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How Strong Are the Effects of Technological Disruption? Smartphones' Impacts on Internet and Cable TV Services Consumption

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Abstract

Emerging technologies have created disruptions in organizational, business process and industry contexts. They act as shocks to a system. We focus on a retail telecom service provider's offerings of different bundles, including mobile phones, Internet and cable TV services. We conduct empirical regularities analysis for Singapore, which was affected by the emergence of smartphones in 2009. We assess the impacts on the service bundle choices of a provider's customers. We analyze customer switching among service bundles involving three services. We compute switching probabilities for each of the service levels offered, as well as between bundles. We use Markov chain transition analysis to describe the patterns. We find evidence for: smartphone effects on the contents of service demand; substitution between different kinds of Internet services; and migration of video consumption from cable TV to mobile services. Our results provide a basis for improved management of retail services bundling and pricing strategies.

Keywords: Bundling, consumer choice, Markov chain transitions, switching, telecoms, service subscriptions.

More than a quarter of the world's TV households will subscribe to triple-play services by 2016. The … penetration doesn't sound too impressive until you realize that this represents 387 million homes, up from 96 million at end-2010

Triple-play forecast, from Research and Markets [16]

1. Introduction

During the decade leading up to 2010 and beyond, we have seen a dramatic rise in individual and organizational interest in mobile systems and technologies, digital entertainment via the Internet, and enhanced cable TV services, including pay-per-view programming. The interest has been so strong that telecoms services providers have also seen an increasing portion of their revenues coming from the offering of *triple-play telecom services*, which involve the offering of three different kinds of telecom services [17]. Two of the services require a lot of bandwidth: *cable TV* and *high-speed Internet*. The third is less bandwidth-intensive: *voice and telephone services*. More recently, the term *quadruple-play services* has entered the lexicon of the retail telecom business, to mean the *inclusion and integration of mobility* for the Internet, TV and phone support on the current generation of high-powered mobile phones and tablet PCs.

As a disruptive emerging technology, smartphones have recently been shaking up the technological capabilities behind retail telecom services. This is true for consumer demand for mobile telephony especially, as well as related demand for mobile Internet, TV, and movie services. A *smart-phone* is a "cellular telephone with built-in applications and Internet access. Smartphones provide digital voice service as well as text messaging, e-mail, Web browsing, still and video cameras, MP3 player[s], video viewing and … video calling. In addition to their built-in functions, smartphones can run myriad applications, turning the once single-minded cellphone into a mobile computer" [14].

Research and Markets, a global digital economy consultancy, has reported that "triple-play revenues will reach US$170 billion by 2016, nearly US$100 billion more than the 2010 total. The U.S. will supply US$39 billion of the additional revenues, with Japan up by US$9 billion and China increasing by US$8 billion" [16]. In other words, technological innovations with mobile telephony and the Internet are coming together to create a new technological revolution that will be nothing short of extraordinary for traditional telecom services providers. In addition, new firms will figure out how to harness the power of the different telecom services – and the digital convergence that will occur beyond it, while others provide the digital devices to support the transformation (e.g., Apple's iPhone and iPad, Samsung's Galaxy phones, and so on).

Growth in single-service plans has shown a decline during the past five years since 2007 in Singapore,

the home base for the present research. In contrast, multi-service subscriptions have grown by more than 7%, during a period of total service growth no more than 5% overall. From these numbers, it is clear that, for Singapore at least, smartphone-based telecommunications services are now powering the everyday lives of a large percentage of the population of five million.

The *bundling* of multiple services is a marketing strategy that is intended to increase revenue for the service provider by encouraging consumers to purchase multiple services at a relative discount. It offers the added benefit of creating relationship stickiness with the customer, who will be forced to endure relatively higher transaction costs, if she wishes to pull out of any of the components of the service bundle. Such services in retail telecoms are not a by-product of "true" integration. Instead, the operators create service bundle on the basis of separate business sectors, so the cost of customer servicing is not easily determined, and profitability is beyond most cost accountants' grasp.

Prices do matter, but a greater impact was created by the entry of smartphones in 2009 in Singapore. Customers – existing and new – were willing to pay a lot for new smart devices. Smartphones acted as shock to the telecom services system. Consumers reacted in a positive way by switching to new smartphone-centric services bundles. This improved their telecom services experience. Our corporate sponsor was delighted about this since, prior to that time, price was the dominant concern related to feature phone services.

