

Will Generative AI Disrupt the Digital Economy?

Early Evidence from Card Spending Data

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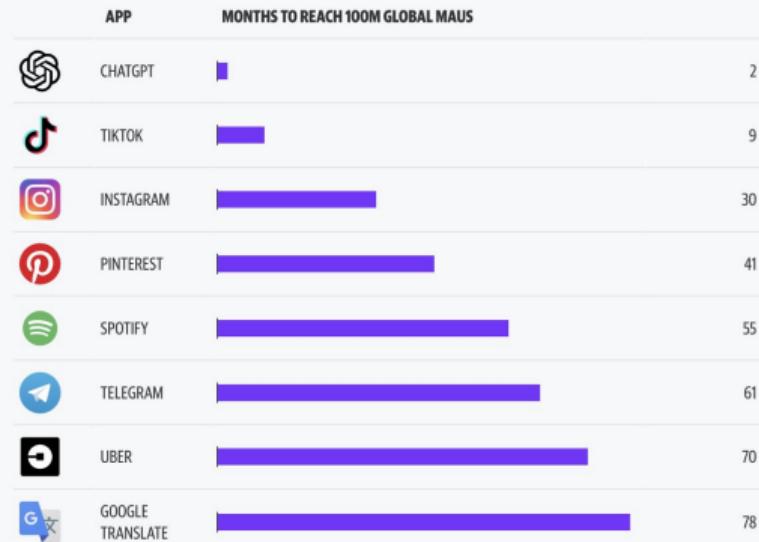
Preliminary and incomplete

1-slide Overview

- We use card spending data to see how initial OpenAI payments may have changed payments to 300+ other digital-fulfillment services in 18 categories, within 3 quarterly OpenAI adopter cohorts (2023Q1-Q3)
- We match OpenAI adopters to subsequent adopters on pre-adoption spending
- Identification is based on 3 differences,
 - Pre/post within an OpenAI adopter cohort
 - Between an OpenAI adopter cohort and subsequent adopter cohort
 - Diff-in-diff between this year and previous year for seasonality
 - ...but causal interpretation requires ignorability
- We find that OpenAI adoption
 - increases other AI tools adoption for all 3 adopter cohorts
 - has a few moderators
 - changes most brands' market share by less than 1-2%

HOW LONG IT TOOK TOP APPS TO HIT 100M MONTHLY USERS

ChatGPT is estimated to have hit 100M users in January, 2 months after it's launch.
Here's how long it took other top apps to reach that:



SOURCE: UBS

yahoo!
finance

Why do consumers pay for ChatGPT-4?



You

What are the top 3 benefits that individual consumers get from ChatGPT4 subscription, as opposed to using the free ChatGPT3.5 service? Please be specific.



ChatGPT

The top three benefits individual consumers gain from subscribing to ChatGPT-4, compared to using the free ChatGPT-3.5 service, are:

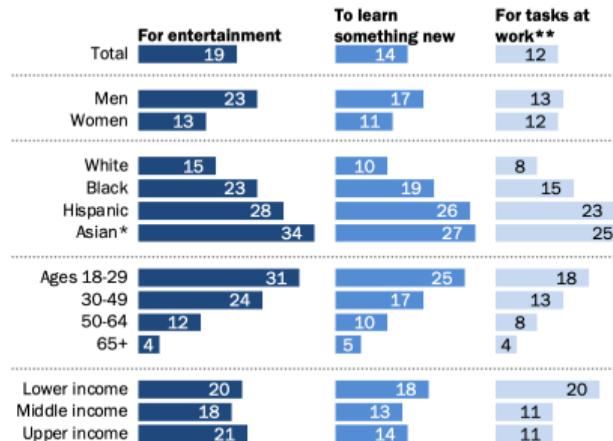
1. **Advanced Model Access:** Subscribers get access to the latest GPT-4 model, which typically offers improved performance in areas such as understanding context, generating more accurate and relevant responses, and displaying a better grasp of complex topics compared to GPT-3.5.
2. **Higher Limits and Prioritized Access:** Subscribers often receive higher usage limits, meaning they can interact with the AI more frequently and for longer sessions. Additionally, during times of high demand, subscribers usually have prioritized access, reducing the likelihood of encountering capacity-related usage restrictions.
3. **New Features and Updates:** Subscribers are often the first to experience new features, enhancements, and updates. This can include access to beta features, improvements in response quality, and other advancements not immediately available to non-subscribers.

Survey: Why do consumers say they use ChatGPT?

- One in ten employed Americans used ChatGPT at work
- 19% of Americans used ChatGPT for entertainment
- 14% of Americans used ChatGPT to learn something new

Young adults who have heard of ChatGPT are more likely than their older counterparts to have used it

Among the 58% of U.S. adults who have heard of ChatGPT, % who say they have ever used it ...



*Estimates for Asian adults are representative of English speakers only.

**This item was asked only of respondents who were working for pay at the time of the survey.

Note: White, Black and Asian adults include those who report being only one race and are not Hispanic. Hispanic adults are of any race. Family income tiers are based on adjusted 2021 earnings. Those who did not give an answer are not shown.

Source: Survey of U.S. adults conducted March 13-19, 2023.

PEW RESEARCH CENTER

What consumer benefits does ChatGPT-4 offer?

- Ken's version:
 - A powerful transformation of a large semantic corpus
 - A large improvement in human/computer fluency
 - A bundle of inter-related services
 - Some pretty good specialized assistance, especially coding and editing
 - Wide-ranging, fast, low-quality general assistance
 - Incompetent assistance in many areas, like the internet it was trained on
 - Especially accessible to those who communicate skillfully
- It's unclear what category it's in, what it competes with, what it enhances

Why might OpenAI affect other digital services?

- “When we buy a product, we essentially ‘hire’ it to help us do a job.”

Christensen et al. (2016)

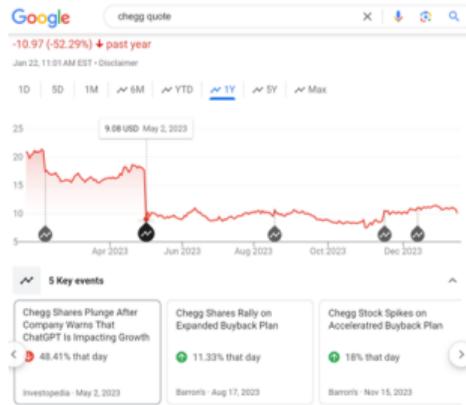
- If Gen AI can do your job better than you can, your job might be in trouble
- If Gen AI can help do a ‘customer job’ better than a ‘hired’ paid service can, that service’s payment might be in trouble

≡ Transfer learning

From Wikipedia, the free encyclopedia

Transfer learning (TL) is a technique in machine learning (ML) in which knowledge learned from a task is re-used in order to boost performance on a related task.^[1] For example, for image classification, knowledge gained while learning to recognize cars could be applied when trying to recognize trucks. This topic is related to the psychological literature on transfer of learning, although practical ties between the two fields are limited. Reusing/transferring information from previously learned tasks to new tasks has the potential to significantly improve learning efficiency.^[2]

Investors appear concerned



Chegg Shares Plunge After Company Warns That ChatGPT Is Impacting Growth

By BILL MCCOLL Published May 02, 2023

- 2023Q1 Chegg earnings call: "Chegg had a solid quarter, ending Q1 above our guidance on total revenue and adjusted EBITDA. ... since March, we saw a significant spike in student interest in ChatGPT. We now believe it's having an impact on our new customer growth rate."

BlackRock: "Generative AI has significant implications for different areas of the economy ranging from displacing web-based search tools to automating various services industries."

Research Questions

- How does ChatGPT-4 adoption change consumers' other digital purchases?
 - Effects may accrue from rivalry/synergy of related services' benefits, or GPT-4-induced changes in customer time, money or attention, or GPT-4-induced introduction to other services (inc. AI)
 - Which subcategories and merchants change most?
 - We'll cast a wide net, examine all digital fulfillment categories available
 - Which customers change most?
 - Data are anonymous so we'll classify customers by past purchases; still in progress
- Answers matter for forecasters, investors, policymakers, competitors, and understanding broader Gen-AI effects on digital economy
- Caveats: Limited mechanism evidence;
No price variation to identify economic complement/substitute relationships

Literature: Technology Adoption & Consumers

- Brynjolfsson et al. (2023): Incentivized experiments ($N>40k$) suggest that 10 popular digital goods (social media, search, maps, videos, amazon) generate $>\$2.5T$ in consumer surplus, or 6% of GDP
- Allcott et al. (2022): Clever RCT + phone monitoring app to measure consumer welfare, habit formation and self-control problems. 78% of consumers self-constrained screen time. 31% of social media use due to self-control problems
- No studies of GPT4 effect on purchases yet, that we know of

Literature: Gen AI & Workers

- Dell'Acqua et al. (2023): Randomly endowed consultants with (a) nothing, (b) GPT4, or (c) GPT4+Training ; compared task performances to pretests
 - GPT4-endowed consultants worked more, better & faster
 - Within the AI frontier, GPT4 increased high-skill consultants' work quality by 17%; low-skill by 43%
 - Outside the AI frontier, GPT4 worsened task accuracy but improved speed and human-judged recommendation quality
- Eisfeldt et al. (2023): Firms with high labor exposure to Gen AI earned daily excess returns 0.4% higher than firms with low exposure, after ChatGPT released
 - Gen-AI exposure based on ChatGPT inferences about job titles' susceptibility to replacement ; corroborated by earnings call discussions of Gen AI

