The antitrust crackdown on big tech: A cross-country analysis of regulatory efficacy as reflected in the securities market

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Abstract

We examined the financial effects of antitrust regulation on big tech firms in the United States, the European Union, and China using an event study model. Improper data use, tying, and exclusivity significantly affected stock performance. The Chinese crackdown substantially reduced stock returns, but monetary penalties had the greatest effect across regimes. Enforcement in the United States and European Union had nonsignificant influence due to lengthy judicial reviews. We recommend prioritizing monetary penalties for their financial efficacy in reining in big tech.

JEL classification:

L43, L44, L51, L86

Keyword: big tech, antitrust crackdown, self-referencing, tying of services, exclusivity contracts, non-interoperability, improper data collection and use, algorithmic discrimination, monetary penalty, event study, financial efficacy

I. Introduction

Big tech companies have become global giants due to the widespread adoption of the Internet (Table 1). Concerns regarding their monopolistic control over platform services and the vast amount of consumer data they hold are prevalent worldwide. Social media platforms such as Facebook and Twitter have faced criticism for spreading disinformation and endangering democracy. The European Parliament has passed laws such as the General Data Protection Regulation, the Digital Markets Act (DMA), and the Digital Services Act (DSA) to mitigate the negative socioeconomic externalities created by big tech. Conversely, Chinese platforms have faced large fines and corrective measures since late 2020. For example, Alibaba and Tencent were heavily punished by Chinese competition authorities for failing to file prior notifications for mergers with numerous small digital companies. Additionally, Tencent was prevented from obtaining an exclusive licence for popular music hits on its platform. In 2021, the ride-hailing app DiDi was removed from app stores due to data security concerns. These hefty punishments indicate the determination of Chinese authorities to rein in big tech companies through antitrust crackdowns and other means.

Table 1. Annual revenue of big tech firms from 2017 to 2022 (unit: billion USD)

	2017	2018	2019	2020	2021	2022
Amazon	177.87	232.89	280.52	386.06	469.82	513.98
Apple	229.23	265.6	260.17	274.52	365.82	394.33
Google (Alphabet)	109.65	136.22	160.74	181.69	256.74	279.80
Alibaba	22.99	56.15	71.99	109.48	134.57	
Meta	40.65	55.84	70.7	85.97	117.93	116.61
Tencent	21.90	45.56	54.08	73.88	85.84	
Netflix	11.69	55.84	20.16	25.00	29.70	31.62
PayPal	13.09	15.45	17.77	21.45	25.37	27.52
Baidu	13.03	14.88	15.43	16.41	19.54	

source: Statista (http://www.statista.com),companies' annual financial reports.

In the United States, however, Congress is striving to reach a bipartisan consensus on how big tech can be adequately regulated. Competition agencies and courts have maintained restrictive interpretations of antitrust laws, resulting in limited enforcement actions against big tech. Nonetheless, after the appointment of the so-called 'troika' of trustbusters in the Biden Administration—Tim Wu of the National Economic Council, Lina Khan of the Federal Trade Commission (FTC), and Jonathan Kanter of the Antitrust Division of the Department of Justice (DoJ)—new forms of anticompetitive behaviour were identified and addressed using concepts from the neo-Brandeis School (Schlesinger, 2021).

We conducted an international-level empirical study to analyse and evaluate the financial effects of antitrust crackdowns on big tech firms, most of which enjoy dominance in certain types of digital markets. At the industrial level, high velocity and blurred boundaries among lines of business indicate the multifaceted nature of digital platforms, which are often characterised by zero-price services on one side and advertising on another side to capture economic values (Teece, 2020: 1077). The manoeuvres of big tech firms with their market power demonstrate considerable similarities across different market dynamics and political-institutional contexts. The anticompetitive behaviours undertaken by these firms are in various forms, including self-preferencing, tying of services, exclusivity contracts, non-interoperability, and data or algorithmic discrimination.

Traditional antitrust regimes are ill-suited to define relevant markets and identify anticompetitive conducts in a zero-pricing scheme. Tech firms' anticompetitive behaviours are rarely detected by traditional antitrust rules and are likely to hinder competition in the digital economy. Therefore, quantifying the effects of antitrust crackdowns on big tech is crucial at this moment. An empirical and quantitative study can guide trustbusters in adopting crackdown approaches in the contemporary age.

The information of securities is considered the most publicly accessible quantitative indictors for firms. In the present event study model, each legislative or enforcement action is considered to be an independent occurrence that affects a firm's business and financial performance (MacKinlay, 1997: 20–21). We applied this method to assess the effect of antitrust regulation on the financial performance of targeted firms, specifically securities' volatility (trading range), liquidity (trading volume), and stock returns. Under the market efficiency hypothesis and the rational expectation hypothesis, investors can expect a firm's securities to exhibit high volatility, low activity, and reduced returns on equity when they assess the policy risks and uncertainties brought by antitrust crackdowns. We treated non-event trading days as benchmarks and conducted event-time regression tests against these financial

indicators while controlling for fixed effects, the confounding effects from market and macroeconomic dynamics and the COVID-19 pandemic.

Levy and Spiller (1996: 35) observed that regulatory effectiveness is determined by the compatibility of political and regulatory institutions. Big tech companies indeed face different approaches to antitrust crackdowns from various governments. The United States remains divided on how to adequately regulate big tech. Most U.S. competition agencies and courts have applied existing antitrust rules to big tech. Only recently has Congress introduced new bills, and agencies initiated investigations into big tech, both aiming to intensify pertinent antitrust crackdowns. However, the effectiveness of these initiatives, particularly with regard to court support for enforcement actions, remains highly uncertain. Conversely, China adopted a stricter approach, requiring big tech companies to comply with far-reaching administrative orders issued from competition agencies.

The European Union and its member states have adopted a relatively progressive, step-by-step approach. The European Union has enacted a series of new laws targeting big tech that are tougher than existing antitrust rules. There are also a couple of fines or corrective measures have been imposed, and the E.U. judiciary has been more supportive of those antitrust crackdowns. The different approaches among these regimes directly influence the effectiveness of their antitrust regulation. Thus, we compared legislative and enforcement actions targeted at big tech in these three regimes and quantified their effects on the firms' financial performance. Countries seeking to regulate large digital companies can refer to these precedents and our empirical evidence as a guide for their formulation of best practices.

The remainder of this paper is organised as follows: Section II discusses the characteristics of the digital economy that lead to big tech's anticompetitive behaviour and identifies various types of behaviours. Section III presents an analysis of the antitrust regimes and compares their respective approaches to big tech. Section IV describes the data sources and the event study model used to measure the anticipated regulatory effects as reflected on big tech firms' financial indicators. Section V presents the results, and Section VI concludes the paper.

II. Anticompetitive behaviour and its remedies

2.1. The temptation to become big

The big tech companies of the mid-2020s act as digital intermediaries, helping users connect with their preferred trading partners or target audiences. Most operate online through a platform and provide a wide array of digital services or information

to help two or more groups of users interact or gain access to each other. This characteristic is why big tech firms are typically considered digital platforms. However, big tech is unique in four key respects. First, most big tech services involve collecting, processing, and managing information rather than stocking and delivering physical commodities or moneys, unlike traditional intermediaries such as retailers and banks. Second, a platform's utility to a specific user increases with the number of users on the same platform. This increasing returns to scale, known as 'network effect,' exists in both online and offline industries, but especially prominent on digital platforms. Third, the digital service provided by a big tech platform could usually be divided into two or more dimensions, each catering to the demand of a group of users on a specific side of the intermediary. The multi-sided nature of digital platforms can generate network effects between users on the same or different sides of the intermediary.[3]

> *[T]he growth of users on one side of the multi-sided platform can attract more advertisers or suppliers on the other side of the platform, which in turn attracts more users, advertisers, and suppliers* (Stucke et al. 2016: 187).

Platforms might provide services for free or even subsidise user's participation to encourage their engagement (Evans, 2016: 78).

Fourth, depending on the nature and business model of services and user preferences, users may single-home or multi-home for a specific type of services provided by online platforms. For instance, users may share their lives with friends on multiple social media (multi-homing), but search for information only with Google or download smartphone software applications only with Apple's App Store (single-homing). The possibility of multi-homing is a prominent distinction between online and offline businesses (Jullien & Sand-Zantman, 2021; Rochet & Tirole, 2003: 993).

As of 2021, big tech firms have accumulated considerable market power in several major platform services (Table 2). For example, Google dominates the markets of search engine, online search advertising and mobile operating system (Mayer-Schönberger, 2021). Meta holds a dominant position in social media and associated ad markets through Facebook, WhatsApp, and Instagram. Apple, with its established basis of iPhone and iOS, continues to cannibalize the mobile ecosystem, particularly in the payment sector (Cennamo & Santalo, 2013).

[3] This cross-side positive externality is distinct from that in traditional network industries (such as telecommunication), where the network effect typically occurs within one similarly-situated user group.

Table 2. Global dominance of big tech firms, selected platforms in 2021

PLATFORM	COMPANY	MARKET SHARE
APP MARKET	Apple Store	62.4%
	Google Play	33.3%
SEARCH ENGINE	Google	86.2%
ONLINE AD	Google (search)	86%
	Meta (social media)	90%
	Youtube (video)	59%
E-COMMERCE	Taobao (Alibaba)	15%
	Tmall (Alibaba)	14%
	Amazon	13%
STREAM VIDEO	Netflix	20%
	Prime Video (Amazon)	14%
	Tencent Video	12%
STREAM MUSIC	Spotify	32%
	Apple Music	16%
	Amazon Music	13%

Source: Statista (2021: 57-68).

