Article

The Free-of-Charge Phenomena in the Network Economy—A Multi-Party Value Exchange Model

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Abstract: The long-standing economic model is one where customers receive and pay for goods and services. However, in today's modern network economy, why are vendors willing to provide free services and goods to free-riders at an apparent loss? The objective of this study is to provide a theoretical framework explaining why free network services emerge and how they work. This study adopted the multi-case study method, summarized 28 types of revenue model patterns from 51 indicative free network services, and inferred the causes for the antecedent conditions of each revenue model with Qualitative Comparative Analysis (QCA), in order to confirm the causal relationship between the various antecedent conditions, configurations, and revenue models as conclusive evidence. In addition, this study established seven conditional propositions via their links with related theories, which were taken as the basis for providing in-depth explanations of the revenue model of the free network service, and expanded the demonstration of the original network economy.

Keywords: free-rider; network effect; multi-sided markets; network economy; case study

1. Introduction

The Internet has changed the world. In 2013, the revenue from print advertising in the US newspaper industry dropped by 70%, and USD 1 value in the print media industry became USD 0.01 in digital media. In 2015, 44% of adults in the US no longer had a landline telephone connection, switching to mobile communication entirely. The value created by Google is "information," Facebook accumulates value from "friends," and Alibaba generates value by a large number of "commodities" [1]. People define the values of objects in their subject ways. For example, Kyle MacDonald was able to acquire a house worth about USD 50,000 using only a paperclip [2]. However, in the Internet era, the demand-side economy has become the focus, and provided it can attract enough users, almost everyone will be pulled in eventually [3]. In the battle between Google Android and Apple iOS, Apple's profit in 2011 was as high as USD 33 billion, which was the combined profit of Google and Microsoft [4]. The result of a platform war is usually a winner-take-all situation [5]. Even these free "digital public goods" allow a large number of free-riders to enjoy resources without paying. The greater the number of users, the more valuable the platform is to users, which in turn forms an inherent advantage, meaning that it is extremely difficult for competitors to overtake a popular platform.

The most important issue for the network economy is how to create profits without reducing the positive network effect. Any product or service is provided at certain costs. If the users are not charged, how can these free network services make profits? This study proposes that the reason why free network services succeed is that there must be valuable

exchanges behind them. While "there is no free lunch in the world", a large number of users can indeed bring network effects and accumulate the value of network services, thus, a free network service cannot be sustainable if it fails to monetize the flow of a large number of free-riders.

Previous research regarding the profitability of free network services was mostly conducted with freemium or two-sided market subsidies, which lack a rigorous theoretical framework. This study inferred the revenue model of free network services from actual cases in order to attain a theoretical explanation. The next section offers the literature review for the new form of "digital public goods" that has subverted economic concepts from the past. The latter work aims at theoretical development. We adopt a holistic multi-case study method, observing individual cases and summarizing universal rules based on inductive reasoning [6]. The advantage of the multi-case study lies in the concept, which can provide an understanding of the free network services. Then, the pattern matching strategy is used to investigate how free network services can allow a large number of non-paying users and how they convert such free-riders into banknotes. Finally, we conduct a Qualitative Comparative Analysis (QCA) to confirm the causal condition regarding the inference of propositions which can be used as verification for future theory expansion.

2. Digital Public Goods

All goods can be classified based on the characteristics of rivalry and excludability [7]. "Non-rivalry" means that consumption by anyone will not reduce the consumption by others of a good; "non-excludability" means that all consumers can enjoy the good equally and cannot prevent others from using the good. Private goods are both rivalrous and exclusive, and they can only be used exclusively after acquisition (exclusive use); in relative terms, public goods are not rivalrous or exclusive and can be shared by all consumers without interference from each other. The marginal cost for service to an additional consumer is zero. In the case of a cable TV program, even if multiple viewers are added, the marginal cost will not be increased. Like public goods, common goods are not exclusive, which means that users can enjoy common goods without paying. The difference between public goods and common goods is that common goods are rivalrous, meaning they have a limited supply. There is often controversy regarding charging for public goods. Since serving one more consumer does not increase the marginal cost, public goods should not require payment. However, if there is no charge, who would be willing to provide services? Due to the characteristics of public goods, it is difficult to measure their value. It is also impossible to isolate non-paying users. Since people can enjoy the benefits without paying, everyone may prefer to be a free rider, thereby resulting in market failure. A solution is for the government to provide public goods using the funds from taxes in order to benefit everyone [7,8].

When the goods are available for free, such market power does not exist and cannot be used to allocate resources in the economic system [7]. Free goods result in a market no longer dominated by price, which is a challenge for economic analysis. When the price of any item falls, its demand will rise, which is the law of demand in traditional economics [8]. The zero price is one market, and any other price is another market [9]. No matter how low the price is, if users have difficulty in paying for it, it usually reduces their participation intention; however, when the price is zero, it can allow the demand curve to grow nonlinearly, thus, it is easier to achieve the so-called network effect. Since the value of the platform is created by the user community, it means that the biggest factor in the success of a platform is its ability to attract a large number of users, and users who are willing to use the platform must have a considerable incentive, that is, the platform can provide "free" services [4]. That free service is not necessarily meaningful, because even if you have tens of millions of users, you still cannot make money, thus, "free" should be regarded as a business model that helps generate revenue and achieve profitability [10]. As the value of a customer's goods is not related to the price they want to pay but is related to the "perceived value", which cannot be quantified [11], when the product price drops to

zero, although the total demand will increase, it will not increase indefinitely, because even free products are not necessarily needed by everyone [12,13].

In the network economy, consumption involves not only the purchase of a single product but also choosing other products complementary to the product, which expands network effects [14]. For digital products, the 5% rule operates—5% of users paying for the product can support other free-riders [9]. Social and economic exchanges complement each other and determine individual behavior. Any actor first calculates the value and cost of an action before taking the action: the calculation considers both social and economic factors. If the exchange is mainly relational, the exchange is called a social exchange; if the exchange is transactional, the exchange is called an economic exchange [15]. It appears that editing Wikipedia is attractive to a small group of its users, to the enthusiastic welcome of its large reader group. A large number of free-riders is actually the best return for the minority contributors because the more prestige and attention capital is accumulated the greater their social-relational rewards. This is an example of the so-called "monetizing eyeballs" effect [9]. To sum up, the marginal benefits of "digital public goods" with network effects will increase when the public goods are used by more people. Meanwhile, a free monetization model can be established because the marginal cost of digital content and services provided is almost zero. Unlike traditional production factors, the network economy has increasing marginal benefits.