Literature: ChatGPT & Customer Data

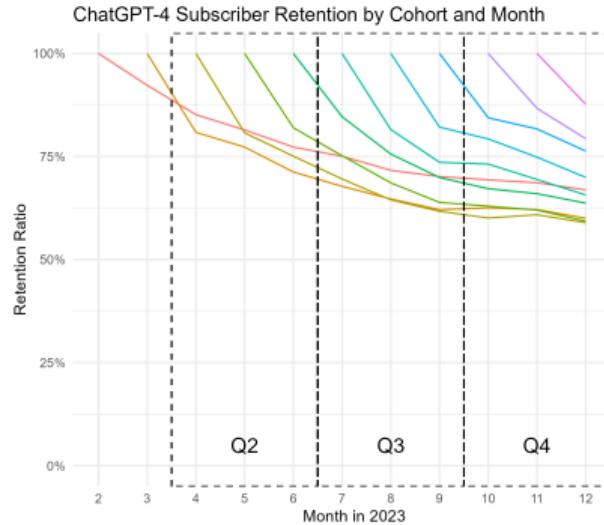
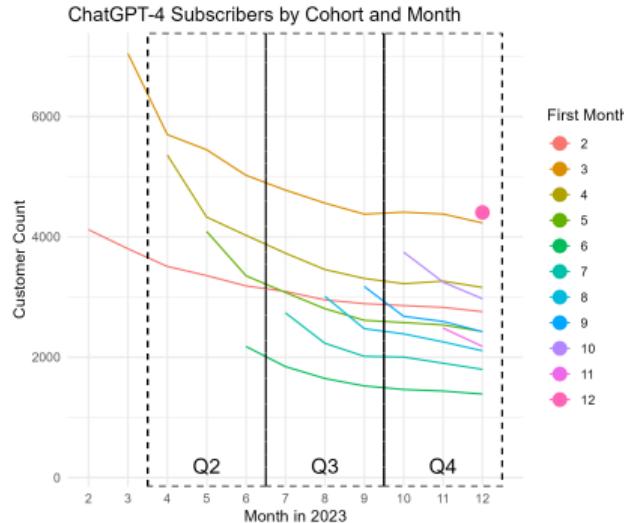
- Li et al. (2024; & others): LLMs can replace humans in market research data
 - Human- and LLM-generated perception agreements can exceed 75%
 - LLM-generated data correspond to intertemporal changes in revealed preferences
- ChatGPT4 release reduced StackOverflow posts...
 - by 16%, relative to Russian and Chinese language alternatives, suggesting ChatGPT adoption will cannibalize future LLM training data (Rio-Chanona et al. 2023)
 - but did not reduce comparable Reddit posts. S.O. answer quality declined due to user exit (Burtch et al. 2023)
- Gen AI has reduced demand for some freelancers
 - Hui et al. (2023) : ChatGPT release reduced Upwork freelance writer jobs and payments, relative to other freelance categories
 - Demirci, Hannane, & Zhu (2023) : ChatGPT release reduced freelance automation-prone job listings

Datasource

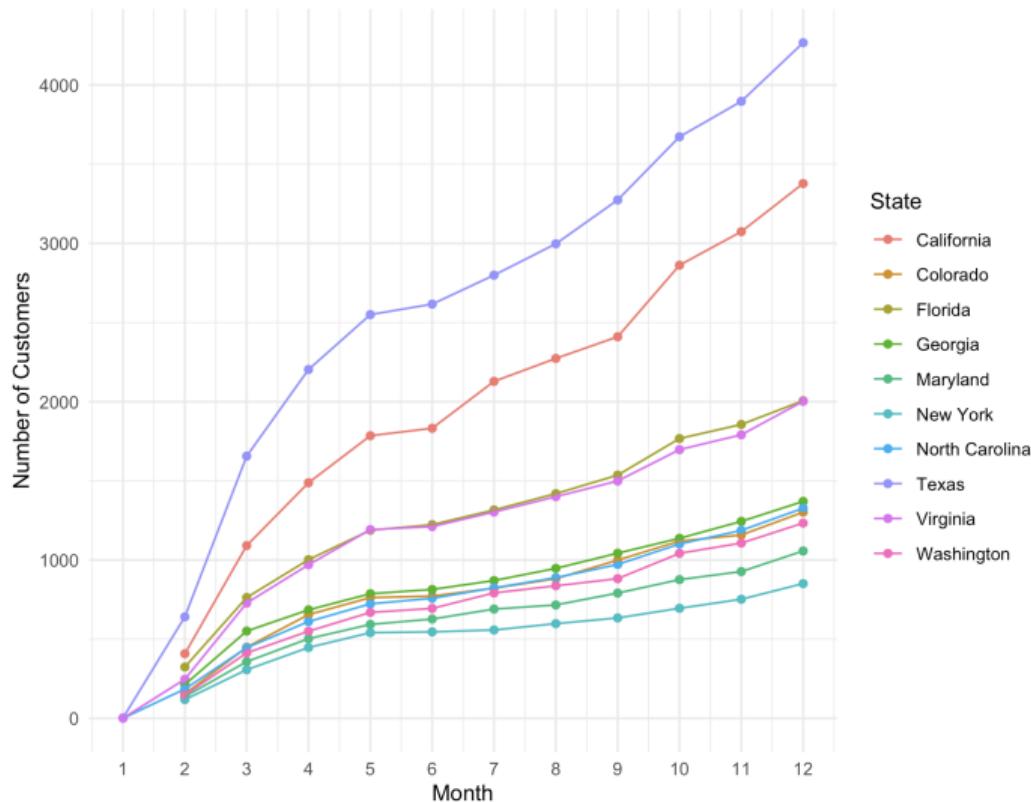
- Anonymous credit & debit card spending panel
 - Complete transaction records sourced from partner financial institutions
 - ~8 million US adults in 2023
 - Reports individual payments to 5.2k large 'merchants' \cong customer-facing brands
 - We'll focus on 452 digital-fulfillment merchants in 18 subcategories
 - 216k payments to OpenAI, \$4.4M, 99.8% of payments are \sim \$20
 - Balanced panel of 19,614 OpenAI payers in 2022-2023
- Limitations: Many sales are intermediated; products unknown

earnestanalytics

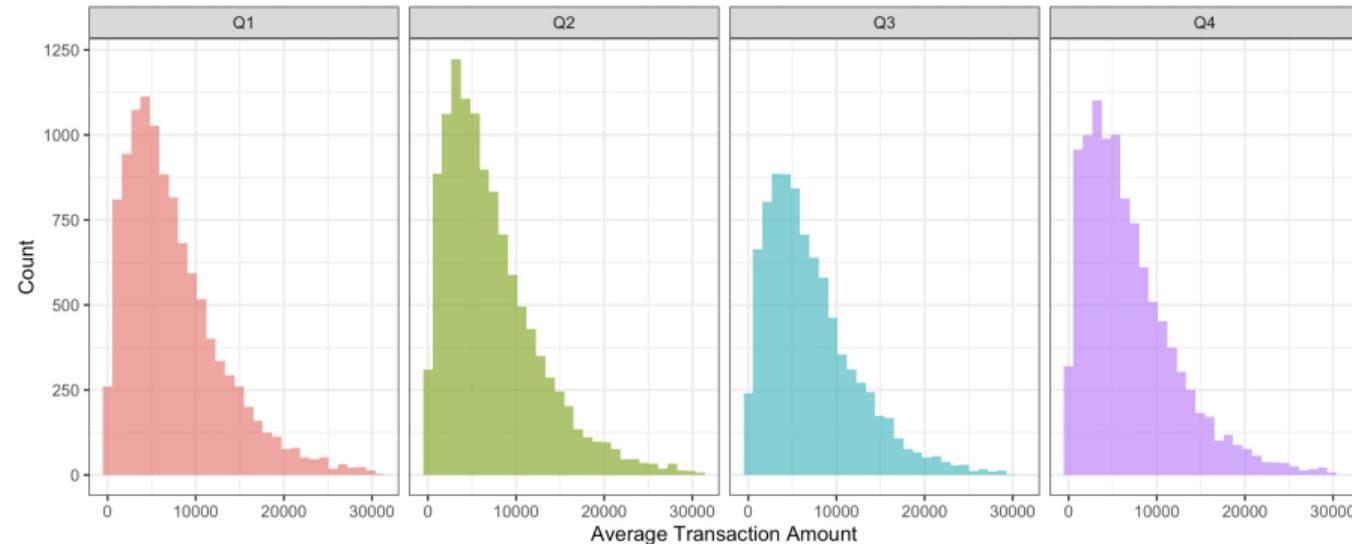
ChatGPT Customers & Retention by Adoption-Month Cohort