Multi-sidedness and network effect both complicate the analysis for the influence of big tech on consumer welfare and market efficiency. Due to positive externalities across multiple sides of the platform, monopolies might sometimes be efficient and welfare-enhancing under specific circumstances, and therefore should not be presumed as anticompetitive in all cases. Furthermore, the phenomenon of price skewness[4] vividly exemplifies the positive externality from one side of a platform to another side might be stronger than that in other directions. Consequently, individual sides of a platform may possess different significance in terms of platform competition. Additionally, the phenomenon of multi-homing in certain digital services helps to constrain the tendency of tipping and counterbalance big tech's market power to some extent in pertinent markets (OECD, 2014: 29; Evans, 2016).

Nevertheless, big tech companies have prominent incentives to engage in strategic practices to safeguard their dominance amid the volatility and blurred boundaries of digital business. Applying Williamson's theory to the digital economy,

[4] Price skewness refers to some sides of a platform being charged low or zero prices and others being charged relatively high prices (Jullien & Sand-Zantman, 2021).

Teece defined user data (personal information, location, behaviours, and sentiment) as proprietary assets that are costly to obtain (Teece, 2020: 1077–1079; Williamson, 2000:597). Therefore, data-driven firms collect large quantities of user data and train their algorithms through data feeding, especially when users prefer multi-homing (O'Connor, 2016). This enables the firms to provide high-quality platform services and thus survive in the dynamic business world (Teece, 2020: 1077).

2.2. Big tech's anticompetitive behaviour

Big tech's strategic practices include below-cost pricing, zero pricing[5], freemiums, tie-in services, self-preferencing, and the unilateral imposition of ad hoc platform rules that adversely affect the bargaining power of users during an exchange (Ezrachi & Stucke, 2016; Mueller, 1996). Eight specific types of anticompetitive behaviours by big tech are usually recognised (Jullien & Sand-Zantman, 2020; Morton et al., 2019):

1. Self-preferencing (demoting): The most notable case of this type is Google manipulating its search results to assign products on Google Shopping higher rankings over rivals. Such behaviour is also practised in Amazon e-commerce.
2. Tying of services: Apple has been accused of exercising monopoly control in its App Store by requiring content developers to use Apple Pay for in-app payments. Other examples include tying Google Play with Gmail and other Google apps and combining multiple benefits and services for Amazon Prime membership.
3. Exclusivity contract: Google has employed restrictive agreements with browser and phone partners such as Apple, Mozilla, Samsung, and Verizon, making Google the default search engine on mobile phones. Google's agreements with Android-based mobile device manufacturers forbid the preinstallation or promotion of rival search engines if they opt to receive a share of Google's search revenue.
4. Non-interoperability: This practice is essentially a technical method to achieve exclusivity or impose discrimination. By blocking applications, hyperlinks, or content-sharing from other platforms, big tech companies aim to retain users, along with their data and attention, within its own ecosystem and accordingly

[5] On two-sided platforms, pricing on one side of the platform affects demand on other side (Rochet & Tirole, 2003: 991–992). Big tech firms can enlarge their platforms' user bases with zero pricing while surcharging ad clients on the other side. For example, Google and Meta allow the free usage of search services and Facebook while dominating the online ad market with high penetration rates. The problem with zero pricing is that below-cost pricing, which used to be evidence of illegal predatory pricing, is not necessarily anticompetitive any more due to the two- or multi-sided nature of the platform.

suppress the popularity, network effect, or advertising revenue of rivals. Enforcement cases of non-interoperability so far are concentrated in China (discussed in Section 3.3).

5. Improper collection and use of data: Contrary to the common belief that data are low-cost and widely available, Stucke and Grunes argue that data are expensive to obtain and cumulate, and are essential for data-driven businesses (Stucke & Grunes, 2016: 36–40).

   > *[V]oluminous data are valuable because they reveal patterns of information that enable companies to understand user behaviours and preferences and improve their product or services accordingly* (Stucke & Grunes, 2016: 37).

   The acquisition and use of big data have become key to competition for digital firms (Manyika et al., 2011: 13). For example, Meta provides free social networking services to harvest users' data and earn revenues with user-targeted ads. These firms thus have incentives to limit rivals' access to big data to maintain their competitive advantages. Data concentration constitutes considerable entry barriers for competitive rivals (Stucke & Grunes, 2016: 36–40). The OECD found that search queries entail a non-linear, increasing returns to scale pattern: small search engines could perform as well as big ones in terms of relevance for popular searches but struggle with less frequent tail inquiries (OECD, 2014: 29). The European Union also noted that the revenue per search increased with the volume of search queries (EC, 2010: 1077). Data scale improves the ability of algorithms to learn through trial-and-error (Stucke et al., 2016: 184), which in turn yields positive feedback on search results. This positive feedback may cause consumer lock-in.

   Other examples include Netflix tracking its subscribers' viewing habits to predict consumer preferences. Amazon reported that 30% of sales were due to its recommendation engine that uses personal purchase histories. To harness big data's tipping effects, these platforms have incentives to engage in opportunistic behaviour, 'such as changing privacy policies or making such policies difficult to enforce' (Whittington & Hoofnagle, 2012: 1350).

6. Algorithmic discrimination: Similar to the aforementioned practices, algorithmic discrimination involves behaviours that could extend big tech's dominant position to adjacent markets for new profits. This practice also forecloses competitors or new entrants to big tech's dominated market from key inputs or distribution channels. For example, Baidu's cloud services might be provided at discriminatory speeds to other digital firms, which the State Administration for Market Regulation (SAMR), the Chinese central competition authority, has

proclaimed illegal and proscribed.

7. Anticompetitive price-related conduct: Horizontal price-fixing, vertical price maintenance, and misleading pricing strategies appear in digital industries as well. The French competition authority alleged that Apple colluded with two wholesalers to maintain high prices. In China, SAMR fined Tmall (Alibaba) and Vipshop (Tencent) for fraudulent discounts and baseless lowest-price claims. Nevertheless, due to the difficulties generated by multi-sidedness in establishing anti-competitiveness, zero-price schemes have seldom been deemed illegal.
8. Merger and acquisition (M&A): M&As are an effective strategy for vertically foreclosing new entrants or existing competitors from challenging incumbents in market they dominate (Jullien & Sand-Zantman, 2021). For example, the acquisition of WhatsApp by Meta significantly increased Facebook's user base and enabled Facebook's self-learning algorithms to develop much faster than those of new entrants (Stucke et al., 2016: 182). Google's mergers with Android and DoubleClick were instrumental in expanding its dominance to adjacent advertising markets and pursuing new sources of profit (Morton et al., 2019). According to DoJ statistics, the five major tech firms initiated 616 M&A deals between 2010 and 2019, with transaction values exceeding US$1 million (Swartz, 2021a). Affeldt and Kesler (2021: 4–6) identified 54 acquisitions of competitive apps between 2015 and 2019 by the five major tech companies.

III. Comparison of antitrust regimes

Modern competition law began with the passage of the Sherman Act in the United States in 1890, followed by the Clayton Act in 1914. The Celler–Kefauver Act of 1950 strengthened the Clayton Act, and since then, competition law has become common practice in countries worldwide (Sawyer, 2019: 4–8). Competition law promotes and preserves market competition by addressing anticompetitive practices. It typically addresses (1) business practices that restrict free trade, (2) abusive behaviours by firms to retain dominance, and (3) M&As of large corporations, including joint ventures, that may jeopardise market competition (Kennedy, 2020).

Trustbusters, however, encounter difficulties in imposing competition law on big tech firms. Due to the multifaceted nature of digital platforms, the concept of the relevant market used to identify products and practices involving direct competition does not easily apply to digital services. Competition law may not be enforced successfully without clearly defining the boundaries of relevant markets. Additionally, the price of services on each side of a multifaceted platform is mutually interrelated.

In assessments of predatory pricing, the price and cost of every side of the platform should be considered, which creates special difficulty in determining whether big tech firms' zero-pricing schemes involve anticompetitive low prices. The neo-Brandeis School advocates for an alternative approach to rein in big tech, arguing that antitrust crackdowns should not be limited to existing strict standards but should aim to ensure the greater good and promote democracy (Khan, 2016; Stoller, 2020).

Because big tech firms are either American or Chinese-registered and because the European Union and its member states have imposed competition and privacy regulations on them, we selected three antitrust regimes: the United States', the European Union's, and China's, and explored their respective regulatory approaches.

3.1. Fettered trustbusting in the United States

The FTC and the DoJ's Antitrust Division are responsible for enforcing competition law at the federal level. The FTC employs three types of legal procedures to discourage anticompetitive behaviour among firms: (1) consent decrees to ensure voluntary compliance by offending companies, (2) administrative proceedings, and (3) federal litigation (Van Loo, 2019: 14–22). Settlements are the most common outcome of their enforcement, resulting in fines and behavioural remedies. In the 1970s, the DoJ spent 13 years, including 6 years of trial, challenging IBM's dominance in computer hardware and software, but eventually dropped the case (Wu, 2020). It also initiated an antitrust case against Microsoft in the 1990s and achieved partial success, although the appeal court ruled against breaking up the tech giant (Page & Lopatka, 2007; Gavil & First, 2014). After these enforcements, however, the FTC and DoJ became more lax and had not addressed big tech cases until the second half of 2020.

