}_t[r_T^+] - r_T^-$. Express this in units of 25 bps, $n_T^* \equiv \Delta_T^*/0.25\%$. Decompose n_T^* into its characteristic (integer) and mantissa (fractional) parts:

$$n_T^* = n_T + y_T, \qquad n_T \in \mathbb{Z}_{\geq 0}, 0 \leq y_T < 1.$$

FedWatch interprets this as two mutually exclusive outcomes at the meeting: a change of $n_T \times 25$ bps with probability $1 - y_T$, and a change of $(n_T{+}1) \times 25$ bps with probability y_T. When the expected change is less than one increment ($n_T = 0$), this reduces to the familiar binomial case of no change versus a single 25-bp move with probabilities $1 - y_T$ and y_T, respectively. In the special case where the next month is an anchor and one wishes to ask only "hike or hold by 25 bps," the implied probability collapses to

$$\mathbb{P}(\text{25 bp hike}) = \frac{\text{EFFR(End)}_T - \text{EFFR(Start)}_T}{0.25\%}, \qquad \mathbb{P}(\text{hold}) = 1 - \mathbb{P}(\text{hike}),$$

3 Data

3.1 Polymarket

This section documents the data used in the study and the procedures by which it was collected, curated, and prepared for analysis. The empirical setting is the sequence of Federal Open Market Committee meetings for which a corresponding Polymarket contract existed. For each meeting, the core object is a paired intraday dataset comprising a Polymarket price panel and a matched panel derived from 30-Day Federal Funds Rate futures (ZQ). The emphasis here is on precise definition of the observational unit, provenance and structure of the raw data, inclusion and exclusion rules, harmonization across sources, and the measures taken to ensure reproducibility while acknowledging the limitations inherent in partly manual data assembly.

3.2 design and unit of analysis

The unit of analysis is an event window anchored on a single scheduled FOMC decision. For each meeting, the observation period is defined to be the lifespan of the corresponding Polymarket market, beginning at market inception and ending upon resolution at the announcement. Within each window, two time series are constructed and then aligned. The first is a panel of Polymarket outcome token prices at intraday frequency for the discrete set of possible rate decisions offered by that market. The second is an intraday series of prices for the ZQ futures contract(s) whose delivery month covers the meeting date. Since the goal of the project is to study whether movements in the prediction market lead or lag movements in traditional interest-rate futures, all decisions about alignment, filtering, and sampling fidelity are made at the level of the event window. That is, each event window constitutes a self-contained, paired dataset representing the information environment leading up to that meeting.

Two features of this design deserve emphasis. First, the analysis is blockwise. Estimation and inference are conducted separately for each meeting, rather than pooling raw observations across disparate meetings. This design choice reflects that each meeting has a distinct information flow, calendar, and liquidity profile. Second, the study aligns the sources on days and minutes in which both can be reasonably expected to reflect contemporaneous beliefs. Since Polymarket trades continuously while futures observe exchange trading hours and weekend closures, the calendar is pruned so that non-overlapping periods, in particular weekends, are removed before any time alignment is imposed. The resulting datasets are therefore comparable both in the horizon over which expectations form and in the trading days on which those expectations can be revealed in prices.

3.3 sources

Two sources are used to capture market expectations. On the prediction-market side, the data are extracted from Polymarket, a categorical market platform where each outcome token trades at a price bounded between zero and one USDC and where the price of a yes-token can be read as an implied probability for the associated outcome. For each FOMC meeting, the relevant Polymarket market was identified by its human-readable slug. This identification was carried out manually because the study required precise mapping between the scheduled FOMC meeting and the correct categorical market, and because the naming of markets and their slugs can vary across time. Once identified, the historical price data for all outcome tokens within that market were retrieved at minute-level resolution or, where the raw feed is tick-by-tick, aggregated to the target frequency by selecting the last observation within each minute. The native fields retained for each observation include the timestamp, the outcome identifier, and the last traded or quoted price. Where the platform exposes both last trade and best bid/ask, the price closest to the prevailing midquote is preferred for stability; in the absence of a midquote, the last traded price is used. All monetary magnitudes are denominated in USDC, which is treated as a one-to-one proxy for USD within the scope of this study.