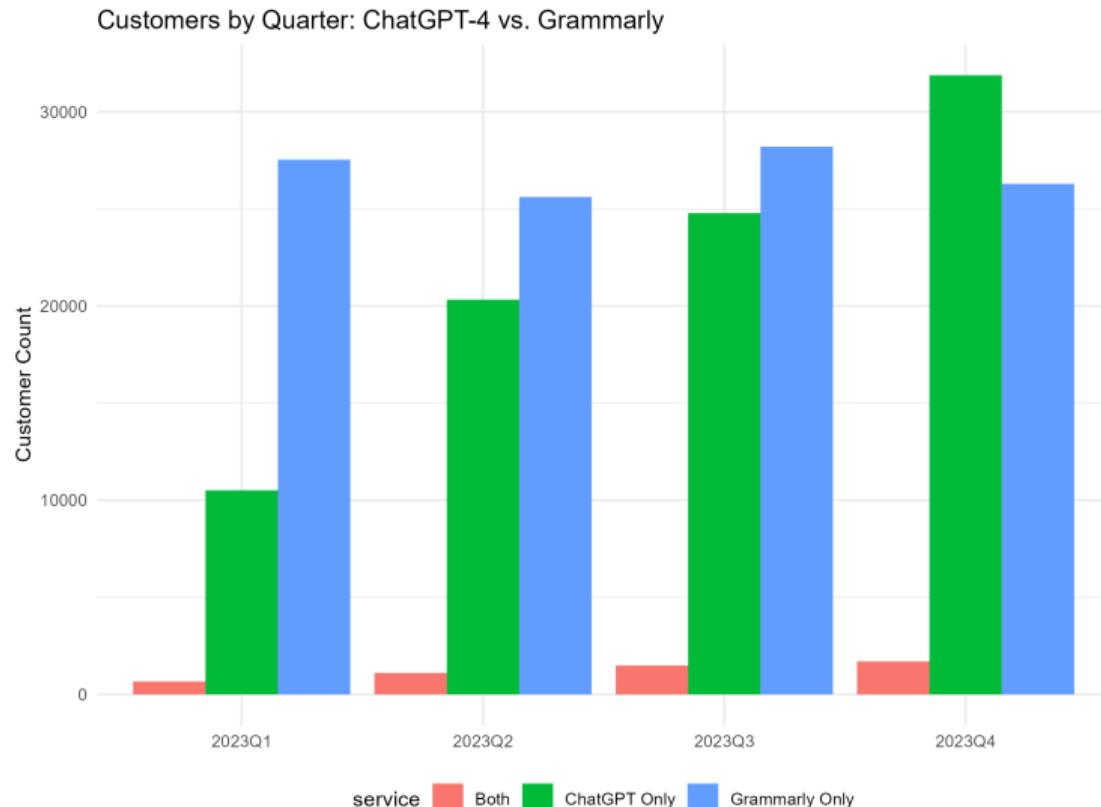
Monthly Customers in Top 10 States



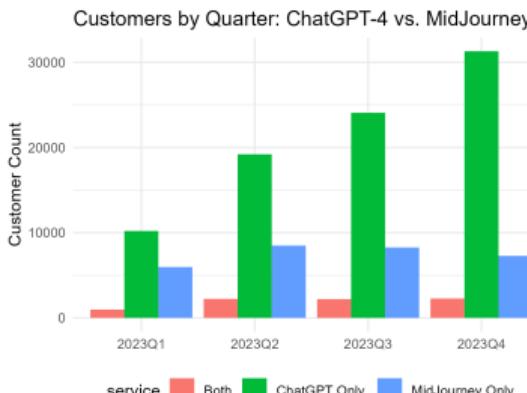
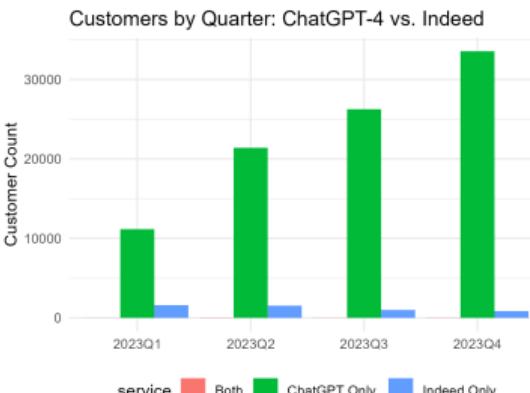
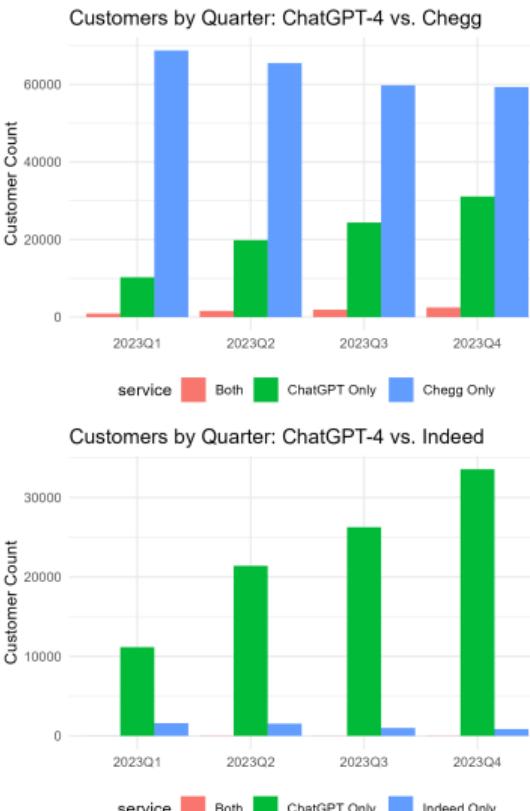
Average Monthly Card Spending by Adoption Cohort



ChatGPT v. Grammarly



Descriptives: ChatGPT v. Others



What's the ideal experiment?

- Treat consumers with GPT4, see how their other purchases change?
 - This could estimate ITT
 - But, $ITT \neq ATT$, and maybe they are very different
- Noncompliance complicates manipulations of technology effects on consumption
- Ideal experiment seems infeasible
 - recruit customers who want GPT4 but don't have it yet? sampling problem
 - teach recruited customers how to use GPT4? treatment problem

Cautionary Tale

Full Text Trade Journal

DVRs Not So Hot?

Kirschbaumer, Ken. *Broadcasting & Cable*; New York Vol. 135, Iss. 24. (Jun 13, 2005): 26.

BROADCASTING CABLE

In a six-month study, ESPN gave viewers digital video recorders. At the end, the sports network came to this realization: Many people couldn't care less about DVRs.

ESPN picked 100 households for its DVR experiment and periodically had trained researchers drop in to observe how using the device changed family viewing habits.

The murky verdict: **Ultimately, 75% want to keep the DVR, but ESPN had trouble keeping the group intact. Over time, 90 of the 100 New York-area households dropped out and were replaced by others, and by the end, only 68 homes remained.**

"The findings of this study certainly contradict the prevailing wisdom that DVRs will become the norm [in] U.S. households and that the 30-second spot will be rendered obsolete," wrote ESPN's Artie Bulgrin, senior VP of research and sales development, and Rachel Mueller-Lust, ABC research VP. (Right now, about 7% of the nation has DVRs.)

Abstract

Translate

In a 6 month study, **ESPN gave 100 households a DVR and had researchers drop in to find out how viewing habits changed.** The study found that for most users, skipping commercials is not the primary motivation for having a DVR, and that many people may never be interested in DVR or VOD technology, which should reassure advertisers.

Bulgrin says the study, conducted for ESPN by Horowitz Associates, suggests that "the sky is not falling" on the current 30-second advertising model. "Generally speaking, commercial avoidance is a secondary outcome of watching television with a DVR," the study says.

And viewers may not want the things. "There are millions and millions of Luddites in this country," says Bulgrin. "The majority of homes in the country don't intend to use either VOD or DVR technologies."

Indeed, **the test had so much churn because some people had trouble working the TiVo technology and many concluded they just didn't care.** (Personal issues were another factor.)

Empirical Strategy

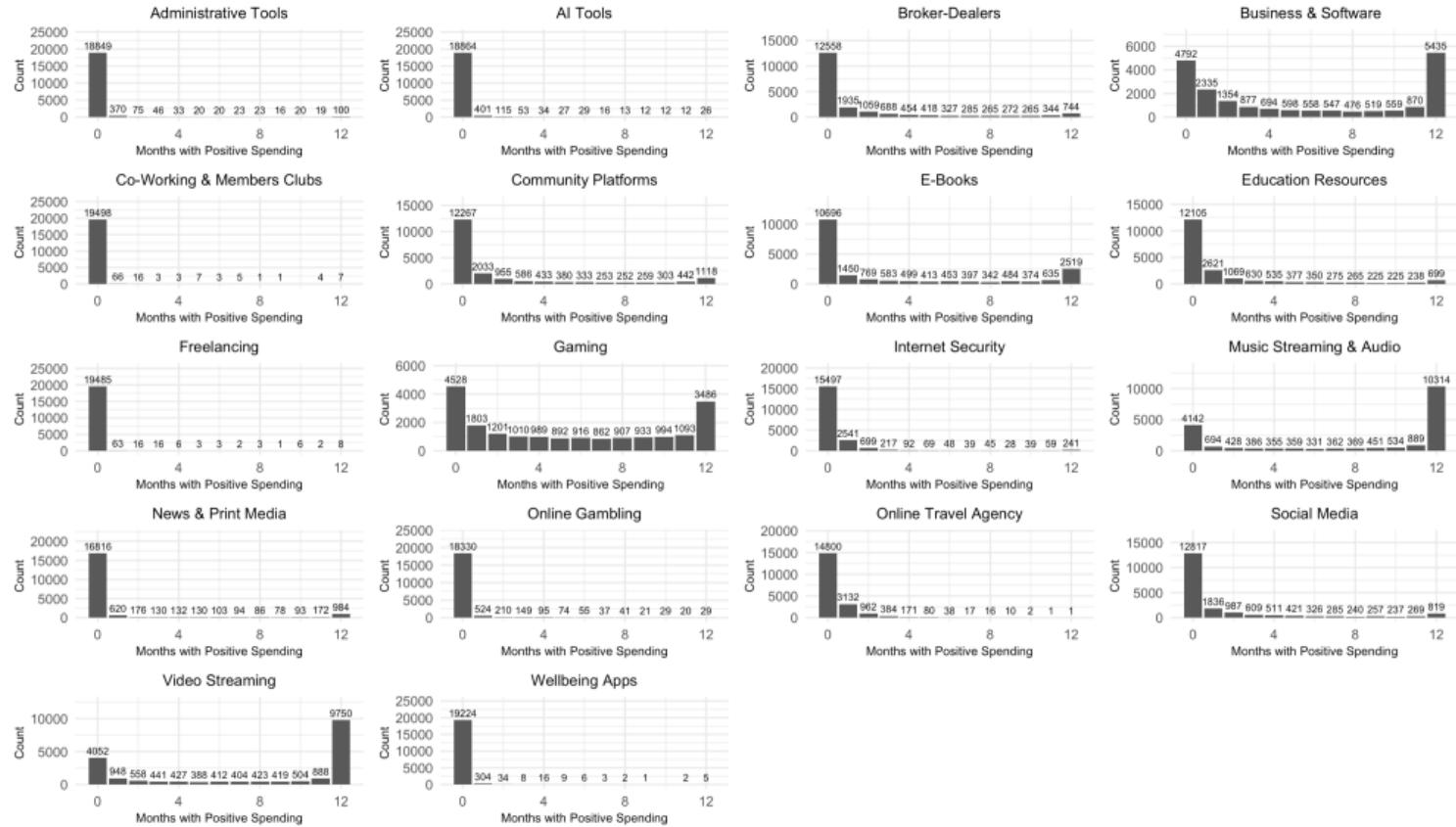
- Consider ChatGPT4 introduction as a quasi-experiment, analyze customer cohorts (Kim & McCarthy 2022, Oblander & McCarthy 2023)
 - Disregard: Earliest adopters (March 2023); least representative
 - “Treated”: 2023Q2 adopters ($N_T = 11,144$)
 - “Control”: 2023Q3 adopters ($N_C = 8,470$)
- Coarsened Exact Matching (CEM) balances (t,c) on observables
 - CEM nonparametrically reduces model dependence by controlling for pretreatment confounds in observational data; differs qualitatively from PSM (Iacus et al. 2011)
 - We match customers on past behaviors (2022 payments) to explain future behaviors
- Dfce-in-dfce-in-dfce's (DDD):
 - Pre/post GPT4 introduction: Q1 vs. Q2
 - Between consecutive-quarter adopter cohorts
 - Analogous DD from 2022 for brand/group seasonality

Are CEM-DDD estimates causal?

