A Decision-Analytic Event-Study Framework for Evaluating Digital Health Technology Investments

Ruiqing Geng

Shengli No.1 Middle School of DongyingChina
2784317883@qq.com

Abstract Digital health investments are strategic technology-management decisions for healthcare firms, yet their short-run external evaluation is difficult to observe. This paper develops a decision-analytic event-study framework for assessing market reactions to twenty-five public digital health technology investment announcements by listed healthcare and life-sciences firms from 2018 to 2024. The events cover acquisitions, AI collaborations, remote monitoring, connected care, real-world evidence platforms, and digital health analytics initiatives. Announcement dates are traced to public sources, and market data are drawn from Yahoo Finance adjusted prices, SPY returns, and Fama-French daily factors. The main Fama-French three-factor specification reports statistically weak cumulative abnormal returns: -0.32% over the minus-one to plus-one window and 1.37% over the minus-five to plus-five window, while the event-day to plus-two window is negative at -0.78%. Sign tests, Wilcoxon checks, randomization inference, and bootstrap confidence intervals indicate that the expanded public sample still does not support a uniform positive premium. Mechanism regressions based on resource-based and continuous-innovation signals are treated as exploratory screens. The framework supports technology-management decision makers by converting public digital-health investment announcements into auditable external evaluation signals.

Index Terms digital health technology investment, event study, technology management, decision analytics, abnormal returns

I. Introduction

Digital health has moved into the strategic language of large health-sector firms. Pharmaceutical companies invest in real-world evidence platforms, AI discovery partnerships, and patient data infrastructure, while medical device firms add remote monitoring, diabetes algorithms, surgical analytics, and connected-care platforms. From a technology-management and decision-analysis perspective, these announcements are technology-investment decisions: they disclose commitments to data infrastructure, workflow integration, service innovation, and healthcare system transformation. They are also difficult to evaluate because the same announcement can signal scarce digital capability or reveal integration risk.

This paper studies whether capital markets react to digital health technology investment announcements made by listed healthcare and life-sciences companies. Rather than evaluating realized operating performance, it uses market reaction as an external decision signal around the announcement date. This framing follows the event-study tradition, where reaction is inferred from abnormal returns around a public event [1]–[3]. For technology management and healthcare management systems, the question is relevant because digital transformation projects require large resource commitments before operational benefits become visible.

The analysis uses twenty-five public events from 2018 to 2024 covering pharmaceutical, medical device, medi- cal technology, life-sciences tools, and healthcare-services issuers. Each event is tied to a public source, a listed ticker, and a transparent trading-date alignment rule. Stock prices come from Yahoo Finance adjusted data, with SPY as the market benchmark and Fama-French daily factors for expected-return models. We estimate abnormal returns under market-adjusted, market model, CAPM, three-factor, and five-factor specifications, then examine whether resource-based and continuous innovation coding is associated with CAR variation.

The results are intentionally reported with conservative claim boundaries. Under the Fama-French three-factor model, the event-day CAR is -0.10%, the [__1, +1] CAR is -0.32%, the [0, +2] CAR is -0.78%, and the longer [__5, +5] CAR is 1.37%. None of the main averages is statistically significant at conventional levels, and bootstrap intervals cross zero. Mechanism regressions have limited adjusted explanatory power, suggesting that the sample supports exploratory decision analysis rather than strong causal claims.

The paper contributes by moving digital health investment announcements into a technology-management evaluation setting, complementing studies of biopharma- ceutical news and clinical trial outcomes [4]– [6]. It also links event-study evidence to resource-based view and continuous innovation mechanisms [7]– [9] and provides auditable public-data artifacts for follow-up studies with larger event samples.

II. Related Work and Research Questions

Event studies assume that new public information can be reflected in stock prices quickly when markets are sufficiently informationally efficient [1]. The method estimates abnormal returns around announcements relative to an expected-return benchmark [2]. Daily-return designs are useful for firm-specific events, although variance changes and short-horizon noise require care [3]. In health finance, pharmaceutical and biotechnology stocks react to clinical trial news, drug development signals, and health-event information [4]– [6], [10], [11]. Most studies focus on clinical or R&D outcomes rather than digital health infrastructure investment.