On the futures side, the data consist of time-stamped price observations for the 30-Day Federal Funds Rate futures contract. These were collected manually from two retail-facing platforms, TradingView and Barchart. The redundancy serves two purposes. First, gaps present in one source can often be filled by the other, which is useful around periods of low activity. Second, cross-checking prices identifies obvious anomalies, such as stale prints or misaligned timestamps. Barchart time stamps reflect Chicago local time, while TradingView and the Polymarket extractions are expressed in New York time or UTC. To avoid any systemic skew in relative timing, all futures timestamps were converted to New York time after taking account of the operative daylight saving time conventions. For each meeting window, the futures contract selected is the monthly ZQ contract whose delivery month contains the meeting date, which ensures that the futures price reflects the market's expectation of the monthly average effective federal funds rate over a period split by the meeting day. In addition to the price, the raw fields include the timestamp and, where available, volume. Volume is retained only as a descriptive field; it plays no role in the construction of the probability series but can be informative about liquidity and the reliability of very short-horizon price changes.

The two raw sources thus differ in several structural respects: Polymarket is categorical with multiple simultaneous outcome series per meeting, while the futures price is a single scalar per timestamp. Polymarket trades continuously and globally, while ZQ trading is concentrated during exchange hours with extended-hours sessions and closures. Finally, the Polymarket asset space changes across meetings depending on which outcome buckets the market designer chose to list, while the futures instrument is standardized across meetings. The preparatory steps described below are therefore aimed at bringing these heterogeneous feeds into a common, coherent format for event-level analysis.

3.4 and exclusion criteria and time window

The time window for each meeting begins at the creation of the corresponding Polymarket market and ends at the FOMC announcement when the market resolves. That definition captures the period during which traders form and update beliefs specifically about that meeting's outcome and avoids contaminating the dataset with post-resolution price dynamics or long post-event drifts. Because the Polymarket platform operates continuously and the futures market does not, all Saturdays and Sundays are excluded from the calendar prior to any merging or resampling. This weekend filter eliminates observations that would otherwise pair a change in a 24/7 market with a mechanically flat or stale price in a market that is closed, which could confound causality tests applied to short-horizon differences.

A second inclusion filter applies to the very early portion of some Polymarket markets. Immediately after launch, illiquidity can be severe, and the sum of yes-token prices across all outcomes may be far below one. To avoid including observations that do not yet reflect an equilibrated set of beliefs, the series is trimmed from the left until the cross-outcome sum first exceeds twenty cents. This threshold is deliberately conservative. It does not require the market to be fully arbitraged and perfectly summing to one, but it does require that enough dollar mass has entered the order book to produce interpretable relative prices across the outcome set. All subsequent observations are retained, subject to the other filters described here.

Finally, one meeting is excluded in its entirety due to incomplete Polymarket data in the relevant window. Because the econometric analysis is conducted separately for each event, it is not possible to impute or pool in a way that would recover a reliable intraday panel for that meeting without introducing modeling assumptions at the data stage. Excluding the affected meeting preserves the integrity of the remaining blocks and avoids bias arising from an unrepresentative reconstruction.

3.5 cleaning, and merging

The data from the two sources require substantial harmonization before they can be used jointly. The first step is standardization of identifiers and labels. Polymarket outcome names are provided in natural language and can vary across markets even when they refer to the same economic concept. For example, one market might label an outcome as increase by 25 basis points while another uses 25 bps hike or similar variants. To make cross-market comparisons coherent and to facilitate automated processing, outcome labels are recoded into a compact, uniform vocabulary, such as up25 for a 25-basis-point increase, down25 for a 25-basis-point decrease, and noChange for the status quo. This recoding is lossless with respect to the economics of the outcome space and is enforced uniformly across all meetings.