- I.e. does CEM-DDD rule out alternate explanations
 - Pro: Past behaviors are often good predictors of future behaviors
 - Con: Consumers self-select into products and adoption timing. I don't know any approach that can fully rule out time-varying unobservables (starting a business, going to school, looking for a job, etc)
- My take: Suggestive but any causal statements condition on ignorability
Probably worth knowing even if not fully causal interpretation

Subcategories, brands and usage among OpenAI Payers

Subcategory	Number of Brands	Unique Users	Market Share	Largest Brands (2022 Market Share)
AI Tools	13	572	2.92%	quillbot (.91%), jasper (.73%), replika (.43%)
Administrative Tools	8	716	3.65%	evernote (1.37%), calendly (1.28%), efax (.65%)
Broker-Dealers	23	6,803	34.68%	coinbase (14.69%), robinhood (11.49%), fidelity_investments (4.55%)
Business & Software	68	14,391	73.37%	microsoft (42.65%), adobe (24.69%), microsoft_365 (13.85%)
Co-Working & Members Clubs	4	105	.54%	wework (.23%), soho_house (.19%), freedom_boat_club (.10%)
Community Platforms	24	6,899	35.17%	patreon (15.96%), canva (8.71%), fiverr (6.22%)
E-Books	5	8,377	42.71%	audible (31.24%), kindle (23.41%), epic (.35%)
Education Resources	47	6,906	35.17%	chegg_services (11.36%), udemy (7.32%), course_hero (5.84%)
Freelancing	2	112	.57%	upwork_gig_pay (.43%), fiverr_gig_pay (.16%)
Gaming	64	14,731	75.10%	google_play (35.24%), steam_games (29.43%), nintendo (27.65%)
Internet Security	13	3,868	19.72%	norton (5.50%), expressvpn (4.68%), mcafee (4.33%)
Music Streaming & Audio	13	15,223	77.61%	itunes (63.65%), spotify (35.33%), siriusxm (13.90%)
News & Print Media	15	2,682	13.67%	ny_times (7.66%), washington_post (2.77%), wsj (2.74%)
Online Gambling	15	1,107	5.64%	draftkings (2.36%), fanduel (2.36%), jackpocket (1.16%)
Online Travel Agency	17	4,400	22.43%	expedia (9.64%), priceline (5.23%), viator (2.35%)
Social Media	26	6,385	32.55%	onlyfans (11.13%), facebook_other (8.71%), discord (7.54%)
Video Streaming	38	15,257	77.79%	netflix (43.75%), hulu (30.65%), youtube (29.98%)
Wellbeing Apps	4	363	1.85%	headspace (.94%), calm (.59%), talkspace (.22%)



Coarsened Exact Matching (CEM)

1. Use expertise to pick pre-treatment matching variables
 - More {variance, variables} \Rightarrow fewer matches
 - Z_{ij} : 2022 Months i paid in subcategory $j = 1, \dots, 18$
2. Matching
 - Further coarsened Z_{ij} into three levels
 - 0: No payments in 2022 (Never)
 - 1: Payments for 1-10 months in 2022 (Inconsistently)
 - 2: Payments for 11-12 months in 2022 (Consistently)
 - CEM nonparametrically balances t, c with weights
3. CEM-DDD estimate is LATT in matched subsample

Table 1: Sample Sizes

	Control	Treated
All	8,471	11,144
Matched (ESS)	6,711	9,929
Matched	7,698	9,929
Unmatched	772	1,215
Discarded	0	0

Treatment/Control Comparison (No CEM)

Table 2: Summary of Balance for Matched Data

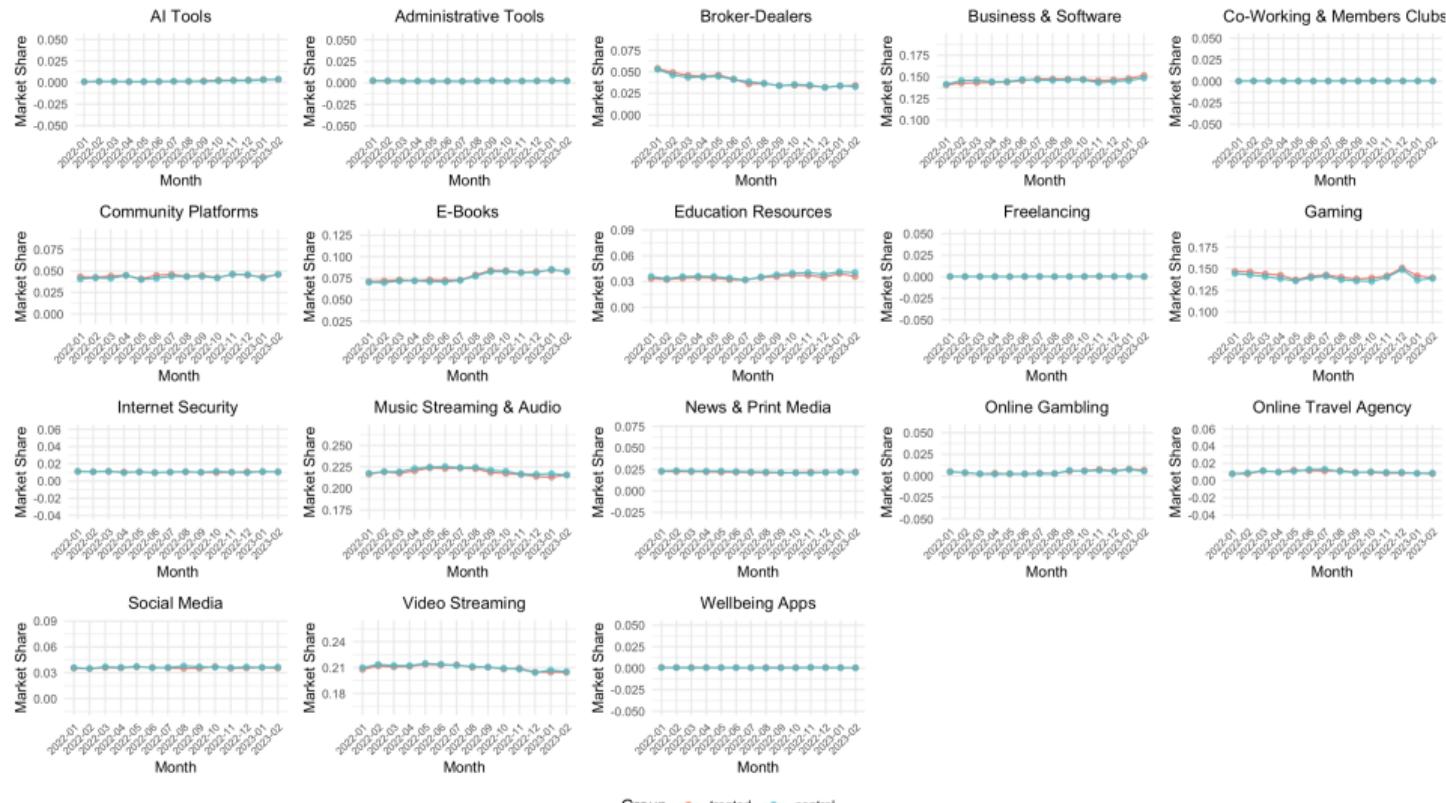
	Std. Mean Diff.	Var. Ratio	eCDF Mean	eCDF Max
Administrative Tools	.00	.97	.00	.00
AI Tools	.00	.98	.00	.00
Broker-Dealers	.02	1.02	.00	.02
Business & Software	.02	.99	.01	.02
Co-Working & Members Clubs	.02	1.56	.00	.00
Community Platforms	.04	1.07	.01	.02
E-Books	.02	1.01	.01	.01
Education Resources	-.04	.93	.01	.01
Freelancing	-.01	1.02	.00	.00
Gaming	.05	1.00	.02	.02
Internet Security	.02	1.13	.00	.01
Music Streaming & Audio	-.03	1.01	.01	.01
News & Print Media	.02	1.08	.01	.01
Online Gambling	.02	1.19	.00	.01
Online Travel Agency	.00	1.03	.00	.00
Social Media	.02	1.04	.00	.01
Video Streaming	-.01	1.00	.00	.01
Wellbeing Apps	.02	1.26	.00	.00

Matching Result

Table 3: Summary of Balance for Matched Data

	Std. Mean Diff.	Var. Ratio	eCDF Mean	eCDF Max	Std. Pair Dist.
Administrative Tools	.00	.97	.00	.00	.09
AI Tools	.00	1.03	.00	.00	.12
Broker-Dealers	.01	.99	.00	.02	.49
Business & Software	.01	.99	.01	.02	.47
Co-Working & Members Clubs	.00	.82	.00	.00	.05
Community Platforms	.02	1.02	.00	.01	.32
E-Books	.01	1.00	.00	.01	.37
Education Resources	-.02	.96	.01	.01	.41
Freelancing	.00	.87	.00	.00	.04
Gaming	.03	.99	.01	.02	.65
Internet Security	.00	.98	.00	.01	.20
Music Streaming & Audio	.00	1.00	.00	.00	.38
News & Print Media	.00	.99	.00	.00	.12
Online Gambling	.02	1.12	.00	.01	.23
Online Travel Agency	-.01	.96	.00	.01	.56
Social Media	.00	.98	.00	.00	.34
Video Streaming	.01	.99	.00	.01	.40
Wellbeing Apps	.03	2.44	.00	.00	.10

Pre-Treatment Trends in Matched Data



Triple Difference after Matching

- Weighted least squares and standard errors clustered by subclass (matched group)

$$Y_{it}^j = \beta_0 + \beta_1 \text{Group}_i + \beta_2 \text{Period}_t + \beta_3 \text{Year}_t + \\ \beta_4 (\text{Group}_i \times \text{Period}_t) + \beta_5 (\text{Group}_i \times \text{Year}_t) + \beta_6 (\text{Period}_t \times \text{Year}_t) + \\ \beta_7 (\text{Group}_i \times \text{Period}_t \times \text{Year}_t) + \epsilon_{it}$$

$$Y_{it}^j = \begin{cases} 1\{\text{User } i \text{ paid subcategory/merchant } j \text{ in time } t\}, \text{ or} \\ \text{User } i \text{ s payment to subcategory/merchant } j \text{ in time } t \end{cases}$$

$$\text{Group}_i = \begin{cases} 1, & \text{if user adopted GPT4 in 2023Q2} \\ 0, & \text{if user adopted GPT4 in 2023Q3} \end{cases}$$