Senator Klobuchar indicated that trustbusters were inactive due to narrowly formulated antitrust standards (Klobuchar, 2021: 312–314). Section 1 of the Sherman Act prohibits contracts, combinations, and conspiracies in restraint of trade, primarily focusing on hardcore cartels, such as price-fixing arrangements and other horizontal agreements, whereas the Clayton Act outlaws price discrimination and various vertical restraints, such as tying clauses, exclusive dealing agreements, and mergers between competitors (Viscusi et al., 2005: 122–123). The terms and conditions set out in the law or by judicial precedent substantially constrain the ability of regulators seeking to address tech firms' novel anticompetitive practices emerging in the digital economy. Consequently, the FTC, the DoJ, and various states began filing antitrust lawsuits against big tech in as late as 2020 (Table 3).

Table 3. Public litigations in the United States against big tech firms since 2020

Firm	Plaintiff (Date)	Allegation	Status
Google	DoJ+12 states (Oct. 20, 2020)	Google was sued for engaging in anticompetitive behaviour through paying Apple between US$8 and 12 billion to have Google set as the default search engine on iPhones.	Judge Amit Mehta ruled against Google on Aug. 5, 2024. Remedies will be decided in Nov. 2024.
Meta	FTC (Dec. 9, 2020)	Meta was sued for illegal monopolisation of the social networking market by acquiring Instagram (US$1 billion in 2012) and WhatsApp (US$19 billion in 2014). FTC requested the divestiture of Instagram and WhatsApp from Meta.	Dismissed on Jun. 28, 2021, revived on Jan. 11, 2022. Still pending.
Google	Texas-led 10 states (Dec. 16, 2020)	Google was sued for illegal digital advertising monopoly (through precise ad targeting with its consumer data analytics) and negotiated with Meta for preferential treatment.	Pending.
Google	40 states (Dec. 17, 2020)	Google was accused of manipulating its search results to ensure its own products and services were ranked higher than those of their rivals.	Google denied destruction of evidence. Status conference held on Aug. 24, 2022.
Google	Utah-led 36 states	Google was alleged to establish or maintain a monopoly with its Play Store on the Android mobile system.	Google agreed to US$700 million settlement. (Sep. 5, 2023)

	(Jul. 7, 2021)		
Google	DC, Texas, Washington & Indiana (Jan. 24, 2022)	Google was alleged to have made misleading promises about its users' ability to turn off location tracking during movement from 2014–2020.	Google agreed to US$391.5 million settlement with 40 states. (Nov. 16, 2022)
Google	DoJ & 8 states (Jan. 24, 2023)	Google was alleged to abuse its monopoly on online advertising and has stifled competition. DoJ called for a divestiture of Google's ad exchange and publisher-ad server.	Judge Leonie Brinkema heard opening statements on Sep. 9, 2024.

Source: *The Washington Post*, *Wall Street Journal, New York Times*.

Under the Biden Administration, the leaders of the DoJ and the FTC, who came from the neo-Brandeis School, advocated for aggressive antitrust crackdowns and elevated sectoral regulation on big tech. However, the federal and state trustbusters are constrained by the judiciary due to existing antitrust standards. The U.S. court system is one of the most independent judicial branches in the world. The Supreme Court and lower courts have been criticised for being overly restrictive in their interpretation of antitrust laws. In Verizon v. Trinko (2004), the Supreme Court indicated that monopoly is the greatest driving force of market rivalry, suggesting that monopoly can be beneficial for competition. However, whether market rivalry could offset the threat of monopoly power sufficiently and promptly remains controversial (Sallet, 2022: 15).

That judicial attitude has generated narrow legal standards that drastically limit trustbusters' ability to cope with the challenges brought by big tech. For instance, U.S. courts have increased the evidentiary burden of plaintiffs for antitrust cases since the late 1970s, which has materially weakened the enforcement capabilities of trustbusters (Klobuchar, 2021: 12). The number of antitrust investigations peaked at 1,611 in 1977 and has decreased ever since (Viscusi et al., 2005: 124–126). In Ohio v. American Express (2018), the most vital U.S. case for digital platforms to date, the Supreme Court affirmed a heightened burden of proof for the plaintiff, which quickly resulted in judgements against plaintiffs in digital marketplace cases in 2019 and 2020

(Werden, 2020: 3). In June 2021, Judge James E. Boasberg dismissed the FTC's litigation against Meta due to insufficient evidence to support its claims,[6] which compelled the FTC to consolidate and refile the case once again (Allyn, 2022).[7]

As for legislation, Congress has not reached a consensus on how big tech ought to be regulated and therefore still lacks a coherent antitrust policy for digital platforms. Republicans prefer minimal intervention, arguing that antitrust law should solely focus on economic efficiency (Wilson & Klovers, 2020: 13–15). By contrast, the neo-Brandeis School, which has found support among Democrats, is advocating for fierce antitrust regulation, including divesting big tech in appropriate cases and incorporating public interest considerations such as democratic values and social equality into antitrust legislation and enforcement (Khan, 2016). Democrats have proposed several legislative bills in both chambers of Congress to address the challenges posed by big tech. However, bipartisan disagreement has resulted in a deadlock in the legislative process. To date, no substantial progress on these bills was made, and neither have any new law or amendment successfully enacted regarding digital platforms in the United States (Kennedy, 2020).

3.2 The European Union and its adaptive competition law

The European Union's competition policy encompasses four domains: (1) cartels and the control of collusion and other anticompetitive agreements; (2) market dominance and the prevention of the abuse of firms' dominant market positions; (3) mergers and the control of proposed mergers, acquisitions, and joint ventures involving companies with a certain turnover in the European Union; and (4) state aid and the control of direct and indirect aid given by E.U. member states to companies (Lorenz, 2013: 70–86). The European Commission (the Commission) oversees the enforcement of competition policies, including antitrust crackdowns.

In 2009, the Commission launched one of its earliest investigations into digital platforms, which concerned Google Shopping and Google Search, and concluded 8 years later that Google had abused its relevant dominant position. Following Google Search adjusting its algorithms to place Google Shopping at the very top of search results, the number of visits to price comparison sites other than Google Shopping decreased considerably. The Commission identified this practice as illegitimate

[6] The FTC defined the market for personal social networking services and singled out Meta's monopoly in the market. Meta rebuffed the claim by incorporating TikTok, iMessage, Twitter, Snapchat, LinkedIn and YouTube into the market, arguing that the market is highly competitive. Judge Boasberg sided with Meta and dismissed the case without prejudice (Swartz, 2021b).

[7] Senator Klobuchar contended that the case was thrown out because of the complicated procedural posture (Klobuchar, 2021: 12).

preferential treatment (BBC, 2015). Google was found guilty and fined €2.4 billion in June 2017, equivalent to 2.5% of its 2016 European Union revenue. This was a notable antitrust crackdown on big tech, and it established a new category of anticompetitive conducts from digital platforms, namely self-preferencing. The General Court, the court of first instance in the E.U. judiciary, affirmed the Commission's decision in this groundbreaking antitrust enforcement in November 2021. Google appealed the judgement further to the European Court of Justice in January 2022 (Reuters, 2022).

The Commission launched another investigation into Google's Android mobile platform in April 2015. Google was alleged to have breached the E.U. competition law by requiring mobile phone manufacturers to preinstall Google Search, Google Chrome, and other major Google apps and by offering financial incentives to manufacturers and telecom operators to grant exclusive default position to Google Search on mobile devices they provided (Scott, 2016). This was one of the first antitrust crackdowns worldwide targeting digital ecosystems constructed by big tech. By adaptively interpreting existing competition law, the Commission found that Google had abused its dominance in the Android ecosystem and imposed a record fine of €4.3 billion in July 2018. On appeal, the General Court supported the Commission's decision and its theory of harm, dismissing Google's claim almost entirely while slightly reducing the fine to €4.125 billion in September 2022 (Chee, 2022).

A third investigation, initiated in July 2016, related to Google's AdSense tying strategies. Google demanded that websites using Google-powered internal search functions have to favour Google's ad service, AdSense for Search, and exclude ads from other sources on the search result pages. The Commission determined that Google was guilty of discriminating against ad service competitors and imposed a monetary penalty of €1.49 billion in March 2019 (Hern & Jolly, 2019). The total fines from these three Google cases amounted to €9.68 billion. Up to now, the General Court has demonstrated a supportive attitude towards the Commission's efforts to fine-tune competition rules to regulate new types of anticompetitive practices by big tech. However, all these decisions are still pending in the judicial review process, and their final outcomes remain to be seen. In addition to the investigations at the E.U. level, member states including France, the Netherlands, Luxembourg, and Italy have also found big tech firms in contravention of existing competition law, and hefty fines were thus imposed.

For ensuring a contestable playing field of enterprises and better protecting consumers and their fundamental rights online, the European Union introduced new laws to promote fair and open digital markets. In late 2020, the Commission proposed

the DMA and DSA to the European Parliament. The Parliament and the European Council reached agreements on the DMA and DSA in March and April 2022, respectively, and both came into force in November 2022.

The DMA aims to prevent undesirable outcomes of certain behaviours by digital gatekeepers, such as restrictive practices and the unfair use of data. Digital platforms with (1) an annual revenue of more than €7.5 billion or a market valuation of at least €75 billion in the previous financial year and (2) 45 million monthly active end users (10% of the E.U. population) and more than 10,000 annual active business users for the previous 3 years are presumed to be gatekeepers. The DMA mandates 23 obligations for gatekeepers to prevent anticompetitive practices or to open up digital platforms of vital sectors in the digital economy. Instead of the *ex post* case-by-case adjudication process typically seen in competition law, the DMA adopts a precautionary approach, spelling out obligations *ex ante* for gatekeepers to follow (Portuese, 2022: 3–7).