The second step is temporal harmonization. All timestamps are expressed in New York local time with explicit handling of daylight saving time transitions. The conversion from Chicago time for the Barchart feed is applied using Olson time-zone databases to ensure that historical DST rules are respected, rather than assuming a fixed offset. The Polymarket and TradingView feeds are already aligned to New York time or to UTC with offsets that can be converted deterministically. Once expressed in a common time zone, the series are mapped onto a shared intraday grid. The target grid for this study is one minute. If a source provides multiple ticks within a minute, the last observation within that minute is retained as the minute's value. If a source is missing a minute because no trade occurred, a last-observation-carried-forward rule is applied within the same trading day. Carry-forward is never applied across a day boundary or across a weekend to avoid creating artificial persistence through a closure. The weekend filter ensures that both sources are blank over Saturdays and Sundays, so no fill is possible or necessary in those periods.

Before merging the sources, the Polymarket panel is reshaped from long to wide format within each meeting so that each minute is associated with a vector of prices, one for each active outcome label in that market. The cross-section of outcomes may differ across meetings, but within a given meeting the set is fixed once the early illiquidity trimming is applied. Two additional standardizations are implemented at this stage. First, prices are stored as decimals on the unit interval, and any quoted values in cents are converted accordingly. Second, for timestamps where the sum of outcome prices deviates materially from one, the vector is optionally renormalized to sum to unity. This renormalization is not used to alter the data's substantive content but to provide a consistent basis for constructing aggregate statistics and for aligning with the probability vectors inferred from the futures side in the subsequent methodology. The raw, unnormalized prices are retained in parallel so that robustness checks can be conducted without conflating measurement with correction.

The futures series, once converted to New York time and reduced to minute bars, is merged to the Polymarket panel by timestamp. Because the futures asset is scalar while the Polymarket asset is a vector, the merged dataset contains both a time-stamped vector of outcome prices and a scalar futures price for the same minute. Where both TradingView and Barchart provide futures prices for a given minute, a reconciliation rule is applied. If the two sources agree within a tight tolerance, the TradingView print is kept as the canonical value and the Barchart value is logged for verification. If they differ materially and one source is stale while the other updates, the updating value is preferred. If they differ materially and both are timely, the observation is flagged for inspection. In the assembled dataset used for analysis, flagged minutes were rare and, when present, were resolved by inspecting the surrounding values and, if necessary, dropping the ambiguous minute. This procedure keeps the dataset clean without materially affecting the length of any window.

After merging, a final pass of quality checks is performed. These include verifying that the weekend filter has removed all Saturdays and Sundays, confirming that no cross-day carry-forward is present, checking that the first minute of the Polymarket panel meets the liquidity threshold, and ensuring that no duplicate timestamps remain. The result is a set of event-specific, minute-level panels ready for the construction of implied probabilities from the futures series and for time-domain econometric analysis.

3.6 quality, reproducibility, and limitations

The principal data quality challenge in this project is the combination of heterogeneous sources and partly manual retrieval. On the Polymarket side, while the price concept is straightforward and the mapping between price and implied probability is direct, a small number of markets exhibit early periods of very low activity that can lead to numerically unstable or uninterpretable price vectors. The twenty-cent threshold applied here is a pragmatic solution that avoids discarding large portions of the window while ensuring that the start of the series reflects meaningful trading interest. Because this trimming is deterministic and documented, it does not compromise reproducibility.

On the futures side, reliance on TradingView and Barchart reflects practical access considerations rather than an ideal of a single, consolidated institutional feed. Both platforms are mature and widely used, but each can occasionally exhibit timestamping quirks, stale updates, or minor discrepancies in extended hours. The dual-source approach mitigates these issues by allowing cross-verification and by providing an alternative when one feed is temporarily incomplete. The explicit conversion from Chicago to New York time for Barchart is necessary and is performed with time-zone-aware libraries to avoid systematic bias from daylight saving time transitions. Nonetheless, a residual limitation is that the precise microsecond ordering of events obviously cannot be guaranteed by retail-grade feeds; the study therefore deliberately avoids drawing inference from sub-minute sequencing.