3. Methodology

In this multi-case study, multiple free network services are analyzed through the inductive approach, and their revenue model is summarized. We adopt grounded-theory-based partial-pattern-matching to infer general arguments, matching theoretical patterns with empirically found patterns from each case. In order to ensure that the research findings are consistent with the observed results, triangulation of data sources and methods is used in this study. Multiple data sources are adopted to repeatedly verify whether diverse evidence can yield consistent results, improving the validity of research [16,17]. After summarizing the revenue model of free network services one by one, this study adopted the Qualitative Comparative Analysis (QCA) method to verify the causal relationship between the premise and conclusion of the revenue model, and simultaneously completed "If-Then testing", which are presented in the form of statements, and "general rules" can be established by the relationship between p and q to connect to the theory [16]. Finally, seven conditional propositions were proposed according to the causality model. The iterative process of this research is illustrated in Figure 1.
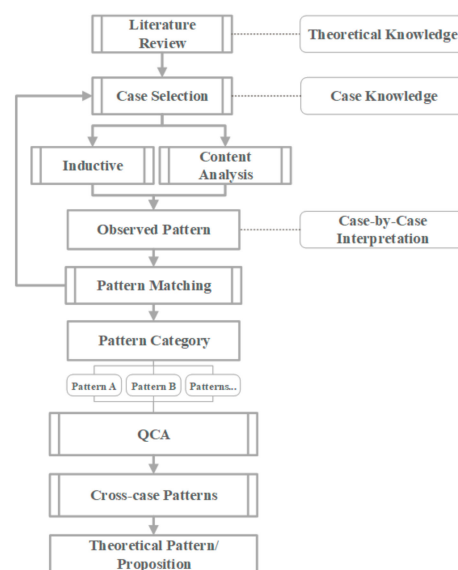

Figure 1. Research flowchart.

3.1. Multi-Case Study

Evidence obtained from multiple cases is more robust [17]. The continuous replication of logical procedures from multiple cases can accumulate a certain foundation for theoretical construction. This can include literal replication, where the result meets prediction conditions, and theoretical replication, where the result does not meet prediction conditions. If the results of the analysis of practical cases are different from the prediction, it can be regarded as the starting point to revise the theory.

Case studies can be thought of as multi-case experiments. Different from the traditional sampling approach, case studies attempt to discover the logic that repeats in different cases. This can be used as an important step in building a theoretical framework [17]. We regard each case as an independent experiment to analyze the individual free network service and derive the related concepts. The conclusions from the different cases are used as individual evidence to support the discovery and reproduction of the revenue model of multiple network services. Then, different cases are compared to determine the distinctions between different types of revenue models. Each type of model had to include cases that were highly similar to each other but significantly different from the cases in other types of models. The research findings are summarized in the cross-case analysis report.

3.2. Pattern Matching

Finding "common variations" in multiple cases can substantiate research findings across different cases, and the distinctive characteristics of cases can be used to analyze the differences between types of models [16]. Case studies face significant challenges in analyzing the evidence presented by the cases, but pattern matching is one of the suitable analysis strategies [17]. The basic principle of pattern matching is to compare the observed pattern with the existing theoretical pattern to further confirm or expand existing theories.

In this study, the grounded-theory-based partial-pattern-matching [18] is adopted. It is a bottom-up induction method developed from the concept of grounded theory. Corresponding to existing theoretical patterns, observed patterns—summarized directly from the empirical data—are derived from the researchers' internal ideas and existing literature. This explanation-building procedure is a special type of pattern matching. Unlike traditional pattern matching that uses continuous comparative analysis, the theoretical pattern of constructive interpretation is not established at the beginning of the study. Generally, the evidence obtained by testing and comparing different types of cases is used to repeatedly revise the theoretical standings. The product of this step-by-step interpretation process can serve as the basis for not only analysis of each individual case but also for cross-case analysis. It also includes counter-interpretations of cross-case analysis, which can refine theoretical concepts [6,17].

In this study, we first collect secondary data for each case. Then, the content analysis, coding and classification of individual cases was performed to construct the initial theoretical concept. The data of the cases are compared, which entailed repeatedly comparing the case findings with the initial theory in order to revise the theoretical concept. As the theoretical concept keeps developing, it is continuously compared with the results of multiple cases, and finally, a revenue pattern that can explain the free network services is established.

4. Data Analysis

Secondary data are used in this study that include existing case studies, official statistics, official service terms or privacy policies, news reports, and online data. The data focuses on the exchange between parties and revenue sources of participants related to free network services. Descriptions including subjective user evaluations, operating profitability, investment strategies, internal allowances, and content data that cannot be objectively verified are not included in the analysis.

The granularity of this study is defined as one single network service. If one company provides multiple free network services, they will be considered separately. For example,

apart from its primary social network, the data from Facebook also includes Facebook Messenger and Facebook Game. These three services are significantly different. Therefore, this study distinguishes Facebook into three network services, including Facebook, Facebook Messenger, and Facebook Game, and analyzes the revenue pattern by individual service. In addition, if the case was determined as providing a fee-free solution, it would be included and considered as a new case. For example, Google Maps provides API services with simultaneous free quotas and charging standards, thus, this study added Google Maps APIs, and independently explored its revenue model.

4.1. Collection and Processing of Case Data

The cases selected in this study must provide free network services to users. In order to summarize the different revenue models of free network services, different types of cases are considered to enable cross-case comparisons.

The selection of cases in case studies should emphasize the diversity of contexts and causal structures [17,19]. We refer to the business model research report [20], which included 176 companies in five regions and 22 countries and summarized 12 industry categories: (1) search, AdTech, and services, (2) Internet software and services, (3) media, (4) social media, (5) social/messaging, (6) travel, (7) transportation, (8) fintech, (9) app marketplaces, (10) e-commerce/marketplace, (11) enterprise software, and (12) IoT, software, and manufacturing. Since this study only investigates free network services, the categories of enterprise software, IoT software, and manufacturing are not considered.

The cases are selected from the 12 industry categories above, and characteristic cases in each industry category are selected. A total of 36 free network service cases are initially selected. For case studies on theoretical construction, the number of sample cases can be increased based on the research situation and data collection process [21]. An example in this study is the Google Android issue: on July 18, 2018, the European Commission hit Google with an antitrust fine because its Android mobile operating system is free and open source for mobile device makers but it benefits from pre-installation of Google Mobile Services such as Google Play Store, Google Chrome, Search and so on. Google changed the licenses agreements of Android for the European Economic Area to comply with EU decision [22]. Therefore, we split the Android case into the EU zone—Android-EU—and the non-EU zone—Android-NonEU—and discuss the revenue model of the different regions. We also added cases that are often said to be able to compete with the free network services cases we chose. For example, the content analysis of free network services in the travel industry found that Airbnb is often mentioned. Therefore, this study added Airbnb as an alternative case. Similarly, when collecting data related to social media and social/messaging, we discover that TikTok, LinkedIn, and Twitter are also referred to frequently. They are also included as alternative cases to provide more sources of information for subsequent analysis and to fully understand the overall picture of revenue patterns in specific industries. In the end, this study selected a total of 51 cases. The background information for each case is summarized in Table A1 of Appendix A.