In this research, we will investigate the impact of smartphones on retail telecom services subscriptions, including broadband Internet, mobile phones and cable TV. Since the research is still in an early stage, and is intended to capture the empirical regularities that occurred around the emergence of smartphones in the marketplace, we will not model such issues as the marginal value that different services offer in the mix. Nor will we investigate the effects of different prices for each service or bundle discounts.

Instead, to explore the impacts of technological disruption on telecom services bundling, we will answer the following research questions:

- What evidence is there that consumers who used the provider's bundled services made decisions to switch to new bundles with smartphone services
- Do we observe differential substitution between different kinds of retail telecoms services?
- Did the introduction of smartphones result in bundle downgrade and upgrade effects occur for Internet and cable TV services?

To answer these research questions, the remainder of the article is organized as follows. Section 2 provides some theoretical perspectives to guide our exploration of the bundling issues. Section 3 offers information on the research site and the large data set that we will analyze. For this, we will use a Markov chain transition model, as described in Section 4. Sections 5 and 6 present our results on service bundle switching, and an extension for cross-platform effects. A discussion and conclusions follow.

2. Literature

We offer background on disruptive technologies, and telecom services bundling, switching and churn.

2.1. Disruptive technologies

Disruptive technologies introduce a different level of performance or change the nature of consumer demand, by introducing new functionality and performance. They have the potential to change business processes in organizations and markets. They also cause consumers to shift their purchases to products based on the new technology [2, 5]. *Technological disruption* occurs when a new technology displaces the mainstream technology in the market [7].

Technological innovation in the telecom industry has been especially disruptive. New Internet applications require high bandwidth and stable networks [9]. The recent proliferation of smartphones and tablet PCs has dramatically boosted demand for mobile Internet use and the related services market [20]. Smartphones are changing the way people use their phones, with Internet and email, as a camera, map-routing and direction-finding GPS device, and as new payment channel. They improve consumers' experience with phones [24].

This disruption has created much higher demand for mobile and entertainment-related applications that need more bandwidth and less response latency than ever before. A delay of a couple of seconds with email is never a problem, but for real-time streaming music and movies, even a tiny delay renders them unusable. A couple of seconds delay can have negative effects for the service provider, causing service churn [27].

2.2. Retail telecom services

With the ongoing technological changes in telecom services, new approaches beyond the traditional wired services are developing rapidly. We have seen increasing convergence and competition involving telephony, cable TV and Internet services, as well as their combination with mobile services [12]. When consumers decide whether to adopt broadband Internet, they also consider other services that are complementary to it. For example, the Internet provides consumers with information about TV programs, and the Internet

has created ways to substitute for traditional phone services, with email and chat tools on the Internet [11].

2.3. Bundling

Bundling occurs as: (1) *price bundling*, involving the sale of two or more separate products as a package at a discount; (2) *product bundling*, which includes the sale of two or more separate products at any price; (3) *pure bundling*, in which a firm sells only the bundle, and not the individual items; and (4) *mixed bundling*, which involves selling the bundle and all of the products separately [21]. Bundling is a customary feature of contemporary product markets, even markets in which consumers exhibit considerable discretion in choice [8]. Customers prefer bundled products based on ease of use and convenience [13].

Bundled services offer different benefits to consumers. For example, providers offer price discounts when consumers subscribe to more than one service. The providers benefit because bundle customers tend to stay longer [25]. Other research [6] has shown that retail telecom service discounts alone lead to increased customer turnover, which is undesirable. But discounted bundles including long-distance services have proven to be an effective deterrent of churn, in a competitive environment where companies offer price promotions to steal their competitors' customers [11].

An early bundling study showed how a monopolist could extra additional customer surplus [19]. We know too that it is better to sell individual products and a bundle, not just the bundle alone [1]. Bundling enables a firm to leverage its monopoly power in one product market to deter entry of competitors in a second product market [23, 26]. New competitive strategies, such as large-scale bundling [3], emerged in the early days of e-commerce. More recently, telephony companies and cable TV operators have bundled entertainment goods with mobile, Internet, and TV services [15].