3.3. China's form of agile governance

Although Chinese political institutions also comprise three branches, China is considered an authoritarian state under the leadership of the Chinese Communist Party (Lieberthal & Oksenberg, 1988: 34–37). China has created 'a vast, Sinocentric legal order in which the Chinese state plays a nodal role' (Shaffer & Gao, 2020: 1–2). The unbalanced distribution of power results in strong administrative capacities but prevents effective oversight by the National People's Congress and the courts.

a) Anti-monopoly regulation

China established the SAMR in 2018 and the Anti-Monopoly Enforcement Agency in November 2021. The agency was then elevated to the deputy-ministerial level, renamed the national Anti-Monopoly Bureau (AMB), and became responsible for enforcing the anti-monopoly law (AML) enacted in 2008 (You, 2020: 10–11).

Recognising that the anticompetitive practices in digital sectors are far more complicated than those addressed by the AML in the past, the State Council announced the Antitrust Guidelines on Platform Economy in February 2021 for the AMB to implement. The guidelines define the conduct and conditions through which big platforms might achieve horizontal or vertical monopolies such as manipulating technical standards, data, algorithms, or platform rules (Colino, 2022: 243–246). The administrative remedies available for correcting these manipulations include divestiture, data portability or other behavioural reforms to shape an open network or platform. The guidelines grant the AMB more authority in forestalling the misuse of

data and algorithms, including practices like 'boiling big data,' and other types of market power abuse, such as the 'choose one from two' practices[8] (Cao, 2020: 177).

On the enforcement side, the SAMR found Alibaba guilty of abusing market power and imposed a record-high fine of CN¥18.2 billion in April 2021. Administrative decisions, including remedies and fines levied on big platforms, are listed in Table 4.

Table 4. Antitrust enforcement on big platforms in China since 2021

Firm	Date	Allegation
Alibaba	2021.4.12	CN¥18.28 billion fine for 'choose one from two' contracting with online sellers
Alibaba, Tencent, Meituan, DiDi	2021.7.7	Illegal M&As from big platforms
Tencent	2021.7.10	M&As with esports platforms Huya and Doyu rejected
Tencent	2021.7.13	M&A with search engine Sohu approved
Tencent	2021.7.24	Exclusive copyright licensed to Tencent Music (music platform) rescinded
Meituan	2021.10.8	CN¥3.42 billion fine for 'choose one from two' contracting with online sellers

Source: SAMR (http://www.samr.gov.cn).

The SAMR and State Council continued to draft the Guidelines for the Classification of Platforms and the Guidelines on the Responsibilities of Internet Platforms in October 2021. The first guideline resembles the DMA and defines superplatforms as those having 500 million users, being active in at least two business categories, or having a market valuation of more than CN¥100 billion in the previous year. Once classified, superplatforms must ensure interoperability and data protection, improve self-governance, perform annual risk assessments, and refrain from self-preferencing and forcing users to opt for affiliated services as a precondition to stay with the platform (Colino, 2022: 253).

b) Platform interoperability

[8] 'Boiling big data' refers to higher service charges imposed on old clients compared with new ones because of the high switching costs of pivoting to other platforms. 'Choose one from two' refers to the no co-service policy of dominant platforms with their rivals to force merchants providing products exclusively from their platforms (Colino, 2022: 244).

Interoperability, an obligation often seen in common carrier regulations, remains rare in Chinese businesses due to a lax regulatory environment. Consequently, major Chinese platforms engage in non-interoperable operations when competition is fierce. The most notable example is Taobao Mall's (owned by Alibaba) denial of access to WeChat (a social media owned by Tencent) in 2013. In retaliation, WeChat denied access to Taobao Mall and Alipay (the default payment system for Taobao). Since then, almost every major platform has engaged in blocking access to competitors' services and constructing its own ecosystem, ranging from e-commerce, online payment, videos, games to social media. Other well-known cases include WeChat blocking access to Uber's red-envelope marketing event while providing direct access to DiDi (in which Tencent invested) in 2015, and WeChat and QQ (another social media owned by Tencent) blocking access to TikTok (owned by ByteDance) in 2018.

In September 2021, the Ministry of Industry and Information Technology and the Cyberspace Administration of China (CAC)[9] invited big platforms to an administrative guidance meeting, where they were advised to cease non-interoperable manoeuvres within the next 5 days. The major platforms swiftly vowed to self-regulate. Alibaba and Tencent announced that they would not block access to each other starting in July 2021. WeChat then offered call-out functions for consumers, and Alipay established the Principles of the Open Ecosystem in November 2021.

3.4 Credibility and agility of antitrust regimes

Levy and Spiller stated that policy effectiveness results from a 'goodness of the fit of the regulatory system with a country's institutions' (1996: 35). Kim and Suh concluded that institutional factors such as the rule of law and regulation quality play a critical role in enabling Uber's international expansion (Kim & Suh, 2021: 2–3). Thus, the efficacy of crackdowns is determined, in part, by the antitrust regimes within which big tech firms operate.

The efficacy of antitrust crackdowns can be assessed using two criteria: regulatory credibility and agility. Credibility enhances efficacy because it decreases the costs of implementation and enforcement (North, 1995: 23; Bosetti & Victor, 2011). North and Weingast contended that credibility is established when policymakers adhere to the law in exercising discretionary administration (1996: 134). Agility refers to agencies' capability to make policy shifts in response to market and political-societal contingencies.

[9] To coordinate fragmented regulatory authorities in governing China's cyberspace, the CAC, which is directly under the State Council, was established in May 2011. It was then reformed to incorporate its counterpart in the Communist China Party in March 2018. The CAC oversees website registry, Internet Protocol address distribution, and the monitoring and directing of Internet access and online content businesses (Zhang, 2022: 14–16).

In terms of antitrust efficacy as anticipated and reflected in the securities market, credibility could be further divided into two prongs. The first is the extent of discretion entrusted in antitrust enforcement agencies. That type of credibility could be estimated through the level of definiteness and density of laws and regulations and the room they leave for agency discretion. Securities investors would perceive this prong of credibility well before concrete discretionary enforcements while those rules are firstly promulgated. The second prong is the degree of support that the court system would afford to the antitrust agencies and affirm their discretionary decisions as law-abiding. The level of judicial affirmation on antitrust agencies differs across various cases and is eminently fact-dependent, therefore could be assessed only after the agency hands down its enforcement decision. The more certain the courts will maintain the agency's decision in the judicial review process, the more credible the antitrust regime will be. Considering these characteristics, it would be apposite to classify the first prong as pre-enforcement credibility, and the second as post-enforcement credibility.

Credibility and agility may trade off against each other. A regime can be considered credible when laws and regulations are implemented without any discretion of antitrust agencies. Over time, however, the legislation and enforcement action could become rigid and inflexible, losing adaptability to unforeseen developments. Conversely, a regime would be considered noncredible if the antitrust authority, imbued with discretionary power, swiftly comes up with new points of view which deviate from its precedents, and nimbly overcomes unforeseen challenges with discretionary enforcement decision. The regulatory efficacy of an antitrust regime is hence determined by the balance of the two criteria given this trade-off.

The United States has a highly independent judiciary system and strong oversight from Congress, as illustrated in Table 5. Credible regulation is achieved through legislation, congressional oversight, and judicial review, which all constrain administrative discretion. The courts have taken a conservative attitude towards antitrust crackdowns in recent years, upholding strict interpretations of laws and regulations and imposing elevated evidentiary burdens on enforcers, which consolidates pre-enforcement credibility, yet substantially restrains the capabilities of trustbusters to explore new categories of anticompetitive acts and adapt current antitrust standards to rein in big tech. Without judicial support, agile attempts of the FTC or DoJ would ultimately be reversed in the appeal procedure, and the trustbusters could hardly make sustainable policy changes on antitrust regulation with discretion (Klobuchar, 2021).

Table 5. Comparison of antitrust regimes

	The United States	The European Union	China
Digital Acts	Numerous drafts	DMA & DSA	Administrative guidelines
Antitrust approach	*Ex post* enforcement	*Ex ante* compliance	*Ex ante* compliance
Regulatory credibility	**High** credibility Conservative judicial attitude severely limiting administrative discretion	**Moderate** credibility Consistent support from the General Court	**Low** credibility Lack of separation of power, adequate governance, and high political risks
Regulatory agility	**Low** agility Inflexible enforcement and congressional disagreement	**Moderate** agility Strong administration and new laws responding to big tech	**High** agility Strong administration swiftly adapting to the surge of big tech

Source: author.

The European Union is a supranational polity where the Commission acts not only as the executive branch but also the sole initiator of E.U. legislation. Although an independent court system exists to review the Commission's decisions, the lack of strong oversight from the Parliament reduces pre-enforcement credibility. The Commission leads a strong administration but abides by the law and court precedents in policymaking and law implementation (Jones et al., 2012: 374–387). Nevertheless, most substantial enforcement actions against big tech, notably the trio against Google, have changed existing competition rules to some extent to accommodate the particularities of digital platforms. These actions have been supported by the General Court, which helps to enhance post-enforcement credibility, although they are still pending before the European Court of Justice except the earliest one.[10] Considering these facts, the European Union demonstrates moderate regulatory credibility (Table 5).

[10] On September 10, 2024, the European Court of Justice, the E.U.'s top court, ruled in its Google Shopping judgement that the Commission was right to find Google's conduct "discriminatory" and its appeal "must be dismissed in its entirety" (Gerken, 2024).