4.2. Coding of Case Data

In order to maintain the integrity of the cases, all the collected case data is written into a case memo, and the data of each case is checked to summarize the characteristics related to the revenue model. It is further marked by code notes to simplify the massive amount of data and classify it into a few concepts. As the platforms have a reciprocal exchange relationship with the consumers and the suppliers [23], the remuneration for value exchange is not only in the form of money. More likely, exchanges are compensated with increased reputational and attention capital. For example, the leverage of Facebook is friends, that of eBay is ratings by buyers and sellers, and that of Twitter is followers (1). We encode the data accordingly: participants in the value exchange (to identify the non-paying users), content providers, paying users, a description of the objects exchanged by both parties, the value that the free network service provides, and the requirements

of participants. In the meanwhile, the possible monetization paths of the free models (1) and the platform economy [4,13] are adopted as the initial code for "revenue source", including freemium, the three-party market, transaction fees, and charging for access. With the increase in the number of cases analyzed, the types of revenue models will become increasingly convergent, and thus the coding will gradually converge. Finally, this study integrated the coding of the revenue sources into five categories, which are explained as follows. The data coding for the WeChat (Communication) case is shown in Table 1.

Table 1. Data coding of WeChat (Communication) (Adapted from [24]).

Service: WeChat (Communication)	Side 1	Side 2	Side 3
Participating parties	Users	Merchants	Corporations
Non-paying users	✓		
Content providers	✓	✓	
Payers	Δ A subset of non-paying users is lured to pay for "Subscription account"	✓	✓
Value provided from the service	Communication	Exposure	Corporate communication
Value required to the service	Headcount	Verification fee	Verification fee
Revenue sources	Freemium (UP+), Premium service (PP), Advertising (AdP)		

1. Freemium (UP+). A subset of non-paying users is lured to pay. First, users are attracted by free network services. After users become accustomed to the services, advanced services with a fee are introduced, which increases the revenue of free network service providers. For example, when the amount of content on a platform increases, consumers may be willing to pay for quality content or to block advertisements.
2. Advertising (AdP). A type of third-party market, where a third-party pays for free commodity exchanges between the other two parties. Network advertising is the most common model. Advertisers buy ad impressions from free network service providers to publish advertisements to increase product exposure and attract potential customers to purchase their products [25].
3. Transaction commission (2P). Payment is required only when two parties (the buyers and the sellers) on the platforms actually complete a transaction. Therefore, it does not hinder users from joining the platforms, but platforms must also beware of the buyers and sellers who might switch to offline transactions to avoid the fee. In order to prevent offline transactions, the platforms try their best to provide all information and standardized services so that consumers and producers have no direct contact.
4. Payment as a content provider (CP). It is also known as charging for access. The platforms charge the content providers for the provision of a channel through which to contact the users, and there is usually a shelf fee for goods or services.
5. Value-added services to content provider (CP+). A subset of content providers is lured to pay the advanced version of charging for access. The platforms provide advanced paid services for content providers, such as identifying more accurate and valuable users or displaying producers' content to users in more prominent positions. This brings more added value to the producers.
6. Premium service (PP). Payment is from payers for a premium service. Network services that are mainly paid-for services are provided to enterprise users.
7. Others (OP). Revenue sources other than the above sources, such as donations, interest, or other revenue sources.

4.3. Revenue Concept Maps

After the features related to the revenue models are extracted and coded, the revenue concept maps of the cases are drawn based on the case data coding table. This allows us to visualize the revenue pattern. When a new revenue concept map is being drawn, it is compared to the revenue concept maps of the cases in the same industry or from the same network service provider. This is done in order to search for new findings and to evaluate whether the original coding content and revenue concept maps should be modified. Based on the cross-case inductive analysis method, the revenue concept maps of multiple cases are compared to investigate the similarities and differences of each model and determine possible multi-exchange relationships. The repeated comparison process can result in gradually converging from which the theoretical logic can be constructed. The revenue concept map for the WeChat (Communication) case is referred to in Figure 2.
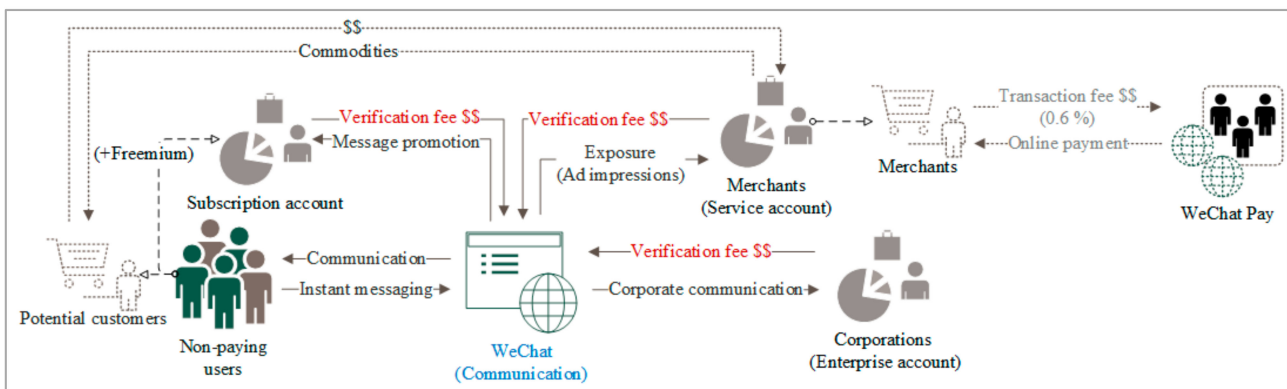

Figure 2. Revenue concept map of WeChat (Communication) (Adapted from [24]).

4.4. Pattern Matching

The results of the above process are the revenue concept maps of 51 cases. We then confirm the replication results of the revenue patterns by abstracting revenue concept maps in order to identify and summarize the types of revenue pattern diagrams for free network services. The principles for abstracting the revenue concept maps into revenue pattern diagrams are described as follows.

1. One free network service only belongs to one kind of revenue pattern diagram. In the case of WeChat communication, the "Service Account" is designed for merchants in the hope that they will also use WeChat Pay. Although this brings in revenue from the transaction fees of the WeChat Pay platform, WeChat Pay is not included in the revenue pattern diagram of WeChat communication but is discussed separately.
2. The revenue pattern is at least a dyad (two actors) relationship, which means that the free network services offer certain free services and have non-paying users. The other actors as payers or third-party content providers, whether existing depend on the revenue concept map.
3. The exchange relationship between the free network service providers and all participants will be simplified for further model generation. In the case of free network services in the Google ecosystem, advertising service is controlled by the Google Ads service [26]. Based on the simplification principle, the free network service will use the fee charged to substitute the advertising service but will not be included in the detailed revenue model of Google Ads.