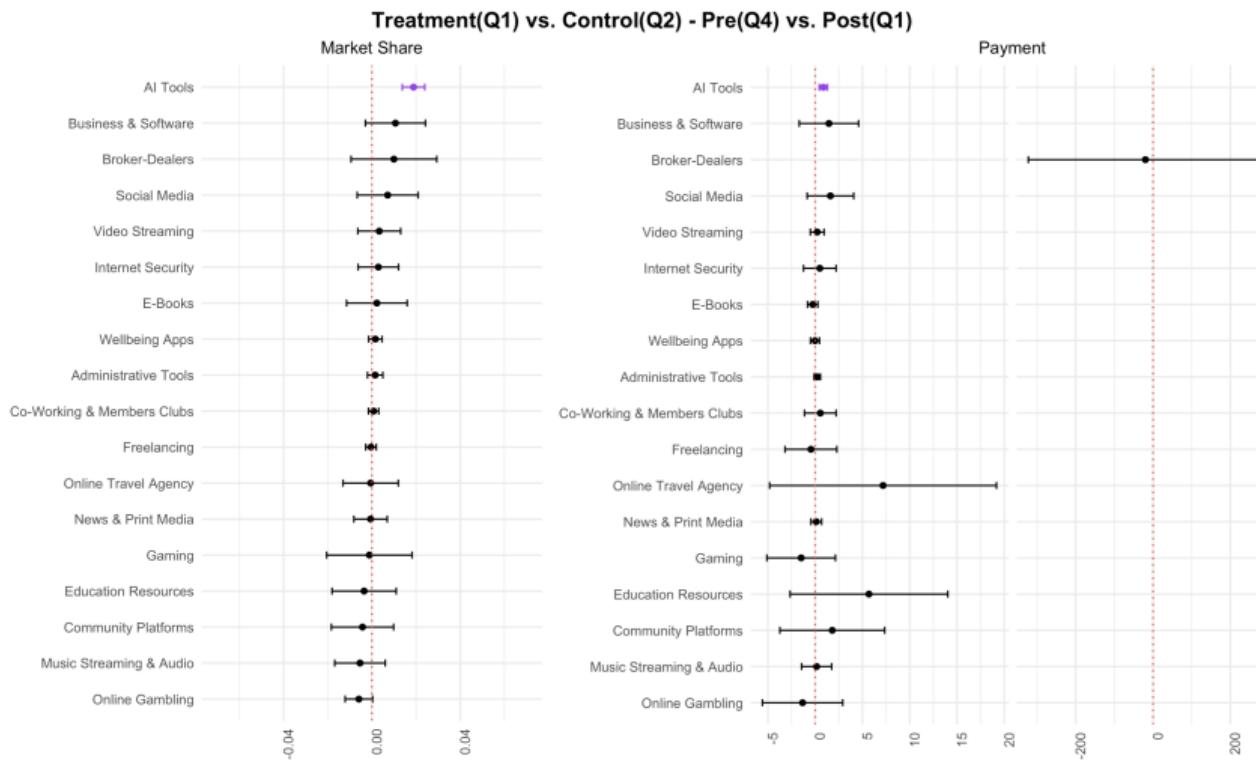
$$\text{Period}_t = \begin{cases} 1, & \text{if transaction in Q2 (Apr-Jun)} \\ 0, & \text{if transaction in Q1 (Jan-Mar)} \end{cases}$$

$$\text{Year}_t = \begin{cases} 1, & \text{if transaction in 2023} \\ 0, & \text{if transaction in 2022} \end{cases}$$

3 CEM-DDD result sets

- We have 3 possible treatment cohorts: Q1, Q2, and Q3 adopters
- We have 3 corresponding control cohorts: Q2, Q3, and Q4 adopters, respectively
- So, 3 (T, C, Pre, Post) combinations
 1. Q1, Q2, Q4, Q1
 2. Q2, Q3, Q1, Q2
 3. Q3, Q4, Q2, Q3

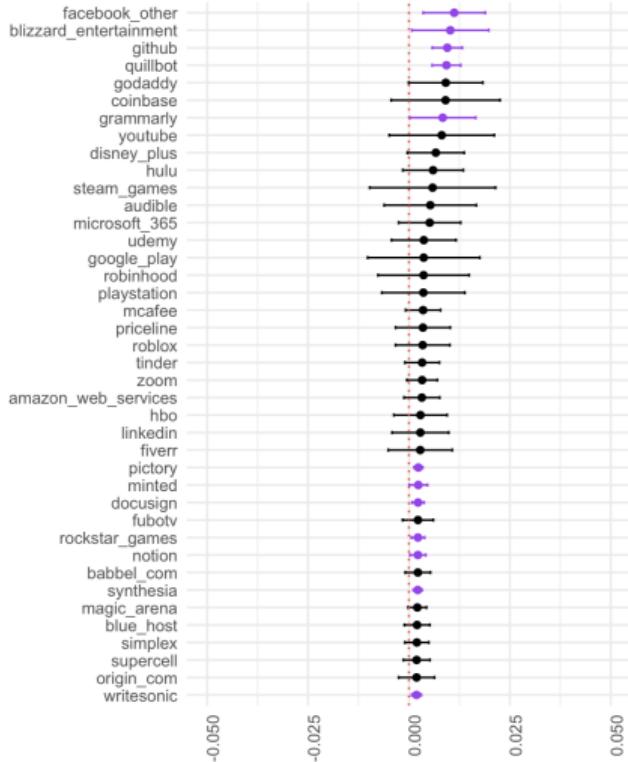
Q1 adopters: Subcategory effects



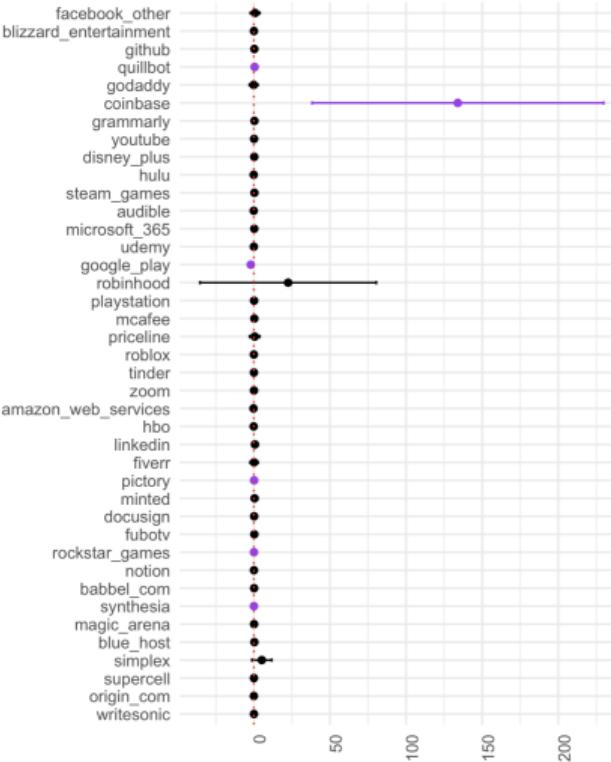
Q1 adopters: Merchant effects

Treatment(Q1) vs. Control(Q2) - Pre(Q4) vs. Post(Q1)

Market Share by Top 40 Merchants



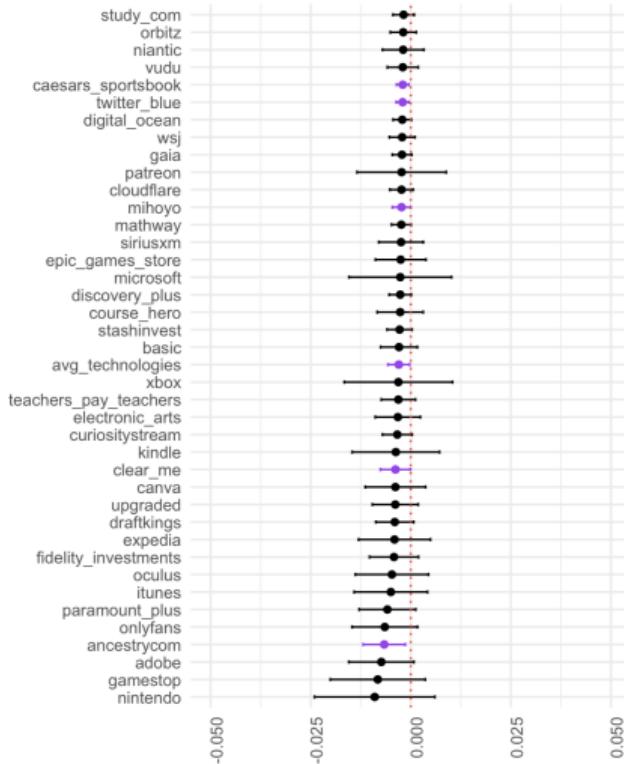
Payment by Top 40 Merchants



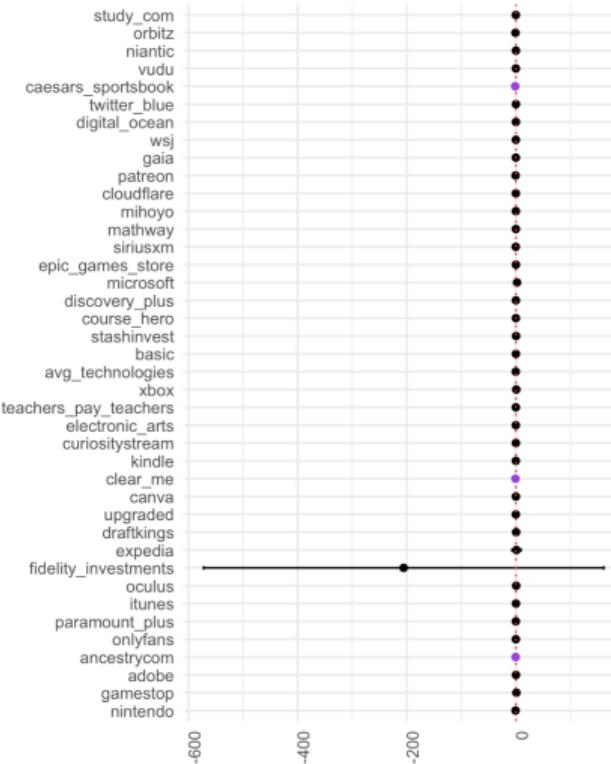
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Treatment(Q1) vs. Control(Q2) - Pre(Q4) vs. Post(Q1)