2.4. Customer turnover and account churn

Customer turnover – or *account churn* – has been a key concern of marketing researchers and telecom industry managers. Their interest is to understand how service quality, different business developments, and events in the marketplace cause customers to switch service providers [10]. Pricing, failure of core services, ineffective responses to service failures, competition, and other inconveniences have been critical. Others have suggested that customers churn due to changes in their economic circumstances [4]. Economists have suggested that price discrimination and bundling can be leveraged to charge customers different prices based on their past behavior [22]. Also, information on past customer behaviors can be used to reduce churn [18].

3. Research Setting and Data

3.1. Research Setting

Our research setting involves a telecom operator that provides three typical services in bundles: mobile phone, Internet and cable TV services. There exist several types of service subscription bundles. See Table 1.

Table 1. Service subscription bundle types

Service Bundles	Bundle Composition
Single	Mobile alone; Internet; Cable TV
Double	(Mobile + Internet); (Mobile + Cable TV); (Internet + Cable TV)
Triple	Mobile + Internet + Cable TV

Mobile services emphasize data upload and download capacity, and feature phones and smartphones. The firm launched new mobile voice and data services that focused on high-functionality support for smartphone users in December 2009. With access to an advanced mobile network, smartphone users were able to enjoy diverse functionality, such as Facebook and Twitter, free access to a range of quality TV programs, instant messaging, and so on.

3.2. Data

Our data were obtained from multiple data sources and interviews at the research site over a period of several months during 2012 under the conditions of anonymous customers and non-disclosure of their details. They cover the period from June 1, 2007 to May 31, 2012, and describe customer switching among different service bundles, where our interest is centered. Smartphones were introduced in December 2009, around the middle of this period. The data cover a sample of hundreds of thousands of customers and their subscriptions for mobile phone, Internet and cable TV services. They include records collected for any subscription-related events. They represent the start and end dates for new subscriptions, contract renewals, and contract terminations. New subscriptions typically involve two-year contracts, a standard in the industry.

We cleaned the raw data set by excluding duplicate and inconsistent data. For the analysis, we identified tens of thousands of customers who subscribed to bundles with the three services offered by the telecom service provider at various times. We use this group of subscribers to examine service subscription transition patterns following the market entry of smartphones.

The service bundles are organized based on the three different service areas. Within each of the service

areas, there are multiple plan options that are available to customers. We will focus on a number of popular plans, as shown in Table 2.

Table 2. Service plans used

Services Plans (#)	Plans Evaluated
Mobile (8)	4 feature phone plans: F1, F2, F3, F4 4 smartphone plans: S1, S2, S3, S4
Internet (7)	FB1, FB2, FB2(M), FB3, FB3(M), FB4, FB4(M)
Cable TV (5)	TV1, TV2, TV3, TV4, TV5

To represent the mobile phone service included in the available plans, we selected four *feature phone plans* (F) and their matching *smartphone plans* (S). The index numbers (1, 2, 3, 4) reflect the plans' available of free voice minutes in increasing order. There are seven fixed broadband (FB) services that offer Internet connectivity in the home. The index for these (1, 2, 3, 4) reflects the services in the order of increasing download speed. Some mobile plans, indicated by (M), offer a USB-type device (e.g., a dongle) for mobile Internet connectivity outside the home. This permits the customer to use a laptop outdoors, for example, and is in addition to the capabilities of a typical home Internet subscription. The cable TV service (TV) includes five plans reflecting different numbers of channel bundles that customers can select among.