Digital transformation research provides a second foun- dation. Digital business strategy concerns the fusion of digital resources with scope, scale, speed, and value creation [9]. Reviews emphasize that digital technologies reshape processes, value propositions, and performance pathways [12]. In healthcare, transformation also involves stakeholder coordination, patient-centered service design, and implementation risk [13]. Investors may therefore reward data or platform capability while penalizing costly or weakly integrated initiatives.

The theoretical lens of this paper combines the resource- based view and continuous innovation. Resource-based view argues that valuable, rare, inimitable, and non- substitutable resources can support sustained advantage [7]. Dynamic capabilities extend this argument by em- phasizing the ability to integrate, build, and reconfigure resources as markets change [8]. Digital health investments are consistent with these theories when they provide proprietary data, clinical workflow integration, connected device ecosystems, or AI-enabled learning loops. Continu- ous innovation mechanisms matter because digital health value often depends on repeated software updates, data feedback, and platform adoption rather than on a one-time asset purchase.

The first research question concerns the average an- nouncement effect. If investors interpret digital health investment as a credible signal of new digital capability and future operational transformation, abnormal returns may be positive around the announcement date. Because the sample is public, manually verified, and heterogeneous, the question is framed as exploratory rather than confir- matory.

RQ1. Do digital health technology investment an- nouncements generate positive cumulative abnor- mal returns for healthcare firms in short event windows?

The second research question concerns heterogeneity. Medical device and medical technology firms may receive clearer benefits from digital health investments because connected devices, remote monitoring, and AI-assisted procedures can be linked directly to products and service revenue. Pharmaceutical firms may benefit from data and AI partnerships, but the value chain can be longer and harder to observe.

RQ2. Does market reaction differ across health-sector
subsectors and announcement categories?

The third research question follows the resource and innovation logic. Announcements that combine resource- based signals with continuous innovation signals may be more informative to investors than announcements with weaker capability implications. Given the still-limited event universe, this part is treated as a mechanism screen, not as a definitive regression test.

RQ3. Which announcement characteristics are asso- ciated with stronger CARs, and how should these associations be interpreted for healthcare technology management?

III. Data and Methodology

The dataset contains twenty-five public digital health investment announcements by listed healthcare and life- sciences firms. Table I summarizes the event sample. The selected events include acquisitions, equity investments, platform launches, and strategic collaborations involving AI discovery, real-world evidence, remote monitoring, connected diabetes care, surgical informatics, medical imaging AI, and specialty analytics. Each row records firm name, ticker, announcement date, subsector, cate-

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gory, disclosed deal value, and public source label. Event dates are aligned to the first trading day on or after the public announcement date.

Event selection followed a reproducible public-source protocol rather than convenience sampling. Candidate events were searched from company investor-relations pages, press releases, SEC-linked disclosures when avail- able, and reputable health-technology news using firm names combined with terms such as digital health, AI healthcare, remote monitoring, connected care, real-world evidence, digital therapeutics, platform, acquisition, in- vestment, and partnership. An event was included only when it had an assignable public announcement date, a listed parent security, daily price and factor coverage for the estimation and event windows, and an investment or collaboration involving software, data platforms, AI or analytics, remote monitoring, connected devices, or digital care delivery. Product marketing items without a resource commitment, private-firm announcements with- out a tradable security, ambiguous dates, and events with obvious same-day earnings, regulatory, litigation, unrelated merger, or macro confounders were excluded where public information allowed. The twenty-five events should therefore be read as a transparent public-data sample, not as an exhaustive universe of all digital health investments.

Operationally, the proposed workflow separates four auditable layers: provenance-confirmed digital health an- nouncements, public return and factor data alignment, expected-return estimation with CAR construction, and mechanism or robustness evaluation through regressions, ablations, and placebo dates. The workflow is an event- study evaluation protocol rather than a text-mining model or a trading recommender; it reports market-reaction evidence, not buy, hold, or sell signals.