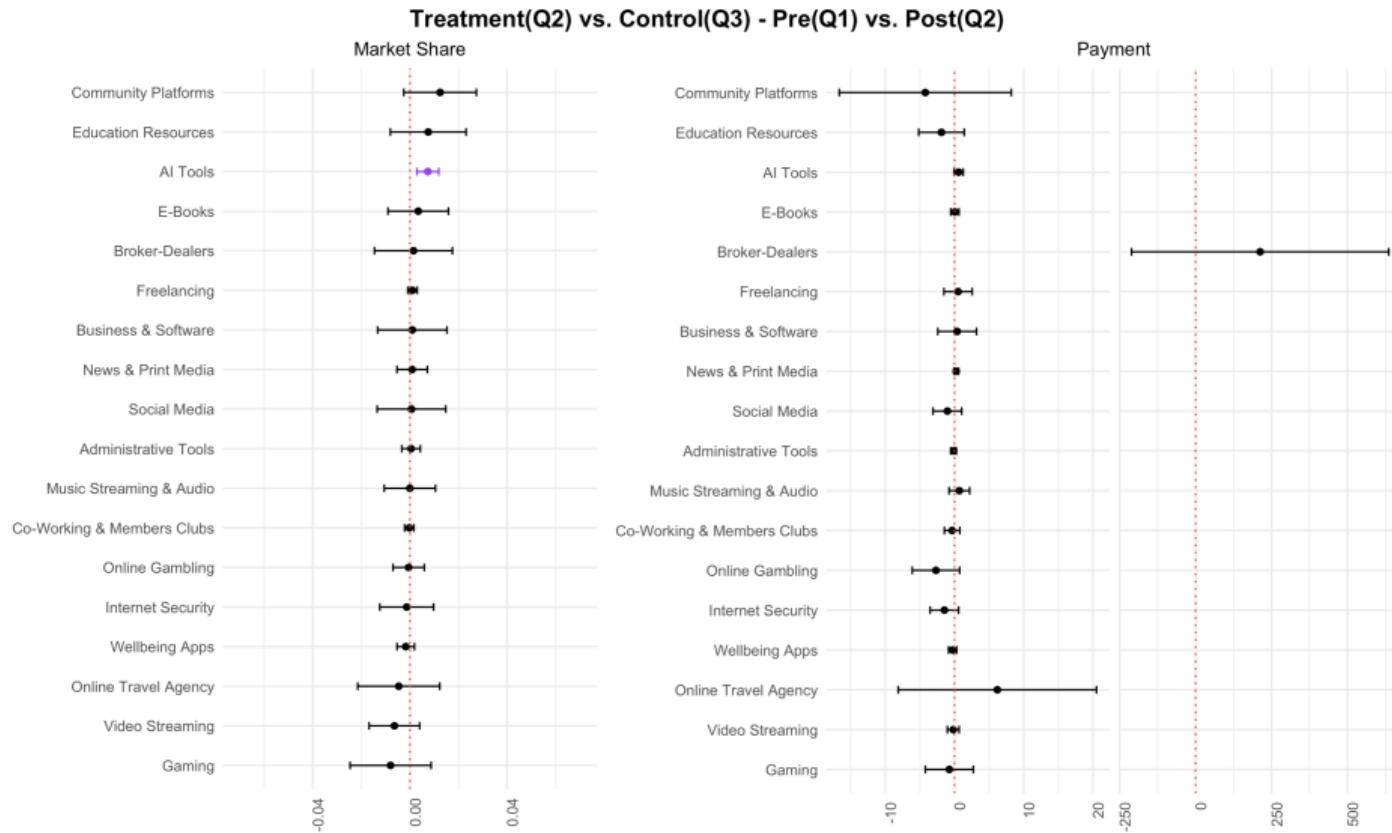
Market Share by Bottom 40 Merchants



Payment by Bottom 40 Merchants



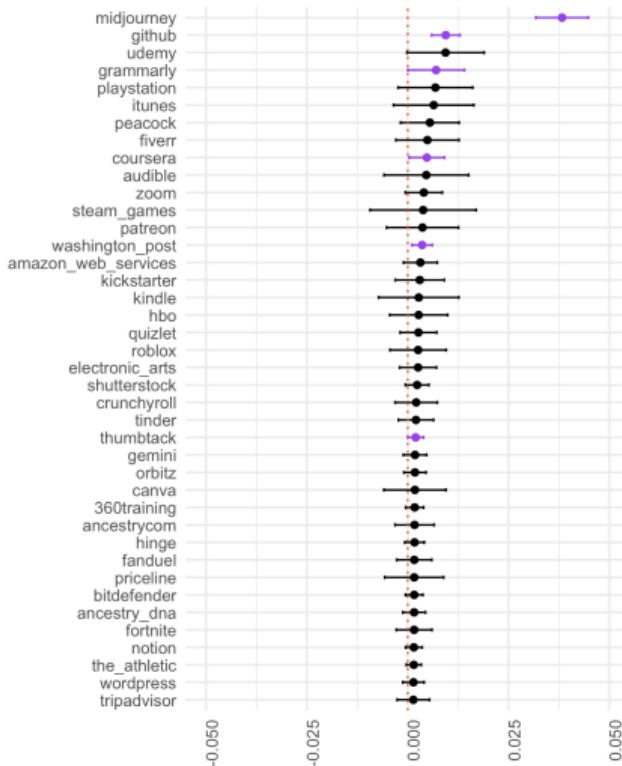
Q2 adopters: Subcategory effects



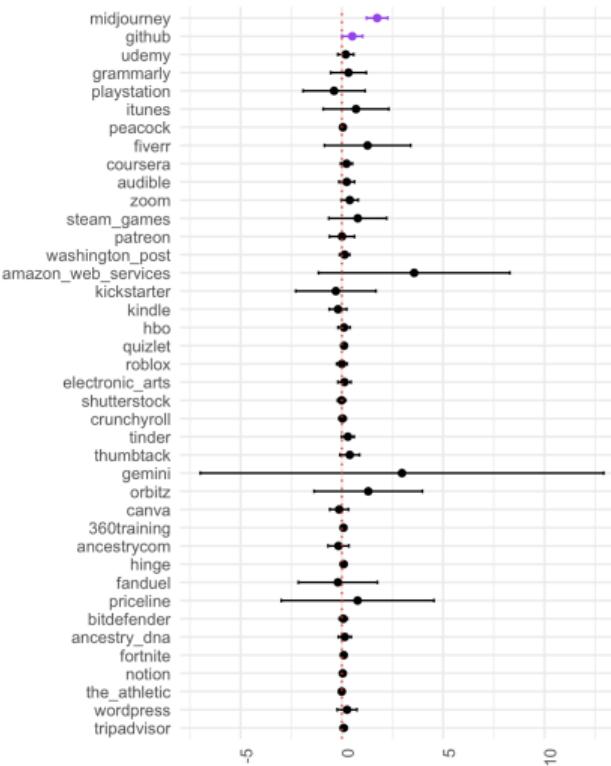
Q2 adopters: Merchant effects

Treatment(Q2) vs. Control(Q3) - Pre(Q1) vs. Post(Q2)

Market Share by Top 40 Merchants



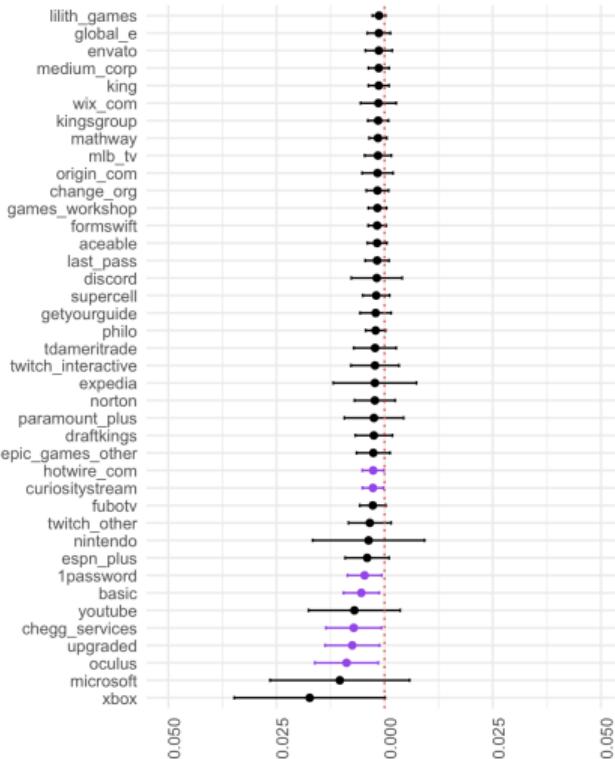
Payment by Top 40 Merchants



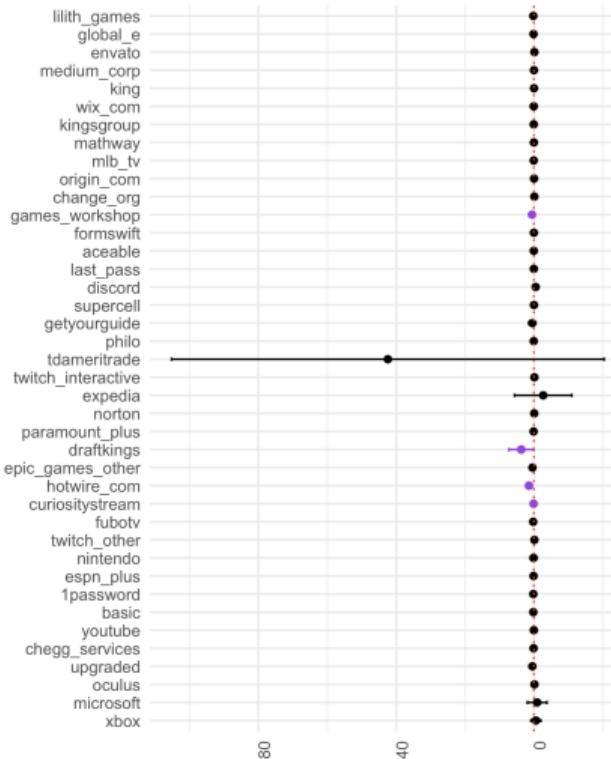
Q2 adopters: Merchant effects

Treatment(Q2) vs. Control(Q3) - Pre(Q1) vs. Post(Q2)