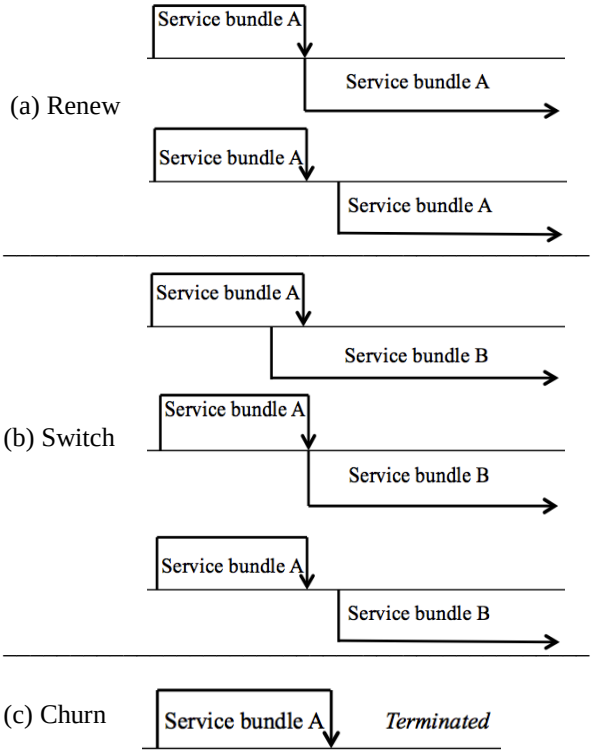
The data contain information about consumer bundle subscriptions, and when those changed. The details of the data include: service bundle names and identifiers; customer service contract start, termination and end dates; and the current status for contracts that are right-censored. Based on Table 2, including the possibility of deciding to discontinue any of the three services at some time.

4. Markov Chain Transition Model

Our goal is to characterize and analyze the behavior of customers who switched one or more times from one service or bundle of services to another during the study period, for the Internet, cable TV and mobile services. We use a Markov chain transition matrix to model the switching patterns from any of the 280 different bundles with three services as *states*. The Markov process represents a customer who starts with, say, a service bundle for mobile, Internet and cable TV services representing a state, and then may switch to another service bundle representing a different state. This occurs with some probability that can be estimated.

The transition probability for each service combination is measured based on three different events: a new contract for a new subscription; a contract renewal for the same subscription; and a contract termination. This leads to three cases for each service bundle type, as shown in Figure 1:

Figure 1. Service bundle transitions



- *The customer renews the service bundle*. The customer can do this right after her contract ends, or somewhat later. If the customer renews, this is also the equivalent of a decision to keep the service bundle. (See Figure 1a.)
- *The customer switches to a different service bundle*. The customer can do this before or when the currently-chosen service contract expires, or with some lag after expiry. (See Figure 1b.)
- *The customer no longer uses the company's services, resulting in churn*. This can happen in a contract period or at its end. (See Figure 1c.)

5. Baseline Bundle Switching Results

We next present our empirical regularities results for bundle switching that occurred in the aftermath of the December 2009 rollout of smartphone services by the telecom service provider. We use the Markov chain transition matrix approach to identify switching probabilities for the different service bundles. For an effective illustration of the matrices, our analysis utilizes *state transition network diagrams*, in which the nodes represent the states and the arcs indicate the transitions. Network diagrams are appropriate vehicles with which to present the results of our research, and illustrate the

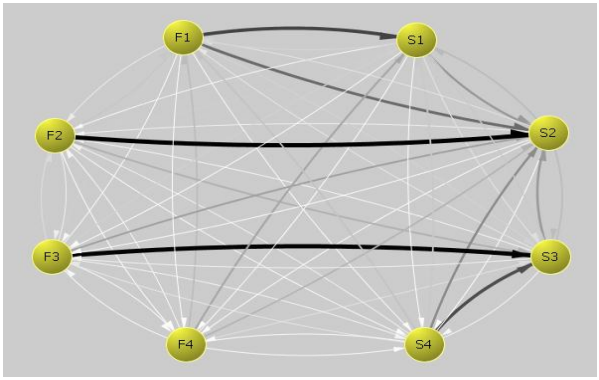
answers to our research questions. They also help us to extract relevant business insights from the overall service migration patterns present in the data. For simplicity of presentation, the actual probability values are not included in the diagrams; instead, we include textual legends below the diagram to indicate the probability ranges that are included. Generally speaking, the darker and thicker the arcs are, the higher transition probabilities they represent.

5.1. Single-service switching analysis

To show the switching patterns for individual services, we applied our approach for each of the three services separately first. The results establish some empirical regularities of the data, based on the observations during the two and a half years period following the introduction of smartphone services in December 2009. The provider's services are grouped into two categories: *feature phone plans* and *smartphone plans*. Figure 2 shows the state transitions that characterize customer actions for the eight service plans during the observation period.