Figure 1 summarizes this four-stage workflow. The left side records verified announcements and public market

TABLE I. Digital health technology investment event sample and screening status

ID	Firm	Ticker	Date	Sector	Announcement category	Deal	Source
E01	Medtronic	MDT	2020-02-13	Device	AI surgery acquisition	ND	Surg. Robotics
E02	Boston	BSX	2021-01-21	Device	Remote monitoring	925	Cardiac
E03	Scientific Philips	PHG	2020-12-18	MedTech	acquisition Remote monitoring	2,800	Rhythm Philips
E04	Stryker	SYK	2022-01-06	Device	acquisition Clinical platform	3,090	MassDevice
E05	Baxter	BAX	2021-09-02	MedTech	acquisition Connected care acquisition	12,400	MassDevice
E06	Roche	RHHBY	2018-02-15	Pharma	Oncology data acquisition	1,900	Healthcare IT
E07	Novartis	NVS	2019-10-01	Pharma	AI medicine partnership	ND	Microsoft
E08	ResMed	RMD	2018-12-03	Device	Digital therapeutics	225	ResMed
E09	Abbott	ABT	2023-09-05	Device	acquisition Connected diabetes	ND	BioSpace
E10	Dexcom	DXCM	2018-08-22	Device	acquisition Diabetes algorithm	ND	Dexcom
E11	Johnson &	JNJ	2024-03-18	MedTech	acquisition AI surgery collaboration	ND	J&J
E12	Johnson GE	GEHC	2023-09-06	MedTech	AI algorithm collaboration	ND	GEHC
E13	HealthCare Thermo Fisher	TMO	2023-07-06	LifeSci	RWE data acquisition	912.5	Thermo Fisher
E14	Sanofi	SNY	2021-11-18	Pharma	AI precision medicine investment	180	Sanofi/Nasdaq
E15	Pfizer	PFE	2022-09-20	Pharma	AI disease-model	110	CytoReason
E16	AstraZeneca	AZN	2019-04-30	Pharma	collaboration AI drug discovery	ND	AstraZeneca
E17	Merck	MRK	2022-06-29	Pharma	collaboration Digital sciences studio launch	ND	Merck

ID	Firm	Ticker	Date	Sector	Announcement category	Deal	Source
E18	GSK	GSK	2022-10-18	Pharma	AI data-platform collaboration	70	GSK
E19	Bayer	BAYRY	2023-01-18	MedTech	AI imaging acquisition	ND	Bayer
E20	Novo Nordisk	NVO	2023-09-25	Pharma	Human-data AI	60	Valo
E21	Intuitive	ISRG	2020-02-10	Device	collaboration Surgical informatics	ND	Intuitive
E22	Surgical Zimmer	ZBH	2021-03-31	Device	acquisition Connected intelligence	ND	Zimmer
E23	Biomet Tandem	TNDM	2022-12-13	Device	launch Connected patch-pump	216	Tandem
E24	Diabetes Cardinal	CAH	2024-01-31	H.Svc	acquisition Specialty analytics	1,200	Cardinal
E25	Health McKesson	MCK	2024-01-04	H.Svc	acquisition Healthcare data acquisition	ND	McKesson

Deal is reported in USD millions when publicly disclosed; ND means no deal value was disclosed in the announcement source.
Abbreviations: MedTech, medical technology; LifeSci, life-sciences tools; H.Svc, healthcare services. Complete announcement URLs, trading-date alignment, and public-source screening notes are retained in the event manifest.
data, the center shows data alignment and CAR construction, the evaluation stage links mechanism regressions with ablation and placebo checks, and the output block matches the paper's reported CAR summaries, regression tables, sector heterogeneity, and robustness figures.
Daily adjusted prices are collected for each company and for SPY from January 2017 to April 2024, with GE HealthCare coverage beginning after its public listing in December 2022. All twenty-five events have usable price coverage for the estimation and event windows. Fama-French daily factors are used for factor-adjusted expected returns [14], [15]. For firm i on trading day t, the daily return $R_{i,t}$ is computed from adjusted close prices. The broad market return $R_{m,t}$ is the SPY return. The abnormal return is

$$AR_{i,t} = R_{i,t} - \hat{E}(R_{i,t}), \tag{1}$$

where $\hat{E}(R_{i,t})$ is the expected return from the selected benchmark model. For the market model, expected return is estimated as