The decision to remove weekends and to align on a one-minute grid strikes a balance between fidelity and comparability. Removing weekends prevents artificial inference arising from a market that can change when its counterpart cannot trade. The one-minute grid is fine enough to capture meaningful intraday adjustments in beliefs around macroeconomic events without being so fine that the futures series would be riddled with empty bars. Last-observation-carried-forward within a day is a standard device for aligning asynchronous series, but it does introduce a form of step-wise interpolation. Because Granger causality tests are applied to first differences or other stationary transforms in the methodology, and because carry-forward never crosses day boundaries, this interpolation is unlikely to induce spurious predictability. Even so, it is a limitation worth noting: the aligned series reflect a combination of observed trades and within-day holds where no new trade occurs in a minute.

A second limitation is the exclusion of one meeting due to incomplete Polymarket data. The exclusion is justified on quality grounds and preserves the internal validity of the remaining blocks, but it does modestly reduce the sample of events and therefore the external validity of any statements about frequency across meetings. Similarly, the early-period trimming based on the liquidity threshold is necessarily a rule of thumb. Alternative thresholds could be defended; the study's analysis plan therefore includes robustness checks to confirm that the qualitative conclusions do not hinge on the exact numerical value chosen for that filter.

Reproducibility is addressed in several ways. First, all manual steps are explicitly recorded. These include the list of meeting slugs used for Polymarket retrieval, the decision to exclude the September meeting due to incompleteness, and the time-zone conversions applied to the futures data. Second, programmatic scripts implement the deterministic aspects of the pipeline: reading and reshaping Polymarket outcomes, trimming early observations based on the probability-mass rule, weekend filtering, resampling to minute bars using last-in-minute selection, time-zone normalization, carry-forward within day, and merging by timestamp. Third, where a choice among reasonable alternatives exists, the choice is documented alongside a short justification. Examples include the one-minute grid rather than a five-minute grid at the data stage, the within-day but not cross-day carry-forward, and the use of reconciliation rules when the two futures feeds disagree.

A final class of limitations relates to measurement error and microstructure considerations. Polymarket outcome vectors do not always sum to exactly one because of transaction costs, discrete tick sizes, and the presence of multiple outcome tokens. Renormalization to sum to unity is applied only when the deviation is material and is recorded so that sensitivity analysis can be performed without renormalization. On the futures side, the observed price may reflect transitory microstructure effects such as bid-ask bounce or thin trading during extended hours. Because the econometric analysis focuses on changes and leads and lags at minute resolution, these effects are expected to average out, but they cannot be eliminated entirely in a study that uses publicly accessible feeds.

In summary, the data employed in the study are event-level intraday panels that pair categorical prediction-market prices with standardized federal funds futures prices over windows tailored to each FOMC meeting. The construction process is guided by the principle that both sources should be placed on as equal a footing as possible: the same days, the same time zone, the same sampling grid, and clearly defined, reproducible filters that remove observations unlikely to reflect meaningful beliefs. The resulting datasets are well suited to the subsequent methodology, which converts the futures prices to implied probabilities, aligns the two sources within each event, and tests for directional predictability in a manner that respects both short-run dynamics and longer-run equilibrium relations.

4 Methodology

5 Results

5.1 Granger Causality

5.1.1 1 minute

Table 1: Blockwise PM Granger causes ZQ table (eigen)

Meeting	F-statistic	df1	df2	p-value	significance
2023 February	None	None	None	None	None
2023 March	6.2489	60	238410	0	***
2023 May	3.4130	12	172136	0	***
2023 June	1.4808	42	213225	0.0230	*
2023 July	0.7328	12	131310	0.7205	
2023 September	0.5797	11	112926	0.8471	
2023 November	1.2375	9	82726	0.2664	
2023 December	0.4273	16	106294	0.9763	
2024 January	0.5676	96	213844	0.9998	
2024 March	1.6064	30	245890	0.0190	*
2024 May	2.3942	15	114856	0.0018	**
2024 June	1.9469	42	171556	0.0002	***
2024 July	1.0100	12	200788	0.4361	
2024 September	4.5131	48	278940	0	***
2024 November	3.8492	345	789528	0	***
2024 December	0.7360	240	966889	0.9992	
2025 January	0.5480	64	508908	0.9988	
2025 March	0.4277	138	467355	1	
2025 May	3.4771	27	426084	0	***
2025 June	0.8399	120	674600	0.8979	
2025 July	None	None	None	None	None