When smartphone services (S) were launched, there was significant switching behavior that occurred from the different feature phone plans (F1-F4) to other smartphone plans (S1-S4). The transitions were more likely to occur between services that had the same number of voice minutes, such as F1 to S1, F2 to S2, and so on. The figure shows that the most popular plan was S2: it even attracted other smartphone plan users. See the gray arcs from S1, S3 and S4 to S2. We that note that there were a small number of smartphone plan adopters who returned to feature phone plans.

Figure 2. Switching probabilities, mobile services

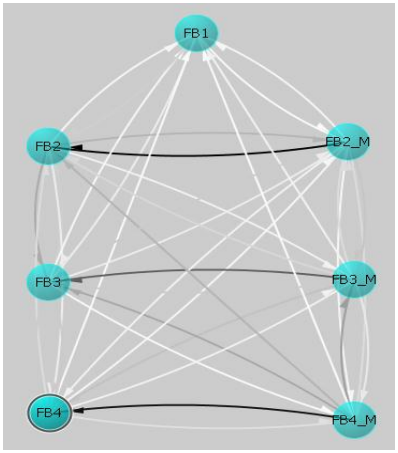


Legend. The figure includes arcs of different tones that represent a range of transition probabilities. (1) White: < 1%; (2) gray: 1% to 5%; (3) black: > 5%. We denote different service plans with F for feature phones, and S for smartphones. The index numbers, 1 to 4, specify increasing voice minutes, with 4 at the high-end number of minutes. The full complexity of the transition paths is not presented in the figure (e.g., we omitted loops to indicate cases where no switches are observed for each state).

We also observed other subscription changes between different smartphone services. For example, some observed switching behavior involved actions to downgrade the customers' services. This includes downgrades of smartphone services; apparently the services did not satisfy customer expectations. Other service upgrades appear to have been occurring in the same timeframe though. Another interesting observation involves customer choices of feature phone services. Though the service was not for smartphone users, there still was some likelihood that customers would switch to it, despite other data and feature phone services that were available.

We also computed the transition probabilities between the plans involving fixed broadband home Internet services. There are two main segments here: Internet services, and Internet services bundled with mobile Internet connectivity. Figure 3 depicts the transition probabilities among these Internet service plans.

Figure 3. Switching probabilities, Internet services



Legend. The figure includes arcs of different tones that each represents a range of transition probabilities: (1) white is < 1%: (2) gray is 1% to 3%: (3) black is > 3%. We denote different fixed broadband service plans with (FB), and (M), which means add-on mobile data services. The index numbers, such as FB1 to FB4, specify increasing download speeds. The full complexity of the transition paths is not included in the figure.

Even though the values of the probabilities are slightly smaller than those for the mobile service transitions, a large number of transitions are observed from Internet services with mobility plans to simple Internet services. The arcs from FB2_M to FB2, FB3_M to FB3, and FB4_M to FB4 illustrate this. We also can see a larger number of slightly thicker downgrade arcs than upgrade arcs. These include the arcs from FB4_M to FB2 and FB3 versus the arcs that go in the opposite directions. The switching patterns that we observe may have arisen due to the launch of smartphone services –

an issue that we will discuss later. Summary statistics for this group of services show that the average probability of no service subscription changes was higher for Internet services bundled with mobile broadband connectivity than for ordinary Internet services without such add-on services.

We further assessed the switching probabilities between the various choices within the cable TV services category. Although we have not included another figure to represent the details of this, suffice to say that there is evidence of downgrades in cable TV services also. We speculate that there might be substitution occurring between the services that customers were able to consume via their smartphones relative to traditional cable TV services available in their homes.

5.2. Triple-service switching analysis

We also investigated switching behavior between different combinations of the three main services: mobile phone, Internet and cable TV services. We can describe each triple-service combination, representing a Markov chain state, with a three-dimensional vector: (mobile phone plan, Internet plan, cable TV plan). The number of possible combinations is 280 (= 8 × 7 × 5). This makes the number of possible transitions to be 280 × 280.

Since it would be visually complicated to render and view the transitions between the hundreds of three-dimensional vectors, we will depict just a part of the entire state transition network diagram, while holding fixed one of the three services in given service plan. See the switching patterns shown in Figure 4.