$$\hat{E}(R_{i,t}) = \hat{\alpha}_i + \hat{\beta}_i R_{m,t}, \tag{2}$$

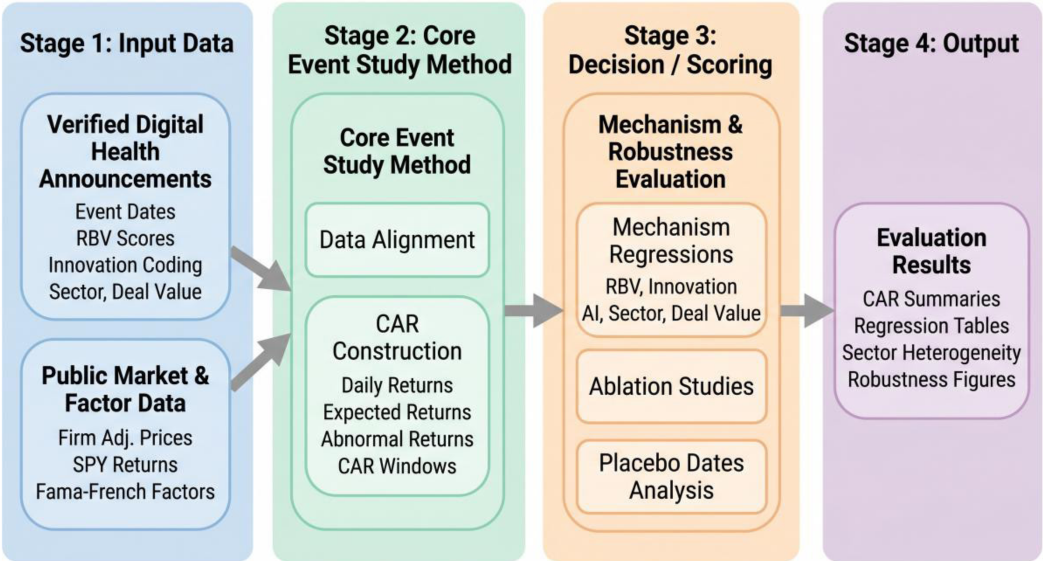

Fig. 1. Decision-analytic workflow for evaluating market reaction to digital health investment announcements. The diagram shows the audited event inputs, public return and factor data, CAR construction, mechanism and robustness evaluation, and final empirical outputs.

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where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are estimated over trading days -130 to -10 before the aligned event day. The CAPM and Fama-French models replace the market-only benchmark with excess market, size, value, profitability, and investmen factors when applicable. For event window $[\tau_1, \tau_2]$, cumulative abnormal return is

$$\mathrm{CAR}_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{i,t} \quad (3)$$

The empirical analysis reports five windows: [0, 0], [__1, +1], [0, +2], [__3, +3], and [__5, +5].
The mechanism analysis uses the Fama-French three-factor [__1, +1] CAR as the dependent variable. The taxonomy specification regresses CAR on an RBV score, a continuous innovation indicator, AI-category and acquisition indicators, sector indicators, log deal value, and a year trend. Because the sample is still modest, this regression is a diagnostic screen rather than a primary inferential model. Robust standard error, winsorized-CAR, nonparametric sign-test, Wilcoxon signed-rank, randomization, bootstrap-interval, and placebo variants receive greater evidentiary weight. A placebo analysis shifts event dates 60 trading days earlier where price coverage permits. These design choices position the study as a decision- analytic framework that can be extended when larger event databases become available.

IV. Empirical Results

Table II reports the main Fama-French three-factor CAR estimates with standard errors, test statistics, p- values, median CARs, positive-event ratios, sign-test p- values, and bootstrap confidence intervals. The event-day mean CAR is -0.10%, and the [__1, +1] window is -0.32%. The longer [__5, +5] window is positive at 1.37%, while the [0, +2] window is negative at -0.78%. None of these estimates is statistically significant at conventional levels, and every bootstrap confidence interval crosses zero. This pattern answers RQ1 with a mixed-reaction interpretation rather than a strong positive-effect claim.