When the revenue concept map of the first case is abstracted into a revenue pattern diagram, the revenue concept maps of subsequent cases can be compared with the first revenue pattern diagram during the abstraction process. If the revenue concept maps of two cases are the same, the second case can be categorized into the first revenue pattern diagram; if different, a new revenue pattern diagram will be produced according to the abstraction

principle. This process is repeated until all the cases have attributable revenue pattern diagrams. The descriptions of legends for the revenue pattern diagrams are illustrated in Table 2.

Table 2. Legends of revenue pattern diagrams.

	Main Actors		Additional Roles
	Non-paying users (U)		Paying: Freemium (UP+) A subset of non-paying users is lured to pay
			Content: User-generated (UC) A subset of non-paying users is content providers
	Payers (P)		Content: Advertising (AdC) A subset of payers is content providers
	Content providers (C)		Paying: Value-added service (CP+) A subset of content providers is lured to pay
	Free network service		

If the participants of free network services are only non-paying users, the participant relationship is called a one-sided party that contains only one revenue model, as shown in Table 3; if there is another group of participants in addition to the non-paying users, such as content providers or payers, the participant relationship is called a two-sided party that concludes six revenue models from different content sources, as shown in Table 4. Take two-sided payment and user-generated content for example, in the cases of Dropbox, Google Drive, Microsoft OneDrive, Facebook, Gmail, LinkedIn, Outlook, WeChat, and Yahoo! Mail, non-paying users provide the source of all content, and one revenue source is the purchase of value-added services by users after they enjoy the free network services. Specifically, a revenue source of Dropbox, Google Drive, and Microsoft OneDrive is to charge service fees to enterprises for providing advanced services, as shown in Figure 3A. Facebook's revenue source is advertising billing, and its revenue pattern is shown in Figure 3B; the revenue source for Gmail, LinkedIn, Outlook, WeChat, and Yahoo! Mail is charging for access to and advertising on corporate services, and their revenue pattern is shown in Figure 3C.

Table 3. One revenue model for a one-sided party.

Revenue Source	Content Source	# of Cases	# of Patterns	Cases Covered
One-sided payment	None	5	1	Bing Search APIs, Google Maps APIs, Google Search APIs, Baidu Maps APIs, AMap APIs
Total		5	1	

Table 4. Six revenue models for two-sided party.

Revenue Source	Content Source	# of Cases	# of Patterns	Cases Covered
One-sided payment	None	2	1	Android-NonEU, iOS
	User-generated	4	3	WhatsApp, Facebook Messenger, Instagram, Twitter
	Third-party	10	5	Airbnb, Facebook Games, Google Play, Ctrip, Groupon, Microsoft Store, GitHub, Booking.com, Vimeo, App Store (iOS)
Two-sided payment	None	4	2	Android-EU, Alipay, WeChat Pay, PayPal
	User-generated	9	3	Dropbox, Google Drive, Microsoft OneDrive, Facebook, Gmail, LinkedIn, Outlook, WeChat (Communication), Yahoo! Mail
	Third-party	3	3	Lyft, Didi Chuxing, Amazon e-commerce
Total		32	17	

Figure 3. Revenue pattern diagrams (**A**) revenue is from premium service, (**B**) revenue is from advertising, (**C**) revenue are both from premium service and advertising (Adapted from [24]).

If the free network services have all three types of participants—non-paying users, content providers, and payers—the participant relationship is called a multi-sided party that summarizes three revenue models from two revenue types, as shown in Table 5.

Table 5. Three revenue models for a multi-sided party.

Revenue Source	Content Source	# of Cases	# of Patterns	Cases Covered
One-sided payment	Third-party	7	5	Wikipedia, Baidu Search, Bing, Google Search, TikTok, Expedia.com, Taobao.com
	Multi-sided	4	2	Waze, Amap, Baidu Maps, Google Maps
Multi-sided payment	Third-party	3	3	YouTube, Uber, Grab
Total		14	10	

The 51 cases are classified into 28 revenue pattern diagrams of free network services. For the free network services with a one-sided participant relationship, the revenue comes only from non-paying users; for the free network services with more than two types of participants, the revenue can come from non-paying users, content providers, or payers, or all of them. Based on the exchange model, the case data from this study is coded and patterns are classified, forming ten types of revenue models. After determining the antecedent cause conditions of each model, we officially entered the Qualitative Comparative Analysis (QCA) procedure.

4.5. Qualitative Comparative Analysis (QCA)

As it integrates qualitative case-orientation and quantitative condition variable-orientation, QCA can provide more in-depth analysis of cross-cases, meaning it can accurately match and compare the conditions of the cases, and produce different causal condition configurations for different results, which become a set theory that is transformed into a theoretical language [19]. Taking multiple free network services as the analysis cases, this study summarized the revenue model of free network services one by one to develop and construct conditional propositions and explanatory theories and used QCA to confirm the causal configuration of the theoretical model.

The study applied the most widely used csQCA technology, that is, the variable value can only be 0 or 1. The data encoding of each case can be regarded as a variable, that is, it can be converted into a truth table of 0 or 1 to construct a data matrix. If the variable existed in the encoding of the case, the value was set to 1, and if it did not exist, it was set to 0. Finally, the "participant relationship" was obtained by referring to the composition of the pattern of the individual case. At the same time, the original "content source" was coded as a "third-party", and then, subdivided into the "advertiser" category, and a total of 18 variables of free network services were obtained, as shown in Table 6.

QCA was used to identify the different causal condition configurations and correlation levels of the revenue model to verify 28 groups of revenue pattern categories. Based on the analysis of this study, in order for the data level of specific evidence to be abstracted to the theoretical concept level, it is necessary to simplify the multiple causal relationship model to develop appropriate conditional propositions and explanatory theories. We used the csQCA analysis method from Tosmana (Vers. 1.6) QCA software, as developed by [27], to explore the causal relationship of different case configurations with the revenue model. Since the variable value of csQCA must be dichotomized, that is, the value must be 0 or 1, this study used third-party payment (P) as the result variable to explore how the component conditions of each cause contribute to the result of third-party payment and made the preliminary classification of the case configuration, that is, the combination of necessary and sufficient conditions. The truth table after csQCA analysis is shown in Appendix A, Table A2.

Table 6. QCA variables.