Figure 4. Switching patterns: triple-service bundles

(a) Between the states: (mobile, Internet, TV1)

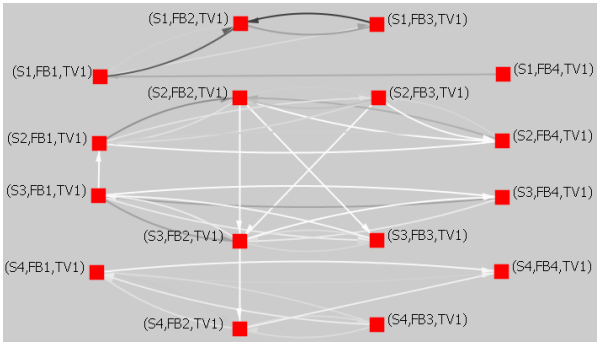
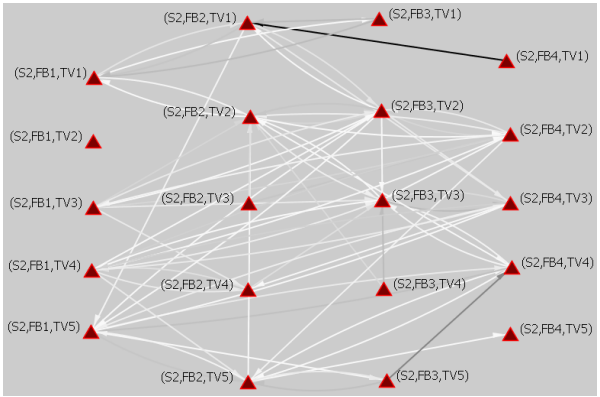


Figure 4a represents service transition probabilities that we have obtained for the smartphone and Internet plans with the cable TV plan fixed to TV1. Figure 4b shows the transitions between the states with different Internet and cable TV plans, while the mobile phone plan is fixed to S2. The states are arrayed in the increasing order of service grade from left to right and from top to bottom. Note that the horizontal and vertical arcs indicate changes in single services, while the diagonal arcs show changes in both services.

These figures contribute to our general and specific understanding of the structure of the transitions across the three service areas. In Figure 4a, the majority of transitions occur in the horizontal rather than vertical direction. This may indicate that customers will be less likely to change their mobile phone service plans compared to their Internet service plans. This tendency increases if the smartphone plan is of a lower grade, as we observe from the thicker arcs in the upper part of the figure. This may imply that customers who adopted services of lower value will be more likely to optimize their service bundles. Vertical transitions are more likely to be observed for the FB2 Internet plan users, who show some propensity to upgrade their smartphone plans. In the group of similar fixed broadband services, the FB2 plan acts as terminal node in the network; there are many arcs that point to it. This transition network diagram only applies to customers who chose the cable TV1 service. For other customers who choose more TV channels beyond the basic cable TV1 service, it is also possible for us to conduct other similar analyses.

(b) Between the states: (S2, Internet, cable TV)



Legend. The figure includes arcs of different tones that each represents a range of transition probabilities: (1) White: < 1%; (2) gray: 1% to 5%; (3) black: > 5%. In Figure 4a, the cable TV plan is fixed to TV1; in Figure 4b, the mobile phone plan is fixed to S2.

Figure 4b depicts the state transitions for Internet and cable TV services for customers who chose smartphone plan S2. Overall, the transition probabilities appear to be very low, except for a few cases, such as the fixed broadband Internet downgrade from FB4 to FB2, when the customer is subscribed to cable TV1 and smartphone service S2. Unlike Figure 4a, which covers changes between mobile and Internet services, in Figure 4b, we observe more diagonal arcs, which indicate that customers are more likely to subscribe to and change their fixed broadband Internet and cable TV services. This also indicates that Internet and cable

TV services are more likely to be tied to household-level preferences, while mobile phone services are more likely to be tied to individual preferences. Interestingly, the many diagonal arcs indicate that, when service transitions are seen to occur, customers tend to upgrade or downgrade two services together, at the same time. In addition, most of the upgrades and downgrades in cable TV services that were observed occurred in the mid-range fixed broadband Internet services FB2 and FB3.