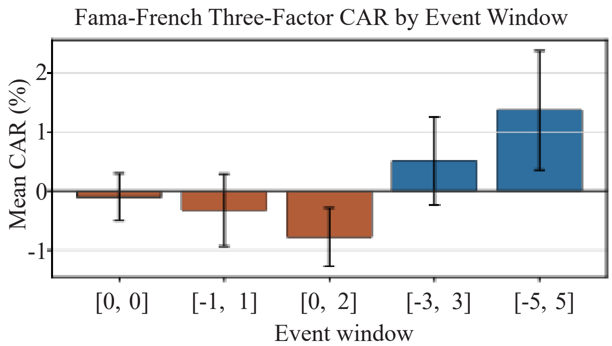

Fig. 2. Main result: Fama-French three-factor CAR across event windows. Bars show mean CAR in percent across the twenty-five announcements.

Figure 2 visualizes the Fama-French three-factor CAR estimates across event windows. The figure shows that average CAR is negative for the immediate and three-day windows but positive for the broader [__3, +3] and [__5, +5] windows. Randomization p-values are 0.618 for [__1, +1], 0.133 for [0, +2], and 0.190 for [__5, +5], reinforcing the conclusion that the public event sample does not provide a conventional significant premium. The Wilcoxon signed- rank check flags the [0, +2] ranking pattern as negative ($p = 0.030$), but sign tests and bootstrap intervals remain more cautious.
The sector split provides descriptive evidence for RQ2. Medical technology and life-sciences data-platform events contribute to the positive longer-window average, while pharmaceutical AI collaborations and healthcare-services analytics events show more mixed reactions. This pattern suggests that investors may respond more directly when the announcement clarifies commercial workflow, data ownership, or connected-device integration.

TABLE II. Fama-French three-factor CAR statistics and small-sample checks by event window

Window	Mean CAR	SE	t-stat.	p-value	Median CAR	Positive ratio	Sign p	Bootstrap 95% CI
[0 , 0]	-0.10	0.40	-0.25	0.805	-0.23	0.44	0.690	[-0.89, 0.66]
[—1 , +1]	-0.32	0.61	-0.53	0.600	-0.41	0.40	0.424	[-1.45, 0.89]
[0 , +2]	-0.78	0.50	-1.57	0.117	-1.16	0.32	0.108	[-1.66, 0.24]
[—3 , +3]	0.51	0.75	0.68	0.495	0.84	0.64	0.230	[-0.87, 2.01]
[—5 , +5]	1.37	1.01	1.35	0.177	1.39	0.60	0.424	[-0.52, 3.33]

Mean, standard error, median CAR, and bootstrap confidence intervals are reported in percent for twenty-five events. The sign test is a two-sided binomial test of whether the positive-event count differs from one half. Bootstrap intervals use event-level resampling with The empirical inputs are based on public company announcements, public market-price data from Yahoo Finance, SPY returns, and Fama-French daily factors. Table I reports source domains and event-level screening notes to keep the submitted paper self-contained. No non-public commercial database or undisclosed synthetic event data are used in the reported metrics. A larger follow-up study should extend the event universe and pre-register exclusion rules for confounding announcements such as earnings releases, regulatory decisions, or same-day merger news.

TABLE III. Exploratory taxonomy-diagnostic summary for [—1, +1] Fama-French CAR

Model	N	R^2	**Adj.** R^2
Controls only	25	0.249	0.098
Sector effects	25	0.035	-0.052
Full screen	25	0.347	0.021
Robust SE	25	0.347	0.021
Winsorized CAR	25	0.507	0.261

Table III reports the exploratory taxonomy diagnostic for RQ3. The controls-only model has an adjusted R^2 of 0.098, while the full taxonomy screen has a small positive adjusted R^2 of 0.021. Winsorizing CAR raises adjusted explanatory power to 0.261, suggesting that the descriptive taxonomy is sensitive to outlying event reactions. Individual RBV, continuous innovation, AI category, acquisition, sector, deal value, and year terms remain exploratory rather than confirmatory. These regressions are retained as management diagnostics and stress tests; they are not treated as mechanism validation or causal evidence.

Figure 3 presents the ablation evidence. The diagnostic pattern is cautionary: the controls-only model still performs slightly better than the full taxonomy screen in adjusted explanatory power, while the winsorized specification indicates that a few extreme CARs shape the mechanism screen. The placebo event-date check has a false-positive rate of 13.3%, which is acceptable for an exploratory public-data workflow but reinforces the need for conservative claims.