Category	Variable	Variable Definition
Participant relationship (6)	P	Is there a third-party payer. If there is a value of 1 in CP, CP+, 2P, PP, AdP, and OP, then this variable is 1, otherwise, it is 0.
	C = P	Whether the third-party content provider is also a third-party payer. If there is 1 value in CP, CP+, and 2P, then this variable is 1, otherwise, it is 0
	U = P = C	Whether non-paying users are also third-party payers and content providers. If the values of U = C and U = P are 1, the variable is 1, and otherwise, it is 0.
Content source (4)	UC	Is it mainly from non-paying users
	CC	Is it mainly from third-party content providers
	SC	Is it mainly from free network service providers
Revenue source (8)	UP+	Is it a freemium
	CP	Whether to pay for content providers
	CP+	Whether to pay for the added value of content providers
	2P	Is it a transaction commission
	PP	Is it a paid service
	AdP	Is it an advertising service
	OP	Is it from "other" channel
	RS	Is there any profit sharing with participants

5. Model Description

The theoretical concept we advocate for is "there is no such thing as a free lunch". The participants in the free network data services have economic or social returns to exchange so as to support a large number of non-paying users.

According to the QCA analysis results, this study simplified the content sources into two categories. If the content source variables (UC, CC, SC) of the case were all 0, it was regarded as a no content source and collectively referred to as "tool-based"; other than the no content source, there was at least one content source, which was marked as "content-based". Then, according to the content-based producer source, they can be divided into sub-categories, including "user-generated content (UC = 1)", "third-party content (CC = 1)", and "service provider content (SC = 1)".

Next, according to the configuration of the antecedent cause conditions in each model, the source of revenue was simplified into third-party payment and generalized advertising revenue, and then, the repeated similar and different pattern categories were re-analyzed for subsequent inferences of conclusions.

5.1. Third-Party Payment

Most "tool-based" services derive their revenue from freemium (UP+), except for the operating system type (Android-NonEU, iOS), as shown in Table 7. As operating systems are mostly bundled with devices or equipment for sale, it is not possible for them to earn extra income from users, and they can only charge third-parties to compensate a large number of non-paying users. Conversely, "content-based" services can all earn income from third-parties, as shown in Table 8. It is particularly worth mentioning that, if the content comes from a free network service, there is no freemium. It is inferred that such services usually provide additional APIs, such as Baidu Maps, Amap, Google Maps so that APIs tool-based services can obtain payment as freemium, which means they can have both kinds of income.

Table 7. Classification matrix of third-party payment for tool-based services.

Revenue Source	
Freemium (UP+)	Third-Party Payment (PP/AdP/CP/CP+/2P/OP)
Bing Search APIs, Google Maps APIs, Google Search APIs, Baidu Maps APIs, AMap APIs	Android-NonEU, iOS
PayPal, Alipay, WeChat Pay	
Android-EU	

Table 8. Classification matrix of third-party payment for content-based services.

Content Source	Revenue Source	
	Freemium (UP+)	Third-Party Payment (PP/AdP/CP/CP+/2P/OP)
User-generated		WhatsApp
		Facebook Messenger, Instagram, Twitter
		Dropbox, Google Drive, Microsoft OneDrive
		Facebook, Gmail, LinkedIn, Outlook, Yahoo! Mail, WeChat
Third-party		Wikipedia
		Bing, Google Search, Baidu Search, TikTok
		Airbnb, App Store, Booking.com, Facebook Games, GitHub, Google Play, Groupon, Microsoft Store, Vimeo, Ctrip
		Expedia.com, Taobao.com
		YouTube
		Amazon e-commerce, Lyft, Uber
		Didi Chuxing
		Grab
Free network service		Waze, Baidu Maps, Amap
		Google Maps

5.2. Generalized Advertising Services

At present, common advertising charging methods include cost per mile (CPM), cost per click (CPC), and cost per action (CPA). In addition, the cost per sales (CPS) pricing method is gradually becoming popular in recent years, that is, advertisers only pay after the product is sold [28–30], which is similar to the concept of the transaction commission. Therefore, this study argues that the content produced by the content provider is also for trading, and is broadly similar to advertisers, thus, the aforementioned "third-party payment" was further subdivided into two categories of "non-advertising revenue" and "generalized advertising revenue", in order to develop clearer conditional propositions.

Revenue types include advertising services (AdP), payment as a content provider (CP), payment for value-added content (CP+), transaction commission (2P), etc., all of which are regarded as "generalized advertising revenue", while freemium (UP+), paid services (PP), other channel income (OP), etc., are regarded as "non-advertising revenue". The source of revenue for most "tool-based" services is not generalized advertising revenue, as shown in Table 9; for "content-based" services, most types of user-generated content do not rely on generalized advertising revenue. Instead, the type of third-party content depends on the generalized advertising revenue. If the content comes from a free network service, its revenue source is only generalized advertising revenue. The classification matrix for "content-based" services is shown in Table 10.

Table 9. Classification matrix of generalized advertising revenue for tool-based services.

Freemium (UP+)	Revenue Source	
	Third-Party Payment	
	Non-Advertising (PP/OP)	**Generalized Advertising (AdP/CP/CP+/2P)**
Bing Search APIs, Google Maps APIs, Google Search APIs, Baidu Maps APIs, AMap APIs	Android-NonEU, iOS	
Android-EU		
PayPal, Alipay, WeChat Pay		

Table 10. Classification matrix of generalized advertising revenue for tool-based services.

Content Source	Revenue Source		
	Freemium (UP+)	**Third-Party Payment**	
		Non-Advertising (PP/OP)	**Generalized Advertising (AdP/CP/CP+/2P)**
User-generated		WhatsApp	Facebook Messenger, Instagram
	Dropbox, Google Drive, Microsoft OneDrive		
			Twitter
	Facebook, Gmail, LinkedIn, Outlook, Yahoo! Mail, WeChat		
Third-party		Wikipedia	Airbnb, Facebook Games, Google Play, GitHub, Booking.com, Vimeo, Groupon, Microsoft Store, Ctrip, App Store
			Bing, Google Search, Baidu Search, Expedia.com, Taobao.com
	Lyft, Didi Chuxing, Amazon e-commerce		Lyft, Didi Chuxing, Amazon e-commerce
	YouTube, Grab		YouTube, Grab
			TikTok
	Uber		
Free network service			Waze, Baidu Maps, AMap
			Google Maps

6. Conditional Propositions

This study combined 51 cases to summarize in a revenue concept map of individual cases through the inductive method, and a total of 28 revenue pattern diagrams were collected using cross-case pattern comparison. At the same time, the multiple causal relationships between antecedent cause conditions and the revenue results of each cause were determined through QCA. In order to develop appropriate conditional propositions, this study repeatedly used QCA to simplify the conditional configuration to third-party payment and generalized advertising revenue. Finally, the classification results were compared with the QCA causal relationship configurations.