6. Extension: Cross-Platform Effects

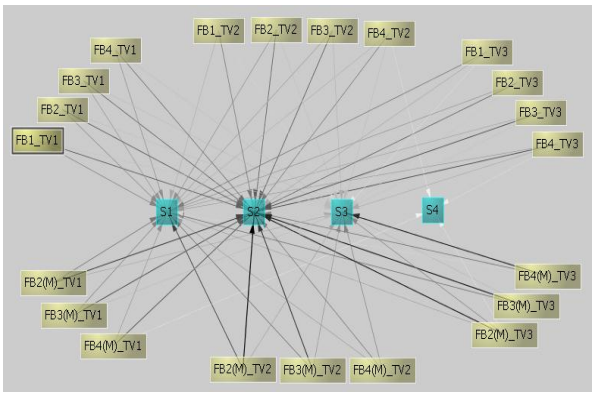
Our empirical exploration also makes it appropriate to understand the cross-platform effects on the probabilities of the observation of switching between different services. In this section, we present results from somewhat more constrained analyses to extract relevant knowledge and insights related to the launch of smartphones in the Singapore market.

6.1. New smartphone subscription plans

A key interest in this research is to investigate how the launch of smartphones may have influenced telecom services customers. More specifically, we are interested to assess the nature of customer service transitions from feature phone to smartphone plans relative to their subscriptions in fixed broadband Internet and cable TV services. Figure 5 is the associated service transition diagram that ties in with this purpose. We only considered customers who were once feature phone plan users, and, thereafter, adopted smartphone plans. The four states in the middle of the figure – S1, S2, S3 and S4 – represent the four smartphone plans. The surrounding states represent other Internet and cable TV plans, when customers chose to transition from feature phone to smartphone plans.

The results suggest that higher switching probabilities for bundle composites including fixed broadband Internet paired with additional mobile services (e.g., FB2(M)) to smartphone services (in the lower part of the figure), compared to non-mobile service users (in the upper part of the diagram). In terms of cable TV subscriptions, customers with many channel bundles seem to exhibit a higher propensity to adopt smartphones. This may be due to socioeconomic factors that the Markov chain analysis approach cannot consider. This figure offers preliminary evidence that is suggestive of the effects of the introduction of smartphone services on changes in Internet broadband service subscriptions. Additionally, the leading bundle that includes the most demanded smartphone services (S2) suggests that other factors (e.g., discounts, supplementary services) had an impact on customer choices about their service bundle subscriptions.

Figure 5. Switching patterns: smartphones services

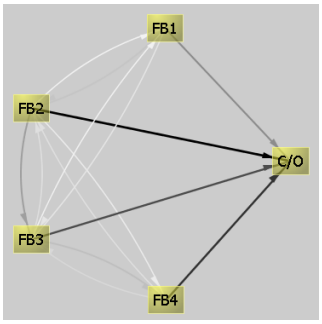


Legend. The figure includes arcs of different tones that each represents a range of transition probabilities. (1) White: < 3%: (2) thin gray: 8% to 15%: (3) thick gray: 15% to 22%; and black: > 22%. It also includes codes for fixed broadband (FB), mobile data download (M) and cable TV services (TV); and for smartphone services (S). The index numbers, such as S1 or S4, specify increasing voice minutes, with '4' representing the high-end number of minutes for smartphones. The full complexity of the transition paths is not shown in the figure.

6.2. Substitution Involving Smartphones

Smartphones have capabilities to provide broadband services in the fixed broadband Internet and mobile Internet environments. To identify evidence of a substitution effect away from fixed broadband Internet services after the introduction of smartphones, we focused on new smartphone plans adopters. We did this to see if could observe the extent to which they changed their Internet service plans to smartphone plans. See Figure 6.

Figure 6. Smartphone effects on fixed broadband



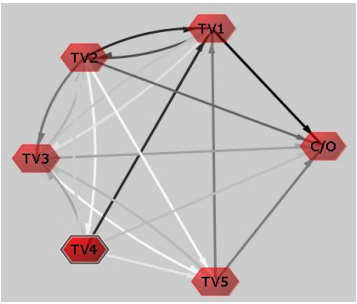
Legend. The transition probabilities are as follows. (1) White: < 1%; (2) gray: 1% to 3%; (3) black: > 3%. The index numbers, such as FB1 or FB4, specify increasing voice minutes, with '4' representing the high-end number of minutes for mobile phones. FB means fixed broadband. C/O stands for churn.