The passage of digital acts and guidelines in the European Union could increase regulatory efficacy by enhancing legal certainty and adapting to market dynamics (EC, 2020a: 96–98). The Commission's impact assessment report for the DMA indicates that legal certainty, speedy intervention, and flexibility increase policy effectiveness (EC, 2020a: 96–98). With strong administrative and lawmaking capabilities, the European Union can establish a regulatory regime based on explicit and substantive rules to ensure efficiency and flexibility (Levy & Spiller, 1996: 5–11). Through these mechanisms, the European Union has made substantial responses to big tech on both enforcement and legislative fronts. However, due to the requirements of due process in enforcement and the negotiation procedures in legislation, the European Union faces challenges in responding immediately to digital market dynamics. Therefore, the Commission's credibility and agility are both moderate.

In China, the separation of power is nominal (Chen, 2020). Its strong administration, limited by neither legislative oversight nor judicial review, cannot ensure credible regulation. Chinese trustbusters have been reported to possess strong discretion (Heilmann & Perry, 2011: 3–4), which has created political risk for businesses, especially in terms of policy contingency.[11] Those features significantly affect regulatory credibility of the Chinese antitrust regime (Zhang, 2022: 38–40).

Conversely, a strong administration can flexibly accommodate political and economic contingencies, such as public disdain towards big platforms, ensuring policy efficacy (Levy & Spiller, 1996: 9). Chinese antitrust agencies recently shifted from lax to stringent enforcement and initiated a series of corrective measures on a massive scale, which demonstrate considerable regulatory agility (Boer, 2021: 132). However, the volatile policy swings decrease again the regime's credibility (Zhang, 2022: 40; Table 5).

IV. Modelling regulatory effects on Big Tech

4.1. Event study model

Event study models have been widely applied to social science and business research since approximately 2013 (Miller, 2023: 204). In his much-cited paper, MacKinlay (1997) stated that the event study 'using financial market data measures

[11] The CAC launched investigations into Didi, YuManMan, and BZ for violating data privacy laws in June 2021. The CAC later announced that platforms with more than 1 million monthly active users must undergo data management assessments before they can have overseas initial public offerings (IPOs). The CAC also published a notice regarding apps' breaches of laws through collecting and utilising personal information. These administrative orders were promulgated before the passage of the Personal Information Protection Law (Cao, 2020: 4). The investigations led to the mandated removal of DiDi's apps from app stores. DiDi's stock price subsequently plummeted only 3 days after its IPO. The hasty regulation reminded investors of considerable political risk, leading them to dump the stocks.

the effect of a specific event on the value of a firm' (1997: 13). Miller (2023) views this method as a way of estimating 'treatment' effects in a statistically reduced form (2023: 204). Eden et al. (2021) revisited the event study method more broadly than the traditional definition, describing it as 'an empirical method used to capture stakeholders' reactions on a high-frequency market to an event that is observed and perceived as high influence by one or more actors' (2021: 174).

In regulatory research, the event study model considers the event under study as the 'announcements of various legal and regulatory action or proposed action,' including passed legislation, policy initiatives, reform plans, enforcement actions, litigation, negotiations, settlements, or court decisions (Bhagat & Romano, 2002: 145). Schwert (1981) demonstrated the assessment of regulatory effects on the value of regulated firms using financial data. Wright (2011) evaluated the consumer benefits incurred by antitrust enforcement on Intel by examining the abnormal returns of Intel's and AMD's securities.

Three assumptions must hold when the event study model is employed to examine the effects of cross-country antitrust remedies on big tech: (1) the market is efficient; (2) the event is unanticipated, and (3) no confounding effects occur during the event window (McWilliams & Siegel, 1997: 628). The market efficiency hypothesis and rational expectation hypothesis implies that any new information relevant to the company will be quickly responded to by investors and simultaneously incorporated into stock price movements (Schwert, 1981: 121; McWilliams & Siegel, 1997: 629; MacKinlay, 1997: 13). This assumption might not hold if the event window is long. Therefore, we set the event window from the trading day the event occurred or the next trading day if the event news was announced after midday.

Because an antitrust crackdown on a firm may involve a series of actions, from investigation and litigation to court decisions, pooling multiple events would contradict the hypothesis of unanticipated events and invalidate the model. To adjust this hypothesis, one could drop subsequent events; however, this approach might lead to crucial information being omitted, such as the ultimate verdict generated by the event afterwards. We adopted the selection criteria suggested by Miller (2023), using the 'first big event' (2023: 224).

4.2. Event-time regression

The event estimation equation for this study is illustrated in (F1):

$$y_{it} = \sum_{j=1}^{t} \gamma_j D_{ij} + (\alpha_i + \delta_t) + \beta X_{it} + \varepsilon_{it} \qquad \text{(F1)}$$

where y_{it} is the outcome for the estimation. For firm *i*, $D_{i,t-j}$ is the event indicator at calendar time (trading day) *t* and coefficient γ captures the dynamic effects of the

events. When the model is estimated on the panel data, the unit (firm)-specific effect α_i and the time-specific effect δ_t, must be the added to control for the fixed effects (Miller, 2023: 205–206). X_{it} denotes the control variables and β is the coefficient estimate. ε_{it} is the traditional error term unique to each observation.

A set of firm dummy variables is created to control for the firm-specific fixed effects. Because data are recorded either daily, monthly, or annually, month and year dummy variables are created accordingly. However, too many daily dummy variables causes multicollinearity in the estimation model (Miller, 2023: 209). Therefore, a continuous variable controlling for the daily fixed effects is created instead.

Similarly, we quantified characteristics of the antitrust regimes using world governance indicators (WGI)[12] to avoid multicollinearity and autocorrelation problems. Four indicators from WGI were selected to obtain an average percentile score for each regime: voice and accountability, government effectiveness, regulatory quality, and rule of law (Kaufman et al., 2010). The results in Table 6 indicate that China has a comparatively lower score than the European Union and the U.S., suggesting that China is still considered a noncredible regime for rulemaking and law enforcement. Its regulatory agility may be heavily counterbalanced by low credibility.

Table 6. Percentile score for the antitrust regimes

	2020	**2021**
China	43.4	44.24
Europe	84.17	84.41
France	85.68	86.77
Germany	91.94	92.54
Italy	69.09	69.82
Japan	88.32	88.8
S. Korea	82.06	84.08
Luxembourg	97.24	97.59
Netherlands	96.75	96.39
Russia	32.60	29.47
United Kingdom	90.25	89.90

[12] The World Bank's WGI reports on six dimensions of governance for over 200 countries and territories over the period 1996–2022. The six dimensions are voice and accountability, political stability and absence of violence or terrorism, government effectiveness, regulatory quality, rule of law, and control of corruption. Each is presented using a percentile score, with higher values corresponding to better outcomes. For the methodology of the WGI, see http://www.govindicators.org.

USA	84.15	85.67

Source: (Kaufmann & Kraay, 2023).

Wörsdörfer (2022) stated, '(T)he years of 2020 and 2021 have seen the opening of several antitrust probes and investigations against some of the most powerful and dominant companies in the world' (Wörsdörfer, 2022: 345). We defined the time range of the panel data as from the first trading day of 2020 to the last trading day of 2021, totalling 496 days. During this period, the COVID-19 pandemic spread globally. Because of its widespread effect, short response time, and unanticipated occurrence, the pandemic is assumed to induce a trend in stock price movements, which confounds the estimated treatment effects (Eden et al., 2021: 173; Miller, 2023: 217). We added a proxy variable, the economic policy uncertainty index (EPU)[13], to isolate the actual effect caused by the pandemic.

The assumption of nonconfounding effects was not held in our study. Because the event window is already set short, we added control variables to neutralise the confounding effects (McWilliams & Siegel, 1997: 634). These could be macroeconomic factors and corporate events, such as earnings announcements (MacKinlay, 1997: 13). Thus, (F1) was modified to (F2):

$$y_{it} = \sum_{j=1}^{t} \gamma_j D_{ij} + (\alpha_i + \delta_t) + \rho WGI_i + \sigma T_t + \theta EPU_{it} + \beta X_{it} + \varepsilon_{it} \quad \text{(F2)}$$

where WGI_i is an antitrust regime variable that denotes the level of regulatory credibility and agility in a regime; Tt is a time-calendar variable marking each trading day; EPU_{it} denotes global shock effect from COVID-19; ρ, σ, and θ are the coefficient estimates.

A firm's securities return $\tilde{y}_{it}$ is calculated as (F3)

$$\tilde{y}_{it} = \frac{(y_{Cit} - y_{Cit-1})}{y_{Cit-1}} \quad \text{(F3)}$$

where y_{Cit} is the daily closing price and y_{Cit-1} is the closing price on the previous trading day.

The difference in a firm's share prices $(y_{Cit} - y_{Cit-1})$ indicates a stationary time series, that is, a random walk (Maddala, 1992: 531–532). The event-time regression

[13] Founded by multiple endowments, Prof. Baker's team developed the EPU to measure policy-related economic uncertainty. The index is constructed from three types of underlying components. The first and most flexible component quantifies newspaper coverage of policy-related economic uncertainty. This newspaper-based approach is also used for the majority of other country- and topic-specific indexes. For the United States, two other sources are utilised: the number of federal tax code provisions set to expire and disagreement among economic forecasters. The third component of the team's policy-related uncertainty index draws on the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters. For the EPU methodology, see Baker et al. (2016).

tests are thus used to estimate the coefficients on the securities returns, controlling for fixed and confounding effects.

4.3. Data and model robustness

The database comprises nine big tech firms on which hefty antitrust regulations were imposed in 2020 and 2021: four U.S. firms, namely Amazon, Apple, Google (Alphabet), and Meta, and five Chinese firms, namely Alibaba, Baidu, DiDi, Meituan, and Tencent. Because they are all listed on the Nasdaq market, we collected their daily trading data from 2020 and 2021 on Nasdaq to control for market disturbances incurred by various trading floors.[14] Our database contains 4,679 observations over 496 trading days.