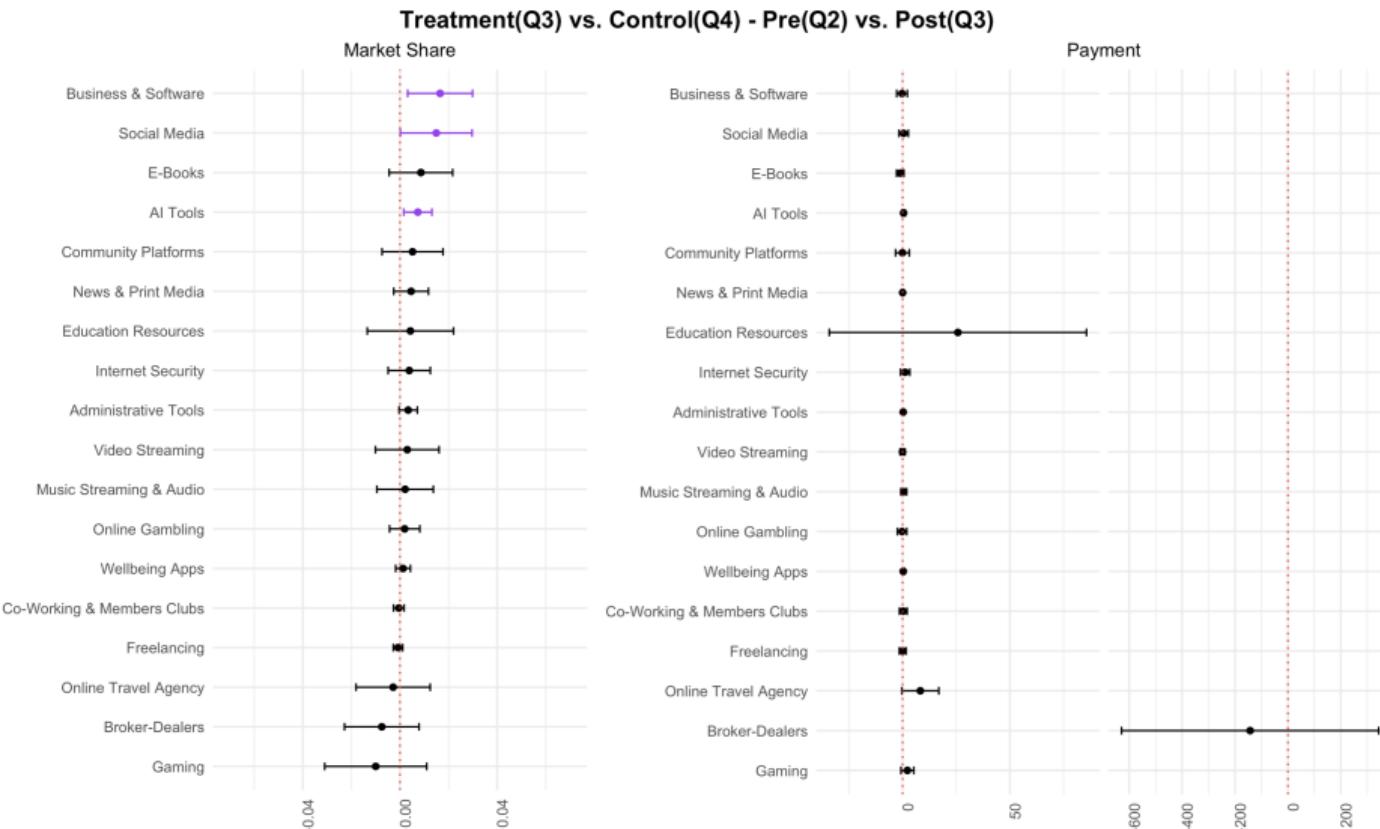
Market Share by Bottom 40 Merchants



Payment by Bottom 40 Merchants



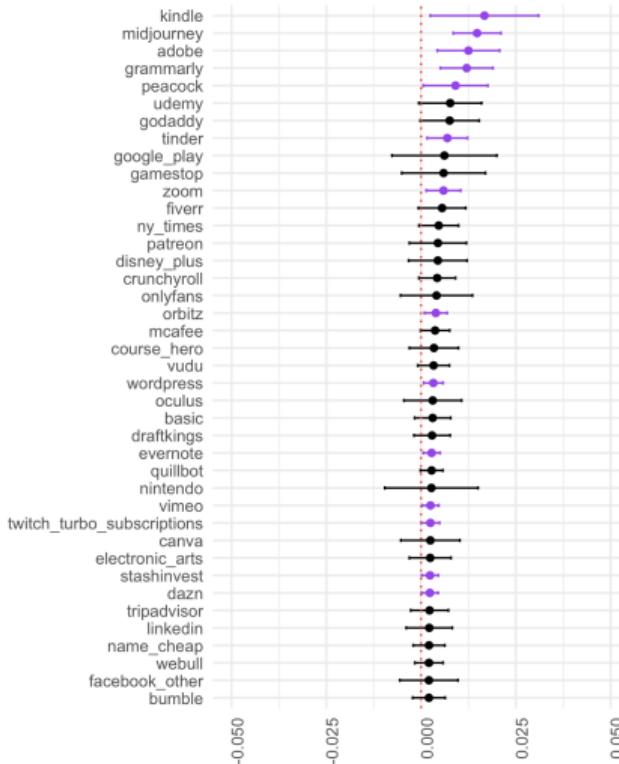
Q3 adopters: Subcategory effects



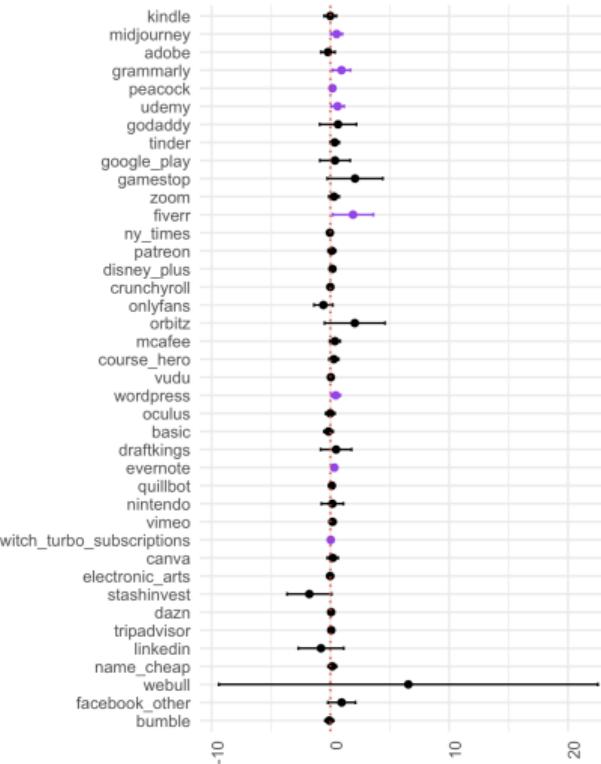
Q3 adopters: Merchant effects

Treatment(Q3) vs. Control(Q4) - Pre(Q2) vs. Post(Q3)

Market Share by Top 40 Merchants



Payment by Top 40 Merchants



Q3 adopters: Merchanty effects

Treatment(Q3) vs. Control(Q4) - Pre(Q2) vs. Post(Q3)



Intensity of Treatment Effects

- We partition the Q2 treatment users into 2 groups:
 - Those who adopted in April and paid OpenAI 3x in Q2: N = 3,240
 - Those who adopted in April and paid OpenAI 1-2x in Q2: N = 1,312
- And partition the Q3 treatment users into 2 groups:
 - Those who started adopting in July and paid OpenAI 3x in Q3: N = 1,665
 - Those who started adopting in July and paid OpenAI 1-2x in Q3: N = 666
- Motivated by 'intensity-of-treatment' effects, but self-selected
- We re-run the CEM-DDD estimator within each partition

Intensity of Treatment Effects (Treatment Q2)

	Unpartitioned Estimate	3 OpenAI Payments	1-2 OpenAI Payments
	(1)	(2)	(3)
Administrative Tools	4e-04	-0.0017	0.0018
AI Tools	0.0073**	0.0078.	0.0118*
Broker-Dealers	0.0014	-0.0117	2e-05
Business & Software	9e-04	0.0154	-0.0118
Co-Working & Members Clubs	-3e-04	-4e-04	-7e-04
Community Platforms	0.0124	0.0169	0.0018
E-Books	0.0034	-0.0054	0.0128
Education Resources	0.0075	6e-04	0.0034
Freelancing	0.001	6e-04	0.0037
Gaming	-0.008	-0.0055	-0.0236
Internet Security	-0.0014	-0.0035	0.0103
Music Streaming & Audio	-1e-04	-9e-04	-0.0072
News & Print Media	9e-04	0.0033	0.0013
Online Gambling	-6e-04	0.0015	0.0059
Online Travel Agency	-0.0046	-0.0039	-0.0219.
Social Media	6e-04	0.0032	-0.0033
Video Streaming	-0.0064	-0.0041	0.0038
Wellbeing Apps	-0.0018	-0.0018	-0.0043*

Intensity of Treatment Effects (Treatment Q3)

	Unpartitioned Estimate (1)	3 OpenAI Payments (2)	1-2 OpenAI Payments (3)
Administrative Tools	0.0034	0.0081**	9e-04
AI Tools	0.0073**	0.0057	0.0132
Broker-Dealers	-0.0075	-0.0089	-0.0206
Business & Software	0.0165**	0.006	0.0093
Co-Working & Members Clubs	-5e-04	-0.0019	-1e-04
Community Platforms	0.0051	0.0124	0.0325
E-Books	0.0086	-0.0049	0.0068
Education Resources	0.0043	-0.0045	-0.0153
Freelancing	-8e-04	-0.0017	-0.0026
Gaming	-0.01	0.0117	-0.0189
Internet Security	0.0038	0.0029	0.0143
Music Streaming & Audio	0.0021	-0.0032	0.0221
News & Print Media	0.0046	0.0056	0.0095
Online Gambling	0.0019	0.0075	0.0057
Online Travel Agency	-0.0028	-0.0048	0.012
Social Media	0.0149**	0.0276**	0.0068
Video Streaming	0.003	0.0039	-0.0085
Wellbeing Apps	0.0012	3e-05	0.0057

Where to go next?

- Is there a richer theoretical story we can tell?
 - Consider sub-subcategories
- Look at payment changes around annual autorenewal dates
- Show how CEM-DDD estimates differ between partitions with
 - Previous payments for AI tools, business, education, ...
- More possible moderators:
 - Segment consumers, name segments, run CEM/DDD within segments
 - Enrich adoption measures, e.g. first-time adopters, multihomers, deadopters
- Incorporate consumer locations, total spending, or nondigital spending?
- Consumer survey or online experiment for mechanism evidence?

Discussion

- How does ChatGPT-4 adoption change consumers' other digital payments?
 - Early evidence suggests rules out 2% share changes for most brands
 - Some cross-fertilization with other AI tools
 - Effects on later adoption cohort might be larger than earlier cohorts:
Q3 adopters increased business and social media usage
 - Little evidence that education brands are in trouble, except Chegg/Course Hero
- This evidence is early
 - Causal interpretation requires ignorability
 - GPT-X continues to evolve
 - Digital services continue evolving, many are incorporating Gen-AI as a feature

Thank You!

All feedback welcome:
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Appendix

AI Tools adoption ordering within 2023Q2?