The figure shows the results of fixed broadband Internet service plan changes conditioned on the transition from feature phone services to smartphone services. The results suggest that there is some likelihood that demand for Internet services is diminished due to customer adoption of new smartphone services. The latter services are able to provide Internet connectivity, and substitute for the existing home Internet servces. The results represent the increasing penetration of mobile services as a basis for people to gain access to the Internet.

6.3. Changes in cable TV subscriptions

Smartphone users and those with wi-fi-based Internet connectivity via their PCs are able to access a range of TV content, albeit with somewhat slower connectivity than through fixed broadband Internet services. The accessibility that mobile devices creates with the Internet makes it possible for consumers to upgrade or downgrade their cable TV services and still view their favorite shows and movies via other mobile and Internet services.

Figure 7. Smartphone effects on cable TV



Legend. Transition probabilities are represented by the arcs. (1) White: < 0.5%; (2) gray: 0.5% to 2%; (3) black: > 2%. The index numbers, such as TV1 or TV4, specify increasing the number of channels, with '4' representing the high-end number of channels. TV means cable TV. C/O stands for churn.

Figure 7 relates to the change of the cable TV service sbuscription in which the transition from feature phone service to smartphone services occurred. The results show that switching plainly occurred from TV 5 and TV 4 services to TV 1 which means downgraded cable TV services. The potentially strong effects of the rollout of smartphone services on cable TV subscription downgrades is apparent.

7. Discussion

This research has investigated switching patterns between different retail telecom service bundles. We assessed the empirical regularities of transition probabilities for different services to understand the extent to which the introduction of smartphones has affected the service choices that customers make. Our assessments are based on the application of Markov chain transition matrix analysis. More specifically, evaluated the potential for smartphones to impact broadband Internet and cable TV subscription changes.

Our empirical results show that the impact of smartphones on bundle switching has been strong. Smartphones have acted like a shock-creating disruptive technology in the retail telecom services system. This is because new mobile services designed for smartphone users seem to have influenced consumers to shift the mix of services they are using to a new mix involving mobile services. There was less evidence to suggest that there is substitution between mobile services involving data uploads and downloads, and Internet services in the home though. We drew a similar conclusion related to the limited impact of Internet services available in the home and via mobile phones on changes in customer's cable TV subscriptions.

As it has become increasingly convenient for customers to access digital content through smartphones and tablet PCs, the result is that they also have become more and more interested to consume entertainment goods through them. Our analysis has yielded practical evidence about the impact of a disruptive technology on the switching patterns among three different retail telecom services. Our method helped to identify the primary changes in customer subscriptions. We also assessed the extent to which data services to support mobility have been important.

Our study demonstrates the kinds of issues that we can look into with a data set of such a large scale. Although we did not undertake causal modeling at this stage of the present project work, nevertheless we expect that customers who consume higher-priced service subscriptions will keep a watchful eye for the availability of less expensive options. They will be more likely to churn or find less expensive bundles. In addition, managers may be interested to focus more on influencing the trajectories of customers who are likely to move from lower to high revenue-generating service subscriptions.

We expect our future research to take a number of different directions. First, we will explore the development of an explanatory event history model that will be useful for developing explanatory and predictive likelihoods for different kinds of bundle switching activities, based on observable heterogeneity among customers. Second, we will also explore the assessment of the marginal effects of each service's price as a further basis for explaining and predicting switching, in additional to the effects of smartphones as a disruptive technology. Third, it may also be useful to evaluate the

effect of the attractiveness of the discounts of the various bundles that are possible service switching outcomes for customers who already are consuming a given service bundle. Finally, we hope to look into the range of actions that the provider can take to influence how its customers migrate from one service bundle to another to achieve maximum profit. This may require, for example, the use of customer-specific pricing and bundle content offers.

8. Anonymization of data

This research was conducted with the participation of an organizational sponsor under a binding non-disclosure agreement. Permission to publish this article was granted based on consultation with the sponsor in September 2012. The data used to create the results are anonymized. Identities of individual households and account holders cannot be traced back through the behavioural data we have discussed and analyzed.

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