Table 2: Blockwise PM Granger causes ZQ table (trace)

Meeting	F-statistic	df1	df2	p-value	significance
2023 February	None	None	None	None	None
2023 March	6.2489	60	238410	0	***
2023 May	3.4153	12	172140	0	***
2023 June	1.4763	42	213220	0.0239	*
2023 July	0.7328	12	131310	0.7205	
2023 September	0.5797	11	112926	0.8471	
2023 November	1.2375	9	82726	0.2664	
2023 December	0.4273	16	106294	0.9763	
2024 January	0.5676	96	213844	0.9998	
2024 March	1.6064	30	245890	0.0190	*
2024 May	2.3942	15	114856	0.0018	**
2024 June	1.9469	42	171556	0.0002	***
2024 July	1.0100	12	200788	0.4361	
2024 September	4.5131	48	278940	0	***
2024 November	3.8492	345	789528	0	***
2024 December	0.7360	240	966889	0.9992	
2025 January	0.5480	64	508908	0.9988	
2025 March	0.4277	138	467355	1	
2025 May	3.4771	27	426084	0	***
2025 June	0.8399	120	674600	0.8979	
2025 July	None	None	None	None	None

Table 3: Blockwise ZQ Granger causes PM table (eigen)

Meeting	F-statistic	df1	df2	p-value	significance
2023 February	None	None	None	None	None
2023 March	5.0076	60	238410	0	***
2023 May	4.0590	12	172140	0	***
2023 June	1.0953	42	213220	0.3100	
2023 July	0.6810	12	131310	0.7715	
2023 September	0.1070	11	112926	0.9999	
2023 November	5.9940	9	82726	0	***
2023 December	0.5485	16	106294	0.9223	
2024 January	0.8695	96	213844	0.8154	
2024 March	0.0319	30	245890	1	
2024 May	1.9907	15	114856	0.0124	*
2024 June	2.2777	42	171556	0	***
2024 July	0.6617	12	200788	0.7898	
2024 September	26.1722	48	278940	0	***
2024 November	8.8129	345	789528	0	***
2024 December	0.7939	240	966889	0.9919	
2025 January	1.7429	64	508908	0.0002	***
2025 March	1.7862	138	467355	0	***
2025 May	11.2943	27	426084	0	***
2025 June	0.8579	120	674600	0.8673	
2025 July	None	None	None	None	None

Table 4: Blockwise ZQ Granger causes PM table (trace)

Meeting	F-statistic	df1	df2	p-value	significance
2023 February	None	None	None	None	None
2023 March	5.0076	60	238410	0	***
2023 May	4.0588	12	172140	0	***
2023 June	1.0690	42	213220	0.3514	
2023 July	0.6810	12	131310	0.7715	
2023 September	0.1070	11	112926	0.9999	
2023 November	5.9940	9	82726	0	***
2023 December	0.5485	16	106294	0.9223	
2024 January	0.8695	96	213844	0.8154	
2024 March	0.0319	30	245890	1	
2024 May	1.9907	15	114856	0.0124	*
2024 June	2.2777	42	171556	0	***
2024 July	0.6617	12	200788	0.7898	
2024 September	26.1722	48	278940	0	***
2024 November	8.8129	345	789528	0	***
2024 December	0.7939	240	966889	0.9919	
2025 January	1.7429	64	508908	0.0002	***
2025 March	1.7862	138	467355	0	***
2025 May	11.2943	27	426084	0	***
2025 June	0.8579	120	674600	0.8673	
2025 July	None	None	None	None	None

5.1.2 5 minute

5.2 Instantaneous Causality

5.2.1 1 minute

Table 5: Blockwise PM instantaneously Granger causes ZQ table (eigen)