AI tools adoption ordering figure

Limitation

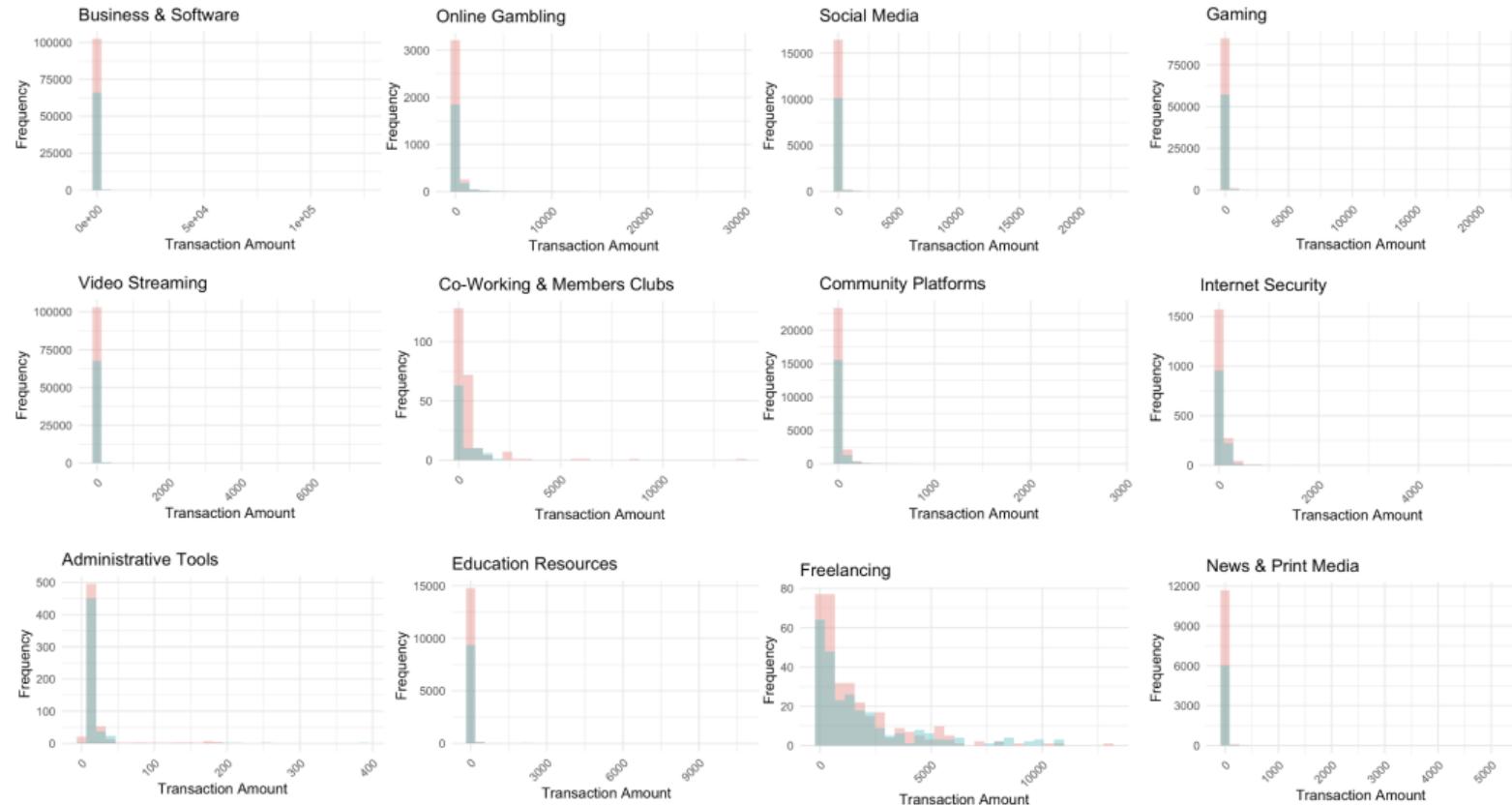
- Ignorability may not hold
 - Unobserved OpenAI demand drivers may correlate with unobserved drivers of demand for other AI services

Merchant Selection Criteria

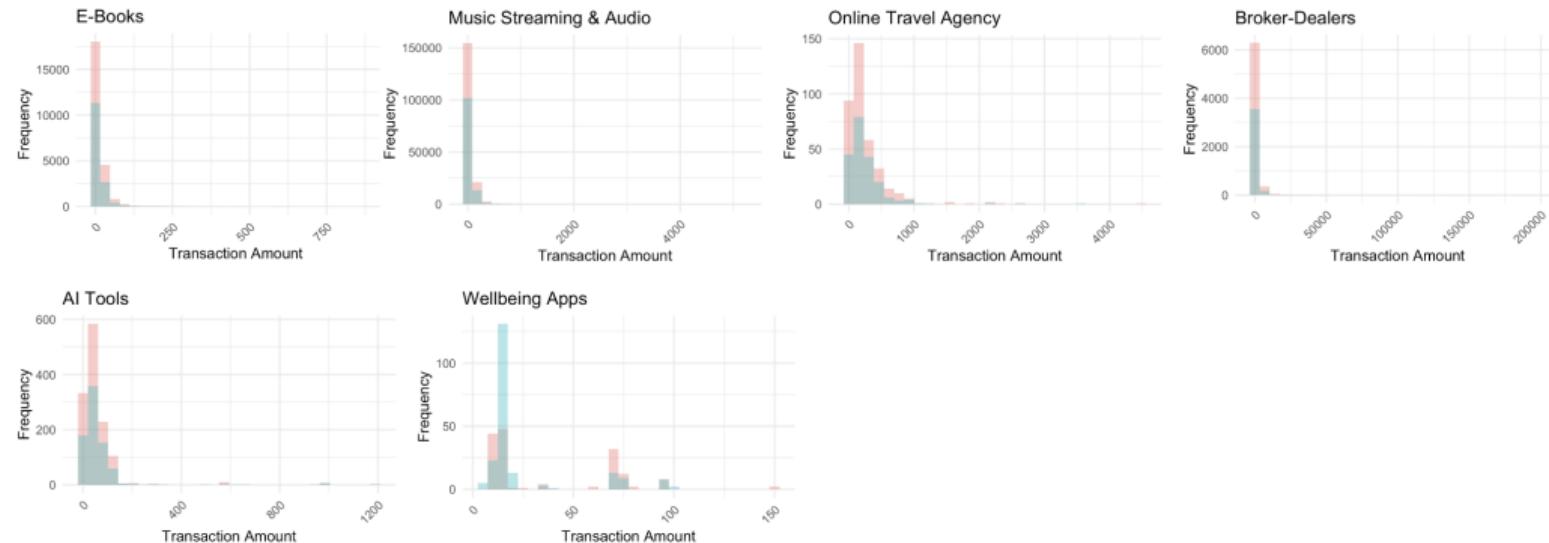
- Focus on merchants offering digital services
- Services that operate in a similar domain are more likely to be influenced or enhanced by its advancements in AI
- Merchants from other industries, such as Restaurants or Health & Beauty, are less likely to be affected by advancements in AI language models
- Identify 253 merchants within the digital service category

Subcategory	Largest Brands
AI Tools	jasper, quillbot, replika
Administrative Tools	calendly, efax, myfax
Broker-Dealers	coinbase, robinhood, tdameritrade
Business & Software	microsoft, adobe, godaddy
Co-Working & Members Clubs	wework, sohohousemembership
Community Platforms	patreon, canva, fiverr
E-Books	audible, kindle, audiobooksusa
Education Resources	chegg, udemy, coursehero
Freelancing	upwork, fiverr, igpay
Gaming	googleplay, steamgames, nintendo
Internet Security	norton, expressvpn, mcafee
Music Streaming & Audio	itunes, spotify, siriusxm
News & Print Media	nytimes, wsj, theathletic
Online Gambling	fanduel, betmgm, jackpocket
Online Travel Agency	expedia, priceline, viator
Social Media	facebook, ther, onlyfans, discord, linkedin
Video Streaming	netflix, hulu, disneyplus
Wellbeing Apps	headspace, calm, talkspace

Distribution of Transaction Amount across Subcategories



CDistribution of Transaction Amount across Subcategories



Correlation Matrix of the Matching Variables

Table 4: Correlation Matrix of Matching Variables

Variable	Administrative Tools	AI Tools	Broker-Dealers	Business & Software	Co-Working & Members Clubs	Community Platforms	E-Books	Education Resources	Freelancing	Gaming	Internet Security	Music Streaming & Audio	News & Print Media	Online Gambling	Online Travel Agency	Online Social Media	Video Streaming	Wellbeing Apps
Administrative Tools	1	.05	.01	-.09	.01	.08	.06	.02	.04	0	.02	.03	.06	-.01	.01	.04	.04	.01
AI Tools	.05	1	.01	-.06	-.01	.08	.04	.06	.01	.02	.01	.03	0	0	.02	.05	.04	.01
Broker-Dealers	.01	.01	1	.06	0	.03	.03	.04	0	.05	.02	.02	-.01	.08	.01	.04	.04	0
Business & Software	.09	.06	.06	1	.02	.2	.19	.13	.03	.3	.12	.22	.09	.03	.07	.16	.26	.03
Co-Working & Members Clubs	.01	-.01	0	.02	1	.01	.01	0	0	-.01	0	.01	.04	.01	.04	.01	.01	0
Community Platforms	.08	.08	.03	.2	.01	1	.15	.08	.04	.16	.06	.11	.09	-.01	.03	.2	.14	.02
E-Books	.06	.04	.03	.19	.01	.15	1	.09	.01	.14	.08	.14	.13	-.02	.07	.08	.2	.06
Education Resources	.02	.06	.04	.13	0	.08	.09	1	0	.12	.06	.13	.04	.04	.06	.07	.12	.01
Freelancing	.04	.01	0	.03	0	.04	.01	0	1	0	0	.01	0	-.01	0	0	0	0
Gaming	0	.02	.05	.3	-.01	.16	.14	.12	0	1	.09	.11	0	.04	0	.24	.3	.04
Internet Security	.02	.01	.02	.12	0	.06	.08	.06	0	.09	1	.08	.05	.02	.03	.08	.1	.01
Music Streaming & Audio	.03	.03	.02	.22	.01	.11	.14	.13	.01	.11	.08	1	.11	.05	.09	.09	.28	.02
News & Print Media	.06	0	-.01	.09	.04	.09	.13	.04	0	0	.05	.11	1	0	.06	.06	.12	.06
Online Gambling	-.01	0	.08	.03	.01	-.01	-.02	.04	-.01	.04	.02	.05	0	1	0	.02	.04	-.01
Online Travel Agency	.01	.02	.01	.07	.04	.03	.07	.06	0	0	.03	.09	.06	0	1	.03	.1	.02
Social Media	.04	.05	.04	.16	.01	.2	.08	.07	0	.24	.08	.09	.06	.02	.03	.1	.14	.03
Video Streaming	.04	.04	.04	.26	.01	.14	.2	.12	0	.3	.1	.28	.12	.04	.1	.14	1	.02
Wellbeing Apps	.01	.01	0	-.03	0	.02	.06	.01	0	.04	.01	.02	.06	-.01	.02	.03	.02	1

Monthly market share of all AI tools brand in 2023