The combined evidence supports a careful answer to the research question. Digital health investment announcements are followed by mixed short-window market reac- tions and a positive but statistically weak broader [__5, +5] average. The reaction is not statistically strong enough to claim that digital health investment reliably creates imme- diate shareholder value. Instead, the results are consistent with selective investor attention to credible digital health resource signals, substantial event-level heterogeneity, and limited cross-sectional power.

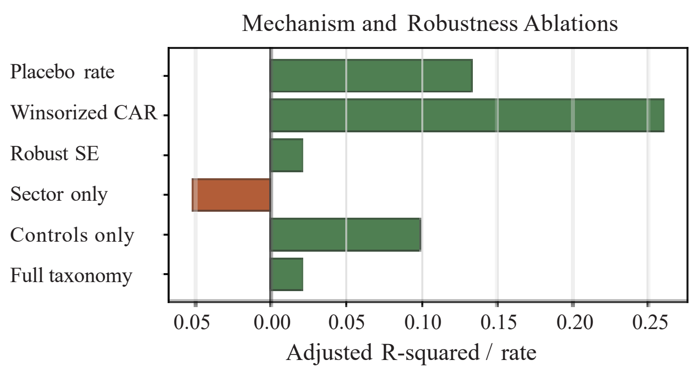

Fig. 3. Mechanism and robustness ablations. Bars compare adjusted explanatory power under taxonomy and robustness variants; the placebo bar reports the false-positive rate.

V. Discussion

The findings indicate mixed market reaction. From a resource-based view, digital health investments can signal data assets, platform relationships, AI capability, and con- tinuous innovation routines. These resources may matter for future financial performance transformation, especially when connected devices and monitoring platforms can be linked to recurring services. Still, investors do not appear to assign a uniform premium to every digital health announcement. The expanded twenty-five-event sample shows a positive but statistically weak longer-window CAR, negative short post-announcement reaction, and limited mechanism-regression support.

This cautious pattern is useful for technology management and healthcare management systems. Managers often describe digital health investments as strategic transformation initiatives, but capital markets may re- quire clearer evidence about integration, monetization, and timing. The negative [0, +2] CAR under factor models suggests post-announcement reassessment when investors separate the headline signal from acquisition costs, execution risk, or uncertainty about reimbursement and adoption. The positive [__5, +5] average suggests that some announcements still receive favorable broader-window attention, but the evidence is too heterogeneous for a universal premium claim.

The study is limited by its public-source event universe, mixed event types, public price data, and lack of intraday trading or analyst revision measures. These limits do not invalidate the event-study evidence, but they narrow the claim to short-run announcement reaction under public-data constraints.

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VI. Conclusion

This paper examines the stock-market reaction to dig- ital health investment announcements by listed health- care and life-sciences firms. Using public announcements, Yahoo Finance adjusted prices, SPY returns, and Fama-French daily factors, it estimates abnormal returns for twenty-five events from 2018 to 2024. The results show negative immediate and three-day factor-adjusted reactions, a positive but statistically weak [__5, +5] CAR, and no robust evidence of a uniform positive premium. Sector patterns suggest heterogeneity, and placebo tests show that arbitrary shifted dates can still produce occasional false positives. Mechanism regressions based on resource-based view and continuous innovation coding remain exploratory rather than confirmatory.

The paper's contribution is a transparent decision- analytic design rather than an exaggerated performance claim. This framework supports technology-management decision makers by converting public digital-health investment announcements into auditable external evaluation signals. Digital health investments may act as strategic resource signals, but market reaction depends on event content, sector context, and implementation credibility. Future work can use commercial return and accounting databases, separate acquisitions from partnerships, and test whether short-run reactions predict later operational and financial transformation.

Data Availability and Replication

The empirical inputs are based on public company announcements, public market-price data from Yahoo Finance, SPY returns, and Fama-French daily factors. Table I reports source domains and event-level screening notes to keep the submitted paper self-contained. No non-public commercial database or undisclosed synthetic event data are used in the reported metrics. A larger follow-up study should extend the event universe and pre-register exclusion rules for confounding announcements such as earnings releases, regulatory decisions, or same-day merger news.

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