Meeting	χ^2	df1	p-value	significance
2023 February	None	None	None	None
2023 March	22.7964	6	0.0009	***
2023 May	1.7779	3	0.6198	
2023 June	7.1283	6	0.3091	
2023 July	0.7415	2	0.6902	
2023 September	0.3182	1	0.5727	
2023 November	3.7030	1	0.0543	.
2023 December	0.0655	1	0.7981	
2024 January	2.0396	4	0.7285	
2024 March	2185.1144	6	0	***
2024 May	4.3906	3	0.2223	
2024 June	1.6870	3	0.6398	
2024 July	5.3890	3	0.1454	
2024 September	80.6587	6	0	***
2024 November	32.5638	15	0.0054	**
2024 December	7.1102	10	0.7150	
2025 January	11.7129	8	0.1645	
2025 March	14.6879	6	0.0228	*
2025 May	14.8822	3	0.0019	**
2025 June	8.0940	6	0.2313	
2025 July	None	None	None	None

Table 6: Blockwise PM instantaneously Granger causes ZQ table (trace)

Meeting	χ^2	df1	p-value	significance
2023 February	None	None	None	None
2023 March	22.7964	6	0.0009	***
2023 May	1.7818	3	0.6189	
2023 June	7.0150	6	0.3195	
2023 July	0.7415	2	0.6902	
2023 September	0.3182	1	0.5727	
2023 November	3.7030	1	0.0543	.
2023 December	0.0655	1	0.7981	
2024 January	2.0396	4	0.7285	
2024 March	2185.1144	6	0	***
2024 May	4.3906	3	0.2223	
2024 June	1.6870	3	0.6398	
2024 July	5.3890	3	0.1454	
2024 September	80.6587	6	0	***
2024 November	32.5638	15	0.0054	**
2024 December	7.1102	10	0.7150	
2025 January	11.7129	8	0.1645	
2025 March	14.6879	6	0.0228	*
2025 May	14.8822	3	0.0019	**
2025 June	8.0940	6	0.2313	
2025 July	None	None	None	None

Table 7: Blockwise ZQ instantaneously Granger causes PM table (eigen)

Meeting	χ^2	df1	p-value	significance
2023 February	None	None	None	None
2023 March	22.7964	6	0.0009	***
2023 May	1.7779	3	0.6198	
2023 June	7.1283	6	0.3091	
2023 July	0.7415	2	0.6902	
2023 September	0.3182	1	0.5727	
2023 November	3.7030	1	0.0543	.
2023 December	0.0655	1	0.7981	
2024 January	2.0396	4	0.7285	
2024 March	2185.1144	6	0	***
2024 May	4.3906	3	0.2223	
2024 June	1.6870	3	0.6398	
2024 July	5.3890	3	0.1454	
2024 September	80.6587	6	0	***
2024 November	32.5638	15	0.0054	**
2024 December	7.1102	10	0.7150	
2025 January	11.7129	8	0.1645	
2025 March	14.6879	6	0.0228	*
2025 May	14.8822	3	0.0019	**
2025 June	8.0940	6	0.2313	
2025 July	None	None	None	None

Table 8: Blockwise ZQ instantaneously Granger causes PM table (trace)

Meeting	χ^2	df1	p-value	significance
2023 February	None	None	None	None
2023 March	22.7964	6	0.0009	***
2023 May	1.7818	3	0.6189	
2023 June	7.0150	6	0.3195	
2023 July	0.7415	2	0.6902	
2023 September	0.3182	1	0.5727	
2023 November	3.7030	1	0.0543	.
2023 December	0.0655	1	0.7981	
2024 January	2.0396	4	0.7285	
2024 March	2185.1144	6	0	***
2024 May	4.3906	3	0.2223	
2024 June	1.6870	3	0.6398	
2024 July	5.3890	3	0.1454	
2024 September	80.6587	6	0	***
2024 November	32.5638	15	0.0054	**
2024 December	7.1102	10	0.7150	
2025 January	11.7129	8	0.1645	
2025 March	14.6879	6	0.0228	*
2025 May	14.8822	3	0.0019	**
2025 June	8.0940	6	0.2313	
2025 July	None	None	None	None

5.2.2 5 minute

6 Discussion

7 Conclusion

8 Bibliography

literature

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