We identified 24 competition law rulemaking activities (Appendix Table 1) and 85 firm-specific enforcement cases (Appendix Table 2), totalling 109 'first big' antitrust events. Because the rulemaking activities are industry-wide and affect all firms, the total antitrust incidences are 194 (= 85 + 11(US/EU rulemaking) × 4(US firms) + 13(CN rulemaking activities) × 5(CN firms)).

We created a discrete variable *event_flag* to indicate the occurrence of antitrust events. Three discrete variables, *US, EU,* and *CN*, were created to indicate the events occurring in the respective antitrust regimes. A set of discrete variables—*selref* (self-referencing), *tying* (tying of services), *ex* (exclusivity contract), *inter* (non-interoperability), *data* (improper collection and use of data), *algo* (algorithmic discrimination), *price* (anticompetitive price-related practices), and *M&A* (merger)—were created to represent the eight major anticompetitive behaviours targeted by trustbusters. A continuous variable, *fine*, records the amount a firm was fined for breaching antitrust regulations or for settling antitrust claims with trustbusters.

We input values for these discrete variables based on our reading of the event texts (Table 7). The event texts contain news articles from *The Washington Post*, *The Wall Street Journal*, *The Guardian*, *The Economist*, *Competition Policy International*, and *Market Watch* and, notices and documents from the European Union, the FTC, the DoJ, the U.S. House, the U.S. Senate, SAMR, and CAC.

The trading information comprised firms' daily high price, low price, open price, close price, trading volume, turnover ratio, and the release dates of financial reports. The daily high, daily low, and volume of the Nasdaq Composite Index (COMP) were also recorded. These data were retrieved by accessing the API of Nasdaq Data Link (data.nasdaq.com). In terms of macroeconomic data, we collected the gross domestic product (GDP) growth, unemployment, and interest rates of both the United States

[14] Alibaba, Baidu, Meituan, and Tencent are also listed on the Hong Kong stock market. DiDi was delisted from Nasdaq on June 10, 2022.

and China. The data sources were the U.S. Bureau of Economic Analysis (BEA), the U.S. Department of Commerce (DoC), and China's National Bureau of Statistics (NBS; Table 7).

Table 7. Variables used in the event-time regression

Variable	Value/unit	Description	source
Antitrust event			
event_flag	{1, 0}	1 = antitrust event, 0 = none	Author-generated
selref	{1, 0}	1 = self-preferencing conduct, 0 = none	Author-generated
tying	{1, 0}	1 = tying conduct, 0 = none	Author-generated
ex	{1, 0}	1 = exclusivity contract, 0 = none	Author-generated
inter	{1, 0}	1 = non-interoperable conduct, 0 = none	Author-generated
Data	{1, 0}	1 = improper use and collection of data 0 = none	Author-generated
algo	{1, 0}	1 = algorithmic discrimination against rivals, 0 = none	Author-generated
Price	{1, 0}	1 = anticompetitive price-related practices, 0 = none	Author-generated
M&A	{1, 0}	1 = M&A in investigation, litigation, or disapproved, 0 = none	Author-generated
fine	US$	The recorded fine or settlement payment for a given antitrust event	various news sources
Antitrust regime			

WGI	{100, 0}	The annual WGI percentile for each antitrust regime	World Bank
US	{1, 0}	1 = U.S. antitrust event, 0 = other or none	Author-generated
EU	{1, 0}	1 = E.U. or European state antitrust event, 0 = other or none	Author-generated
CN	{1, 0}	1= Chinese antitrust event, 0 = other or none	Author-generated
securities performance indicator			
HL price	US$	Daily trading range = a firm's daily high share price – daily low share price	Nasdaq+
volume	≥ 0	Daily trading volume = the total number of a firm's daily buy shares + daily sell shares	Nasdaq+
ROE	±%	Percentage change in a firm's daily share prices	Nasdaq+
Financial and economic factor			
finreport	{1, 0}	1 = release day of financial reports, 0 = none	Nasdaq+
qtime	{496, 1}	Trading date of Nasdaq, setting January 2, 2020, = 1	Nasdaq+
Nasdaq	≥ 0	the value of Nasdaq index (COMP)	Nasdaq+
GDP	±%	Monthly growth rate of U.S. GDP for U.S. firms; monthly growth rate of the Chinese GDP for Chinese firms	U.S. BEA, U.S. DoC, CN NBS
Interest	±%	Monthly growth rate of the U.S. interest rate for U.S. firms; monthly growth rate of Chinese interest rate for Chinese firms	U.S. BEA, U.S. DoC, CN NBSE

Unemploy	±%	Monthly growth rate of U.S. unemployment rate for U.S. firms; monthly growth rate of Chinese unemployment rate for Chinese firms	U.S. BEA, U.S. DoC, CN NBS
Covid-19			
EPU	⩾0	Indices for economic policy uncertainty	EPU index

Source: author.

To obtain robust estimates, two additional financial indicators were included in the regression tests to account for regulatory effects: daily trading range and daily trading volume (Table 7). The trading range represents price fluctuations over a given trading period and is used to measure securities' risk and volatility. Investors can expect a greater policy risk and uncertainty associated with the firm and a wider trading range when trustbusters rein in the firm (Hayes, 2024). The trading volume measures securities' liquidity. When the security is a favourable option for investors and traded at a reasonable price, it could experience high trading volume. Conversely, a low-volume stock might be challenging to buy or sell, which can be unfavourable for substantial investors (Nickolas, 2023). Investors use volume with other indicators, such as price movement, rather than alone to gain insight into trend direction and the timing of trades (Nickolas, 2023).

The results are robust when all tests against the three financial indicators produce consistent estimates. Under the market efficiency hypothesis and rational expectation hypothesis, investors could expect securities to experience increased volatility and low trading activity with reduced returns on equity if they assess the policy risks and uncertainties entailed by an antitrust crackdown.

V. Securities performance affected by antitrust crackdown

5.1. Monetary penalty matters

The frequencies of each anticompetitive practice for each big tech firm are recorded in Table8, based on Appendix Tables 1 and 2. The average number of enforcement cases for U.S. companies is 10, whereas the number for their Chinese counterparts is nine, indicating that big tech firms across continents face similar levels of antitrust scrutiny. Among the eight types of misconduct, tying of services is the most common target of crackdowns, followed by exclusivity contracts and improper

collection and use of data. For U.S. companies, tying of service is the most frequent antitrust violation. For Chinese firms, the types of breaches are more evenly distributed, with non-interoperability and mergers that reduce competition also being primary targets for crackdowns, in addition to the top three.

Table 8 Anticompetitive practices of big tech*

	CASE	SELREF	TYING	EX	INTER	DATA	ALGO	PRICE	M&A	FINE**
GOOGLE	16	2	9	8	2	4	1	1	0	6
AMAZON	5	0	1	2	0	2	1	1	0	3
FACEBOOK	6	0	1	1	0	3	0	0	2	1
APPLE	13	0	10	1	0	0	1	2	0	3
SUBTOTAL	40	2	21	12	2	9	3	4	2	13
AVERAGE	10	0.5	5.25	3	0.5	2.25	0.75	1	0.5	3.25
ALIBABA	12	1	3	5	4	3	4	2	2	4
TENCENT	21	1	1	4	6	7	3	2	5	4
MEITUAN	5	1	3	3	1	2	2	1	1	2
DIDI	4	1	1	1	1	2	2	1	5	2
BAIDU	3	0	0	1	1	0	1	0	1	1
SUBTOTAL	45	4	8	14	13	14	12	6	11	13
AVERAGE	9	0.8	1.6	2.8	2.6	2.8	2.4	1.2	2.2	2.6
TOTAL	85	6	29	26	15	23	15	10	13	26

*: Firms may be involved in multiple malpractices in one case, the total count of the practices therefore exceeds the number of enforcement cases.

**: Incidences of fines or settlements

Source: author

Table 9 presents the results of analysing antitrust events and fines and settlement payments against big tech firms' securities performances. Column A and B display the coefficient estimates for the discrete event variable (*event_flag*), with Column B adding a continuous fine variable (*fine*) in the estimation. Both β_{flag} and β_{fine} yielded significant and positive estimates at the 0.1% level, indicating that the daily trading range increases by US$14,000 to 15,000 once trustbusters announce an antitrust enforcement action. Alternatively, the daily trading range rises by less than US$0.016 because the fine or settlement payment amount increases by US$1,000. These significant estimates demonstrate that antitrust crackdowns increase the policy risks and uncertainties faced by big tech, consequently increasing their securities' volatility.

Columns C and D display the event-time regressions against daily trading volume. None of the coefficient estimates for *event_flag* and *fine* are statistically significant. Column E presents the negative and significant coefficient estimates for *event_flag* at the 0.01% level, whereas Column F additionally displays the negative and significant coefficient estimate for *fine* at the 0.1% level, together with nonsignificant estimation for *event_flag*. A security's daily return decreases by 0.77% ($e^{-1.466} - 1 = 0.231 - 1 = -0.769$)[15] when trustbusters begin an investigation or file antitrust litigation against it. However, the discrete variable is left with a nonsignificant estimate when the fine amount is jointly estimated (as displayed in Column F). For a firm fined for competition breaches or paying for settlement, a 1% increase in the amount causes its daily stock return to drop by 0.65%.