This study confirmed that the "revenue source" of the free network service was related to the "content source" dependent on different "participant relationships". Seven conditional propositions were proposed according to the causality model.

6.1. Unilateral Relationship

The primary characteristics of information products are free and perfect, which means that one more copy of the digital product is free, and the copy will be exactly the same

as the original digital version. Through the Internet, the transmission distance becomes unlimited; therefore, the features of being free, complete, and having real-time replication makes the overall value of the network service much greater than the individual value of the product [13]. Another feature of an information product is that it is unbundled; in the past, multiple songs were presented on one CD, which is beneficial to record companies, and this is atomic economics. However, as the network makes the transmission cost almost zero, and selling singles will not cause cost increase, this is network economics [4]. Therefore, for a tool-based free network service that simply provides functions and no content, the functions are disassembled and sold separately, thus, the revenue path is often to pay for purchased advanced functions after the free content, such as Bing Search APIs, Google Maps APIs, Google Search APIs, Baidu Maps APIs, AMap APIs, and other cases.

Proposition 1. *If a free network service is tool-based, it can charge non-paying users as freemium.*

6.2. Bilateral Relationship

The biggest challenge in the two-sided market is the problem of "which comes first, the chicken or the egg". The users on one side and the market influence each other, meaning the users on one side will affect the users on the other side, thus, a platform with more friends will do better at attracting new users to form a network effect, and an effective feedback loop can increase value. If people think that the platform is valuable, they will be attracted to join the platform, thus, more users can promote more user interaction, and the platform will create more value and attract more tangible or intangible currency, which will feedback more value to users and attract more users, and continue as a virtuous cycle [4,31]. Compared with the unilateral relationship of only free users and free network services, the main feature of forming a bilateral relationship is that there are third-party content providers or payers. Although content providers or payers may also be derived from free users, there must be third-party participants in the bilateral relationship, and they are either the payers or the content providers, and only one role exists.

6.2.1. Tool-Based Free Network Service

Regarding tool-based network services, if there is no free value-added service provider, the main source of income is the "other" channel for third-party payment. Like Android-NonEU (non-EU region) and iOS, when more users use the operation system, the value it brings is that it can receive additional income from other services as a subsidy by carrying other services; for example, Google pays Apple every year to put Google software on iOS [5]; Android-NonEU (non-EU region) provides GMS free of charge in addition to Android, with the intention of earning a large amount of advertising revenue from GMS via the deployment by a large number of different mobile device vendors.

On the other hand, if the tool-based network service can provide free value-added services, such as Android-EU, Alipay, WeChat Pay, and PayPal, basically, the revenue model of Android-EU (European Union) should be the same as Android (non-EU region). As the European Union accused the Android operating system of monopolization, and then, derived a special charging situation, this study did not include it in the proposition discussions and only discussed the revenue model of Alipay, WeChat Pay, and PayPal. As the main revenue sources of these three are all "other" channels, they also receive transaction commissions for generalized advertising services.

Proposition 2. *If the free network service is tool-based, it can collect fees from third-parties, with income coming mainly from other channels; it can also charge non-paying users as freemium, and charge for generalized advertising, with income mainly coming from transaction commissions.*

6.2.2. Content-Based Free Network Service: User Generated Content

More users represent more user feedback content and more user behavior information, which has the value of realization. At the same time, the information services used by

more users will form the mainstream information services in the market, which encourages enterprises to pay for a more exclusive commercial version of the service, and thus, obtain paid corporate service revenue; a large number of users also represent more "eyeballs", which naturally attracts the traditional classified advertising model to earn more income. On the other hand, as content providers use the service for free, those users who want to exchange to gain social recognition or prestige will also be willing to switch to being paying users and purchase more exposure opportunities for the content they provide; such cases include WhatsApp, Facebook Messenger, Instagram, and Twitter, which do not offer value-added payment for free users, as well as Dropbox, Google Drive, Microsoft OneDrive, Facebook, Gmail, LinkedIn, Outlook, WeChat, and Yahoo! Mail, which do offer value-added payment for free users. Most revenue sources of these two types are from third-parties and are mainly for corporate services or fee-based services of traditional advertising.

Proposition 3. *If the free network service is content-based, and the content source is user-generated content, it can charge third-parties mainly for corporate services or narrowly defined advertising charges; it can also charge non-paying users as freemium.*

6.2.3. Content-Based Free Network Service: Third Party Provided Content

There are three main sources of income that the media industry relies on: advertisements, transactions, and subscriptions [1], and content-based network services provided by third-parties can also be regarded as being part of the media industry, while free network services are regarded as large advertisement boards. The purpose of the boards is to gain more exposure for content providers to obtain transaction opportunities, and then, collect commissions from each transaction. In addition, the network has created another sales method, meaning the "subscription". The subscription streaming service model is more consumer-friendly due to its simplicity, as consumers only need to pay a fixed monthly fee instead of making decisions every time [4]. Therefore, most of the revenue sources are derived from transaction commissions, including Airbnb, Facebook Games, Google Play, Ctrip, Groupon, Microsoft Store, Booking.com, Vimeo, App Store (iOS), Lyft, Amazon e-commerce, and other cases; while GitHub, which is a free network service for open source software version management, is the exception due to its operating revenue from content providers who pay to purchase advanced services. In addition, Ctrip, Groupon, Microsoft Store, Booking.com, Vimeo, App Store (iOS), Lyft, Amazon e-commerce, and other cases, collect access fees from content parties besides the transaction commission. This fee is nothing more than giving the content provider the right to list their products or services, or provide paid advanced services, which allows content providers to have higher exposure or easier access to users to facilitate more trading opportunities. The search cost for the bilateral market of matchmaking is reduced due to the reduction of asymmetric information, and such networks should have the two-way effect [32]. Therefore, it can attract participants from the other side, and as the revenue sources are all from third-party content providers, they are all broad-based advertising revenue models; only Lyft, Didi Chuxing, Amazon e-commerce, and other cases provide paid premium services for free users.

Proposition 4. *If the free network service is content-based, and the content source is a third-party provider, it can charge fees from the generalized advertising, which are all paid by third-party content providers; it can also charge non-paying users as freemium.*

6.3. Multilateral Relationship

When an actor has more opportunities to exchange, the actor has more power; such opportunities to exchange or control interests are directly related to the actor's structure in the network, and this can change depending on the actor's position change [33]. Therefore, a free network service that forms a multilateral relationship can obtain more resources and represent more revenue sources. Unlike bilateral relations, multilateral relationships have

non-paying users, third-party content providers, and third-party payers, and all three sides can derive payers, thus, presenting multiple revenue sources.

6.3.1. Content-Based Free Network Service: Third Party Provided Content

While the main feature of information technology is disintermediation, via platform opens more new sources of supply, enables market aggregation, provides a centralized market, and creates re-intermediation [4]. Wikipedia, Baidu Search, Bing, Google Search, TikTok, Expedia.com, Taobao.com, YouTube, Uber, Grab, etc. are all platforms that connect multi-party participants so they can earn revenues from narrowly defined advertising services. Additionally, through platform expands the visibility of resources that brings benefit to more transaction commission as well as paid services from enterprises or non-paying users.

Proposition 5. *If a free network service is content-based and the content source is from a third-party, it can collect fees from the content provider and third-parties other than the content provider, which mainly refers to corporate services and generalized advertising; however, it can also charge non-paying users as freemium.*

6.3.2. Content-Based Network Services: Multiple Parties Provided Content

The intermediary mechanism of the business model of the network economy has created many emerging channels that have connected a large number of users, generated unprecedented market power and efficiency, and changed many business ecologies [4]. Waze, Amap, Baidu Maps, Google Maps provide the content of network services at their own huge expense, and while the source of their revenue only comes from generalized advertising, the more important purpose is to facilitate a new service ecosystem.

Proposition 6a. *If a free network service is content-based, and the main content source is the network service provider, it can charge a fee from the generalized advertising.*

The platform should not charge users for revenue but should subsidize platform participants and charge users for the value obtained from the ecosystem. Although users decide the network effect, they may not be able to represent the platform's currency value, thus, the platform's promotion of multilateral interaction must create considerable excess value, in order that the platform can profit. If the purpose of the persistent loss of Market A is to let Market A grow to drive Market B, the premise must be that the profit of Market B is greater than the losses of Market A, and both sides of the market must grow at the same rate [4]. For example, Amap, Baidu Maps, and Google Maps all provide derived services such as Google Maps APIs, Baidu Maps APIs, and AMap APIs to bring more value to multi-sided users with complementary functions; that is, to provide complementary services to users, which were originally free, to use the service to increase the income of advanced services, while allowing multiple markets to profit by connecting a variety of services in own ecosystem.

Proposition 6b. *If a free network service is content-based, and the main content source is a network service provider, most network services that can derive tool-based services can charge non-paying users as freemium.*

7. Conclusions

Whether the network economy can make profits is a very complex issue. Nowadays, Google and Facebook users have exceeded 1/7 of the global population [4]. In addition, it took YouTube only one year after launch to reach more than 100 million views per day: no TV channels in history have ever created such audience ratings [9]. The unique advantages of the network economy promote interaction between external users. Only after links are established with a certain number of users will users consider the network services valuable, which is a "chicken–egg" problem [4]. Network services are similar to

traditional public goods in that they are difficult to charge for. To charge users, barriers to user entry must be set up, which may reduce the number of users of the services and their network effects. They would lose their market value as a result. However, by simply providing free network services, providers may fail to make profits and be unable to sustain their operation.

The Internet, with its easy communication capabilities, allows the supply- and demand-sides to see each other more easily, which promotes more transactions. This finding can be verified from the cases of bilateral relationships. In the network economy, the payment method of buyers and sellers may change between direct and indirect payments, and the transaction may not only be an economic exchange. Instead, it may involve reputation or attention as a social exchange; therefore, when the number of free-riders increases, the number of providers or users who are willing to pay may also increase. This gives the free network services more resources to monetize the free-riders.

Although users are not charged, the accumulated user base can drive positive network effects. This creates a multi-sided value exchange opportunity for service providers to convert a large "headcount" into a lot of money. In addition, with the social bridge, initially free information has more chances to be circulated to people who are willing to pay for it. Google Maps, which is a multilateral relationship case, absorbs huge content production costs and lets free-riders enjoy unlimited access to map information. Although they can only earn general advertising revenue, the related Google Maps APIs connect users of other markets, thereby driving different users to repurchase the same information. This creates a business model where both sides can profit.

This study summarized 28 types of revenue model and seven conditional propositions that have provided different interpretations of the business strategies of network services. For start-up companies that intend to provide network services, this study provides reference paths for different revenue models. "Free" is not the only means of survival. Business operators can obtain paid revenue patterns by comparing the "participant relationship" patterns with the "content source" conditions, and then design or plan corresponding service items. By attracting users to enjoy services for free, they can realize the network effects of positive expansion and make profits.

In the future, the "general rules" of the revenue model from this study can be future testing or confirming in the follow-up to develop hypotheses. Individually focus on an overall revenue model inside a large ecosystem such as Facebook, Apple, Amazon, and Google or Baidu, Alibaba, and Tencent can also be incorporated into future research recommendations.

Appendix A

Table A1. Background information for 51 cases [24,34–42].

Free Network Service	Background			Number of Users *	Service (In This Study)
	Launched	Parent Company	Headquarters Location		
Search, AdTech & Services					
Google Search	1997	Alphabet/Google	United States	1billion MAU (2021)	Text search
Google Search APIs	–			–	Search engine
Baidu Search	2001	Baidu	China	500 million MAU (2020)	Text search
Bing	2009	Microsoft	United States	450 million MAU (2019)	Text search
Bing Search APIs	–			–	Search engine
Travel					
Booking.com	1996	Booking Holdings (since 2005)	Netherlands	20.1 million users (2018)	Accommodation reservation (online to offline, O2O)
Ctrip.com	1999	Trip.com Group Limited	China	69.846 million MAU (2017)	Accommodation reservation (online travel agency, OTA)
Airbnb	2008	Airbnb	United States	13 million users (2018)	Accommodation reservation (O2O)
Expedia.com	1996	Expedia	United States	18.8 million users (2018)	Accommodation reservation (OTA)
Transportation					
Uber	2009	Uber	United States	33.9 million users (2018)	e-Hailing
Lyft	2012	Lyft	United States	1 million DAU (2019)	e-Hailing (in California, U.S.)
Didi Chuxing	2012	Beijing Xiaoju Technology	China	550 million users (2018)	e-Hailing
Grab	2012	Grab	Singapore	86 million downloads via App (2018)	e-Hailing (in Southeast Asia)
Social Media					
Facebook	2004	Facebook	United States	2.89 billion MAU (2021)	Social networking service (blog)
Instagram	2010 (Burbn)	Facebook (since 2012)	United States	1 billion MAU (2021)	Social networking service (image and video)
TikTok	2016	ByteDance	China	500 million MAU (2018)	Social networking service (short videos)
Twitter	2006	Twitter	United States	336 million users (2018)	Social networking service (short message)
LinkedIn	2003	Microsoft (since 2016)	United States	560 million users (2018)	Social networking service (professionals)
App marketplace					
Google Play	2008	Alphabet/Google	United States	1 billion MAU (2017)	APP Store