Table 9. Effect of antitrust crackdown on big tech firms' securities performance

VARIABLE	(A) DAILY TRADING RANGE	(B) DAILY TRADING RANGE	(C) DAILY TRADING VOLUME	(D) DAILY TRADING VOLUME	(E) % CHANGE IN DAILY ROE	(F) % CHANGE IN DAILY ROE
ANTITRUST EVENTS	15,157**	14,367**	-7.48e+06	-6.92e+06	-1.466***	omitted
	[4,801]	[4,805]	[8.25e+06]	[8.26e+06]	[0.392]	
FINES (LOG FORMAT IN (I))		1.59e-05**		0.011		-0.646**
		[5.51e-06]		[0.009]		[0.189]
WGI	256***	231**	2.48e+05	2.30e+05	0.020**	-0.018
	[77]	[78]	[1.34e+05]	[1.35e+05]	[0.006]	[0.030]
TRADING DATE	7.252***	7.250***	-3,564	-3,565	-0.001***	-0.019
	[2.027]	[2.026]	[3,484]	[3,484]	[0.000]	[0.011]
EPU	31***	31***	-25,969***	-25,953***	-0.001***	0.010
	[1.817]	[1.815]	[3,100]	[3,100]	[0.000]	[0.005]
FINANCIAL REPORTS	9,044**	9,070**	9.28e+06	9.30e+06	0.466	omitted
	[3,130]	[3,127]	[5.38e+06]	[5.38e+06]	[0.261]	

[15] Because the estimated relationships between the percentage changes in share prices and discrete policy variables are nonlinear (i.e., $\log Y = \alpha + \beta x$), β does not provide the $\%\Delta Y$ due to ΔX. Rather, $\%\Delta Y$ is given by $e^{\beta} - 1$ (Kennedy, 1992: 106).

TRADING VOLUME (% CHANGES IN (E) & (F))	-1.63e-05*** [8.51e-06]	-1.63e-05*** [8.51e-06]			-0.261*** [0.022]	-0.437 [0.270]
NASDAQ INDEX (% CHANGES IN (E) & (F))	2,770*** [289]	2,734*** [289]	2.81e+06*** [4.94e+05]	2.79e+06*** [4.95e+05]	0.853*** [0.023]	1.339* [0.559]
GDP GROWTH RATE	736*** [95]	734*** [95]	5.45e+05*** [1.63e+05]	5.44e+05*** [1.63e+05]	0.024** [0.008]	-0.208 [0.598]
% CHANGES IN INTEREST RATES	-981*** [126]	-981*** [126]	-1.50e+06*** [2.15e+05]	-1.50e+06*** [2.15e+05]	0.012 [0.011]	0.257 [0.631]
% CHANGES IN THE UNEMPLOYMENT RATES	1,819*** [194]	1,824*** [194]	1.02e+06** [3.33e+05]	1.02e+06** [3.33e+05]	0.036* [0.016]	-0.809 [0.451]
SAMPLE SIZE	**4,680**	**4,680**	**4,680**	**4,680**	**4,276**	**20**
R-SQUARE VALUE	0.144***	0.146***	0.049***	0.049***	0.318***	0.920***
FIRM DUMMY	V	V	V	V	V	V
YEAR DUMMY	V	V	V	V	V	V
MONTH DUMMY	V	V	V	V	V	V

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; [x]: standard error
Source: author

The results indicate that the fine or payment absorbs the explanatory power of crackdown measures when levied on firms. Compared with antitrust correction measures, monetary penalties are easier to comply with. Monetary penalties send investors a quantified and clear signal regarding the severity of the illegal practices and their potential effect on the corresponding big tech firm. Conversely, correction measures entail high monitoring costs in enforcement, making their actual effect on big tech's financial performance somewhat difficult to predict, which affects post-enforcement credibility.

Antitrust crackdowns indeed increase policy risks and uncertainty for big tech, which leads to high securities volatility. For firms that are fined, a selloff in their securities' returns is highly anticipated. Reduced stock returns combined with unconfirmed low trading activity suggest that the securities price continues to slide downward without a reverse trend.

For the fixed effects, *WGI*, the variable representing the antitrust regimes, had mixed results from coefficient estimates. The variable *qtime*, which controls for daily

fixed effects, provides significant and consistent coefficient estimates against securities' performances. Big tech securities experience high volatility, low trading activity, and reduced returns as the trading calendar advanced. For *EPU*, representing the global shock of COVID-19, the coefficient estimate is significant and consistent across models. The increase in the EPU score implies higher policy and macroeconomic uncertainty, which necessarily increases securities volatility, mitigates trading activity, and reduces stock returns. Other control variables such as the Nasdaq index, GDP growth rate, and unemployment rate generate statistically significant confounding effects on big tech's securities performance.

5.2. Data governance matters

Table 10 presents the results from running a set of discrete enforcement variables against big tech's securities performance. In Column G, the allegation of big tech's improper data use is found to significantly amplify securities volatility at the 5% level. Big tech's daily trading range widens by US$6,700 when alleged for data misuse. As displayed in Column I, the accusation of using nonpublic data also generates a significant and negative coefficient estimate for stock returns at the 0.1% level. The enforcement decreases the stock return by 0.67%
($e^{-1.119} - 1 = 0.327 - 1 = -0.673$) when imposed.

Table 10 Effectiveness of enforcement types

VARIABLE ANTITRUST EVENTS	(G) DAILY TRADING RANGE	(H) DAILY TRADING VOLUME	(I) % CHANGE IN DAILY ROE
SELF-REFERENCING	-1,148	-1.87e+07	0.815
	[5,729]	[9.83e+06]	[0.461]
TYING	-2,513	-2.66e+07**	0.705
	[5,866]	[1.01e+07]	[0.465]
EXCLUSIVITY CONTRACT	5,816	-2.47e+07**	-0.649
	[7,042]	[1.21e+07]	[0.566]
NON-INTEROPERABILITY	-3,544	1.61e+06	0.177
	[4,662]	[8.0e+06]	[0.390]
USE OF NONPUBLIC DATA	6,702*	5.45e+06	-1.119***
	[3,038]	[5.21e+06]	[0.251]
DISCRIMINATION	-7,063	5.88e+06	-0.330
	[6,051]	[1.04e+07]	[0.494]

ANTICOMPETITIVE PRICE	8,148	1.15e+07	0.232
	[7,384]	[1.27e+07]	[0.595]
MERGER	5,425	2.71e+06	-0.361
	[5,101]	[8.75e+07]	[0.411]
WGI	60	1.42e+05*	0.001
	[37]	[6.29e+04]	[0.003]
TRADING DATE	7.203***	-1,646	-0.001***
	[2.033]	[3,672]	[0.000]
EPU	31***	-25,286***	-0.001***
	[1.819]	[3,101]	[0.000]
FINANCIAL REPORTS	9,159**	9.69e+06	0.463
	[3,139]	[5.38e+06]	[0.261]
TRADING VOLUME	-1.63e-04***		-0.262***
(% CHANGES IN (E) & (F))	[8.54e-06]		[0.022]
NASDAQ INDEX	2,780***	2.40e+06***	0.850***
(% CHANGES IN (E) & (F))	[289]	[6.08e+05]	[0.023]
GDP GROWTH RATE	740***	4.93e+05**	0.024**
	[95]	[1.66e+05]	[0.008]
% CHANGES IN INTEREST RATES	-977***	-1.42e+06***	0.012
	[126]	[2.22e+05]	[0.011]
% CHANGES IN THE	1,820***	9.89e+05**	0.037*
UNEMPLOYMENT RATES	[195]	[3.35e+05]	[0.016]
SAMPLE SIZE	**4,679**	**4,679**	**4,275**
R-SQUARE VALUE	0.144***	0.052***	0.320***
FIRM DUMMY	V	V	V
YEAR DUMMY	V	V	V
MONTH DUMMY	V	V	V

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; [x]: standard error

Source: author

The effects brought about by allegations of big tech's improper data use may not lie solely in unfair competition against rivals but also in the breach of personal data protection. Because the digital economy is fundamentally data-driven, with a considerable focus on collecting and processing of personal data, this type of wrongdoing is more easily understood and perceived by investors than others. Consequently, investors expect a regulatory response, and this expectation results in

stronger and more profound consequences on big tech's business revenue and securities performance for data misuses than for other types of breaches.

Column H in Table 10 illustrates that the coefficient estimates for service tying and exclusivity contracts are significantly negative at the 1% level. Because both the tying of services and exclusivity contracts require a contractual relationship with trading partners, they are often indicted concurrently, effectively disrupting big tech firm's securities liquidity. The enforcement resulting from these two types of wrongdoing reduces the trading volume by about 51.3 (=26.6+24.7) million shares.

The empirical evidence suggests that, without fines imposed on big tech, the enforcement against its use of nonpublic data, service tying, and exclusivity contracts effectively causes volatility in its trading price, low trading activity, and a selloff in its stock return (Table 10).

5.3. Nonsignificant effects of antitrust regime characteristics

Figure 1 illustrates big tech firms' year-to-date stock returns in 2021. After peaking in February, the stocks of Chinese big tech diverged from the Nasdaq index (the green line) and the securities of American big tech, plummeting until the end of the year. This raises the question: do antitrust regime differences affect big tech's financial performance?