Table A1. *Cont.*

Free Network Service	Background			Number of Users *	Service (In This Study)
	Launched	Parent Company	Headquarters Location		
App Store (iOS)	2008	Apple	United States	500 million WAU (2018)	APP Store
Microsoft Store	2012	Microsoft	United States	75 million active devices (2015)	APP Store
Facebook Game	2016	Facebook	United States	90 million MAU (2018)	Online game
GitHub	2008	Microsoft (2018)	United States	40 million users (2020)	Software hosting
Social/Messaging					
WhatsApp	2009	Facebook (since 2014)	United States	1.3 billion MAU (2017)	Instant messaging
Facebook Messenger	2011	Facebook	United States	1.2 billion MAU (2017)	Instant messaging
WeChat (Communication)	2011	Tencent	China	1 billion MAU (2018)	Instant messaging
Internet Software & Services					
iOS	2007	Apple	United States	1.3 billion monthly active devices (2018)	Mobile operating system
Android-EU Android-NonEU	2007	Alphabet/Google	United States	2 billion MAU (2017)	Mobile operating system
Google Maps	2005	Alphabet/Google	United States	1 billion MAU (2017)	GPS navigation
Google Maps APIs	–			1.79 million users (2021)	Embedded web mapping
Waze	2006	Alphabet/Google (since 2013)	Israel	130 million MAU (2020)	GPS navigation
Amap	2004	Alibaba Group (since 2018)	China	140 million MAU (2018)	GPS navigation
AMap APIs	–			–	Embedded web mapping
Baidu Maps	2005	Baidu	China	85.64 million MAU (2018)	GPS navigation
Baidu Maps APIs	–			1.55 million users (2019)	Embedded web mapping
Gmail	2004	Alphabet/Google	United States	1.5 billion users (2018)	Webmail
Yahoo Mail	1997 (Yahoo)	Oath (2016)	United States	228 million MAU (2018)	Webmail
Outlook	2012	Microsoft	United States	400 million users (2018)	Webmail
Dropbox	2008	Dropbox	United States	700 million users (2021)	File hosting
Google Drive	2012	Alphabet/Google	United States	2 billion users (2020)	File hosting
Microsoft OneDrive	2007	Microsoft	United States	18 million users (2015)	File hosting

Table A1. *Cont.*

Free Network Service	Background			Number of Users *	Service (In This Study)
	Launched	Parent Company	Headquarters Location		
eCommerce/Marketplaces					
Taobao.com	2003	Alibaba Group	China	229 million DAU (2019)	E-commerce (C2C)
Amazon e-commerce	1994	Amazon	United States	310 million MAU (2018)	E-commerce
Groupon	2008	Groupon	United States	24.9 million users (2021)	Online deal marketplace
Media					
YouTube	2005	Alphabet/Google (2006)	United States	1.9 billion MAU (2020)	Video hosting
Wikipedia	2001	Wikipedia Foundation	United States	1.8 billion unique-device visitors monthly (2021)	Online encyclopedia
Vimeo	2004	Vimeo	United States	170 million MAU (2018)	Video hosting
Fintech					
Alipay	2013	Ant Financial/Alibaba Group	China	676 million MAU (2021)	Online payment
WeChat Pay	2014	Tencent	China	1.25 billion MAU (2021)	Online payment
PayPal	1998	PayPal (2002-eBay)	United States	361 million users (2021)	Online payment

* The abbreviation of measurement ways: MAU (monthly active users), WAU (weekly active users), DAU (daily active users).

Table A2. QCA truth table: causal condition variables corresponding to result variables.

Free Network Service	Causal Condition Variables													Result
	C = P	U = P = C	UC	CC	SC	UP+	CP	CP+	2P	PP	AdP	OP	RS	P
Android-NonEU, iOS	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Bing Search APIs, Google Maps APIs, Google Search APIs, Baidu Maps APIs, AMap APIs	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Android-EU	0	0	0	0	0	1	0	0	0	0	0	1	1	1
PayPal, Alipay, WeChat Pay	0	0	0	0	0	1	0	0	1	0	0	1	0	1
WhatsApp	0	0	1	0	0	0	0	0	0	1	0	0	0	1
Android-NonEU, iOS	0	0	0	0	0	0	0	0	0	0	0	1	0	1

Table A2. *Cont.*

Free Network Service	Causal Condition Variables													Result
	C = P	U = P = C	UC	CC	SC	UP+	CP	CP+	2P	PP	AdP	OP	RS	P
Facebook Messenger, Instagram	0	0	1	0	0	0	0	0	0	0	1	0	0	1
Twitter	0	0	1	0	0	0	0	0	0	1	1	0	0	1
Dropbox, Google Drive, Microsoft OneDrive	0	1	1	0	0	1	0	0	0	1	0	0	0	1
Facebook	0	1	1	0	0	1	0	0	0	0	1	0	0	1
Gmail, LinkedIn, Outlook, Yahoo! Mail, WeChat	0	1	1	0	0	1	0	0	0	1	1	0	0	1
Wikipedia	0	0	0	1	0	0	0	0	0	0	0	1	0	1
Bing, Google Search, Baidu Search	0	0	0	1	0	0	0	0	0	0	1	0	0	1
TikTok	0	0	0	1	0	0	0	0	0	1	1	0	0	1
Airbnb, Facebook Games, Google Play	1	0	0	1	0	0	0	0	1	0	0	0	0	1
GitHub	1	0	0	1	0	0	0	1	0	0	0	0	0	1
Booking.com, Vimeo	1	0	0	1	0	0	0	1	1	0	0	0	0	1
Groupon, Microsoft Store, Ctrip	1	0	0	1	0	0	1	0	1	0	0	0	0	1
App Store	1	0	0	1	0	0	1	1	1	0	0	0	0	1
Expedia.com	1	0	0	1	0	0	0	0	1	0	1	0	0	1
Taobao.com	1	0	0	1	0	0	0	1	0	0	1	0	0	1
YouTube	0	0	0	1	0	1	0	0	0	0	1	0	1	1
Lyft	1	0	0	1	0	1	0	0	1	0	0	0	0	1
Didi Chuxing	1	0	0	1	0	1	0	0	1	0	0	0	1	1
Uber	1	0	0	1	0	1	0	0	1	1	0	0	0	1
Amazon e-commerce	1	0	0	1	0	1	1	1	1	0	0	0	0	1
Grab	1	0	0	1	0	1	0	0	1	0	1	0	0	1
Waze, Baidu Maps, AMap	0	0	1	1	1	0	0	0	0	0	1	0	0	1
Google Maps	1	0	1	1	1	0	0	1	0	0	1	0	0	1

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