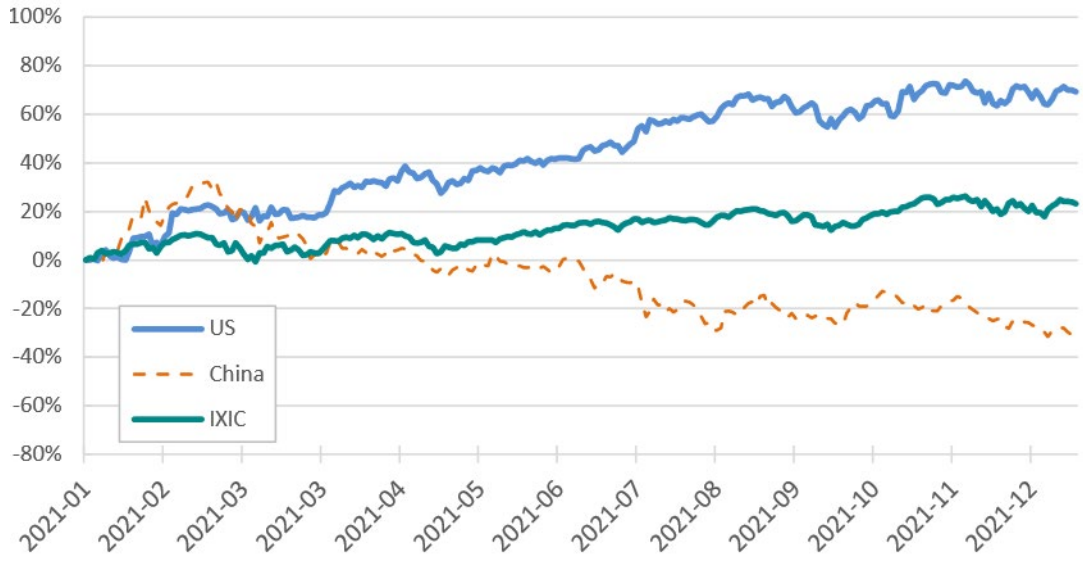

Figure 1. Big tech firms' share prices (% changes, ytd), 2021

Source: author.

Table 11 displays the results of running three antitrust regime variables against big tech's financial performance. Surprisingly, none of the three regime variables generated significant estimations. Only in Column N did we obtain a significant and

negative coefficient estimate for the Chinese antitrust regime at the 5% level. A targeted platformer experiences a selloff in its daily stock return by 0.54% ($e^{-0.775} - 1 = 0.461 - 1 = -0.539$) when the Chinese trustbusters adjudicated against it. This result is consistent with Figure 1.

The models in Columns K and O produce significant coefficient estimates for fines and settlement payments at the 5% and 1% levels, respectively. These results suggest that the effect of the Chinese regime is absorbed by that of the monetary penalty when estimated jointly. A US$1,000 increase in the fine amount or settlement payment enlarges the daily trading range by 1.4 cents. For the penalised firm, a 1% increase in the fine amount alternatively causes a selloff in its stock return by 0.68%.

Table 11. Antitrust crackdowns in the United States, the European Union and China

VARIABLE	(J) DAILY TRADING RANGE	(K) DAILY TRADING RANGE	(L) DAILY TRADING VOLUME	(M) DAILY TRADING VOLUME	(N) % CHANGE IN DAILY ROE	(O) % CHANGE IN DAILY ROE
US ANTITRUST EVENTS	-2,931 [9,854]	-1,805 [9,859]	8.29e+06 [1.69e+07]	9.16e+06 [1.70e+07]	0.111 [0.781]	Omitted
EU ANTITRUST EVENTS	9,947 [9,800]	8,481 [9,813]	1.14e+07 [1.69e+07]	1.02e+07 [1.69e+07]	-0.265 [0.777]	0.724 [1.509]
CN ANTITRUST EVENTS	6,036 [5,044]	5,756 [5,043]	2.39e+05 [8.67e+06]	4.57e+05 [8.68e+06]	-0.775* [0.402]	2.172 [3.651]
FINES (LOG FORMAT IN (O))		1.40e-05* [5.61e-06]		0.011 [0.010]		-0.679** [0.198]
WGI	47 [106]	33 [106]	62,114 [1.82e+05]	51,873 [1.82e+05]	0.004 [0.008]	-0.008 [0.409]
TRADING DATE	7.248*** [2.027]	7.249*** [2.026]	-3,541 [3,485]	-3,540 [3,484]	-0.002*** [0.000]	-0.019 [0.010]
EPU	31*** [1.817]	31*** [1.816]	-25,941*** [3,100]	-25,929*** [3,100]	-0.001*** [0.000]	0.005 [0.008]
FINANCIAL REPORTS	9,051** [3,128]	9,075** [3,127]	9.31e+06 [5.38e+06]	9.33e+06 [5.38e+06]	0.476 [0.261]	omitted

TRADING VOLUME (% CHANGES IN (N) & (O))	-1.63e-04*** [8.51e-06]	-1.63e-04*** [8.51e-06]			-0.258*** [0.022]	-0.432 [0.279]
NASDAQ INDEX (% CHANGES IN (N) & (O))	2,742*** [289]	2,715*** [289]	2.80e+06*** [4.95e+05]	2.78e+06*** [4.95e+05]	0.829*** [0.021]	1.665*** [0.306]
GDP GROWTH RATE	734*** [95]	732*** [95]	5.43e+05*** [1.63e+05]	5.42e+05*** [1.63e+05]	0.027** [0.008]	0.349 [0.757]
(% CHANGES IN) INTEREST RATES	-982*** [126]	-981*** [126]	-1.50e+06*** [2.15e+05]	-1.50e+06*** [2.15e+05]	0.006 [0.011]	-0.180 [0.694]
(% CHANGES IN) THE UNEMPLOYMENT RATES	1,824*** [194]	1,828*** [194]	1.02e+06** [3.33e+05]	1.02e+06** [3.33e+05]	0.039* [0.015]	-0.927 [0.537]
SAMPLE SIZE	**4,680**	**4,680**	**4,680**	**4,680**	**4,276**	**20**
R-SQUARE VALUE	0.145***	0.146***	0.049***	0.050***	0.318***	0.922**
FIRM DUMMY	V	V	V	V	V	V
YEAR DUMMY	V	V	V	V	V	V
MONTH DUMMY	V	V	V	V	V	V

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$; [x]: standard error

Source: author.

Contrary to our expectations, the results in Table 11 demonstrate that the antitrust regime within which big tech operates does not significantly affect their financial performance. Although the Chinese regime is associated with low credibility and consistency, the administration's agility in reining in big tech enhances policy efficacy. Moreover, the targeted Chinese big platforms, unlike their U.S. counterparts, did not appeal but complied with the authority's decision. Chinese antitrust enforcement thus sends investors mixed signals regarding policy uncertainty and effectiveness, resulting in a mild influence on big tech's securities performance. Although the targeted platform's stock return is sold off, its securities liquidity remains high and volatility low.

The premise of unanticipated information may explain the nonsignificant estimates of the E.U. and U.S. regimes. Although we set the criterion of identifying

regulatory events as the ‘first big’ one, investors may still have difficulties anticipating the outcome of antitrust remedies due to the uncertainty of whether the enforcement will be upheld during the long process of judicial review by multi-level courts on either continent. Consequently, investors may not respond to legislative drafts until the acts are signed into law, or no reaction to litigations until final judgement of the top court is laid down. This means that neither U.S. nor E.U. antitrust events during the observation period provide effective signals to investors, and big tech companies’ financial performance remains unaffected by antitrust enforcements. Lagged effects may emerge after court verdicts are delivered.

The Chinese administration’s crackdown on digital platforms has a nonsignificant influence when fines are levied. The results indicate that monetary penalties are effective instruments for reining in big tech across different regimes. Because fines and settlement payments are easily collected with few implementation and monitoring costs, investors can be assured of their immediate and actual effects on big tech’s financial performance and anticipate the resulting volatility in securities prices and sell-offs in stock returns.

VI. Conclusion

Our study demonstrates that addressing big tech’s improper use of data, service tying, and exclusivity contracts can significantly affect their financial performance. The Chinese regulatory authority’s agility in reining in big tech also results in a selloff in stock returns. However, these corrective measures become relatively ineffective in comparison with monetary penalties. Instead, monetary penalties or settlement payments effectively control big tech firms across different regimes.

The statistical insignificance of U.S. and E.U. enforcement remedies may be attributed to the uncertainty of whether the enforcement will be upheld by courts in either region. Consequently, U.S. and E.U. antitrust events fail to provide clear signals to investors during the observation period. The prolonged effects may only become observable after the judicial review processes are completed. Future studies should monitor policy development and court decisions on both continents.

Big tech firms’ collection and use of data involve not only anticompetitive behaviour but also breaches of privacy protection. Several litigations and monetary penalties have been levied on big tech firms for breaching data security and privacy laws across all three regimes. To holistically assess the effects of antitrust and data regulations, future empirical studies should quantify the effects of data and privacy protection policies on big tech firms.

For countries aiming to regulate big tech, monetary penalties should be the regulatory priority due to their efficacy across different regimes. This finding sends out important messages to trustbusters around the world. When discussing effective remedies, the focus of antitrust scholars and enforcers has been on corrective measures, such as structural or behaviorial remedies, and little attention has been paid to monetary penalties. Fines and settlement payment have long been marginalized and neglected in policy considerations with regards to big tech regulation. Trustbusters sometimes even determine not to impose a fine for new types of antitrust offenses from digital platforms, not knowing the fact that the absence of monetary penalties would seriously undermines their enforcement effectiveness.

Where monetary penalties are not yet a feasible option, making the antitrust regime adaptable and flexible could improve regulatory efficacy. One approach is establishing supportive court precedents for adaptive antitrust crackdowns. Shareholders can anticipate regulatory effectiveness once courts honour antitrust remedies and establish precedents specifically attuned to the digital economy. Another approach is new legislation (McClymont & Sheppard, 2020). Trustbusters imbued with authority by new digital legislation can investigate and penalise misbehaving big tech firms. Investors can then be assured of the effectiveness of the new antitrust regime and anticipate changes in the firms' financial performance.

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